Evaluation Plans

Deliverable 6.2

Updated versions – February 2022

Summary of changes

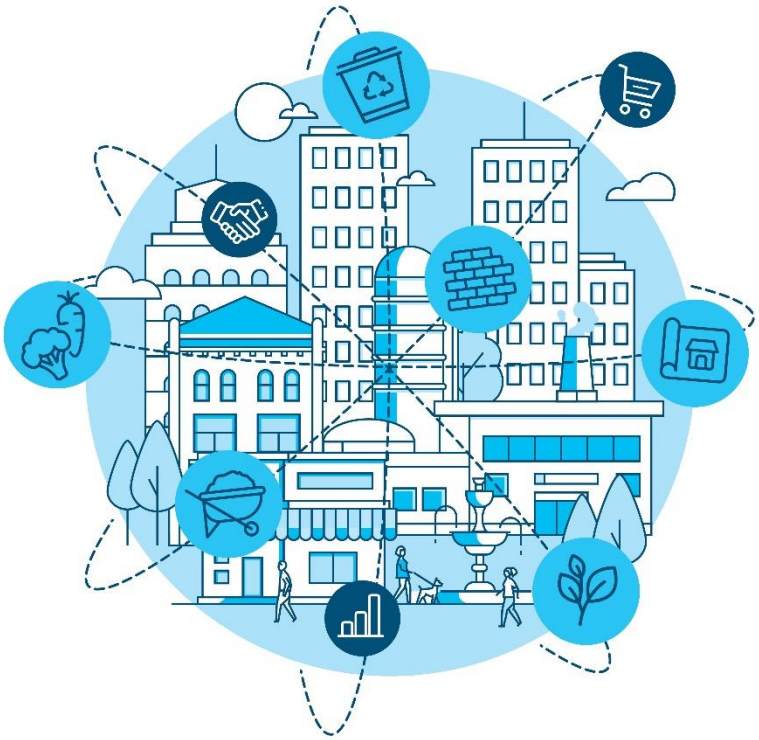
The primary aim of this revision of the CityLoops evaluation plans has been to clarify and refine the expected outcomes of the demonstration actions and strengthen the connection between the expected outcomes and the indicators chosen to evaluate the actions.

In the section "**Indicators to be monitored**", the list of expected outcomes has been revised. To match the revised outcomes, new indicators have been added while others have been removed. The section "**Plan for monitoring**" has been updated to reflect the revised indicator selection. Other parts of the evaluation plans are substantially unchanged. Some formatting changes and corrections of minor errors have been made throughout the deliverable.

Evaluation Plan: Biowaste sector, Apeldoorn

Deliverable 6.2

Gemeente Apeldoorn / Municipality of Apeldoorn



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Deliverable lead	Municipality of Apeldoorn (Gemeente 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.

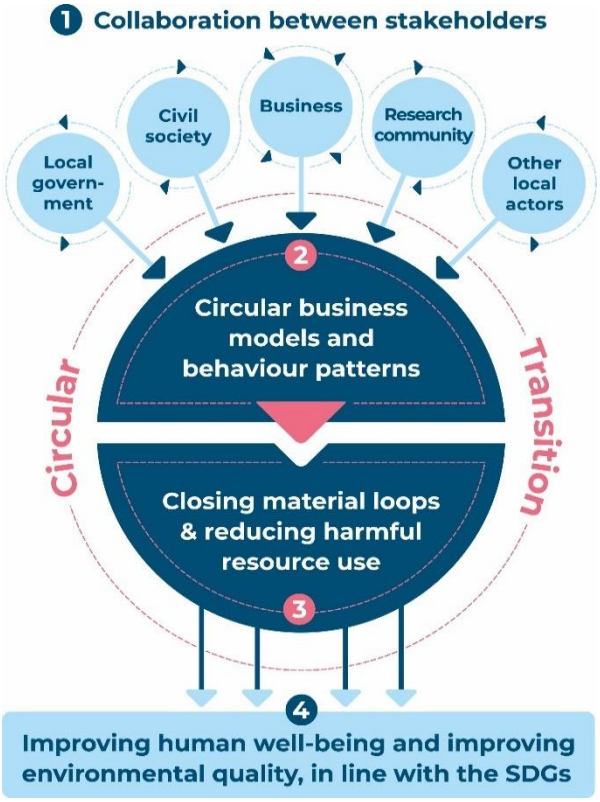


Figure 1. The four Vision Elements of the Circular City vision and causal links for CE transition.

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).

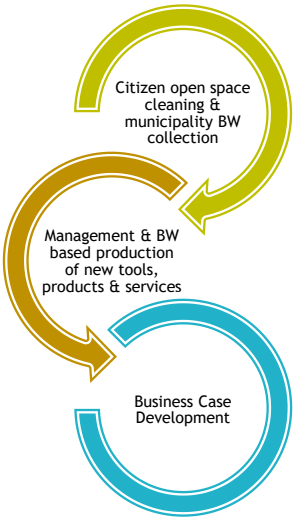


Diagram 1. DAs and flow of project

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.

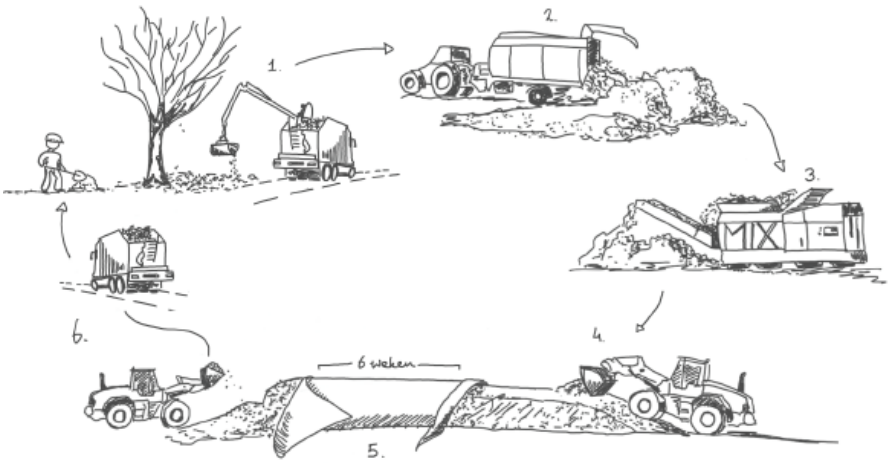


Figure 2. Bokashi as part of circular city Apeldoorn

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.

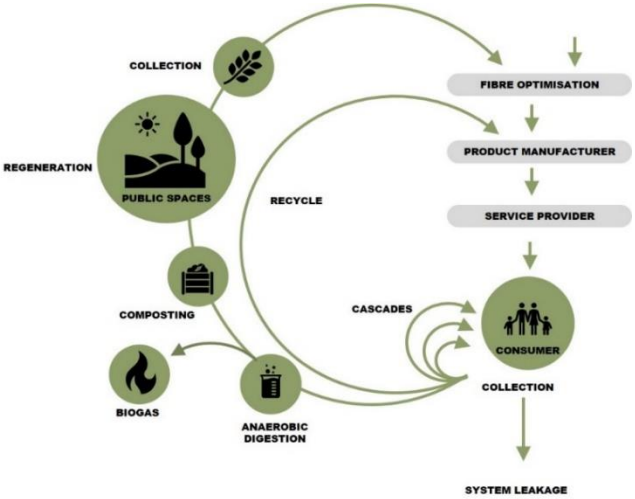


Figure 7. Fibre-based products: The circular system

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).

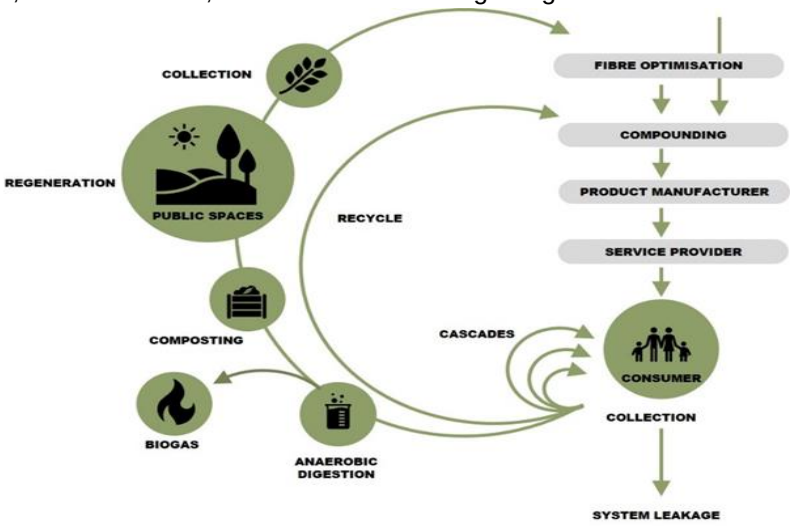


Figure 8. 3D objects: The circular system

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
			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*	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
Identifier	*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
Identifier	*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.

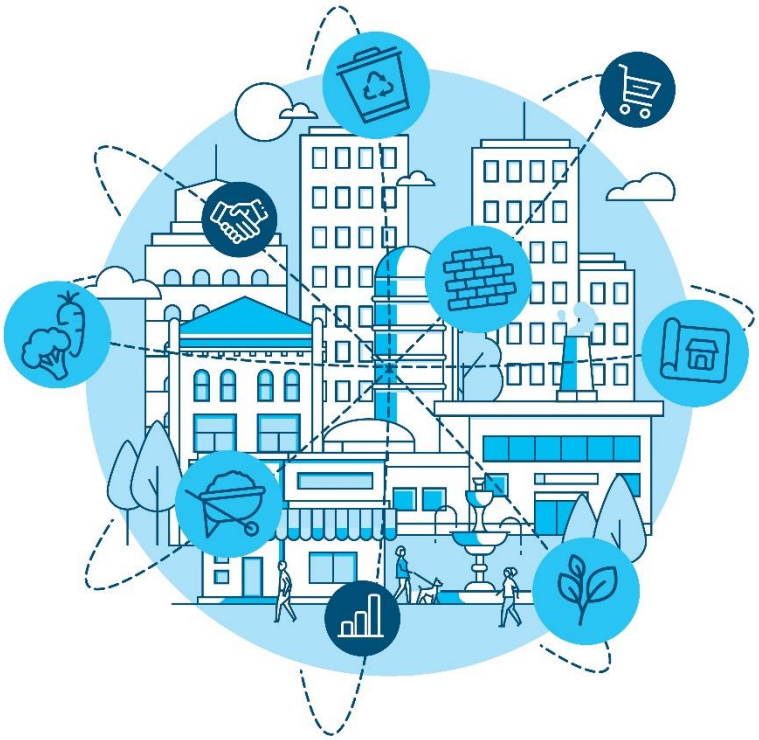
CityLoops runs from October 2019 until September 2023.

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

Evaluation Plan: CDW sector, Apeldoorn

Deliverable 6.2

Gemeente Apeldoorn / Municipality of Apeldoorn



Version	3.0
WP	6
Deliverable	6.2 Evaluation Plan: Construction and Demolition Waste of Municipality of Apeldoorn
Date	18 February 2022
Dissemination level	Public
Deliverable lead	Municipality of Apeldoorn (Gemeente Apeldoorn)
Authors	A. H. Hellemans, Municipality of Apeldoorn (Gemeente Apeldoorn) S. van Laar, Muncipality of Apeldoorn (Gemeente Apeldoorn)
Reviewers	• Petra Bennink, policymaker, circular economy • Saxion University: Bram Entrop • Nordland Research Institute: Bjarne Lindeløv, Megan Palmer-Abbs, Jens Ørding Hansen
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 Construction and Demolition Waste sector.
Keywords	Evaluation, Indicators, Apeldoorn, Construction and Demolition Waste
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Contents

1. Introduction

The objective of the CityLoops evaluation work is to ensure a comprehensive evaluation framework which 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). The evaluation aims to cover all the four Vision Elements at the core of the CityLoops circular city definition from Vangelsten et al. (2021), see figure 1. 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.

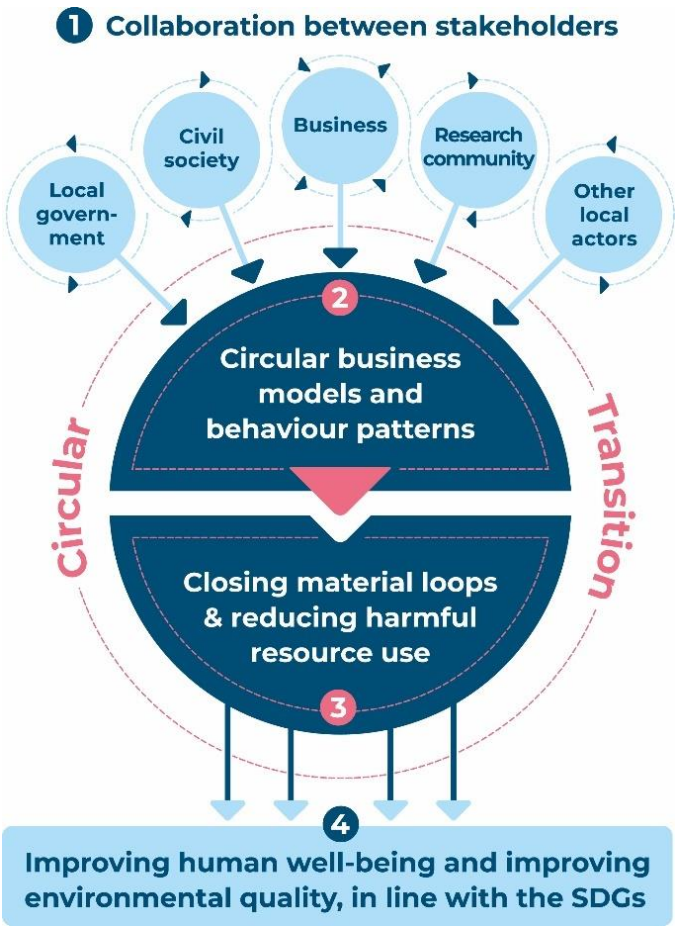


Figure 1. The four Vision Elements of the Circular City vision and causal links for CE transition.

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 the cities which are involved in the CityLoops Project, closing urban material loops. In MoA we have formulated two main streams to address, in order to become more circular. These are infrastructure -as part of construction and demolition waste- and biowaste. MoA has the ambition to purchase 30% circularity in 2030 (in euro). Until 2025 we work according to the policy plan "Working towards our future" (https://apeldoorn.begroting-2021.nl/assets/docs/infographic2021.pdf). This policy is focusing on reducing residual waste in a sustainable way. It also contains goals to reduce the effects of climate change and to create a safe and healthy environment. Now and towards our near future.

1.1. Demonstration Action: Designing and reconstructing public space in a circular way

The main CDW demonstration project in the municipality of Apeldoorn will be the circular design and reconstruction of 3,000 m^2 of public space. This space includes pavement, sidewalks, green space, and parking space along a residential street called Griffiersveld. This street is located in the south-eastern part of Apeldoorn in a neighbourhood that goes by the name of De Maten (see Figure 2). Data from the 1980s illustrate that streets in this neighbourhood are dominated by concrete, typical of the wider neigbourhood. This feature makes the locality of particular interest in developing more sustainable and circular spaces and learnings for future 'at scale' projects.

Figure 2. Location and size of De Maten (left) and the area surrounding Griffiersveld (right).

The challenge for this pilot is to (A) assess if new materials can be made from the recovered materials, (B) be used as a learning resource to generate new digital tools, and (C) collaborative design methods towards innovative and circular approaches to street renovation. The Municipality of Apeldoorn (MoA) operates a central storage site for soil and sand with a new physical construction material marketplace where the coordination of the recirculation of construction materials takes place. In collaboration with Saxion University of Applied Sciences, multiple research activities will be conducted to explore the current state and design new solutions for construction with MoA. Developing these activities further, and moving to more circular construction methods, MoA must first develop a set of processes for the Griffiersveld renovation project. These can be divided into three distinct categories:

A) social processes to involve people,
B) technological processes related to execution and materials, and
C) economic processes related to contracting, transactions and developing the business models.

Part of this work is to collaboratively develop a materials inventory system with researchers. It is the expectation that this inventory will underpin decision-making for future activities based on the data analysis of resources (quantities, quality, etc). The following section presents the demonstration action in detail along with its expected outcomes.

Figure 3. Examples of concrete elements and repairs in Griffiersveld.

1.2. CityLoops tools/processes tested in the demonstration action

Demonstration Action (DA) part 1: LCA: In order to understand the most circular ways of working, a Life Cycle Analysis (LCA) for different material flows and streams will be carried out for the Griffiersveld renovation project. Tools and methods will be developed to meet this task. Saxion University will review Apeldoorn's current circular soil practices, associated processes and material flows at one of MoA's depots. In support of this, some progress has already been made using a Danish CO2 emission calculator tool for soil (February 2020, Roskilde University). This tool has previously been used to calculate soil handling and associated transportation to the Netherlands. It is envisaged that this tool can be used to calculate the CO2 impact of moving soil, or other (bulky) construction materials, on the Griffiersveld project.

DA part 2: Construction material passport and CDW materials databank: In March 2021, MoA will operate a physical construction material hub. Currently the municipality of Apeldoorn uses ANTEA-GBI software to store data on their public space construction projects. In the material hub anyone should drop off and/or pick up secondary construction materials free of charge.

The MoA's goal is to put materials emerging from demolition or renovation works into a digital marketplace before they are dug up, to see if there is demand, allow them to be included in design for new construction, and avoid the logistics problems of bulk storage. Apeldoorn will work with Excess Materials Exchange (EME), a start-up specialised in matching supply of secondary construction materials to demand for their future reuse. Various business subscriptions can be made to subscribe to this service (e.g., monthly fee). After a proof-of-concept phase, MoA will decide which package is most suitable. In preparation for this activity, a materials database is required. In collaboration with Saxion University, an analysis of state of the art in digital material passports will take place. This is essentially a material database which acts as an inventory and includes the GIS (location) storage information about the materials for future retrieval and reuse. In addition, Saxion University will also investigate the use of 3D modelling software, such as Revit, to visualise and store data about materials. The demonstration action will take these learnings and procure a digital material database solution, applying 3D modelling. At the same time, MoA will obtain the laser scanning of the street development under consideration and will enter this information into the (digital) material passport when it is available. During reconstruction of Griffiersveld Street, materials currently in use at the site will be documented in the material passport (with data from the scans). The materials will then be placed on the marketplace. This new approach to recording and managing CDW material flows will be used to optimise and valorise recycled materials on new projects if possible and needed.

DA part 3: Co-design process for public space: As in many large organisations, larger projects are generally embedded across multiple departments of the MoA. At each stage of a project, multiple external organisations will support in attaining the project goals. Public space projects, like the Griffiersveld project, feature the same multi-stakeholder characteristics. Other departments of MoA as well as material suppliers and manufacturing industry will be invited to learn about and feed into the circular design process. In addition, the MoA wants to involve citizens in their goal of achieving a transition to a circular economy. For the Griffiersveld project, an engagement campaign (between March 2021 – October 2021) will enable the inclusion of residents, sharing knowledge about the circular economy and the circular road renovation activities. This will include an invitation to residents to deposit any unused materials from their personal gardens for reuse on the 'marketplace' or 'material hub'.

Unfortunately, the impact of Covid 19 restrictions will impact the level of citizen interaction in the process of redesigning Griffiersveld, namely spatial and financial constraints.

1.3. Expected outcomes

The CityLoops project promotes both theory and practice of CE in European cities. Key impacts of the project as listed in the Grant Agreement are presented in Annex 1.

From the Griffiersveld demonstration action, the following outcomes are expected:

- Increased knowledge and awareness raising within municipal organisations
- Citizens in Griffiersveld are engaged in the circular economy by means of raised awareness
- Improved innovative products and services in CE practices within municipal organisations
- Results of tested tools deployed in the demonstration action are communicated and disseminated internally and externally
- By the end of the project, procurement of circular products related to Griffiersveld have increased by 10% in volume, due to awareness raising activities within MoA
- Quality assurance certification system for reuse of material fractions has been established (GBI)
- Increased number of jobs changed to include CE thinking
- Tiles, curb stones, and older concrete pavers have been reused within the municipality
- Concrete pavers have been reused in the Griffiersveld district development
- Reduced CO2 emission from reduced transport and through reusing and recycling material (3,000 m2 road), compared to conventional street development projects
- Improved wellbeing of citizens through the improved open spaces

2. Indicators to be monitored

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

- Relevance to the city's circularity strategies and the DA and Tools: Each selected indicator will monitor specific processes and impacts related to the DA activities and outcomes (and if relevant the application of CityLoops tools outside the scope of the demonstration actions, i.e. city-wide). Indicators may be monitored either at DA 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 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 definitions from ANNEX 1: Strategic objectives based on CityLoops' Circular City definition and ANNEX 2: CityLoops projected project impacts. 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).

The table (next page) lists the selected indicators for each expected outcome linked to the four Vision Elements in the CityLoops circular city definition (Vangelsten et al., 2021). The table describes at which level (scope) the indicators will be applied (Demonstration Action or City level). In Construction and Demolition Waste in Apeldoorn we have 1 Demo Action: Designing and reconstructing public space in a circular way, applying the following tools:

1. LCA
2. Construction material passport and CDW materials databank
3. Codesign process for public space

Table 1. Linking expected outcomes to the selected indicators

Vision Element	Expected outcome	Indicators	Indicator name	Scope
1 Local Stakeholder Actions	Increased knowledge and awareness raising within municipal organisations	3	New tools for better mapping of resources and their location: Qualitative description	D
		9	New formal CE-based collaboration platforms/networks	C
		21	New planning instruments/tools for improved circularity: Qualitative description	D
	Citizens in Griffiersveld are engaged in the circular economy by means of raised awareness	4	CE-related knowledge building campaigns: Qualitative description	C
		11	Communication measures on circular transformations and waste prevention	C
	Improved innovative products and services in CE practices within municipal organisations	3	New tools for better mapping of resources and their location: Qualitative description	D
		21	New planning instruments/tools for improved circularity: Qualitative description	C
	Results of tested tools deployed in the demonstration action are communicated and disseminated internally and externally	11	Communication measures on circular transformations and waste prevention	C
		21	New planning instruments/tools for improved circularity: Qualitative description	D
	By the end of the project, procurement of circular products related to Griffiersveld have increased by 10% in volume, due to awareness raising activities within MoA	12	Circularity requirements in procurement beyond existing levels	D
		16	Procurements making use of stakeholder dialogue to strengthen circularity: Qualitative description	C
2 Circular business models and behaviour patterns	Quality assurance certification system for reuse of material fractions has been established (GBI)	2	New material passports: Qualitative description	C
		30	New digital material databank/marketplace: Qualitative description	D
		31	New digital material databank/marketplace: impact	D
	Increased number of jobs changed to include CE thinking	33	CE-based employment	C

Vision Element	Expected outcome	Indicators	Indicator name	Scope
3 Closing material loops and reducing harmful resource use	Tiles, curb stones and older concrete pavers have been reused within the municipality	27	Increased share of materials retained and reused on demonstration sites	C
	Concrete pavers have been reused in the Griffiersveld district development	27	Increased share of materials retained and reused on demonstration sites	D
4 Improving human wellbeing and reducing environmental impacts	Reduced CO2 emissions from reduced transport and through reusing and recycling material (3,000 m2 road), compared to conventional street development projects	87	Annual CO2 emissions per unit of GDP	D
	Improved wellbeing of citizens through the improved open spaces	68	Share of green space areas within urban limits	D

3. 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.

3.1. New material passports: Qualitative description

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	2
	2	*Indicator name*	**New material passports: 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 – Regulation and incentives – Vision and urban management
Indicator definition and description	*5*	*Definition / Description of indicator*	Description of passport established / updated to facilitate increased circularity. E.g. type of certification/validation, name of the institution issuing the passport, material types/fractions, etc.
	6	*Rationale*	The rationale is that due to the absence of detailed quality information in the GBI on the material at hand (location, kind of material, mass of the material – how much and LCA), reuse of material is not considered. The establishment of a quality assurance certification system for reuse of material fractions (expected outcome) helps us to realize circular loops of materials and reduce the use of virgin materials. The indicator is related to the following expected outcome: • Quality assurance certification system for reuse of material fractions has been established (GBI)
	7	*Methodology*	Qualitative description
	8	*Unit*	Qualitative data
Data	*9*	*Baseline data / definition*	Baseline is 0. Currently there is no qualitative information about material and resources in the GBI system.
	10	*Data Sources / Relevant Databases*	In Apeldoorn we have a 2D information tool called Gemeentelijke Basis Informatie (GBI). This application contains no qualitative information about material and resources. There is quantitative

Metadata group	#	Metadata category	Description/comments
			information about the resources, like 3,000 square meters of concrete in neighbourhood 'x'. The GBI contains no information about m3. For demonstration case input of CDW masses to be reused at start t0= 0 ton
	11	*Overall accuracy*	GBI data is based on cadastral information and therefore quite accurate. The GBI contains no m^3 data.
Context	*12*	*Sector coverage*	CDW
	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, 12
Other	*16*	*Comments*	None

3.2. New tools for better mapping of resources and their location: Qualitative description

. Metadata group	#	Metadata category	Description/comments
Identi-fier	*1*	*Indicator number*	3
	2	*Indicator name*	**New tools for better mapping of resources and their location: 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 – Regulation and incentives – Vision and urban management
Indicator definitio	*5*	*Definition / Description of indicator*	Qualitative description of individual tools, including scope and scale (e.g. demonstration vs city level), target users.

. Metadata group	#	Metadata category	Description/comments
	6	*Rationale*	The rationale is that new tools for mapping providing qualitative descriptions of the resources and their locations will contribute to more knowledge and insights in the current material at hand, informing planning processes with this information. The indicator is related to the following expected outcomes: • Increased knowledge and awareness raising within municipal organisations • Improved innovative products and services in CE practices within municipal organisations
	7	*Methodology*	Qualitative description
	8	*Unit*	Qualitative data
Data	*9*	*Baseline data / definition*	0 - first check quality of data outputs tool/ after that quantities (quality assurance)
	10	*Data Sources / Relevant Databases*	Autocad is the system we test/analyse to check the suitability of the mapping tool.
	11	*Overall accuracy*	Qualitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	CDW
	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*	9, 11, 12
Other	*16*	*Comments*	None

3.3. CE-related knowledge building campaigns: Qualitative description

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	4
	2	*Indicator name*	**CE-related knowledge building campaigns: Qualitative description**
Link to	*3*	*Vision Element*	X | Local stakeholder actions

Metadata group	#	Metadata category	Description/comments
			☐ 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*	Participation in CE-related activities of the Municipality of Apeldoorn makes inhabitants and stakeholders more aware of the impact of CE in their lives. At this moment we involve inhabitants/stakeholders late in the process. By involving inhabitants/stakeholders earlier in the process, we are convinced that acceptance of changes happens more easily. The indicator is related to the following expected outcome: • Citizens in Griffiersveld are engaged in the circular economy by means of raised awareness
	7	*Methodology*	• Identify and categorise knowledge campaigns • Identify groups reached
	8	*Unit*	Qualitative data
Data	*9*	*Baseline data / definition*	1st time inhabitants are actively approached and engaged in a CE road construction project as such. Therefore the baseline is zero.
	10	*Data Sources / Relevant Databases*	• Newsletters / subscription lists • Information sessions • Desk research and feedback forms on engagement approaches implemented
	11	*Overall accuracy*	Qualitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	CDW
	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

3.4. New formal CE-based collaboration platforms/networks

Metadata group	#	Metadata category	Description/comments
Identi-fier	*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, will contribute to knowledge exchange, sharing of information, learnings, and findings, and boost potential partnerships/ collaborations between different stakeholders. The indicator is related to the following expected outcome: • Increased knowledge and awareness raising within municipal organisations
	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*	The baseline is zero 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*	Qualitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	CDW
	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

Metadata group	#	Metadata category	Description/comments
	15	*SDG Reference*	17
Other	*16*	*Comments*	None

3.5. 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*	Collaborative Local Networks, expert meeting, information sessions, newsletters will be kept during project.
	6	*Rationale*	Rationale is that through communication on CE towards the general public (as stakeholders), the public tends to become more aware and more engaged. The knowledge base grows capacities of internal and external stakeholders on CE. The indicator is related to the following expected outcomes: • Citizens in Griffiersveld are engaged in the circular economy by means of raised awareness • Results of tested tools deployed in the demonstration action are communicated and disseminated internally and externally
	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*	Listing of (social media) messages available to general public (#no of references to CE), overview of emails reports and memos (internal and external), meeting minutes
	11	*Overall accuracy*	Qualitative and quantitative data will be collected during demonstration phase.

Metadata group	#	Metadata category	Description/comments
Context	*12*	*Sector coverage*	CDW
	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

3.6. 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*	During the project we will set up a stakeholder dialogue team to interact with the market on which circular activities can be reached in the project. (Normally the tender is traditional: we set up the requirements, market participants purchase/register.) The indicator is related to the following expected outcome: • By the end of the project, procurement of circular products related to Griffiersveld have increased by 10% in volume, due to awareness raising activities within MoA	
	7	*Methodology*	• Decide which procurements are relevant for analysis (e.g. demo action-focussed procurements only or a wider range of procurements)	

Metadata group	#	Metadata category	Description/comments
			• Describe current standard practice in terms of CE requirements • For each procurement case, describe additional requirements beyond standard practice • 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*	0
	10	*Data Sources / Relevant Databases*	Procurement process of DA analysed through qualitative description of process and analysis of the documents. Inventory of procurements in DA. Listing of stakeholders involved in dialogue / qualitative description of process and dialogue (procurement offer + activity log).
	11	*Overall accuracy*	Qualitative and quantitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	CDW
	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

3.7. Procurements making use of stakeholder dialogue to strengthen circularity: Qualitative description

Metadata group	#	Metadata category	Description/comments	
Identifier	*1*	*Indicator number*	16	
	2	*Indicator name*	**Procurements making use of stakeholder dialogue to strengthen circularity: 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

Metadata group	#	Metadata category	Description/comments
	4	*Category*	Regulation and incentives
Indicator definition and description	*5*	*Definition / Description of indicator*	Description of stakeholder dialogue in procurement processes focussing on circularity (e.g. demonstration action-related or at city level)
	6	*Rationale*	For Griffiersveld, MoA requires to deviate from standard procurement practices to facilitate CE thinking and actions by their contractors. In order to explore what is possible, and ensure the line of reasoning, dialogue with stakeholders is a step in the procurement process. The indicator is related to the following expected outcome: • By the end of the project, procurement of circular products related to Griffiersveld have increased by 10% in volume, due to awareness raising activities within MoA
	7	*Methodology*	List number of procurement processes using stakeholder dialogue. For each of these procurement processes: • Describe the stakeholders/actors involved in the dialogue • Describe the dialogue, including when it is in process
	8	*Unit*	Qualitative data
Data	*9*	*Baseline data / definition*	0
	10	*Data Sources / Relevant Databases*	Inventory of procurements in DA. Listing of stakeholders involved in dialogue / scripts / recordings of dialogue (where possible). Qualitative description of process and dialogue (procurement offer + activity log).
	11	*Overall accuracy*	Qualitative and quantitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	CDW
	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

3.8. New planning instruments/tools for improved circularity: Qualitative description

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	21
	2	*Indicator name*	**New planning instruments/tools for improved for improved circularity: 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*	Vision and urban management
Indicator definition and description	*5*	*Definition / Description of indicator*	Define and select planning instruments/ tools relevant to improve circularity.
	6	*Rationale*	More circular activities in implementation require proper planning of the process beforehand. Tools to guide the planning and to provide the relevant information are crucial in the preparatory work to be conducted. The indicator is related to the following expected outcomes: • Increased knowledge and awareness raising within municipal organisations • Improved innovative products and services in CE practices within municipal organisations • Results of tested tools deployed in the demonstration action are communicated and disseminated internally and externally
	7	*Methodology*	Qualitative description of each instrument/tool
	8	*Unit*	Qualitative data
Data	*9*	*Baseline data / definition*	0
	10	*Data Sources / Relevant Databases*	Autocad is the system we test/analyse to check the suitability of the mapping tool. The co-design process planning tool is a process optimalisation which we test and analyse to check if this is suitable for further use in the stakeholder engagement of the organisation.
	11	*Overall accuracy*	Qualitative and quantitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	CDW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area
	14	*Reference period*	Feb. 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*	9, 11
Other	*16*	*Comments*	None

3.9. Increased share of materials retained and reused on demonstration sites

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	27
	2	*Indicator name*	**Increased share of materials retained and reused on demonstration sites**
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*	• Circular value chains and infrastructure • Re-use and recycling
Indicator definition and description	*5*	*Definition / Description of indicator*	The relative share of materials retained and reused on demonstration sites, measured for selected/key on-site waste material fractions and the total mass of waste materials.
	6	*Rationale*	By having more information on the material (material quality and quantity) in combination with the procurement requirements and the stakeholder dialogue, reuse is facilitated. The indicator is related to the following expected outcomes: • Tiles, curb stones and older concrete pavers have been reused within the municipality • Concrete pavers have been reused in the Griffiersveld district development
	7	*Methodology*	For selected waste fractions and total mass of waste materials: Retained and reused mass of materials / total mass of (waste) materials at demonstration site
	8	*Unit*	Mass %
Data	*9*	*Baseline data / definition*	0

Metadata group	#	Metadata category	Description/comments
	10	*Data Sources / Relevant Databases*	- GBI gives information about the type of material in m2 - Scanning delivery reports - Delivery report: In the contract with the construction contractor, there will be specifications of the volume of used materials and how many of reused (recycled) materials have been used - Interviews during the reconstruction of the road
	11	*Overall accuracy*	Qualitative and quantitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	CDW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area
	14	*Reference period*	Feb. 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*	6, 11, 12
Other	*16*	*Comments*	None

3.10. New digital material databank/marketplace: Qualitative description

Metadata group	#	Metadata category	Description/comments
Identi-fier	*1*	*Indicator number*	30
	2	*Indicator name*	**New digital material databank/marketplace: Qualitative description**
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*	• Circular value chains and infrastructure • Re-use and recycling
Indicator definitio	*5*	*Definition / Description of indicator*	Description of the digital material databank/marketplace in term of objective, type, scope, stage of development, target/user groups and other aspects deemed relevant

Metadata group	#	Metadata category	Description/comments
	6	*Rationale*	The digital passport in Apeldoorn contains quantitative and qualitative data, where it's situated and if we can reuse the material flow. Designers and architects can, while they design new roads/pathways, consider if they can use materials which are already in the city. This will help us to realize circular loops of materials and reduce the use of virgin materials. The indicator is related to the following expected outcome: • Quality assurance certification system for reuse of material fractions has been established (GBI)
	7	*Methodology*	Description of the digital material databank/marketplace in terms of objective, type, scope, stage of development, target/user groups, and other aspects deemed relevant
	8	*Unit*	Qualitative data
Data	9	*Baseline data / definition*	The baseline is zero as there is currently no description or tool where we allocate materials in a databank.
	10	*Data Sources / Relevant Databases*	GBI
	11	*Overall accuracy*	Qualitative and quantitative data will be collected during demonstration phase.
Context	12	*Sector coverage*	CDW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area
	14	*Reference period*	Feb. 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

3.11. New digital material databank/marketplace: Impact

Metadata group	#	Metadata category	Description/comments
Identifier	1	*Indicator number*	31
	2	*Indicator name*	**New digital material databank/marketplace: Impact**
Link to	3	*Vision Element*	Local stakeholder actions

Metadata group	#	Metadata category	Description/comments
			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*	• Circular value chains and infrastructure • Re-use and recycling
Indicator definition and description	*5*	*Definition / Description of indicator*	The impact of the digital marketplace is assessed by estimating the mass and value of material registered and traded per time period.
	6	*Rationale*	The digital passport in Apeldoorn contains quantitative and qualitative data, where it's situated and if we can reuse the material flow. Designers and architects can, while they design new roads/pathways, include information about the use of materials which are already in the city. This will help us to realize circular loops of materials and reduce the use of virgin materials. The indicator is related to the following expected outcome: • Quality assurance certification system for reuse of material fractions has been established (GBI)
	7	*Methodology*	Mass of materials registered per time period Mass of materials traded per time period Value of materials traded per time period Time period can be month or year Total mass should be registered, and optionally key material fractions
	8	*Unit*	Tonnes / year, Monetary value/time
Data	*9*	*Baseline data / definition*	The baseline is zero as there is currently no description or tool where we allocate materials in a databank.
	10	*Data Sources / Relevant Databases*	GBI
	11	*Overall accuracy*	Quantitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	CDW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area
	14	*Reference period*	Feb. 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

3.12. CE-based employment

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	33
	2	*Indicator name*	**CE-based employment**
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 Well-being
Indicator definition and description	*5*	*Definition / Description of indicator*	Assess the impact of demonstration actions or at sector/city level by estimating the increase in CE related job
	6	*Rationale*	The indicator is related to the following expected outcome: • Increased number of jobs changed to include CE thinking
	7	*Methodology*	For a selected time period (e.g. year, project period, etc.) estimate: • Number of new CE related jobs • Number of existing jobs becoming circular If deemed practical for the evaluation, jobs that have a range of responsibilities, of which some are related to circularity and some are not, can be assigned a “percentage of circularity”. Using this principle, a change in the percentage can be assigned for existing jobs that become more circular
	8	*Unit*	Jobs
Data	*9*	*Baseline data / definition*	0
	10	*Data Sources / Relevant Databases*	Organised focus groups and interviews
	11	*Overall accuracy*	Qualitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	CDW
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area
	14	*Reference period*	Feb. 2022: completion of baseline data collection July 2022: completion of interim data collection

Metadata group	#	Metadata category	Description/comments
			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, 8, 13
Other	*16*	*Comments*	None

3.13. Share of green space areas within urban limits

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	68
	2	*Indicator name*	**Share of green space areas within urban limits**
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*	Well-being
Indicator definition and description	*5*	*Definition / Description of indicator*	Define requirements for an open green space, for example using the EEA definition for publicly accessible green space per inhabitants. The resulting green space area is divided by the total urban area as defined by the city.
	6	*Rationale*	Through a co-design participation process, the residents of the neighbourhood are engaged in the planning of their neighbourhood. The indicator is related to the following expected outcome: • Improved wellbeing of citizens through the improved open spaces
	7	*Methodology*	Green space within urban area divided by total space of urban area.
	8	*Unit*	%
Data	*9*	*Baseline data / definition*	Baseline is current situation
	10	*Data Sources / Relevant Databases*	- Areal pictures of the neighbourhood - GBI (DA mapping of neighbourhood and identify and measure square meter of green (baseline) / DA mapping of neighbourhood identify green spaces (after intervention)) - Interview/survey
	11	*Overall accuracy*	Qualitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	CDW

Metadata group	#	Metadata category	Description/comments
	13	*Reference area / Spatial implementation scale*	During the project: demonstration area
	14	*Reference period*	Feb. 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, 15
Other	*16*	*Comments*	None

3.14. Annual CO2 emissions per unit of GDP

Metadata group	#	Metadata category	Description/comments
Identifier	*1*	*Indicator number*	87
	2	*Indicator name*	**Annual CO2 emissions per unit of GDP**
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 (global)
Indicator definition and description	*5*	*Definition / Description of indicator*	The indicator calculates the annual direct emissions of CO2 at city level per GDP.
	6	*Rationale*	The division of information management of Apeldoorn collect data of GHG from the 'klimaatmonitor'. Data sources are different, but mostly CBS. Municipality of Apeldoorn does not measure general GHG information. In the business cases we also want to calculate theoretically what the exposure/emission of transport movements are in the project per business case. The indicator is related to the following expected outcome: • Reduced CO2 emissions from reduced transport and through reusing and recycling material (3,000 m2 road), compared to conventional street development projects
	7	*Methodology*	Direct CO2 emissions divided by GDP at city level. Calculated per year.
	8	*Unit*	Tonnes CO2 / Monetary unit

Metadata group	#	Metadata category	Description/comments
Data	*9*	*Baseline data / definition*	1 tonne concrete paving contains 87.9 kg of CO2 for production. 45 stones will go into 1 m2. Every stone/concrete paving is 3.95 kg. So in Griffiersveld: 3,000 m2 x 45 bricks = 135,000 bricks x 3.95 kg = 533,250 kg of bricks. 1 tonne = 1,000 kg. 533.25 tonnes x 87.9 kg CO2 = 46,872.68 kg CO2 is the baseline if we bring new bricks to the area.
	10	*Data Sources / Relevant Databases*	CO2 indicator model Saxion / de hamer (materialen depot)
	11	*Overall accuracy*	Qualitative data will be collected during demonstration phase.
Context	*12*	*Sector coverage*	CDW
	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

4. 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.

5. 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

6. 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.

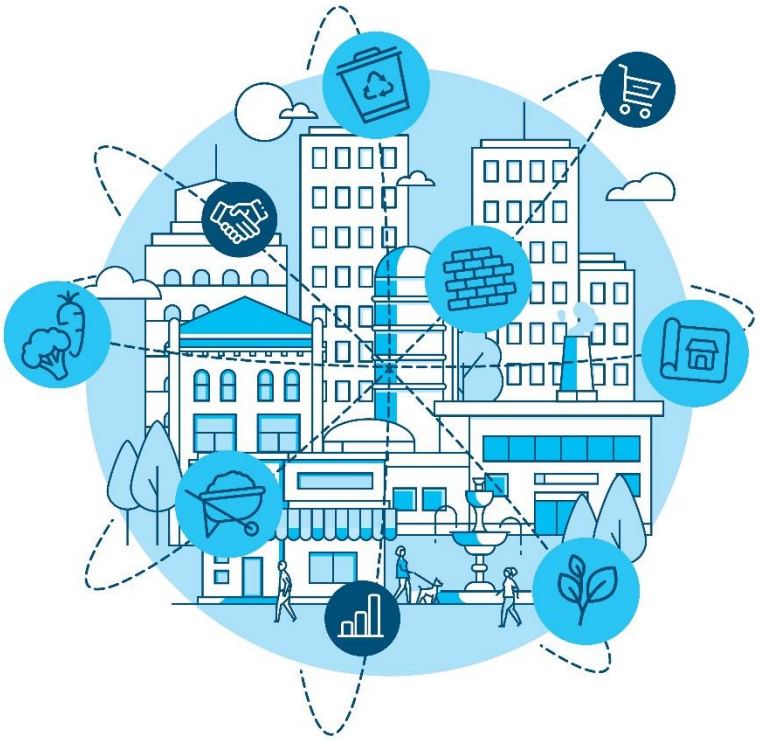
CityLoops runs from October 2019 until September 2023.

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

Evaluation Plan: CDW sector, Bodø

Deliverable 6.2

Bodø Municipality



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Date	18 February 2022
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Deliverable lead	Bodø Municipality
Authors	Tor Gausemel Kristensen, Bodø Municipality
Reviewers	Bjørn Vidar Vangelsten, Amsale Kassahun Temesgen, Jens Ørding Hansen (Nordland Research Institute) Nikolai Jacobi, Simon Clement (ICLEI)
Abstract	This report details how the city of Bodø will evaluate the impact of the CityLoops tools and demonstration activities aimed at improving the circularity of the CDW sector.
Keywords	Evalution, Indicators, Bodø, CDW
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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). 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.

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.

In Bodø an old military airport will be demolished, and a new part of the city will be built in this area. In another area a new airport will be built. Bodø wants to influence the material and mass handling of the process: Less waste, more reuse and repurposing of structures. The 5,000,000 m2 land currently occupied by the air-force have to be cleaned-up regarding soil, CDW and other infrastructure. A stakeholder involvement platform will help facilitate decision processes related to demolition, re-circulation and re-purposing of a large number of military surface and underground structures and infrastructures. On-site soil treatment and re-use will be demonstrated, reducing the net mass deficit in the new airport area. At the new airport area there will be on-site circular demonstration actions related to re-use, re-purposing and re-cycling of infrastructure (CDW, soil) facilitated by the CityLab platform and a 3D planning tool.

The Municipality of Bodø will use this evaluation plan as a "living document". The plan will be updated and improved whenever relevant knowledge emerges from the planning and execution of the demonstration actions.

1.1. Demo Action 1: Demolish the military airport with circular material management processes

Bodø has developed a CDW management plan for the whole project, which will be accessible in english. With such large scale and complexity, it's important to have general

requirements for selective demolition, establishing a central recycling plant and logistics facility to prepare them to be delivered to new constructions, establishing a marketplace for reused and recycled materials. Focus in the planning is to reduce demolishing and integrating circular thinking into all procurement for the new airport new city project.

The following CityLoops tools will be tested in the Demonstration Action:

Tool 1) Life Cycle Assessment for demolition and renovated sites: The LCA tool will be used to quantify the emission savings by keeping soil and CDW on-site. For this purpose, the LCA tool will be used in the 3D tool to simulate this, feeding the visualisation tool with emission and traffic data.

Tool 2) Screening procedures and tool for selective demolition: Screening procedures and guidelines for selective demolition will be used for chosen buildings. It will be included in tendering. The buildings have not been identified yet. This will be done in collaboration with the New Airport New City-team. They will help identify best practise in terms of demolishing in order to reuse materials and masses, and focus on methods on how to demolish military shelters.

Tool 8/9) Construction-material passport and CDW materials databank & Databank and digital marketplace for recovered materials

Bodø have their own databank up and running and will engage and challenge vendors to use the materials on hand. The databank will be used to bookkeep the demolished materials' specifications and location and bookkeep holdings and ins and outs in the storage facility of the demolished materials. The data will also be used to identify which materials may be subject for reuse and recycling. Material passports will be integrated in this solution to keep track of where the different materials are located and their characteristics. There is no plan for digital or physical marketplace yet. It doesn't have to be a webpage, but it can be some form of an exchange of information and materials for this new city development. Bodø will compare/ exchange experiences with Mikkeli and Apeldoorn who are developing databanks as well.

Tool 11) 3D GIS-based visualisation tool for monitoring and planning

This tool uses existing 3D technology in new, innovative ways for monitoring and planning handling of mass and materials. The existing information is used for mapping the masses and their degree of pollution and visualizing this using PowerBI and Augment City. Next step is to use the tool to plan which buildings should be kept or demolished, to simulate how a building may be demolished in order to reuse/recycle materials, and how to utilize the freed space and material. Furthermore the tool is used to simulate material and waste flows.

Expected outcomes:

- 100% of masses & materials have been mapped and evaluated for their reuse potential

- 100% of tenders to suppliers with business interests in the demolition project have contained requirements for circular treatment of materials
- All decisions related to demolition shall be data-based and supported by information from the 3D-GIS based visualisation tool, LCA tool and circular business cases
- An intermediate storage facility on demonstration site or nearby to enable reuse of materials has been established
- A databank and a marketplace for reused materials has been established
- 80% of materials & masses stored onsite/near demonstration site has been prepared for reuse

1.2. Demo Action 2: Involve stakeholders and citizens in city development using innovative tools

The large “New City New Airport” project has three main actors: the military (Norconsult), Avinor airport (Norconsult) and the municipality. The citizens are a large interest group.

Bodø have included the stakeholders in the transformation of the airport and the new city from the beginning. They want the professional stakeholders (e.g. construction consultants, entrepreneurs, architects) to engage in dialogue on practices of screening and (selective) demolition. And they have involved both professional stakeholders and citizens in a dialogue on how to reuse and prolong lifetime of existing buildings and materials when designing the new city.

The following CityLoops tools will be tested in the Demonstration Action:

Tool 12) CityLab (ByLab) stakeholder engagement platform at Bodø town hall (BOD)

The CityLab is a municipal platform to inform, activate and involve citizens. Bodø have already had some CityLab arrangements regarding the development of a new part of the city. Different architect companies have in the CityLab presented their construction and city plan suggestions, but everyone and anyone in the city is invited to participate in this planning. The plan is to keep arranging these meetings, but also possibly arrange CityLab-meetings exclusively for professional and extra relevant stakeholders. Young people and children have been invited to demonstrate how they would develop the new part of the city using the materials we have identified on site.

Tool 11) 3D GIS-based visualisation tool

This tool will be used to show future scenarios to citizens of different visions of the new city development. Can also be used to raise awareness of climate and circular issues, like emissions and waste generation in the city, by presenting it in a visual, captivating and easy to understand way that is more accessible for citizens.

Expected outcomes:

- Increased degree of involvement of citizen and stakeholder inputs in city planning processes
- Improved capacity for stakeholder involvement in urban planning decision-making
- Increased early market engagement ensuring that the circularity potential present in the market will be fully utilized
- Long-term changed procedures on involving stakeholders in construction projects at city level

1.3. Demo Action 3: Embed circular strategies into the planning of a new city district

Given the timespan of CityLoops it is not likely that the new city will be constructed within the timeframe of the project. This action focus on circular city planning: how is the new city part going to look, and how should we build it in a circular way? How can we plan for specific recycling and reuse from demolishing of the old airport? How do we prepare and select materials to be used? CityLoops is a part of the planning of the construction project. Establishing circular procurement policies in the organisation is one of the initiatives from CityLoops. Furthermore, the tools and concepts developed in CityLoops will be put to use in the project.

The following CityLoops tools will be tested in the Demonstration Action:

Tool 11) 3D modelling tool for monitoring and planning

Use the tool to design hypothetical constructions in the new city part that is to be developed. Use the tools to visualise how it may be possible to "move" demolished materials, and freed masses, to construct new structures. Use the tool as city planning tool, and a tool that can show us data related to constructions, i.e. emissions or energy consumption. Use tool to plan, simulate, visualise what demolished/strategic deconstructed materials can be used in new constructions.

Tool 8/9) Construction-material passport and CDW materials databank & Databank and digital marketplace for recovered materials

Use the appropriate reusable materials presented in Bodøs databank to plan construction activities

Tool 12) CityLab (ByLap) stakeholder engagement platform at Bodø town hall

For the new city development, specifically, it will be used for:

Suggestions on how existing structures and solutions may be repurposed, and how materials and masses can be upcycled. CityLab arrangements regarding the development of a new part of the city involving both professional stakeholders and citizens.

Expected outcomes:

- Improved practice of including sustainability and circularity considerations in procurement activities
- CityLoops-initiated goals and ambitions regarding circular materials handling have been manifested in municipal public strategy documents
- Increase in urban planning decisions that are supported by information from the 3D-GIS based visualisation tool, LCA tool and circular business cases
- Within the plans for the new city disctrict, 70% of materials & masses from the demolition site shall be reused, reducing city wide use of virgin materials by 40%
- Circular material use rate increased by 10%

2. 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 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 CityLoops project plans (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).

The indicators are selected because of their relevance to the demonstration project and the city's sustainability goals. The demonstration project is a demolition and construction project where hundreds of thousands of tonnes of masses and materials needs to be treated in a sustainable and circular manner. The indicators help us measure if CityLoops actions to support this, is effective. The city of Bodø have ambitions to improve how CDW is treated in the city in general, and to reduce emission. Both in the demonstration project, and on city level, it is important to involve stakeholders and citizens development projects.

Measuring the selected indicators helps us quantify how much CDW handling, stakeholder involvement, circular innovation and emission values are improved as a result of CityLoops initiatives, actions and tools.

Table 1 to Table 4 list the selected indicators for each of the four Vision Elements in the CityLoops circular city definition (Vangelsten et al., 2021). The tables describe at which level the indicators will be applied (Demonstration Action or City level) and which Demonstration Actions they will evaluate.

Table 1: List of indicators related to Vision Element 1 "Local Stakeholder Actions"

Indi-cator #	Indicator name	Scope (Demo/ City)	Demo action 1 Demo-lition of airport	Demo action 2 Stake-holder Involve-ment	Demo action 3 New city develop ement
3 & 20	New tools for better mapping of resources and their location: Qualitative description and impact	D	X		X
7 & 8	New methods and technologies for stakeholder involvement: Qualitative description and impact	D / C		X	X
10	Stakeholder contribution to improved circularity	D		X	X
12 & 15	Circularity requirements in procurement beyond existing levels	D / C	X	X	
13	Circular procurement ambition set out in strategy / policy documents.	C		X	
16 & 17	Procurements making use of stakeholder dialogue to strengthen circularity: Qualitative description and impact			X	
21 & 22	New planning instruments/tools for improved circularity: Qualitative description and impact	D	X		X

Table 2: List of indicators related to Vision Element 2 "Circular business models and behaviour patterns".

Indi-cator #	Indicator name	Scope (Demo /City)	Demo action 1 Demo-lition airport	Demo action 2 Stake-holder Involve-ment	Demo action 3 New city develop ement
29	New material hotels: Mass of material stored in hotel	D	X		X
30	New digital material databank/marketplace: Qualitative description	D	X		X
31	New digital material databank/marketplace: Impact	D			X
32.1	Tool-based urban planning decisions	D			X

Table 3: List of indicators related to Vision Element 3 "Closing material loops and reducing harmful resource use"

Indi-cator #	Indicator name	Scope (Demo /City)	Demo action 1 Demo-lition airport	Demo action 2 Stake-holder Involve-ment	Demo action 3 New city develop ement
55	EOL-RR (End of Life Reuse Rate)	D	X	X	X
57	Amount of sector specific waste that is produced	D	X		

Table 4: List of indicators related to Vision Element 4 "Improving human wellbeing and reducing environmental impacts"

Indi-cator #	Indicator name	Scope (Demo /City)	Demo action 1 Demo-lition airport	Demo action 2 Stake-holder Involve-ment	Demo action 3 New city develop ement

Links between the selected indicators and the expected outcomes for the specific Demonstration Actions are shown in the tables below.

Table 5: Linking expected outcomes to the selected indicators for Demonstration Action 1: Demolish the military airport with circular material management processes.

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	100% of masses & materials have been mapped and evaluated for their reuse potential	3/20. New tools for better mapping of resources and their location
	100% of tenders to suppliers with business interests in the demolition project have contained requirements for circular treatment of materials	12/15. Circularity requirements in procurement beyond existing levels
	All decisions related to demolition shall be data-based and supported by information from the 3D-GIS based visualisation tool, LCA tool, and circular business cases	21/22. New planning instruments/tools for improved circularity
2 Circular business models and behaviour patterns	An intermediate storage facility on demonstration site or nearby to enable reuse of materials has been established	29. New material hotels: Mass of material stored in hotel
	A databank and a marketplace for reused materials has been established	30/31. New digital material databank/marketplace: Qualitative description

Vision Element	Expected outcome	Indicator
3 Closing material loops and reducing harmful resource use	80% of materials & masses stored onsite/near demonstration site have beend prepared for reuse	55. EOL-RR (End of Life Reuse Rate)

Table 6: Linking expected outcomes to the selected indicators for Demonstration Action 2: Involve stakeholders and citizens in city development using innovative tools.

Vision Element		
1 Local Stakeholder Actions	Increased degree of involvement of citizen and stakeholder input in city planning processes	6. Circularity related stakeholder activities 10. Stakeholder contribution to improved circularity
	Improved capacity for stakeholder involvement in urban planning decision making	7/8. New methods and technologies for stakeholder involvement: Qualitative description
	Increased early market engagement ensuring that the circularity potential present in the market will be fully utilized	10. Stakeholder contribution to improved circularity
	Long-term changed procedures on involving stakeholders in construction projects at city level	10. Stakeholder contribution to improved circularity

Table 7: Linking expected outcomes to the selected indicators for Demonstration Action 3: Embed circular strategies into the planning of a new city district.

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Improved practice of including sustainability and circularity considerations in procurement activities	12/15. Circularity requirements in procurement beyond existing levels 16/17. Procurements making use of stakeholder dialogue to strengthen circularity: Qualitative description
	CityLoops-initiated goals and ambitions regarding circular materials handling have been manifested in municipal public strategy documents	13. Circular procurement ambition set out in strategy / policy documents. | City, 19. Progress towards circular city strategy objectives
2 Circular business models and behaviour patterns	Increased urban planning decisions that are supported by information for the 3D-GIS based visualisation tool, LCA-tool and circular business cases	32.1. Tool-based urban planning decisions
3 Closing material loops and reducing	Within the plans for the new city disctrict, 70% of materials & masses from the demolition site shall be	55. EOL-RR (End of Life Reuse Rate)

Vision Element	Expected outcome	Indicator
harmful resource use	reused, reducing city wide use of virgin materials by 40%	
	Circular material use rate increased by 10%	39. Circular Material Use Rate | Demonstration action

3. 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 that they will test.

3.1. Indicator 3/20. New tools for better mapping of resources and their location | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	3/20
	2	Indicator name	New tools for better mapping of resources and their location: Qualitative description & New tools for better mapping of resources and their location: Impact
Link to Circular City Definition	3	Vision element	Local stakeholder actions
	4	Category	Engagement and capacity building Regulation and incentives Vision and urban management
Indicator definition and description	5	Definition / description of indicator	3: Qualitative description of individual tools, including scope and scale (e.g. demonstration vs city level), target users. Describe impact of CityLoops tools described in indicator Number 3 on material flows and other relevant parameters 20: Describe impact of CityLoops tools described in indicator # 3 on material flows and other relevant parameters
	6	Rationale	Use the information in the tool to plan how resources can be stored and treated in order to ensure circular treatment by i.ex. using them in nearby projects Bodø has chosen this indicator because of the need to map and identify the resources on the demonstration site in order to evaluate and plan its reuse potential. Expected outcome DA1: 100% of masses & materials have been mapped and evaluated for their reuse potential
	7	Methodology	3: Qualitative description 20: For each tool (estimate) Volume of materials impacted per year Other relevant parameter per year
	8	Unit	3: Qualitative data 20: Tonnes / year. Other relevant quantitative units (Monetary, jobs etc)

Metadata group	#	Metadata category	Description / comments
Data	9	Baseline data / definition	The mapping activities before project initiation versus mapping activities after demonstration phase. This has not been done in the same way before, so the baseline is basically 0.
	10	Data sources / relevant databases	NGI tests/analyses on the masses on site (locally stored report), construction reports, Norconsult's mass analyses. Procurement tenders. Scanning, measurements and inventory assements of buildings on demo site.
	11	Overall accuracy	Very accurate test point data. Not very accurate mass volume data. Some uncertainty in generalizing mass data from test points to nearby areas. Tender data is accurate.
Context	12	Sector coverage	CDW, city developement, tech.dept.
	13	Reference area / spatial implementation scale	Demonstration area incl. city development area
	14	Reference period	2019-2023 Yearly reconciliation, # of tools used
	15	SDG reference	
Other	16	Comments	

3.2. Indicator 6. Stakeholder contribution to improved circularity | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	6
	2	Indicator name	Stakeholder contribution to improved circularity
Link to Circular City Definition	3	Vision element	Local stakeholder actions
	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	Stakeholders have interest and competence in city developement relevant subjects. It is interesting to see if we can operationalize inputs and initiatives from stakeholders i.ex. from CityLab arrangements. Expected outcomes: • DA2: Increased degree of involvement of citizen and stakeholder input in city planning processes
	7	Methodology	List inputs from stakeholders Describe how it has been used by those that invited the stakeholder activity

Metadata group	#	Metadata category	Description / comments
			Describe how it has contributed to improved circularity
	8	Unit	Qualitative data and potentially quantitative impact data
Data	9	Baseline data / definition	Number of initiatives materialised from stakeholder inputs before and after involvement arrangements.
	10	Data sources / relevant databases	Data from projects descriptions, arrangement logs, tenders, grants
	11	Overall accuracy	The very qualitative nature of the data might comprimise its accuracy.
Context	12	Sector coverage	CDW, housing developement, city planning, infrastructure, construction & demolition
	13	Reference area / spatial implementation scale	Mainly demonstration area, but not necesarrily limited to it
	14	Reference period	Yearly reconciliation. # of stakeholder involvement initiatives, # of stakeholder contributions, # of contributions resulting in municipal decisions
	15	SDG reference	
Other	16	Comments	

3.3. Indicator 7/8. New methods and technologies for stakeholder involvement | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	7/8
	2	Indicator name	New methods and technologies for stakeholder involvement
Link to Circular City Definition	3	Vision element	Local stakeholder actions
	4	Category	Engagement and capacity building
Indicator definition and description	5	Definition / description of indicator	7: Number of methods, and for each a qualitative description of the method 8: Description of stakeholder groups involved Number of of people impacted
	6	Rationale	Demonstrating circular solutions to get understanding of its importance. Involvement. Awareness. In this indicator, two tools will be central: Tool 11 (3D tool) and Tool 12 (Stakeholder & citizen

Metadata group	#	Metadata category	Description / comments
			involvement tool). These arrangements will not only be related to the demonstration projects, but also to initiatives in the city in general. Expected outcome DA2: Improved capacity for stakeholder involvement in urban planning decision making
	7	Methodology	7: a) Describe technologies used in stakeholder processes b) Describe technology advantage / disadvantage 8: a) Describe the identified stakeholder groups b) Number of people impacted per stakeholder group
	8	Unit	7: Number of methods, Qualitative data 8: Qualitative data, Number of people
Data	9	Baseline data / definition	Innovative stakeholder activities before the projects versus after the demonstration phase. Number of actions initiated as a direct result from stakeholder inputs
	10	Data sources / relevant databases	Arrangement database: number of arrangements, type of arrangements, number of participants
	11	Overall accuracy	# of attendees and # of arrangements are 100% accurate. It might be difficult to identify the number of actions that have been materialised directly as a result from stakeholder & citizen initiatives.
Context	12	Sector coverage	CDW, city development, citizens, anyone with interest in the demonstration intera, quality of life
	13	Reference area / spatial implementation scale	City level
	14	Reference period	2019-2023 Yearly reconciliation, # of tools & methods used
	15	SDG reference	
Other	16	Comments	

3.4. Indicator 7/8. New methods and technologies for stakeholder involvement | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	7/8
	2	Indicator name	New methods and technologies for stakeholder involvement
Link to Circular City Definition	3	Vision element	Local stakeholder actions
	4	Category	Engagement and capacity building

Metadata group	#	Metadata category	Description / comments
Indicator definition and description	5	Definition / description of indicator	Number of methods, and for each a qualitative description of the method Description of stakeholder groups involved # of people impacted
	6	Rationale	Demonstrating circular solutions to get understanding of its importance. Involvement. Awareness. In this indicator, two tools will be central: Tool 11 (3D tool) and Tool 12 (Stakeholder & citizen involvement tool). The expected outcome is that a guide with generelizable methods for citizen & stakeholder involvement in city planning processes is prepared. Expected outcome DA2: Improved capacity for stakeholder involvement in urban planning decision making
	7	Methodology	Describe technologies used in stakeholder processes Describe technology advantage / disadvantage
	8	Unit	7: Number of methods, Qualitative data 8: Qualitative data, Number of people
Data	9	Baseline data / definition	Innovative stakeholder activities before the projects versus after the demonstration phase. Number of actions initiated as a direct result from stakeholder inputs.
	10	Data sources / relevant databases	Arrangement database: number of arrangements, type of arrangements, number of participants
	11	Overall accuracy	# of attendees and # of arrangements are 100% accurate. It might be difficult to identify the number of actions that have been materialised directly as a result from stakeholder & citizen initiatives.
Context	12	Sector coverage	CDW, city development, citizens, anyone with interest in the demonstration intera, quality of life
	13	Reference area / spatial implementation scale	Demonstration site
	14	Reference period	2019-2023 Yearly reconciliation, # of tools & methods used
	15	SDG reference	
Other	16	Comments	

3.5. Indicator 10. Stakeholder contribution to improved circularity | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	10

Metadata group	#	Metadata category	Description / comments
	2	Indicator name	Stakeholder contribution to improved circularity
Link to Circular City Definition	3	Vision element	Local stakeholder actions
	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	Stakeholders have interest and competence in city developement relevant subjects. It is interesting to see if we can operationalize inputs and initiatives from stakeholders i.ex. from CityLab arrangements. Expected outcomes DA2: • Increased degree of involvement of citizen and stakeholder input in city planning processes • Increased early market engagement ensuring that the circularity potential present in the market will be fully utilized • Long-term changed procedures on involving stakeholders in construction projects at city level
	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	Number of initiatives materialised from stakeholder inputs before and after involvement arrangements.
	10	Data sources / relevant databases	Data from projects descriptions, arrangement logs, tenders, grants
	11	Overall accuracy	The very qualitative nature of the data might comprimise its accuracy.
Context	12	Sector coverage	CDW, housing developement, city planning, infrastructure, construction & demolition
	13	Reference area / spatial implementation scale	Mainly demonstration area, but not necesarrily limited to it
	14	Reference period	Yearly reconciliation. # of stakeholder involvement initiatives, # of stakeholder contributions, # of contributions resulting in municipal decisions
	15	SDG reference	
Other	16	Comments	

3.6. Indicator 12/15. Circularity requirements in procurement beyond existing levels | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	12/15
	2	Indicator name	Circularity requirements in procurement beyond existing levels
Link to Circular City Definition	3	Vision element	Local stakeholder actions
	4	Category	Regulation and incentives
Indicator definition and description	5	Definition / description of indicator	12: Description of requirements in procurements going beyond what is current standard practice 15: Number of procurements with circularity requirements Value of procurement with circularity requirements
	6	Rationale	As a public procurer we have the opportunity to change how providers are practising because of our significant purchasing power. More requirements to circular practise – more incentives from providers – more circularity in society. The city developement project/demonstration project/construction project is presumably suitable for setting a standard to prepare better tenders with high quality requirements to circularity. Expected outcomes DA1: 100% of tenders to suppliers with business interests in the demolition project have contained requirements for circular treatment of materials
	7	Methodology	12: Decide which procurements are relevant for analysis (e.g. demo action focussed procurements only or a wider range of procurements) Describe current standard practice in terms of CE requirements For each procurement case, describe additional requirements beyond standard practice In case of several relevant procurements, summarize relevant progress beyond existing levels 15: For each action: • Type of procurement action • Value of procurement For the whole period considered: • Time period • Number of procurement contracts • Sum up the total value of these contracts
	8	Unit	Qualitative data and potentially quantitative impact data Number of actions Monetary value of procurements

Metadata group	#	Metadata category	Description / comments
Data	9	Baseline data / definition	A comparison of a representative selection of tenders before and after demonstration phase, evaluating amount of tenders with circularity requirements, and the quality of the specific requirements. In this indicator, tenders related to the demonstration project will be evaluated. As the project is not yet initiated, the baseline is 0.
	10	Data sources / relevant databases	Tender history, purchasing history, data gathered before improvement actions, data gathered after demonstration phase, spend data
	11	Overall accuracy	Very good accuracy. Easy to uncover improvement.
Context	12	Sector coverage	Construction & demolishing sector, architects, transport sector, waste mangers, purchasing dept, project managers and decision makers in Bodø Municipality
	13	Reference area / spatial implementation scale	Demonstration site
	14	Reference period	2021-2023. Yearly reconciliation. Data source: procurement history, including tenders.
	15	SDG reference	
Other	16	Comments	

3.7. Indicator 12/15. Circularity requirements in procurement beyond existing levels | City

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	Local stakeholder actions
	4	Category	Regulation and incentives
Indicator definition and description	5	Definition / description of indicator	12: Description of requirements in procurements going beyond what is current standard practice 15: Number of procurements with circularity requirements Value of procurement with circularity requirements
	6	Rationale	As a public procurer we have the opportunity to change how providers are practising because of our significant purchasing power. More requirements to circular practise – more incentives with providers – more circularity in society.

Metadata group	#	Metadata category	Description / comments
			Expected outcome DA3: Improved practice of including sustainability and circularity considerations in procurement activities
	7	Methodology	12: Decide which procurements are relevant for analysis (e.g. demo action focussed procurements only or a wider range of procurements) Describe current standard practice in terms of CE requirements For each procurement case, describe additional requirements beyond standard practice In case of several relevant procurements, summarize relevant progress beyond existing levels 15: For each action: • Type of procurement action • Value of procurement For the whole period considered: • Time period • Number of procurement contracts • Sum up the total value of these contracts
	8	Unit	Qualitative data and potentially quantitative impact data Number of actions Monetary value of procurements
Data	9	Baseline data / definition	A comparison of a representative selection of tenders before and after demonstration phase, evaluating amount of tenders with circularity requirements, and the quality of the specific requirements. Sustainability has in some tenders (~50%) been taken into consideration, but circularity isolated has not been defined very well.
	10	Data sources / relevant databases	Tender history, purchasing history, data gathered before improvement actions, data gathered after demonstration phase, spend data
	11	Overall accuracy	Very good accuracy. Easy to uncover improvement.
Context	12	Sector coverage	Construction & demolishing sector, architects, transport sector, waste mangers, purchasing dept, project managers and decision makers in Bodø Municipality
	13	Reference area / spatial implementation scale	City level
	14	Reference period	2021-2023. Yearly reconciliation. Data source: procurement history, including tenders.
	15	SDG reference	
Other	16	Comments	

3.8. Indicator 13/19. Circular procurement ambition set out in strategy / policy documents | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	13/19
	2	Indicator name	Circular procurement ambition set out in strategy / policy documents.
Link to Circular City Definition	3	Vision element	Local stakeholder actions
	4	Category	Regulation and incentives
Indicator definition and description	5	Definition / description of indicator	List and describe ambition and to which degree the ambitions are being fulfilled
	6	Rationale	While the city has some guidelines and policies on to how sustainability is to be weighted in tenders, there is no policies that demands requirements to circularity. As an initiative from CityLoops, circularity is to be weighted in relevant tenders, and we need to measure how tenders has improved as a result of this. Not only the increase of numbers of tenders with such requirements, but also the quality of the requirements. Expected outcome DA3: CityLoops-initiated goals and ambitions regarding circular materials handling have been manifested in municipal public strategy documents
	7	Methodology	Evaluate each ambition on scale: no progress, little progress, some progress, ambition nearly reached, ambition reached or beyond.
	8	Unit	Score on categorical scale (1-5)
Data	9	Baseline data / definition	A representative selection of tenders before the CityLoops initiatives to improve, versus a selection of tender after. Has the number of tenders with circularity requirements increased? Has the quality of these requirements improved?
	10	Data sources / relevant databases	Tender history, spend data
	11	Overall accuracy	Number of tenders with requirements are very accurate. The quality of the specific tenders is not quantitative, but it's fairly easy to evaluate the quality of the qualification and grant criteria.
Context	12	Sector coverage	Everyone with business interest in the demonstration area, contractors, entrepreneurs, city development dept.
	13	Reference area / spatial	City level

Metadata group	#	Metadata category	Description / comments
		implementation scale	
	14	Reference period	2021-2023. Yearly reconciliation. Data source: procurement history, including tenders.
	15	SDG reference	
Other	16	Comments	

3.9. Indicator 16/17. Procurements making use of stakeholder dialogue to strengthen circularity: Qualitative description | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	16/17
	2	Indicator name	Procurements making use of stakeholder dialogue to strengthen circularity: Qualitative description
Link to Circular City Definition	3	Vision element	Local stakeholder actions
	4	Category	Regulation and incentives
Indicator definition and description	5	Definition / description of indicator	16: Description of stakeholder dialogue in procurement processes focussing on circularity (e.g. demonstration action related or at city level) 17: For each procurement action value of procurement described in indicator # 16, mass of materials impacted
	6	Rationale	If suppliers are involved early in projects, it may increase the chances of them being equipped & prepared for fulfilling our requirements for circularity. Expected outcome DA3: Improved practice of early market dialogue to prepare the suppliers for circularity demands
	7	Methodology	16: List number of procurements processes using stakeholder dialogue. For each of these procurements processes: Describe the stakeholders/actors involved in the dialogue Description of the dialogue including when in the process 17: List number of procurements processes using stakeholder dialogue. Sum up the total value Define how to identify material impacted Sum up volume of material impacted
	8	Unit	16: Qualitative data

Metadata group	#	Metadata category	Description / comments
			17: Monetary value. Tonnes / year.
Data	9	Baseline data / definition	Market involvement timing before and after demonstration phase. Has the time interval between market involvement and project initiation been prolonged?
	10	Data sources / relevant databases	Tender history reports, market involvement literature, master thesis for Bodø Municipality/CityLoops
	11	Overall accuracy	As time is quantitative, it's presumably uncomplicated to measure improvement.
Context	12	Sector coverage	Construction & demolishing sector, architects, transport sector, waste mangers
	13	Reference area / spatial implementation scale	City level
	14	Reference period	2019-2023. Yearly reconciliation. Data source: procurement history, including tenders.
	15	SDG reference	
Other	16	Comments	

3.10. Indicator 21/22. New planning instruments/tools for improved circularity: Qualitative description | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	21/22
	2	Indicator name	New planning instruments/tools for improved circularity
Link to Circular City Definition	3	Vision element	Local stakeholder actions
	4	Category	Vision and urban management
Indicator definition and description	5	Definition / description of indicator	21: Define and select planning instruments/ tools relevant to improve circularity 22: Quantify impact of all planning instruments/tools tools described in indicator # 21.
	6	Rationale	There is a need for the city to map all masses & materials on the demonstration site in order to evaluate its reuse potential, then plan how these resources might be used in other nearby projects. Via CityLoops, Bodø Municipality is using a digital twin for

Metadata group	#	Metadata category	Description / comments
			this, to plan, simulate, visualise how a new part of the city can be built using reused materials and masses. Expected outcome DA1: All decisions related to demolition shall be data-based and supported by information from the 3D-GIS based visualisation tool, LCA tool, and circular business cases
	7	Methodology	21: Qualitative description of each instrument/tool 22: For each instrument/tool: # of projects where tool was used Total mass of materials that the tool has impacted on per year Recirculated mass of materials that the tool has impacted on per year
	8	Unit	21: Qualitative data 22: Number of tools. Tonnes / year.
Data	9	Baseline data / definition	Reuse rate after use of the CityLoops tool versus before. Evaluate if the tool has had effect on circular treatment of CDW. Evaluation of whether the practise of using tools for data-based decisions has increased after implementation of CityLoops developed solutions. Baseline: the tools used before implementation of CL-tools.
	10	Data sources / relevant databases	Digital material databank, reuse rates, laser scannings, building assements from building engineer
	11	Overall accuracy	Accurate
Context	12	Sector coverage	CDW, reuse, city developement, waste managers
	13	Reference area / spatial implementation scale	Demonstration site
	14	Reference period	2019-2023 Yearly reconciliation, # of tools & methods used.
	15	SDG reference	
Other	16	Comments	Tool 11

3.11. Indicator 29. New material hotels: Mass of material stored in hotel | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	29

Metadata group	#	Metadata category	Description / comments
	2	Indicator name	New material hotels: Mass of material stored in hotel
Link to Circular City Definition	3	Vision element	Circular business models and behavioural patterns
	4	Category	Circular value chains and infrastructure Re-use and recycling
Indicator definition and description	5	Definition / description of indicator	The indicator assesses the impact and significance of the material hotel by logging the flow and stock of materials in the hotel.
	6	Rationale	Much of the city's construction project's materials will be placed in an intermediate storage facility, enabling it for reuse in nearby projects. It is interesting to measure what resources are stored in such a material hotel, and how much of the total amount of material in the demonstrations site are stored this way. Expected outcome DA1: An intermediate storage facility on demonstration site or nearby to enable reuse of materials has been established
	7	Methodology	The indicator assesses the impact and significance of the material hotel by logging three variables: The mass of materials entering the hotel in a given time period (e.g. monthly of per year). The mass of materials exiting the hotel in a given time period (e.g. monthly of per year). The total mass of materials in store in the material hotel by the end of each time period (month or year) In addition to logging the total mass, the mass can be logged by selected material fractions.
	8	Unit	Tonnes / year, Tonnes
Data	9	Baseline data / definition	The baseline will be 0, as the material hotel on site is not yet established.
	10	Data sources / relevant databases	Databank that represents the resources in the material hotel.
	11	Overall accuracy	Very good accuracy if the bookkeeping of material movements is good
Context	12	Sector coverage	Entrepreneurs, contractors, organizations with interest of building components in general
	13	Reference area / spatial implementation scale	Demonstration site
	14	Reference period	Second part of 2021 - 2023. Monthly reconciliation in databank.
	15	SDG reference	
Other	16	Comments	

3.12. Indicator 30/31. New digital material databank/marketplace | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	30/31
	2	Indicator name	New digital material databank/marketplace: Qualitative description
Link to Circular City Definition	3	Vision element	Circular business models and behavioural patterns
	4	Category	Circular value chains and infrastructure Re-use and recycling
Indicator definition and description	5	Definition / description of indicator	30: Description of the digital material databank/marketplace in term of objective, type, scope, stage of development, target/user groups and other aspects deemed relevant 31: The impact of the digital marketplace is assessed by estimating the mass and value of material registered and traded per time period.
	6	Rationale	Accounting of materials from the demonstration site, put on a markedplace to make reused resources avaliable for contractors, housing developers, entrepreneurs, public city developers with projects preferrably with nearby projects. The ambition is to make -all- resources avaliable on this markedplace. Expected outcome DA1: A databank and a marketplace for reused materials has been established
	7	Methodology	30: See definition 31: Mass of materials registered per time period Mass of materials traded per time period Value of materials traded per time period Time period can be month or year Total mass should be registered, and optionally key material fractions
	8	Unit	30: Qualitative data 31: Tonnes / year, Monetary value/time
Data	9	Baseline data / definition	30: Amount of reused materials before and after the establishment of the markedplace. 31: As the demolition is not yet initiated, the baseline is 0. It is interesting to compare the amount of masses and materials that is -not- registered in this databank, with the resources that -is-.
	10	Data sources / relevant databases	30: Marketplace, contractors data, demolition data 31: Data from contractors, waste management companies, drone data, demolition logs
	11	Overall accuracy	Not very accurate as some mass quantitites needs to be assumed/modelled/calculated as opposed to when you actually weigh the resources.

Metadata group	#	Metadata category	Description / comments
Context	12	Sector coverage	Contractors, waste managers, city developers, housing developers
	13	Reference area / spatial implementation scale	Demonstration site
	14	Reference period	Second part of 2021 - 2023. Monthly reconciliation in databank.
	15	SDG reference	
Other	16	Comments	The city development project's timescale is almost 100 years

3.13. Indicator 32.1. Tool-based urban planning decisions | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	32.1
	2	Indicator name	Tool-based urban planning decisions
Link to Circular City Definition	3	Vision element	Circular business models and behavioural patterns
	4	Category	Circular value chains and infrastructure
Indicator definition and description	5	Definition / description of indicator	The proportion of urban planning decisions that are supported by tools for improved circularity (e.g. LCA tool)
	6	Rationale	The deployment of relevant data-based tools in decision-making potentially leads to reduced costs due to improved circularity. Expected outcome DA3: Increase in urban planning decisions that are supported by information from the 3D-GIS based visualisation tool, LCA tool, and circular business cases
	7	Methodology	Number of planning decions supported by information from the 3D-GIS based visualisation tool, LCA tool, and circular business cases divided by total number of planning decisions
	8	Unit	%
Data	9	Baseline data / definition	0%
	10	Data sources / relevant databases	Project managers and decision-makers in Bodø Municipality
	11	Overall accuracy	Accurate

Metadata group	#	Metadata category	Description / comments
Context	12	Sector coverage	Project managers and decision-makers in Bodø Municipality
	13	Reference area / spatial implementation scale	Demonstration site
	14	Reference period	Second part of 2021 - 2023
	15	SDG reference	
Other	16	Comments	

3.14. Indicator 39. Circular Material Use Rate | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	39
	2	Indicator name	Circular Material Use Rate
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	Re-use and recycling
Indicator definition and description	5	Definition / description of indicator	The circular material use rate (CMU), also called Circularity rate measures, in percentage, the share of material recovered and fed back into the economy - thus saving extraction of primary raw materials - in overall material use. A higher circularitity rate value indicates more secondary materials substituting for primary raw materials i.e. avoiding the environmental impacts of extracting primary material.
	6	Rationale	Expected outcome DA3: Circular material use rate increased by 10%
	7	Methodology	"Circularity rate (CMU) is defined as the ratio of the circular use of materials (U) to the overall material use (M). CMU = U/M = (RCV_R - IMPw + EXPw) / (DMC + RCV_R - IMPw + EXPw) The overall material use is measured by summing up the aggregate domestic material consumption (DM3. and the circular use of materials (M = DMC + U). DMC is defined in economy-wide material flow accounts. The circular use of materials is approximated by the amount of waste recycled in domestic recovery plants (RCV_R), minus imported waste destined for recovery (IMPw), plus exported waste destined for recovery abroad (EXPw). Waste recycled in domestic recovery plants comprises the recovery operations R2 to R11 as defined in the Waste Framework Directive 75/442/EEC. European statistics on international trade in goods (ITGS) are used to approximate the imports and exports of waste destined for recycling, i.e. the amount of imported waste bound for

Metadata group	#	Metadata category	Description / comments
			recovery (IMPw), and the amount of exported waste bound for recovery (EXPw).” Source: https://ec.europa.eu/eurostat/cache/metadata/EN/env_ac_cur_esms.htm
	8	Unit	%
Data	9	Baseline data / definition	Degree of circularity before and after CityLoops Derive data from national standards and evaluation point can then be likley taken from UCA.
	10	Data sources / relevant databases	Databank/material hotel, data from waste managers, contractors, entrepreneurs, Statistics Norway
	11	Overall accuracy	The complex nature of these calculations might compromise the accuracy
Context	12	Sector coverage	CDW, contractors, entrepreneurs, municipal waste handling
	13	Reference area / spatial implementation scale	Demonstration site
	14	Reference period	2019-2023. Yearly reconcilation. Data source: public reports, material databank, waste data. Measure improvement.
	15	SDG reference	
Other	16	Comments	At this indicator, we can look at baseline data that's older than CityLoops

3.15. Indicator 55. EOL-RR (End of Life Recycling/Reuse Rate) | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	55
	2	Indicator name	EOL-RR (End of Life Recycling Rate)
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	Re-use and recycling
Indicator definition and description	5	Definition / description of indicator	The End-of-Life Recycling Rate (EoL RR) measures the efficiency with which the mass contained in End-of-Life products is collected, pre-treated, and finally recycled.
	6	Rationale	Get a clear and data-based understanding of the EoL RR of the masses on demonstration site

Metadata group	#	Metadata category	Description / comments
			Expected outcome DA1: 80% of materials & masses stored onsite/near demonstration site have been prepared for reuse Expected outcome DA3: Within the plans for the new city disctrict, 70% of materials & masses from the demolition site shall be reused, reducing city wide use of virgin materials by 40%
	7	Methodology	For each material fraction, the End-of-Life reuse rate is defined as the End-of-Life mass reuse degree divided by the available mass of End-of-Life materials.
	8	Unit	%
Data	9	Baseline data / definition	EoL RR of masses on demonstration site
	10	Data sources / relevant databases	Databank/-hotel, data from contractors and entrepreneurs
	11	Overall accuracy	Complexity might compromise accuracy
Context	12	Sector coverage	CDW, contractors, entrepreneurs
	13	Reference area / spatial implementation scale	Demonstration site
	14	Reference period	2019-2023. Yearly reconcilation. Data source: public reports, material databank, waste data. Measure improvement.
	15	SDG reference	
Other	16	Comments	

4. 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.

5. 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

6. 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.

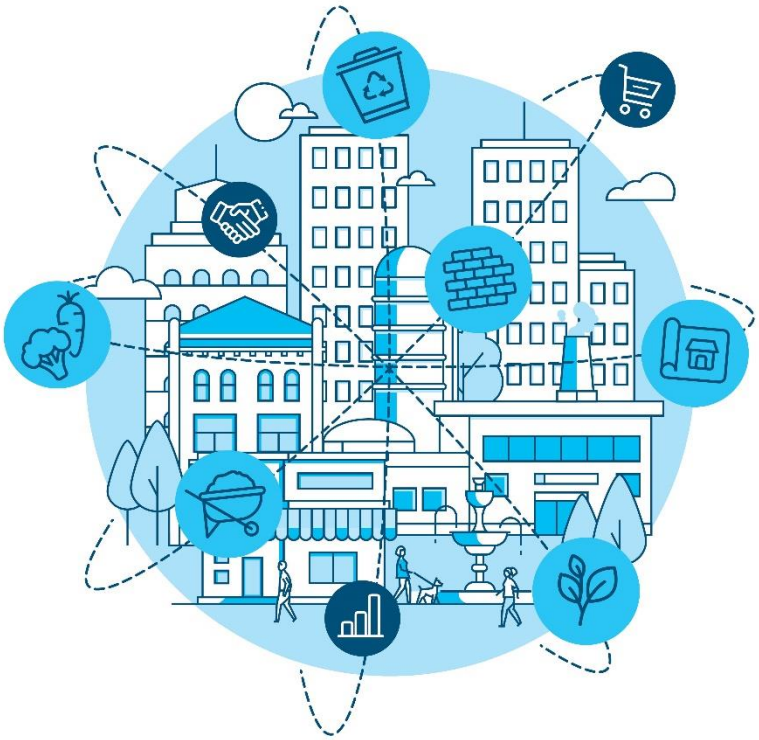
CityLoops runs from October 2019 until September 2023.

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

Evaluation Plan: CDW sector, Høje-Taastrup

Deliverable 6.2

Høje-Taastrup Municipality and Gate 21



Version	2.0
WP	6
Deliverable	6.2 (Evaluation Plan: Construction and Demolition Waste, Høje-Taastrup)
Date	18 February 2022
Dissemination level	Public
Deliverable lead	Gate 21
Authors	Erika Yates, Høje-Taastrup Laura Heron Jessen, Høje-Taastrup Line Bech, Gate 21 Caroline Juel Fritzen, Gate 21 Josephine Mikkelsen, Gate 21
Reviewers	Bjarne Lindeløv, NRI Megan Palmer-Abbs, NRI Jens Ørding Hansen, NRI
Abstract	This report details how the city of Høje-Taastrup will evaluate the impact of the CityLoops tools and demonstration activities aimed at improving the circularity of the Construction and Demolition Waste sector.
Keywords	Evaluation, Indicators, Høje-Taastrup Municipality, Construction and Demolition Waste
License	

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). 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 mainly on the demonstration actions but impacts at city scale are also included.

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 Høje-Taastrup. 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.

Høje-Taastrup Municipality is located in the Greater Copenhagen Area in Denmark. The municipality is aiming to influence a large number of construction and demolition projects with different ownership in order to encourage circular practices. Some projects are municipal while others are private, and they are at different stages of planning and execution at the start of the project. This enables HTK to see what impact the municipality can have by getting involved at various phases of each project and to develop and test planning and decision-making through these cases.

The Evaluation Plan for Høje-Taastrup Municipality will be presented in this report. In the CityLoops project Høje-Taastrup Municipality is focusing on the CDW sector. 5 demonstration actions and 6 different tools will be developed and tested during the CityLoops project in Høje-Taastrup Municipality. The demonstration actions and tools will focus on soil management and circular building projects. The aim of the projects and the tools is to encourage circular practices, influence a large number of construction and demolition projects and to test and develop a planning and decision-making framework aiming at integrating it in Høje-Taastrup's normal procedures. The evaluation plan can help other municipalities replicating the circular building processes, business cases and guidelines for circular economy.

1.1. Demo Action 1: Implementing circularity when selling town hall for demolition

Short description

Høje-Taastrup intends to implement selective demolition and circularity when selling the existing town hall for demolition. The aim is to impose a criterion that as much building material as possible should be reused and as much soil as possible should be kept on-site. The recoverable materials will be incorporated into new buildings or crushed on-site and used as filler. Some materials may also be used in other (as of yet unidentified) building projects off-site. Soil is either prevented from being dug up or reused on site.

Tools tested: 1, 2, 3 and 5

Expected outcomes

- The use of CityLoops tools (selective demolition, pre-demolition screening, LCA for soil and concrete and soil tools) are a part of tendering material and improve the mapping of materials for future use
- Increased stakeholder dialogue, leading to more circularity in tendering material
- Improved practice of including sustainability and circularity considerations in urban development plans and tendering criteria when selling municipal property
- Out of 18,000 tons of soil, 80% is kept on site (15,000 tons)
- Reduced consumption of virgin resources, by using recycled materials instead
- 30 tons of CO2e savings from soil kept on site. In addition, a reduction of CO2 is expected due to a more circular handling of other CDW.

1.2. Demo Action 2: Høje-Taastrup's New City Hall

Short description

A new town hall will be built using recycled concrete in the building foundation and other components. The concrete comes from demolition of eight apartment blocks at Taastrupgård (Demo action 3). Excess soil from the construction of the town hall will be used in Taastrupgård.

Tools tested: 1

Expected outcomes

See Demo Action 3 below. The expected outcomes of DA2 and DA3 are considered together.

1.3. Demo Action 3: Taastrupgård

Short description

Demolishing of eight apartment blocks and recycling the concrete. KAB, a social housing company, owns Taastrupgård. The concrete will be used by the municipality and in other building projects. 10,000 tons of concrete can be recycled. Of this, 2,000 tons will go into making the foundation and other components of the future city hall (see demo action 2); the other 8,000 tons will go into other projects. Gadehavegård is a potential replication project in Høje-Taastrup.

Tools tested: 1

Expected outcomes of DA2 and DA3

- Increased stakeholder dialogue, leading to more circularity in relation to CDW and soil reuse and recycling
- Improved practice of including sustainability and circularity considerations in the procurement process
- New business models for reuse, recycling, and valorisation of CDW and soil developed and validated
- Use of virgin resources (gravel) reduced by 1,088 tons
- The recoverable materials have been incorporated into new buildings or crushed on-site and used as filler. Some materials may also be used in other (as yet unidentified) building projects off-site
    - Recycling of 8,000 tons of concrete into filler in other projects
    - Recycling of 1,088 tons (high-value recycling) of concrete aggregate for the city hall foundation
- CO2 savings from reduced transport of soil and high-value recycling of concrete:
    - 9,000 tons of soil transported 3km instead of 25km, 15 tons of CO2e saved
    - CO2 savings from recycling 8,000 tons of concrete into filler in other projects. 4,000 tons are transported 3 km and 4,000 tons are transported 46 km.
    - CO2 savings from recycling 2,000 tons into 1,088 tons of concrete aggregate for the city hall foundation. Transport of concrete aggregate is halved, to approximately 50 km total. CO2 savings: 5 tons.

1.4. Demo Action 4: Recycled sidewalk tile

Short description

The concrete factory IBF will develop and produce a tile from 30% recycled concrete from excess concrete in their own production. It is locally produced in Hedehusene. Høje-Taastrup will look for possible test areas to try out the tiles in an area where the sidewalk is renovated.

Tools tested: None

Expected outcomes

- Increased awareness of using recycled tiles in projects (scaling potential)
- Reduced use of virgin material due to the use of recycled concrete aggregate
- Pilot project: 30% recycled concrete used in tiles
- CO2 savings from 100m sidewalk with tiles made from 30% recycled concrete

1.5. Demo Action 5: Circular soil management

Short description

Circular soil management at city level in order to keep excavation of soil to a minimum and use excess soil locally, instead of driving it farther away. A draft of the circular soil framework (tool 3) will be tested in this demo action, and results will feed into a template for the municipal soil strategy developed at later stage in the project. In HTK, the framework will be used for developing a politically adopted soil strategy, which will be used for managing soil from construction projects.

Tools tested: 3, 4, 5 and 6

Expected outcomes

- More local reuse of soil as a result of the implementation of CityLoops soil tools and LCA tool in soil management (25% reduction of what the prognosis predicts from 2020-2023)
- Increased involvement of planning department and developers has led to more awareness and earlier consideration of soil reuse potential
- New business models for reuse and valorisation of soil developed and validated
- General increase in reuse of soil on construction sites
- CO2 savings from 400,000 tons less excess soil transported

1.6. CityLoops Tools

Tools 1, 2, 3, 4, 5 and 6 are tested in the demonstration actions:

CityLoops Tools	Description
1. LCA	LCA tool for building materials and soil. Estimates the potential CO2-savings of keeping soil or reuse/recycle building materials.
2. Screening tool for selective demolition	Resource mapping with detailed screening for selective demolition. Guidelines for pre-demolition audit and selective demolition. Identifies materials with potential for reuse.
3. Framework for developing a circular soil strategy	The framework can help trying to influence the developers to reuse soil on site.
4. Instrument for predicting future excavated soil production	Predict annual volumes of future excavated soil within a period of 12 years (2020-2031). It will be evaluated by comparing predicted soil volumes with annual soil volumes reported for a period of 12 years.
5. Tool/methodology for assessing soil reuse potential	Geotechnical drilling tests will show what kinds of soil are present on site, to identify the types of soil and the reuse potential for different purposes.
6. Tool/methodology for identification and assessment of sites/projects fit for soil reuse	The general soil policy and strategic approach will focus on minimising the production of excavated soil and, secondarily, to keep excavated soil on-site if possible. The tool can be used when planning how to dispose of soil from construction sites within the municipality.

2. Indicators to be monitored

10 indicators have been chosen to evaluate the five demonstration actions and the six tools. The indicators represent both the different aspects of circular economy in the CityLoops project, and the different elements for a sustainable development where the environmentally, socially, and economically aspects also have to be considered. Furthermore, the indicators are chosen to represent the expected impacts from the project plan. The key impacts from the project plan includes scientific impacts, innovation/economic impacts, societal impacts, and environmental impacts. The indicators chosen in the evaluation plan can support a standardised documentation of the conductive elements with circular economy. The documentation can support replication of other CDW projects.

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 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 CityLoops project plans (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 to 4 list the selected indicators for each of the four Vision Elements in the CityLoops circular city definition (Vangelsten et al., 2021). The tables describe at which level the indicators will be applied (Demonstration Action or City level) and which Demonstration

Actions (and if relevant, application of CityLoops tools outside the Demonstration Actions) they will evaluate.

Table 1: List of indicators related to Vision Element 1 "Local Stakeholder Actions"

Indicator #	Indicator name	Scope (Demo /City)	Demo action 1	Demo action 2 + Demo action 3	Demo action 4	Demo action 5
3	New tools for better mapping of resources and their location: Qualitative description	D	X			X
9	New formal CE-based collaboration platforms/networks	C				
10	Stakeholder contribution to improved circularity	D	X	X	X	X
12	Circularity requirements in procurement beyond existing levels	D	X	X		
19	Progress towards circular city strategy objectives	C				

Table 2: List of indicators related to Vision Element 2 "Circular business models and behaviour patterns".

Indicator #	Indicator name	Scope (Demo /City)	Demo action 1	Demo action 2 + Demo action 3	Demo action 4	Demo action 5
23	Eco-innovation:	D		X		X

	Qualitative description[1]					

Table 3: List of indicators related to Vision Element 3 "Closing material loops and reducing harmful resource use"

Indicator #	Indicator name	Scope (Demo /City)	Demo action 1	Demo action 2 + Demo action 3	Demo action 4	Demo action 5
27	Increased share of materials retained and reused on demonstration sites	D	X			X
34	Reduced use of virgin materials	D	X	X	X	
52	Quantity of material subjected to recycling	D		X	X	

Table 4: List of indicators related to Vision Element 4 "Improving human wellbeing and reducing environmental impacts"

Indicator #	Indicator name	Scope (Demo/ City)	Demo action 1	Demo action 2 + Demo action 3	Demo action 4	Demo action 5
85	GHG emissions per year	D	X	X	X	X

Links between the selected indicators and the expected outcomes for the specific Demonstration Actions (and if relevant, application of tools outside the scope of the demonstration actions) are shown in the tables below.

Table 5: Linking expected outcomes to the selected indicators for Demonstration Action 1

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	The use of CityLoops tools (selective demolition, pre-demolition screening, LCA for	3. New tools for better mapping of resources and their location: Qualitative description

[1] CE business model refers for example to moving up the waste ladder/hierarchy described in D6.1 Figure 10 (page 40)

Vision Element	Expected outcome	Indicator
	soil and concrete and soil tools) are a part of tendering material and improve the mapping of materials for future use	
	Increased stakeholder dialogue leading to more circularity in tendering material	10. Stakeholder contribution to improved circularity
	Improved practice of including sustainability and circularity considerations in urban development plans and tendering criteria when selling municipal property	12. Circularity requirements in procurement beyond existing levels
3 Closing material loops and reducing harmful resource use	Out of 18,000 tons of soil, 80% is kept on site (15,000 tons)	27. Increased share of materials retained and reused on demonstration sites
	Reduced consumption of virgin resources, by using recycled materials instead	34. Reduced use of virgin materials
4 Improving human wellbeing and reducing environmental impacts	30 tons of CO2e savings from soil kept on site. In addition, a reduction of CO2 is expected due to a more circular handling of other CDW.	85. GHG emissions per year

Table 6: Linking expected outcomes to the selected indicators for Demonstration Action 2+3

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Increased stakeholder dialogue, leading to more circularity in relation to CDW and soil reuse and recycling	10. Stakeholder contribution to improved circularity
	Improved practice of including sustainability and circularity considerations in the procurement process	12. Circularity requirements in procurement beyond existing levels
2 Circular business models and	New business models for reuse, recycling, and valorisation of	23. Eco-innovation: Qualitative description

Vision Element	Expected outcome	Indicator
behaviour patterns	CDW and soil developed and validated	
3 Closing material loops and reducing harmful resource use	Use of virgin resources (gravel) reduced by 1,088 tons	34. Reduced use of virgin materials
	The recoverable materials have been incorporated into new buildings or crushed on-site and used as filler. Some materials may also be used in other (as yet unidentified) building projects off-site - recycling of 8,000 tons of concrete into filler in other projects - recycling of 1,088 tons (high-value recycling) of concrete aggregate for the city hall foundation	52. Quantity of material subjected to recycling
4 Improving human wellbeing and reducing environmental impacts	CO2 savings from reduced transport of soil and high-value recycling of concrete: 9,000 tons of soil transported 3km instead of 25km, 15 tons of CO2e saved CO2 savings from recycling 8,000 tons of concrete into filler in other projects. 4,000 tons are transported 3 km and 4,000 tons are transported 46 km. CO2 savings from recycling 2,000 tons into 1,088 tons of concrete aggregate for the city hall foundation. Transport of concrete aggregate is halved, to approximately 50 km total. CO2 savings 5 tons	85. GHG emissions per year

Table 7: Linking expected outcomes to the selected indicators for Demonstration Action 4

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Increased awareness of using recycled tiles in projects (scaling potential)	10. Stakeholder contribution to improved circularity

Vision Element	Expected outcome	Indicator
3 Closing material loops and reducing harmful resource use	Reduced use of virgin material due to the use of recycled concrete aggregate	34. Reduced use of virgin materials
	Pilot project: 30% recycled concrete used in tiles	52. Quantity of material subjected to recycling
4 Improving human wellbeing and reducing environmental impacts	CO2 savings from 100m sidewalk with tiles made from 30% recycled concrete	85. GHG emissions per year

Table 8: Linking expected outcomes to the selected indicators for Demonstration Action 5

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	More local reuse of soil as a result of the implementation of CityLoops soil tools and LCA tool in soil management (25% reduction of what the prognosis predicts from 2020-2023)	3. New tools for better mapping of resources and their location: Qualitative description
	Increased involvement of planning department and developers has led to more awareness and earlier consideration of soil reuse potential	10. Stakeholder contribution to improved circularity
2 Circular business models and behaviour patterns	New business models for reuse and valorisation of soil developed and validated	23. Eco-innovation: Qualitative description
3 Closing material loops and reducing harmful resource use	General increase in reuse of soil on construction sites	27. Increased share of materials retained and reused on demonstration sites
4 Improving human wellbeing and reducing environmental impacts	CO2 savings from 400,000 tons less excess soil transported	85. GHG emissions per year

Table 9: Linking expected outcomes to the selected indicators for city level

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Internal and external CE-based collaboration platforms/networks established: - Internal: A new environmental group is formed in the municipality focusing on implementing CE in the strategy of the city. The expected outcome from this group/network is to strengthen stakeholder engagement and create a better dialogue between the different departments in the municipality. - External: Scaling of the results from the demo projects to other municipalities and private projects within the municipality	9. New formal CE-based collaboration platforms/networks
	Raised awareness of circular practices across the administration and amongst local citizens and businesses. The internal sustainability group will make a roadmap for an action-oriented strategy for sustainability in the entire municipality.	19. Progress towards circular city strategy objectives

3. 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 that they will test.

3.1. New tools for better mapping of resources and their location: Qualitative description

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	3		
	2	Indicator name	New tools for better mapping of resources and their location: Qualitative description		
Link to Circular City Definition	3	Vision Element	x		1. Local stakeholder actions
					2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1	x	Engagement and capacity building
				x	Regulation and incentives
				x	Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience

Indicator definition and description	5	Definition / Description of indicator	Qualitative description of individual tools, including scope and scale (e.g. demonstration vs city level), target users.
	6	Rationale	The tools that are being used/tested in the demonstration actions will help make the projects more circular. The mapping of resources and their location can help the municipality with planning, reuse/recycling and get an overview of the resources in the area. The indicator will be used in the same way with all the demonstration actions. On demonstration level, the tools will be described more detailed. On city level, the tools will be described in a more general manner. The expected outcome is that the tools listed above will be used to improve mapping of CDW and soil resources in Høje-Taastrup municipality. It is expected that the tools will be scaled and integrated in normal procedure in Høje-Taastrup, and that the project managers using the tools have the adequate competence level to use to tools. The use of tools in the demo projects is expected to have a significant impact on recycle and reuse of CDW and soil and minimise the CO2 impact of the construction projects. These expected outcomes are listed in the demo projects above.
	7	Methodology	Qualitative description of how tools were used for each demo action and lessons learned + quantitative description, number of tools used for each demo action
	8	Unit	Qualitative data
Data	9	Baseline data / definition	Short qualitative description of tools available before the CityLoops tools were developed.
	10	Data Sources / Relevant Databases	Høje-Taastrup Municipality will provide the qualitative and quantitative description needed for the tools. The qualitative description will focus on: 1. How the tools are integrated in normal procedure in Roskilde Municipality (procedure description). 2. How the tools are used by the project managers and assessment of capacity and knowledge to use the tools (interview). The quantitative description will focus on 1. How many of the tools are used (number)
	11	Overall accuracy	Reasonably accurate local level qualitative insights
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	Demonstration actions: DA1 and DA5
	14	Reference period	1.10.2019 – 30.9.2023, three times of monitoring (baseline, interim - M36/Sept22, final - M44/May23)
	15	SDG Reference	12

Other	16	Comments	Corresponds to the project plan: Impact 1, Indicator 1a. *Reduced consumption of virgin construction and organic materials.*

3.2. New formal CE-based collaboration platforms/networks

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	9		
	2	Indicator name	New formal CE-based collaboration platforms/networks		
Link to Circular City Definition	3	Vision Element	x		1. Local stakeholder actions
					2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1	x	Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	# of CE-based collaboration platforms/networks # of members in CE-based collaboration platforms/networks		
	6	Rationale	It is important to know how the demo projects influence other relevant stakeholders. Therefore, the indicator will be divided into internal and external CE-based collaboration platforms/networks. Internal: A new environmental group is formed in the municipality focusing on implementing CE in the strategy of the city. The expected outcome from this group/network is to strengthen stakeholder engagement and create a better dialogue between the different departments in the municipality.		

			External: Learning network with other municipalities. The expected outcome of the network is to share know-how and experience by working with CE in the construction sector in the municipalities with the objective of scaling the results from the demo projects to other municipalities. The indicator will be used in the same way with all the demonstration actions.
	7	Methodology	Counting: a) Number of formalised CE-based collaboration platforms/networks b) Number of people in formalised CE-based collaboration platforms/networks and their position/department in the municipality.
	8	Unit	Number of networks Number of people (plus their position/department)
Data	9	Baseline data / definition	Baseline is 0 (only activities during the project are measured)
	10	Data Sources / Relevant Databases	The data needed for the internal CE-based collaboration platforms/network will be provided by Høje-Taastrup Municipality. The data needed for the external CE-based collaboration platforms/network will be provided by Gate 21. Participants lists, interviews with stakeholders, and lists of networking meetings will be used. Gate 21 provides a template for both.
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City: Høje-Taastrup Municipality
	14	Reference period	1.10.2019 – 30.9.2023, Data collected continuously (data will be filled in in the template after each meeting)
	15	SDG Reference	15
Other	16	Comments	Corresponds to the project plan: Impact 4, Indicator 4b. *Improved stakeholder collaboration in relation to CDW and soil reuse and recycling*

3.3. Stakeholder contribution to improved circularity

Metadata group	#	Metadata category	Fill in data for indicator		
Identifier	1	Indicator number	10		
	2	Indicator name	Stakeholder contribution to improved circularity		
Link to Circular City Definition	3	Vision Element	x	1. Local stakeholder actions	
				2. Circular business models and behavioural patterns	
				3. Closing material loops and reducing harmful resource use	
				4. Improving human well-being and reducing environmental impacts	
	4	Category	1	x	Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
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	The dialogue and collaboration between the municipality and the stakeholders are strategically important for the city. Both the internal and external CE-related stakeholder activities contribute to know-how, knowledge sharing and an increased awareness of CE. Expected outcome: New local stakeholder partnerships and procedures. Improved stakeholder collaboration in relation to CDW and soil reuse and recycling. The indicator will be used in the same way with all the demonstration actions.		
	7	Methodology	a) List inputs from stakeholders		

			b) Describe how it has been used by those that invited the stakeholder activity c) Describe how it has contributed to improved circularity Both the intern and extern stakeholder activities will incorporate interviews from the participants in the network. The focus will be on barriers and solutions. The information can be used as inspiration for other CE building projects.
	8	Unit	Qualitative data + potential quantitative impact data
Data	9	Baseline data / definition	Baseline is 0 (only activities during the project are measured)
	10	Data Sources / Relevant Databases	Interviews with internal stakeholder contribution to improved circularity will be provided by Høje-Taastrup Municipality and RUC. The data needed for the external stakeholder contribution to improved circularity will be provided by Gate 21. The data will be based on interviews with stakeholders. Invites, agenda and minutes from the different stakeholder meetings, workshops will be an important source of information
	11	Overall accuracy	Reasonably accurate local level qualitative insights
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	The reference areas for the internal network are: City: Høje-Taastrup Municipality taking point of departure in the demonstration actions: DA1, DA2, and DA3 The reference area for the external network is: Greater Copenhagen.
	14	Reference period	1.1.2021 – 30.9.2023, Data collected continuously
	15	SDG Reference	15
Other	16	Comments	Corresponds to the project plan: Impact 4, Indicator 4b. *Improved stakeholder collaboration in relation to CDW and soil reuse and recycling*

3.4. Circularity requirements in procurement beyond existing levels

Metadata group	#	Metadata category	Fill in data for indicator
Identi-fier	1	Indicator number	12
	2	Indicator name	Circularity requirements in procurement beyond existing levels

Link to Circular City Definition	3	Vision Element	x		1. Local stakeholder actions
					2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
				x	Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	Description of requirements in procurements going beyond what is current standard practice		
	6	Rationale	Procurement requirements are important to increase circularity in public demolition projects. The requirements will be tested in the demonstration actions in Høje-Taastrup Municipality. The indicator will be used in the same way with all the demonstration actions. I		
	7	Methodology	The methodology is a four-step approach: 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. 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 + potential quantitative impact data		
Data	9	Baseline data / definition	The baseline data will be a description of the current circularity requirements. The data will be described with the same methodology as used in this indicator.		

	10	Data Sources / Relevant Databases	The data needed will be provided by Høje-Taastrup Municipality Construction and demolition tenders and contracts will be used. Qualitative description from project manager (interview) supported by specific criteria tenders.
	11	Overall accuracy	Reasonably accurate local level qualitative insights but not scalable data.
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	Demonstration actions: DA1, DA2+DA3
	14	Reference period	1.1.2021 – 30.9.2023, three times of monitoring (baseline, interim - M36/Sept22, final - M44/May23)
	15	SDG Reference	12
Other	16	Comments	Corresponds to the project plan: Impact 4, Indicator 4a. *New Decision making guidelines and Circular procurement methods and guidelines*

3.5. Progress towards circular city strategy objectives

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	19		
	2	Indicator name	Progress towards circular city strategy objectives		
Link to Circular City Definition	3	Vision Element	x	1. Local stakeholder actions	
				2. Circular business models and behavioural patterns	
				3. Closing material loops and reducing harmful resource use	
				4. Improving human well-being and reducing environmental impacts	
	4	Category	1		Engagement and capacity building
					Regulation and incentives
				x	Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)

				Environment impacts (local) Economic impacts Impacts on urban resilience
Indicator description and definition	5	Definition / Description of indicator	Describe to which degree the city is making progress towards its circularity objectives. Identify categories of relevant strategy documents, select documents and relevant selected CE targets.	
	6	Rationale	Høje-Taastrup Municipality strives to incorporate CE in the building process. In 5 years, using recycled materials will be a commonly integrated component of building projects, and in 20 years it will be the new standard practice.	
	7	Methodology	For each of the identified targets: Describe ambition and judge on scale 1. no progress, 2. little progress, 3. some progress, 4. ambition nearly reached, 5. ambition reached or beyond	
	8	Unit	Score on categorical scale (1-5)	
Data	9	Baseline data / definition	The baseline (2019) will be defined on the categorical scale used in this indicator.	
	10	Data Sources / Relevant Databases	The data needed will be provided by Høje-Taastrup Municipality. The city's strategy documents, decisions and commitments on the promotion of CE will be used.	
	11	Overall accuracy	Reasonably accurate local level qualitative insights but not scalable data.	
Context	12	Sector coverage	CDW	
	13	Reference area / Spatial implementation scale	City: Høje-Taastrup Municipality	
	14	Reference period	1.1.2021 – 30.9.2023, three times of monitoring (baseline, interim - M36/Sept22, final - M44/May23)	
	15	SDG Reference	12	
Other	16	Comments	The circular city strategy objectives from the project plan can be found in 'Key impacts of CityLoops aimed for in the years following the conclusion of the project'	

3.6. Eco-innovation: Qualitative description

Metadata group	#	Metadata category	Fill in data for indicator	
Identifier	1	Indicator number	23	
	2	Indicator name	Eco-innovation: Qualitative description	
Link to Circular City	3	Vision Element		1. Local stakeholder actions
			x	2. Circular business models and behavioural patterns
				3. Closing material loops and reducing harmful resource use

					4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2	x	Circular design and business models
					Circular value chains and infrastructure
				x	Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
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	Business cases for reuse, recycling, and valorisation of CDW are developed during the CityLoops project in Høje-Taastrup Municipality. Business models for building materials (concrete) and soil will be described. The expected outcome is a business case on the demo-projects. The indicator will be used in the same way with all the demonstration actions.		
	7	Methodology	For each model, a qualitative description of model, its circular strategy		
	8	Unit	Qualitative data		
Data	9	Baseline data / definition	Baseline is 0		
	10	Data Sources / Relevant Databases	The data needed will be provided by Høje-Taastrup Municipality and the Danish Association of Construction Clients.		
	11	Overall accuracy	Reasonably accurate local level qualitative insights		
Context	12	Sector coverage	CDW		
	13	Reference area / Spatial implementation scale	Demonstration actions: DA2+DA3 and DA5		
	14	Reference period	Project period 1.1.2021 – 30.9.2023, baseline data and in the end of the project.		
	15	SDG Reference			

Other	16	Comments	Corresponds to the project plan: Impact 4, Indicator 4c. *New products, service concepts and business models relating to the reuse/recycling of the specific material flows addressed, leading to new business opportunities and job creation*

3.7. Increased share of materials retained and reused on demonstration sites

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	27		
	2	Indicator name	Increased share of materials retained and reused on demonstration sites		
Link to Circular City Definition	3	Vision Element			1. Local stakeholder actions
			x		2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
				x	Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
				x	Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	The relative share of materials retained and reused on demonstration sites, measured for selected/key on-site waste material fractions and the total mass of waste materials.		
	6	Rationale	Høje-Taastrup Municipality strives to increase reused/recycled materials in building projects. It is relevant to keep the materials and the soil on site, to reduce the CO2 emissions from both transportation and from consumption of virgin resources. The expected outcome is listed above under demo-projects. The indicator will be used in the same way with all the demonstration actions.		

	7	Methodology	For selected waste fractions and total mass of waste materials: Retained and reused mass of materials / total mass of (waste) materials at demonstration site
	8	Unit	Mass %
Data	9	Baseline data / definition	The baseline 0
	10	Data Sources / Relevant Databases	The data needed will be provided by Høje-Taastrup Municipality and other relevant organizations involved in the project. (Registration system for soil transport and for waste, prognosis for soil and waste production.) Data from CityLoops tools will be used.
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	Demonstration actions: DA1 and DA5
	14	Reference period	Evaluation period 1.1.2021 – 30.9.2023, three times of monitoring (baseline, interim - M36/Sept22, final - M44/May23)
	15	SDG Reference	
Other	16	Comments	Corresponds to the project plan: Impact 1, indicator 1e. *Materials retained on demonstration sites.*

3.8. Reduced use of virgin materials

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	34		
	2	Indicator name	Reduced use of virgin materials		
Link to Circular City Definition	3	Vision Element			1. Local stakeholder actions
					2. Circular business models and behavioural patterns
			x		3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3	x	Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being

				Environment impacts (global)
				Environment impacts (local)
				Economic impacts
				Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	Estimate the reduced use of virgin materials	
	6	Rationale	It is important to reduce (harmful) raw material consumption The expected outcome for the indictor is listed above under table 6	
	7	Methodology	Sum of reduced use of virgin materials	
	8	Unit	tons	
Data	9	Baseline data / definition	The use of virgin materials from similar projects previously done by Roskilde Municipality	
	10	Data Sources / Relevant Databases	The data needed will be provided by Høje-Taastrup Municipality and other relevant organizations involved in the project.	
	11	Overall accuracy	Reliable with some estimation uncertainties.	
Context	12	Sector coverage	CDW	
	13	Reference area / Spatial implementation scale	Demonstration action: DA2	
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected three times (baseline, interim - M36/Sept22, final - M44/May23)	
	15	SDG Reference		
Other	16	Comments	Corresponds to the project plan: Impact 2, Indicator 2a. *Increased recycling/reuse rate of CDW/soil and organic matter within the city boundaries.*	

3.9. Quantity of material subjected to recycling

Metadata group	#	Metadata category	Fill in data for indicator	
Identi-fier	1	Indicator number	52	
	2	Indicator name	Quantity of material subjected to recycling	
Link to Circular City	3	Vision Element		1. Local stakeholder actions
				2. Circular business models and behavioural patterns
			x	3. Closing material loops and reducing harmful resource use

				4. Improving human well-being and reducing environmental impacts	
	4	Category	1		Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
				x	Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	Estimate material subjected to recycling at demo, sector and city level. 'Recycling' means processing of materials to achieve the original high-quality or reduce to low quality.		
	6	Rationale	Recycled materials are important for a sustainable development for Høje-Taastrup Municipality. Several demonstration projects aim to promote recycling of demolition materials in Høje-Taastrup. The expected outcome is listed above under demo-projects. The indicator will be used in the same way with all the demonstration actions.		
	7	Methodology	Sum up mass of each waste material category subjected to recycling. Data may come from contractors, statistical offices, waste management companies or the Sector Circularity Assessment Method. The aim is to develop a methodology to differentiate high-value and low value recycling. CDW is already recycled in Denmark but to a low value. The aim is to increase the level of high-value recycling.		
	8	Unit	tons/year		
Data	9	Baseline data / definition	The quantity of material subjected to recycling from similar projects previously done by Høje-Taastrup Municipality.		
	10	Data Sources / Relevant Databases	The data needed will be provided by Høje-Taastrup Municipality and other relevant organizations involved in the projects.		
	11	Overall accuracy	Reliable with some estimation uncertainties.		
Context	12	Sector coverage	CDW		
	13	Reference area / Spatial implementation scale	Demonstration action: DA2+DA3 and DA4		

	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected three times (baseline, interim - M36/Sept22, final - M44/May23)
	15	SDG Reference	12
Other	16	Comments	Corresponds to the project plan: Impact 2, Indicator 2a. *Increased recycling/reuse rate of CDW/soil and organic matter within the city boundaries.*

3.10. GHG emissions per year

Metadata group	#	Metadata category	Fill in data for indicator		
Identifier	1	Indicator number	85		
	2	Indicator name	GHG emissions per year		
Link to Circular City Definition	3	Vision Element			1. Local stakeholder actions
					2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
			x		4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
				x	Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
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 is calculated for demonstration actions. Focus is on direct emissions.		
	6	Rationale	All the actions in the CityLoops project aim to have an impact on the reduction of GHG. Høje-Taastrup Municipality is part of 'DK2020', a partnership between Danish municipalities, that aims to develop climate action plans in line with the Paris Agreement and C40 framework. The reduction of GHG is an important element in this strategy.		

			The expected outcome is listed above under demo-projects. The indicator will be used in the same way with all the demonstration actions.
	7	Methodology	Direct GHG emissions per demo project calculated with use of LCA tool. Data is volume of reused/recycled material and transportation distances from demolition place to and from depot to construction place
	8	Unit	Tons CO2-equivalents
Data	9	Baseline data / definition	Demonstration level: baseline Is 0
	10	Data Sources / Relevant Databases	Statistics from Høje-Taastrup Municipality In demo project 1 the demolition is planned to take place in 2023. All data might not be available within the time frame of CityLoops. However, a calculation based on assumptions/potenials can be carried out.
	11	Overall accuracy	Medium accuracy, estimated
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	Demonstration actions: DA1, DA2+DA3, DA4, and DA5
	14	Reference period	1.10.2019 – 30.9.2023, yearly or per demonstration case
	15	SDG Reference	
Other	16	Comments	Corresponds to the project plan: Impact 1, Indicator 1c. *Reduced emissions of CO2, NOx and PM related to extraction, processing and transportation (incl. logistics) of construction and organic materials.*

4. 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.

5. 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

6. 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.

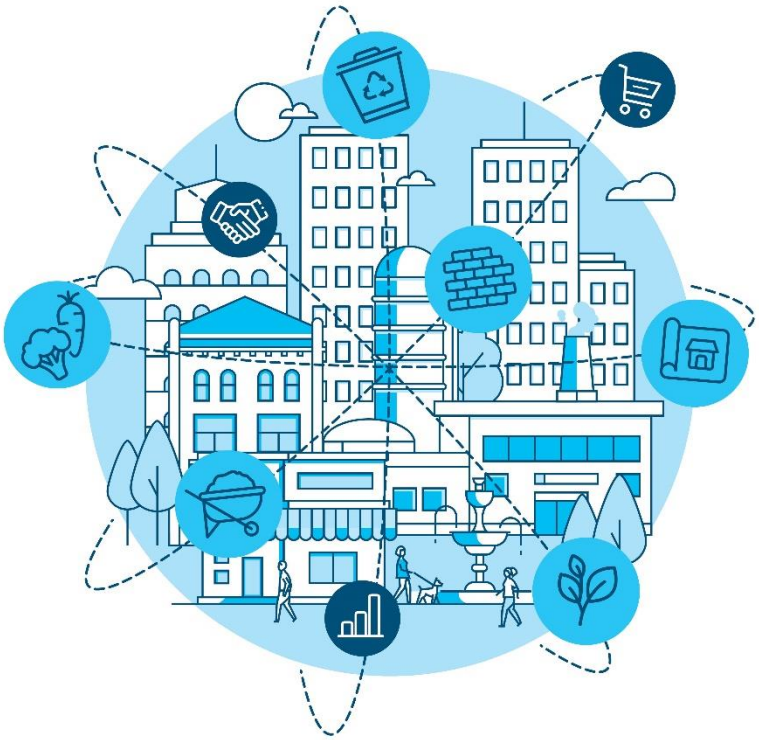
CityLoops runs from October 2019 until September 2023.

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

Evaluation Plan: CDW and Biowaste sectors, Mikkeli

Deliverable 6.2

Xamk and Miksei



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Abstract	This report details how the city of Mikkeli will evaluate the impact of the CityLoops tools and demonstration activities aimed at improving the circularity of the Construction and Demolition Waste and Biowaste sector.
Keywords	Evaluation, Indicators, City of Mikkeli, Construction and Demolition Waste, Biowaste
License	

Contents

1. Evaluation plan for CDW

1.1. Introduction (CDW)

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). 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.

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.

Mikkeli is a city located in eastern Finland, South-Savo Region, on the shores of the fourth largest lake in Europe, Lake Saimaa. Mikkeli has a population of 52,583 (2020) and covers an area of 3,229.57 km² of which 681.11 km² is water. Mikkeli has been involved in municipal climate work since the 1990s and has been part of the climate network since 1997. Finland's goal is to be carbon neutral by 2035 and Mikkeli will achieve carbon neutrality by 2030 at the latest. An important aspect of holistic development related to climate, environment and natural resources is the transition from waste management to a circular economy. The Finnish Waste Act, which will be reformed in 2021, is also based on this thinking. The priority is to use materials efficiently, avoid waste generation and utilize material flows in a way that makes sense for the whole. In 2020, Mikkeli adopted the Declaration of European Circular Economy Cities. In it, the city is committed to developing and promoting the circular economy and raising awareness.

Regarding construction and demolition waste (CDW), Mikkeli recycles 85% of the 33,000 tonnes of CDW it produces per year, using the recycled material mostly for road- and landfilling. Through CityLoops, it aims to substantially improve the rate of CDW reuse and recycling in the City of Mikkeli and create new business opportunities for local companies.

1.1.1. Demonstration action: Circular demolition of 2 buildings

Mikkeli's demonstration involves the demolition of two public buildings using circular material management methods, including digital tools: Pankalampi Health Care Centre (Figure 1) and Tuukkala hospital (Figure 2). In the preparation phase, Mikkeli Development Miksei Ltd and South-Eastern Finland University of Applied Sciences (XAMK) have engaged relevant stakeholders such as the municipality, the operations centre responsible for public equipment, and the public waste management company (Metsäsairila Ltd). To carry out the demolitions with circular material management, the sites will be scanned, and a pre-demolition audit will identify potentially recoverable materials and their characteristics. After a selective demolition procedure, salvaged materials will be incorporated into the digital databank and construction material marketplace. Miksei Mikkeli will promote use of the marketplace by other construction sector actors, private and public, both to offer and to obtain secondary construction materials. After evaluation of the pilot demolitions, the learnings and experience will be incorporated into a circular demolition operations model and generic demolition contract that can be applied in further public projects.

Figure 1. Demonstration building Pankalampi Health Center. (Photo Esa Hannus)

Figure 2. Demonstration building Tuukkala Hospital (Photo Esa Hannus)

CityLoops tools/processes tested during the demonstration action:

- *Life Cycle Assessment for demolition and renovated sites or assessment of environmental impacts of the CDW from the demonstration objects*: The methodology for a life cycle comparison of demolition and renovation sites developed by HTK/RK is tested in the demonstration sites.

- *Pre-demolition screening procedure & selective demolition guidelines*: A Pre-demolition inspection and operations model developed together with HTK/RK and Apeldoorn is tested in demonstration sites. The tool cover instructions and guidelines for resource mapping (pre-demolition audit), selective demolition and transformation to building materials. During demonstration actions, sampling and analysis will be performed in order to monitor environmental and health effects.

- *3D-modelling tool for tracking the flows of on-site CDW*: A model for drone imaging will be developed for the use on demolition sites to track material flows. Tool will be tested on the demonstration sites. This will allow the documentation and modelling of material flows during the demonstrations to help track and estimate the quantities of different material already on site.

- *Databank and digital market-place for recovered materials*: Two connected online platforms will be created. A materials databank will provide information on the quantities of different materials available on the demolition sites. This will allow an effective assessment of the Circular Economy opportunities where waste is generated and will serve as a tool for traceability. An online digital marketplace has been established and will be tested in the demo sites. It will enable the recycling of CDW and materials, services, logistics and workforce.

Expected outcomes

The CityLoops project promotes both theory and practice of CE in European cities. Key impacts of the project as listed in the Grant Agreement are presented in Annex 1. The following city specific impacts listed for Mikkeli in the CityLoops project are related to this demonstration action (Circular demolition of 2 buildings).

- At the end of the project, several new local stakeholder partnerships and procedures with authorities and waste management and construction companies related to demonstration actions (3 stakeholder groups, 30 participating workshops/events/round tables, interviews, meetings, workshops)
- At the end of the project, the skills and knowledge of the citizens and companies in CDW sector (both in Mikkeli and national level) have increased as a result of several new/innovative/strengthened stakeholder engagement tools/procedures related to demonstration actions (webinars, press releases, media articles, newsletter, replication, national meetings).
- The circular economy has been taken into account in the procurement process for demo projects and the tender includes circular economy requirements.
- New planning instrument/tools have been tested in the City of Mikkeli for decision making and monitoring of demonstration projects. Identifying procurement tool for special characteristics in a tender has been updated based on the demo projects.
- Selective demolition has been used in demonstration cases. Over 95% of CDW is sorted onsite for recycling and material or energy recovery.
- Digital marketplace for secondary materials established and in use.
- At the end of the demonstration action, we expect a 10% increase in the cost effectiveness in the demolition of buildings (demolition, transport and treatment of CDW) as compared to the baseline values for similar demolition projects.
- At the end of the demonstration action several items (materials/equipment) have been prepared for reuse.
- At the end of the demonstration action, 5% of materials are retained and reused on demonstration sites.

1.1.2. City-wide application of tool A: Planning & Decision-Making Guidelines

A set of generic guidelines (e.g. procurement guidelines) is developed for incorporating circularity systemically in planning and decision-making processes for construction and demolition projects.

Miksei Mikkeli aims to have CityLoops planning and decision-making guidelines become part of a stable decision-making process with good buy-in from city-companies and city departments involved. Miksei Mikkeli will implement and test the guidelines before, during and after the demolition of the two buildings, including through workshops with stakeholders who impact the local building material and demolition value chain. Following the pilot demolitions, Miksei Mikkeli will consider application of the guidelines in other areas of the internal organisation and seek out the opportunity to apply them in other public construction and demolition projects of the city.

Expected outcomes

The following city-specific impacts listed for Mikkeli in the CityLoops project are related to this city-level application of planning and decision-making guidelines:

- 100% of the procurement of demolition projects in Mikkeli will include the new guidelines for screening and selective demolition, making these an essential part of the procurement processes within the City of Mikkeli.
- The City of Mikkeli wants to be a nationally well-known "Circular Economy City" and operates according to the CE closed loops principles. Circular economy is incorporated in new city-wide strategic objectives.
- At the end of the project, use of CDW (especially crushed concrete) to replace virgin construction materials (soil) have been increased as a result of new guidelines in planning and decision making. As a result, consumption of virgin construction materials within the city of Mikkeli has decreased by 5%.
- At the end of the project, 5% reduction in the emissions of CO2 related to extraction, processing and transportation (incl. logistics) of construction materials (replacement of virgin soil material with crushed concrete).

1.1.3. City-wide application of tool B: Business Cases

Business cases for reuse, recycling and valorization of CDW are developed.

To explore the potential business case for scaling up circular CDW management practices, Miksei Mikkeli and XAMK are holding innovation workshops with stakeholders including the City of Mikkeli, local waste management company and the operational centre responsible for public equipment at least once per month during the preparation and implementation phase of the demonstrations.

One focus on business cases is to collect and analyse data in order to calculate a feasible, scalable model based on experience in the demonstrations. This involves active efforts from Miksei Mikkeli to encourage users (both supply and demand) of the digital material marketplace and find buyers for the salvaged building parts and equipment.

Expected outcomes

Business case development aims to promote circular economy of construction and demolition waste and increase the reuse and recycling of materials. The following impacts listed for Mikkeli in the CityLoops project are specific for city-wide application of tool B (business cases):

- New products, service concepts and business models relating to the reuse/recycling and upcycling of the specific material flows addressed, leading to new business opportunities.
- At the end of the project, the project activities are a component of creating a greener environment and providing a more sustainable economy in the city of Mikkeli (new jobs: 20 – all external).
- At the end of the project, the recycling rate of CDW is close to 75% (CDW prepared for recycling and other material recovery, including backfilling) (95% if energy recovery included). 10% increase in recycling rate and 40% increase in upcycled amount of CDW as compared to baseline statistics from year 2019.
- At the end of the project, 5% reduction in the amount of CDW landfilled or incinerated as compared to the baseline statistics from year 2019.

1.2. Indicators to be monitored (CDW)

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 the application of CityLoops tools 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 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 CityLoops project plans (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 to Table 4 lists the selected indicators for each of the four Vision Elements in the CityLoops circular city definition (Vangelsten et al., 2021). The tables describe at which level the indicators will be applied (Demonstration Action or City level) and which Demonstration Actions (and if relevant, application of CityLoops tools outside the Demonstration Actions) they will evaluate.

A total of 21 indicators were selected from the CityLoops indicator set to monitor CDW. These indicators describe the aims and actions of the CityLoops project to promote circular economy related to construction and demolition waste streams in the City of Mikkeli. Most of selected indicators measure the impact of the project activities on demonstration sites Pankalampi and Tuukkala. Some of the indicators measure the development of the circular economy at the city level. For example, business cases are developed at the city level. City-level effects can also be measured with the statistics of waste management company. In Mikkeli, all the activities increasing circularity of CDW are developed and demonstrated in close collaboration with local and national stakeholders.

Table 1: List of indicators related to Vision Element 1 "Local Stakeholder Actions". Demo action 1a: Demolition of Pankalampi health center. Demo 1b: Demolition of Tuukkala hospital. Tool application A. Guidelines for planning and decision-making, Tool application B. Business case development.

Indi-cator #	Indicator name	Scope (Demo/ City)	Demo action	Tool app A	Tool app B
6	Circularity related stakeholder activities	D	X		
11	Communication measures on circular transformations and waste prevention	D	X		
12	Circularity requirements in procurement beyond existing levels	D	X	X	

15	Procurement with circularity requirements beyond existing levels: Impact	D	X	X	
19	Progress towards circular city strategy objectives	C		X	
21	New planning instruments/tools for improved circularity: Qualitative description	D or C	X	X	
22	New planning instruments/tools for improved circularity: Impact	D or C	X	X	

Table 2: List of indicators related to Vision Element 2 "Circular business models and behaviour patterns". Demo action 1a: Demolition of Pankalampi health center. Demo 1b: Demolition of Tuukkala hospital. Tool application A. Guidelines for planning and decision-making, Tool application B. Business case development.

Indi-cator #	Indicator name	Scope (Demo/ City)	Demo action	Tool app A	Tool app B
23	Eco-innovation: Qualitative description	C			X
24	Eco-innovation: Impact	C			X
27	Increased share of materials retained and reused on demonstration sites	D	X		
28	Volume onsite sorting (Improved source separation)	D	X		
30	New digital material databank/marketplace: Qualitative description	D	X		
31	New digital material databank/marketplace: Impact	D	X		
32	Reduced costs due to improved circularity	D	X		
33	CE-based employment	C			X

Table 3: List of indicators related to Vision Element 3 "Closing material loops and reducing harmful resource use". Demo action 1a: Demolition of Pankalampi health center. Demo 1b: Demolition of Tuukkala hospital. Tool application A. Guidelines for planning and decision-making, Tool application B. Business case development.

Indi-cator #	Indicator name	Scope (Demo/ City)	Demo action	Tool app A	Tool app B
35	Domestic material consumption (DMC) of virgin materials	C		X	
49	Quantity of material subjected to reuse	D	X		
55	EOL-RR (End of Life Recycling Rate)	D and C			X
59	Incineration rate	D and C			X
61	Landfilling rate	D and C			X

Table 4: List of indicators related to Vision Element 4 "Improving human wellbeing and reducing environmental impacts". Demo action 1a: Demolition of Pankalampi health center. Demo 1b: Demolition of Tuukkala hospital. Tool application A. Guidelines for planning and decision-making, Tool application B. Business case development.

Indi-cator #	Indicator name	Scope (Demo/ City)	Demo action	Tool app A	Tool app B
85	GHG emissions per year	C/D		X	

Links between the selected indicators and the expected outcomes for the specific Demonstration Actions and application of tools outside the scope of the demonstration actions are shown in the tables below.

Table 5: Linking expected outcomes to the selected indicators for Demonstration Action (Circular demolition of 2 buildings).

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	By the end of the project, several new local stakeholder partnerships and procedures with authorities and waste management and construction companies established related to demo actions (3 stakeholder groups, 30 participating workshops/events/round tables, interviews, meetings, workshops)	6. Circularity related stakeholder activities
	By the end of the project, the skills and knowledge of the citizens and companies in CDW sector (both in Mikkeli and national level) have increased as a result of several new/innovative/strengthened stakeholder engagement tools/procedures related to demo actions (webinars, press releases, media articles, newsletter, replication, national meetings)	11. Communication measures on circular transformations and waste prevention
	The circular economy has been taken into account in the procurement process for demo projects and the tender includes circular economy requirements	12. Circularity requirements in procurement beyond existing levels 15. Procurement with circularity requirements beyond existing levels: Impact
	New planning instrument/tools have been tested in the City of Mikkeli for decision making and monitoring of demonstration projects. Identifying procurement tool for special characteristics in a tender has been updated based on the demo projects.	21. New planning instruments/tools for improved circularity: Qualitative description 22. New planning instruments/tools for improved circularity: Impact
2 Circular business models and behaviour patterns	At the end of the demonstration action, 5% of materials are retained and reused on demonstration sites.	27. Increased share of materials retained and reused on demonstration sites
	Selective demolition has been used in demonstration cases. Over 95%	28. Volume onsite sorting (Improved source separation)

Vision Element	Expected outcome	Indicator
	of CDW is sorted onsite for recycling and material or energy recovery.	
	Digital marketplace for secondary materials established and in use.	30. New digital material databank/marketplace: Qualitative description 31. New digital material databank/marketplace: Impact
	By the end of the demo action, a 10% increase in the cost effectiveness in the demolition of buildings (demolition, transport and treatment of CDW) compared to the baseline values for similar demolition projects	32. Reduced costs due to improved circularity
3 Closing material loops and reducing harmful resource use	At the end of the demonstration action several items (materials/equipment) have been prepared for reuse	49. Quantity of material subjected to reuse

Table 6. Linking expected outcomes to the selected indicators for city-wide application of Tool A: Planning & Decision-making guidelines

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	100% of the procurement of demolition projects include the new guidelines for screening and selective demolition, making these an essential part of the procurement processes within the City of Mikkeli.	12. Circularity requirements in procurement beyond existing levels 15. Procurement with circularity requirements beyond existing levels: Impact 21. New planning instruments/tools for improved circularity: Qualitative description 22. New planning instruments/tools for improved circularity: Impact
	The City of Mikkeli is well known as "Circular Economy City" and operates according to the CE closed loops principles. Circular economy is incorporated in new strategic objectives.	19. Progress towards circular city strategy objectives (City-level)

Vision Element	Expected outcome	Indicator
3 Closing material loops and reducing harmful resource use	At the end of the project, use of CDW (especially crushed concrete) to replace virgin construction materials (soil) has increased as a result of new guidelines in planning and decision making. 5% reduction in consumption of virgin construction materials within the city of Mikkeli.	35. Domestic material consumption (DMC) of virgin materials
4 Improving human wellbeing and reducing environmental impacts	By the end of the project, 5% reduction in the emissions of CO2 related to extraction, processing and transportation (incl. logistics) of construction materials (replacement of virgin soil material with crushed concrete).	85. GHG emissions per year (demo-level)

Table 7. Linking expected outcomes to the selected indicators for city-wide application of Tool B: Business cases

Vision Element	Expected outcome	Indicator
2 Circular business models and behaviour patterns	New products, service concepts and business models relating to the reuse/recycling and upcycling of the specific material flows established, leading to new business opportunities.	23. Eco-innovation: Qualitative description (City-level) 24. Eco-innovation: Impact (City-level)
	At the end of the project, the project activities are a component of creating a greener environment and providing a more sustainable economy in the city of Mikkeli (new jobs: 20 – all external).	33. CE-based employment (City-level)
3 Closing material loops and reducing harmful resource use	At the end of the project, the recycling rate of CDW is close to 75% (CDW prepared for recycling and other material recovery, including backfilling) (95% if energy recovery included). 10% increase in recycling rate and 40% increase in upcycled amount of CDW as compared to baseline statistics from year 2019.	55. EOL-RR (End of Life Recycling Rate) (city-level)
	At the end of the project, 5% reduction in the amount of CDW	59. Incineration rate (city-level) 61. Landfilling rate (city-level)

Vision Element	Expected outcome	Indicator
	landfilled or incinerated as compared to the baseline statistics from year 2019.	

1.3. Plan for monitoring CDW

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 that they will test.

1.3.1. Circularity related stakeholder activities

Metadata group	#	Metadata category	Fill in data for indicator
Identifier	1	Indicator number	6
	2	Indicator name	Circularity related stakeholder activities
Link to	3	Vision Element	1. Local stakeholder actions
	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 # of people involved
	6	Rationale	Several stakeholder actions are conducted during the CityLoops project and demonstration projects in the City of Mikkeli in order to develop tools and circular economy in close collaboration with local authorities and companies. Expected outcomes: - At the end of the project, several new local stakeholder partnerships and procedures with authorities and waste management and construction companies related to demonstration actions (3 stakeholder groups, 30 participating workshops/events/round tables, interviews, meetings, workshops)

	7	Methodology	a) Identify stakeholder activity (stakeholder groups: 1. Waste and demolition group, 2. Construction and business cases, 3. Additional stakeholders) b) Describe process and when stakeholders are involved c) Identify dialogue methods used (e.g. meetings, networking meetings or interviews with local or national stakeholders) d) Number of people involved
	8	Unit	Qualitative data Number of people
Data	9	Baseline data / definition	Baseline 0 (only activities during the project are measured)
	10	Data Sources / Relevant Databases	Meeting memos Participant lists List of other networking meetings and interviews (date and participants)
	11	Overall accuracy	Not relevant for qualitative descriptions Reliable data (number of people)
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, Demo-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Monthly meetings with Group 1 Group 2-3: several meetings yearly
	15	SDG Reference	
Other	16	Comments	Networking meetings and interviews are organised also at national level (not only stakeholders from City of Mikkeli)

1.3.2. Communication measures on circular transformations and waste prevention

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	11
	2	Indicator name	Communication measures on circular transformations and waste prevention
Link to Circular	3	Vision Element	1. Local stakeholder actions

City Definition	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	Several communication measures are conducted for general public and companies during the CityLoops project in the City of Mikkeli in order to increase knowledge on CE of CDW. The goal is to develop a process, which inspires individuals, groups, businesses, institutions and others to improve their interaction and to cooperate effectively for promoting circular economy. Expected outcomes: - At the end of the project, the skills and knowledge of the citizens and companies in CDW sector (both in Mikkeli and national level) have increased as a result of several new/innovative/strengthened stakeholder engagement tools/procedures related to demonstration actions (webinars, press releases, media articles, newsletter, replication, national meetings).
	7	Methodology	a) Number of communication measures (e.g. webinars/seminars organised by the project, CityLoops presentations in other webinars/seminars, press releases, articles in media, published research articles, newsletter, web pages) towards general public on CE transformation b) Number of people reached
	8	Unit	Number of communication measures Number of people
Data	9	Baseline data / definition	Baseline 0 (only activities during the project are measured)
	10	Data Sources / Relevant Databases	• Published press releases and articles in media (and edition of newspaper if available) • Published research articles (and number of editions of magazine or reports if available) • Participant lists of webinars and other events. • Number of visitors in web pages: number of hits on website. Internet visitor counter on the pages/articles of City Loops -project in www.mikseimikkeli.fi and www.xamk.fi/cityloops on CL • Number of recipients of a newsletter • List of publications / posts in social media (and number of viewers if available)
	11	Overall accuracy	Reliable data (number of articles, number of participants in webinars/workshops organised by the project, number of visits in web pages)

			Uncertainty related to following data: number of editions are maybe not always available, number of participants in other webinars/events can be estimations)
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli and Finland, demo-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data collected continuously: Several articles, newsletters, workshops/webinars etc. per year
	15	SDG Reference	
Other	16	Comments	

1.3.3. Circularity requirements in procurement beyond existing levels

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identifier	1	Indicator number	12
	2	Indicator name	Circularity requirements in procurement beyond existing levels
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	4	Category	Regulation and incentives
Indicator definition and description	5	Definition / Description of indicator	Description of requirements in procurements going beyond the current standard practices.
	6	Rationale	Procurement guidelines are prepared as a result of CityLoops project for City of Mikkeli to increase circularity in public demolition projects. Guidelines include new circular economy requirements beyond standard practice. The guidelines will be tested in demonstration sites Tuukkala hospital and Pankalampi health center and the impacts are assessed as demonstration level. Indicator 15 is selected together with indicator 12. Expected outcomes: - The circular economy has been taken into account in the procurement process for demo projects and the tender includes circular economy requirements.

			- 100% of the procurement of demolition projects will include the new guidelines for screening and selective demolition, making these an essential part of the procurement processes within the City of Mikkeli.
	7	Methodology	a) Decide which procurements are relevant for analysis (e.g. demo action focused procurements only or a wider range of procurements) b) Describe current standard practice in terms of CE requirements. c) For each procurement case, describe additional requirements beyond standard practice. d) In case of several relevant procurements, summarize relevant progress beyond existing levels
	8	Unit	Qualitative data Potential quantitative impact data
Data	9	Baseline data / definition	Demands related to circularity in Mikkeli city's demolition contract procurement documents of recent demolition projects before project started. The baseline is described using the same method and data sources (procurement documents) as the post demonstration action values.
	10	Data Sources / Relevant Databases	Demolition contract offer documents of demonstration sites and earlier demolition projects and guide for the city of Mikkeli's demolition projects. Data from authorities, City of Mikkeli, Tilapalvelut). Data collection based on personal communication.
	11	Overall accuracy	Not relevant
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, Demo- and City level
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Qualitative description after the procurement/demolition process of the demonstration projects (baseline data already collected).
	15	SDG Reference	
Other	16	Comments	

1.3.4. Procurement with circularity requirements beyond existing levels: Impact

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	15

	2	Indicator name	Procurement with circularity requirements beyond existing levels: Impact
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	4	Category	Regulation and incentives
Indicator definition and description	5	Definition / Description of indicator	# of procurements with circularity requirements Value of procurement with circularity requirements
	6	Rationale	Procurement guidelines are prepared as a result of CityLoops project for City of Mikkeli to increase circularity in public demolition projects. Guidelines include new circular economy requirements beyond standard practice. The guidelines are applied to demonstration sites Tuukkala hospital and Pankalampi health center and the impacts are assessed as demonstration level. Indicator 15 is selected together with indicator 12. Expected outcomes: - The circular economy has been taken into account in the procurement process for demo projects and the tender includes circular economy requirements. - 100% of the procurement of demolition projects will include the new guidelines for screening and selective demolition, making these an essential part of the procurement processes within the City of Mikkeli.
	7	Methodology	For each action: • Type of procurement action • Value of procurement For the whole period considered: • Time period • Number of procurement contracts • Sum up the total value of these contracts.
	8	Unit	Number of actions (changes in procurement documents) Monetary value of procurements (demonstration cases Tuukkala and Pankalampi) Number of qualitative demands, number of sorted waste fractions, fraction of unsorted material
Data	9	Baseline data / definition	Data from recent demolition projects of city of Mikkeli. The baseline is calculated using the same method and data sources (procurement documents) as the post demonstration action values.
	10	Data Sources / Relevant Databases	Demolition contract offer documents. Waste statistics of Metsäsairila Ltd. Waste report of contractor (from authorities, City of Mikkeli, Tilapalvelut). Data collection based on personal communication.
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW

	13	Reference area / Spatial implementation scale	City of Mikkeli, demo- and city level
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected after the procurement/demolition process of the demonstration projects (baseline data already collected).
	15	SDG Reference	
Other	16	Comments	

1.3.5. Progress towards circular city strategy objectives

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	19
	2	Indicator name	Progress towards circular city strategy objectives
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	4	Category	Vision and urban management
Indicator definition and description	5	Definition / Description of indicator	Describe to which degree the city is making progress towards its circularity objectives. Identify categories of relevant strategy documents, select documents and relevant selected CE targets.
	6	Rationale	The CityLoops project contribute to the development of a circular economy in the city of Mikkeli. Expected outcomes: - The City of Mikkeli wants to be nationally well-known "Circular Economy City" and operates according to the CE closed loops principles. Circular economy is incorporated in new strategic objectives.
	7	Methodology	For each of the identified targets: Describe ambition and judge on scale 1. no progress, 2. little progress, 3. some progress, 4. ambition nearly reached, 5. ambition reached or beyond
	8	Unit	Score on categorical scale (1-5)
Data	9	Baseline data / definition	Mentions of circular economy objectives in city strategies and documents before the start of the project. The baseline is described using the same method and data sources (strategy documents etc.) as the post demonstration action values.
	10	Data Sources / Relevant Databases	The city's strategy documents, decisions and commitments on the promotion of CE. Open data.

	11	Overall accuracy	Not relevant
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, City-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected and analyzed on an annual basis and will be compared to a baseline established for the year 2019.
	15	SDG Reference	
Other	16	Comments	

1.3.6. New planning instruments/tools for improved circularity: Qualitative description

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	21
	2	Indicator name	New planning instruments/tools for improved circularity: Qualitative description
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	4	Category	Vision and urban management
Indicator definition and description	5	Definition / Description of indicator	Define and select planning instruments/ tools relevant to improve circularity (To be selected together with indicator #22)
	6	Rationale	Several planning instruments/tools are developed and/or demonstrated during the CityLoops project in the City of Mikkeli in order to improve CDW circularity. Expected outcomes: - New planning instrument/tools have been tested in the City of Mikkeli for decision making and monitoring of demonstration projects. Identifying procurement tool for special characteristics in a tender has been updated based on the demo projects. - 100% of the procurement of demolition projects will include the new guidelines for screening and selective demolition, making these an essential part of the procurement processes within the City of Mikkeli.

	7	Methodology	Qualitative description of the following instrument/tool 1. Guidelines for planning and decision making (e.g. procurement guidelines) 3. Life Cycle Assessment for demolition and renovated sites 4. Screening procedures and tool for selective demolition 5. 3D modelling tool for tracking the flows of on-site CDW
	8	Unit	Qualitative data
Data	9	Baseline data / definition	Qualitative description of practises related to demolition processes in the City of Mikkeli before CityLoops project.
	10	Data Sources / Relevant Databases	Project reports, e.g. Tool Factsheets
	11	Overall accuracy	Not relevant
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, demo-level or city-level (guidelines)
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected after demonstration actions (baseline already collected).
	15	SDG Reference	
Other	16	Comments	There are also two other instruments/tools, which are developed in Mikkeli during the CityLoops project. These tools are evaluated with separate indicators: - Tool: Business case development: indicators 23-24 - Tool: Databank and digital marketplace for recovered materials: indicators 30-31

1.3.7. New planning instruments/tools for improved circularity: Impact

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	22
	2	Indicator name	New planning instruments/tools for improved circularity: Impact
Link to Circular	3	Vision Element	1. Local stakeholder actions

City Definition	4	Category	Vision and urban management
Indicator definition and description	5	Definition / Description of indicator	Quantify impact of all planning instruments/tools described in indicator # 21. (To be selected together with indicator #21)
	6	Rationale	Several planning instruments/tools are developed and demonstrated during the CityLoops project in the City of Mikkeli in order to improve CDW circularity. Expected outcomes: - New planning instrument/tools have been tested in the City of Mikkeli for decision making and monitoring of demonstration projects. Identifying procurement tool for special characteristics in a tender has been updated based on the demo projects. - 100% of the procurement of demolition projects will include the new guidelines for screening and selective demolition, making these an essential part of the procurement processes within the City of Mikkeli.
	7	Methodology	1. Guidelines for planning and decision making - number of guidelines produced. - # of projects, where guidelines were used 2. Life-Cycle Assessment for demolition and renovated sites - # of projects where tool was used - Total mass of materials that the tool has impacted on per year (waste/material amounts in demonstration projects) 3. Screening procedures and tool for selective demolition - # of projects where tool was used (e.g. pre-demolition audit) - Total mass of materials that the tool has impacted on per year. - # screenings/samples/analyses 4. 3D modelling tool for tracking the flows of on-site CDW - # of projects where tool was used - # of drone flights - Total mass of materials that the tool has impacted on per year (e.g. waste/material amounts in demonstration projects)
	8	Unit	Number of guidelines Number of projects, where tool was used. Tonnes / year
Data	9	Baseline data / definition	Only qualitative description of practises related to demolition processes in the City of Mikkeli before CityLoops project (indicator 21). Quantitative data is not available (baseline 0).
	10	Data Sources / Relevant Databases	Project reports (data collected in demo projects Tuukkala and Pankalampi)

			Authorities (City of Mikkeli, Tilapalvelut), constructors (waste reports) and waste management company Metsäsairila Ltd. Data collection based on personal communication.
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, demo-level or city-level (guidelines)
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected after demonstration actions
	15	SDG Reference	
Other	16	Comments	There are also two other instruments/tools, which are developed in Mikkeli during the CityLoops project. These tools are evaluated with separate indicators: - Tool: Business case development: indicators 23-24 - Tool: Databank and digital market place for recovered materials: indicators 30-31

1.3.8. Eco-innovation: Qualitative description

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	23
	2	Indicator name	Eco-innovation: Qualitative description
Link to Circular City Definition	3	Vision Element	2. Circular business models and behavioural patterns
	4	Category	Private investments, jobs and gross value added
Indicator definition and description	5	Definition / Description of indicator	Describe the business model, including how it contributes to moving up the waste hierarchy (To be selected together with indicator #24)
	6	Rationale	Business cases for reuse, recycling and valorisation of CDW are developed during the CityLoops project in the City of Mikkeli. Expected outcomes: - New products, service concepts and business models relating to the reuse/recycling and upcycling of the specific material flows addressed, leading to new business opportunities.
	7	Methodology	# of new CE business models

			For each model, a qualitative description of model, its circular strategy
	8	Unit	Qualitative data
Data	9	Baseline data / definition	Business models on circularity of CDW used in City of Mikkeli before the CityLoops-project (Toimintakeskus and Metsäsairila Ltd).
	10	Data Sources / Relevant Databases	Project reports (description of business cases and actions to promote upcycling om materials)
	11	Overall accuracy	Not relevant
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, City-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Baseline data (2019-2020) and in the end of the project
	15	SDG Reference	
Other	16	Comments	

1.3.9. Eco-innovation: Impact

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	24
	2	Indicator name	Eco-innovation: Impact
Link to Circular City Definition	3	Vision Element	2. Circular business models and behavioural patterns
	4	Category	Private investments, jobs and gross value added
Indicator definition and description	5	Definition / Description of indicator	For each case of implementation of CE business models in indicator #23, describe impact in terms of value creation and material flow. (To be selected together with indicator #23)
	6	Rationale	Business cases for reuse, recycling, and valorisation of CDW are developed during the CityLoops project in the City of Mikkeli. Expected outcomes: - New products, service concepts and business models relating to the reuse/recycling of the specific material flows addressed, leading to new business opportunities. Actions have been made to promote upcycling of materials.
	7	Methodology	For each case of implementation of CE business models

			a) Monetary value b) Materials impacted
	8	Unit	Monetary value Tonnes / year
Data	9	Baseline data / definition	Only qualitative description: business models on circularity of CDW used in City of Mikkeli before the CityLoops-project (indicator 23). Quantitative data is not available, or data is not public (baseline 0).
	10	Data Sources / Relevant Databases	Theoretical potential of business cases (estimated monetary value and material flow, included to project´s reports) Realized business cases (monetary value and material flow, data from collaboration companies)
	11	Overall accuracy	Significant level of uncertainty (theoretical monetary value and material flow are estimated)
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, City-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG Reference	
Other	16	Comments	

1.3.10. Increased share of materials retained and reused on demonstration sites

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	27
	2	Indicator name	Increased share of materials retained and reused on demonstration sites
Link to Circular City Definition	3	Vision Element	2. Circular business models and behavioural patterns
	4	Category	Circular value chains and infrastructure
Indicator definition and description	5	Definition / Description of indicator	The relative share of materials retained and reused on demonstration sites, measured for selected/key on-site waste material fractions and the total mass of waste materials.
	6	Rationale	Project tools and activities aim to develop recycling and reuse of materials and part of these materials could be retained and reused on demonstration sites.

			Expected outcomes: - At the end of the demonstration action, 5% of materials are retained on demonstration sites.
	7	Methodology	For selected waste fractions and total mass of waste materials: Retained and reused mass of materials / total mass of (waste) materials at demonstration site
	8	Unit	Mass %
Data	9	Baseline data / definition	Baseline from earlier demolition projects in Mikkeli (2018-summer 2020). The baseline is calculated using the same method and data sources as the post demonstration action values.
	10	Data Sources / Relevant Databases	Data collected from the owner of the demonstration buildings Tuukkala and Pankalampi (City of Mikkeli, Tilapalvelut) and constructors (waste reports). Data collection based on personal communication.
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, Demo-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected after the demonstration actions (baseline data already collected).
	15	SDG Reference	
Other	16	Comments	

1.3.11. Volume onsite sorting (Improved source separation)

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	28
	2	Indicator name	Volume onsite sorting (Improved source separation)
Link to Circular City Definition	3	Vision Element	2. Circular business models and behavioural patterns
	4	Category	Circular value chains and infrastructure

Indicator definition and description	5	Definition / Description of indicator	The relative share of waste materials produced and sorted on demonstration sites
	6	Rationale	Developing selective demolition and onsite sorting is an important part of project´s tool "Screening procedures and tool for selective demolition" which is demonstrated in the City of Mikkeli. Expected outcome: - Selective demolition has been used in demonstration cases. Over 95% of CDW is sorted onsite for recycling and material or energy recovery.
	7	Methodology	The mass of on-site waste materials sorted / the mass of total on-site waste materials
	8	Unit	Mass %
Data	9	Baseline data / definition	Baseline from earlier demolition projects in Mikkeli (2018-summer 2020). The baseline is calculated using the same method and data sources as the post demonstration action values.
	10	Data Sources / Relevant Databases	Register of the permitting authorities (constructor´s waste reports) and Waste management company Metsäsairila Ltd. Data collection based on personal communication.
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, Demo-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected after demonstration actions (baseline data already collected).
	15	SDG Reference	
Other	16	Comments	

1.3.12. New digital material databank/ marketplace: Qualitative description

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	30
	2	Indicator name	New digital material databank/marketplace: Qualitative description
Link to Circular	3	Vision Element	2. Circular business models and behavioural patterns

City Definition	4	Category	Circular value chains and infrastructure
Indicator definition and description	5	Definition / Description of indicator	Description of the digital material databank/marketplace in term of objective, type, scope, stage of development, target/user groups and other aspects deemed relevant (To be selected together with indicator #31)
	6	Rationale	Two connected online platforms - Databank and digital marketplace for recovered materials – are created during the CityLoops project by Xamk and Miksei Mikkeli to increase data management and marketing of demolition materials for reuse. Indicators 30-31 describe the platforms and measure their impacts. Expected outcomes: - Digital marketplace for secondary materials established and in use.
	7	Methodology	See definition
	8	Unit	Qualitative data
Data	9	Baseline data / definition	Qualitative description of practices related to marketing of demolition materials in the City of Mikkeli before CityLoops project (e.g. tori.fi).
	10	Data Sources / Relevant Databases	Project reports, e.g. Tool fact sheet
	11	Overall accuracy	Not relevant
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, Demo-level (Pankalampi)
	14	Reference period	Project period 1.10.2019 – 30.9.2023, in the end of the project (baseline 2019-2020)
	15	SDG Reference	
Other	16	Comments	

1.3.13. New digital material databank/ marketplace: Impact

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	31
	2	Indicator name	New digital material databank/marketplace: Impact

Link to Circular City Definition	3	Vision Element	2. Circular business models and behavioural patterns
	4	Category	Circular value chains and infrastructure
Indicator definition and description	5	Definition / Description of indicator	The impact of the digital marketplace is assessed by estimating the mass and value of material registered and traded per time period. (To be selected together with indicator #30)
	6	Rationale	Two connected online platforms - Databank and digital marketplace for recovered materials – are created during the CityLoops project by Xamk and MikseiMikkeli to increase data management and marketing of demolition materials for reuse. Indicators 30-31 describe the platforms and measure their impacts. Expected outcomes: - Digital marketplace for secondary materials established and in use.
	7	Methodology	Mass of materials or number of items or data registered per time period. Time period can be month or year (year for digital marketplace) Total mass or number of items should be registered, and optionally key material fractions
	8	Unit	Tonnes / time or number of items/ times Number of data saved to databank
Data	9	Baseline data / definition	Only qualitative description of practises related to marketing of demolition materials in the City of Mikkeli before CityLoops project (indicator 30). Quantitative data is not available (baseline 0).
	10	Data Sources / Relevant Databases	Data saved to databank. Items (mass, number and price) registered to digital marketplace
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, Demo-level (Pankalampi)
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected yearly (digital marketplace) or after demonstration actions (databank)
	15	SDG Reference	
Other	16	Comments	

1.3.14. Reduced costs due to improved circularity

Metadata group	#	Metadata category	Fill in data for indicator
Identifier	1	Indicator number	32
	2	Indicator name	Reduced costs due to improved circularity
Link to Circular City Definition	3	Vision Element	2. Circular business models and behavioural patterns
	4	Category	Private investments, jobs and gross value added
Indicator definition and description	5	Definition / Description of indicator	For selected cost type(s) (e.g. transport, virgin material costs, waste treatment costs), direct impacts on costs should be estimated. Demolition costs and waste treatment costs selected in case of Mikkeli.
	6	Rationale	In long term, circular economy should increase the cost effectiveness. Impact of circularity to costs of demolition projects is important information to local government because price is typically selection criterion in procurement processes. Expected outcomes - At the end of the demonstration action, we expect a 10% increase in the cost effectiveness in the demolition of buildings (demolition, transport and treatment of CDW) as compared to the baseline values for similar demolition projects.
	7	Methodology	Quantification of cost savings for the selected cost type (demolition costs, waste treatment costs) using a practical method. The estimate should be accompanied by a qualitative description of the method, which cost items are included and which are excluded, with a justification of the choice.
	8	Unit	Monetary value
Data	9	Baseline data / definition	Demolition costs (including also transport and treatment of CDW) from earlier demolition projects in Mikkeli.
	10	Data Sources / Relevant Databases	Demolition costs (including also transport and treatment of CDW) of demonstration cases (Tuukkala and Pankalampi). Data from authorities (City of Mikkeli, Tilapalvelut) or calculated according to amount of sorted waste fractions (from contractor´s waste report) and price list of waste management company Metsäsairila Ltd. Demolition costs from authorities (City of Mikkeli, Tilapalvelut) Data collection based on personal communication.
	11	Overall accuracy	Reliable data

Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, demo-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected after demonstration actions
	15	SDG Reference	
Other	16	Comments	

1.3.15. CE-based employment

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	33
	2	Indicator name	CE-based employment
Link to Circular City Definition	3	Vision Element	2. Circular business models and behavioural patterns
	4	Category	Private investments, jobs and gross value added
Indicator definition and description	5	Definition / Description of indicator	Assess the impact of demonstration actions or at sector/city level by estimating the increase in CE related jobs
	6	Rationale	Project activities promoting circular economy and new business cases aim to provide new jobs in the City of Mikkeli. Expected outcomes - Social impacts: At the end of the project, the project activities are a component of creating a greener environment and providing a more sustainable economy in the city of Mikkeli (new jobs: 20 – all external).
	7	Methodology	For a selected time period (e.g. year, project period, etc.) estimate: # of new CE related jobs # of existing jobs becoming circular If deemed practical for the evaluation, jobs that have a range of responsibilities, of which some are related to circularity and some are not, can be assigned a “percentage of circularity”. Using this principle, a change in the percentage can be assigned for existing jobs that become more circular.
	8	Unit	Number of jobs or estimated % of job becoming circular -related
Data	9	Baseline data / definition	Number of jobs in Metsäsairila Ltd and Toimintakeskus in the beginning of the project (year 2019). The baseline is calculated

			using the same method and data sources as the post demonstration action values.
	10	Data Sources / Relevant Databases	Number of jobs in Metsäsairila Ltd (open data from company´s annual reports), Toimintakeskus (based on personal communication) and other relevant companies/organizations.
	11	Overall accuracy	Reliable data (number of personnel in chosen organization/companies). Significant level of uncertainty related to possible estimation of the circularity of the jobs
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, City-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023, two times during the project.
	15	SDG Reference	
Other	16	Comments	New jobs are not developed directly from demo actions but are effects of demos.

1.3.16. Domestic material consumption (DMC) of virgin materials

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	35
	2	Indicator name	Domestic material consumption (DMC) of virgin materials
Link to Circular City Definition	3	Vision Element	3. Closing material loops and reducing harmful resource use
	4	Category	Material/energy flow
Indicator definition and description	5	Definition / Description of indicator	The total amount of virgin materials directly used.
	6	Rationale	Project activities aim to increase utilization of reused and recycled materials (e.g. crushed concrete) instead of virgin materials (e.g. virgin soil material). Expected outcomes: - At the end of the project, use of CDW (especially crushed concrete) to replace virgin construction materials (soil) have

			been increased as a result of new guidelines in planning and decision making. 5% reduction in consumption of virgin construction materials within the city of Mikkeli.
	7	Methodology	Amount of used virgin soil material in the City of Mikkeli
	8	Unit	tonnes/year or m^3/year
Data	9	Baseline data / definition	Average consumption of used virgin soil material per year before the project´s start, data from authorities (City of Mikkeli, based on personal communication). The baseline is calculated using the same method and data sources as the post demonstration action values.
	10	Data Sources / Relevant Databases	(Estimated) amount of used virgin soil material in the end of the project, data from authorities (City of Mikkeli).
	11	Overall accuracy	Slight level of uncertainty (estimated/average amounts from authorities)
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, City-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023, two times during the project Baseline: average consumption per year before the project´s start
	15	SDG Reference	
Other	16	Comments	

1.3.17. Quantity of material subjected to reuse

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	49
	2	Indicator name	Quantity of material subjected to reuse
Link to Circular City Definition	3	Vision Element	3. Closing material loops and reducing harmful resource use
	4	Category	Re-use and recycling
Indicator definition and description	5	Definition / Description of indicator	Estimate mass of materials being reused at demonstration level. ‘Reuse’ means reuse of discarded yet still usable product, for the same purpose, by a different user.
	6	Rationale	Several project activities/tools aim to promote the reuse and upcycling of demolition materials in Mikkeli. Expected outcomes:

			- At the end of the demonstration action several items (materials/equipment) have been prepared for reuse.
	7	Methodology	Sum up estimated mass or number of items (e.g. bricks, wood material, HVAC equipment, metal structures) subjected to reuse from demonstration site Pankalampi.
	8	Unit	tonnes/year or number of items
Data	9	Baseline data / definition	Baseline 0 (only activities during the project are measured) Data from earlier demolition projects in Mikkeli is not available; reused materials have not been registered.
	10	Data Sources / Relevant Databases	Toimintakeskus (materials to be sold by Toimintakeskus), City of Mikkeli (materials used in City internally). Data collection based on personal communication.
	11	Overall accuracy	Moderate level of uncertainty (mass of materials or number of items can be partly estimated).
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, Demo-level (Pankalampi)
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected after the demonstration actions
	15	SDG Reference	
Other	16	Comments	

1.3.18. EOL-RR (End of Life Recycling Rate)

Identi-fier	1	Indicator number	55
	2	Indicator name	EOL-RR (End of Life Recycling Rate)
Link to Circular City Definition	3	Vision Element	3. Closing material loops and reducing harmful resource use
	4	Category	Re-use and recycling
Indicator definition and description	5	Definition / Description of indicator	The End-of-Life Recycling Rate (EoL RR) measures the efficiency with which the mass contained in End-of-Life products is collected, pre-treated, and finally recycled.
	6	Rationale	Several project activities aim to promote the recycling and upcycling rate of CDW materials in Mikkeli. Expected outcomes: - At the end of the project, the recycling rate of CDW is close to 75% (CDW prepared for recycling and other material recovery, including backfilling) (95% if energy recovery

			included). 10% increase in recycling rate and 40% increase in upcycled amount of CDW as compared to baseline statistics from year 2019.
	7	Methodology	For each material fraction, the End-of-Life recycling rate is defined as the End-of-Life mass recycled divided by the available mass of End-of-Life materials. It is the product of the Processing Rate and the Collection Rate (EoL RR = EoL PR x EoL CR). EOL-RR is calculated for total CDW and for each material fraction if possible. In case of Mikkeli, recycling includes utilization of material in original or other use and also backfilling.
	8	Unit	% rate.
Data	9	Baseline data / definition	City-level: Amount of recycled CDW categories in waste management company Metsäsairila Ltd. in year 2019 (before project started). The baseline is calculated using the same method and data sources as the post demonstration action values.
	10	Data Sources / Relevant Databases	City-level: Yearly statistics of waste management company Metsäsairila Ltd. Data collection based on personal communication. The data includes CDW from demolition projects owned by City of Mikkeli and part of private demolition projects.
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, City-level
	14	Reference period	Data will be collected and analysed on an annual basis and will be compared to a baseline established for year 2019.
	15	SDG Reference	
Other	16	Comments	

1.3.19. Incineration rate

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	59
	2	Indicator name	Incineration rate
Link to Circular City Definition	3	Vision Element	3. Closing material loops and reducing harmful resource use
	4	Category	Waste generation/management

Indicator definition and description	5	Definition / Description of indicator	Mass percentage of waste, which incinerated.
	6	Rationale	Project activities aim to increase reusing, recycling and upcycling of materials instead of incineration. Expected outcomes: - At the end of the project, 5% reduction in the amount of CDW landfilled or incinerated as compared to the baseline statistics from year 2019.
	7	Methodology	Mass of materials incinerated divided by total amount of waste. Data from waste management companies.
	8	Unit	%
Data	9	Baseline data / definition	Share of CDW, which is incinerated (year 2019, before project started). The baseline is calculated using the same method and data sources as the post demonstration action values.
	10	Data Sources / Relevant Databases	Yearly statistics of waste management company Metsäsairila Ltd. Data collection based on personal communication. The data includes CDW from demolition projects owned by City of Mikkeli and part of private demolition projects.
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, City level
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected and analysed on an annual basis and will be compared to a baseline established for year 2019.
	15	SDG Reference	
Other	16	Comments	

1.3.20. Landfilling rate

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	61
	2	Indicator name	Landfilling rate
Link to Circular City	3	Vision Element	3. Closing material loops and reducing harmful resource use

Definition	4	Category	Waste generation/management
Indicator definition and description	5	Definition / Description of indicator	Mass percentage of waste, which landfilled.
	6	Rationale	Project activities aim to increase reusing, recycling and upcycling of materials instead of landfilling. Expected outcomes: - At the end of the project, 5% reduction in the amount of CDW landfilled or incinerated as compared to the baseline statistics from year 2019.
	7	Methodology	Mass of materials landfilled divided by total amount of waste. Data from waste management companies.
	8	Unit	tons/year or %
Data	9	Baseline data / definition	Share of CDW, which is landfilled (year 2019, before project started). The baseline is calculated using the same method and data sources as the post demonstration action values.
	10	Data Sources / Relevant Databases	Yearly statistics of waste management company Metsäsairila Ltd. Data collection based on personal communication. The data includes CDW from demolition projects owned by City of Mikkeli and part of private demolition projects.
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, City level
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected and analysed on an annual basis and will be compared to a baseline established for year 2019.
	15	SDG Reference	
Other	16	Comments	

1.3.21. GHG emissions per year

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	85
	2	Indicator name	GHG emissions per year

Link to Circular City Definition	3	Vision Element	4. Improving human well-being and reducing environmental impacts
	4	Category	Environment impacts (global)
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	Project activities aim to increase circularity of CDW, which should lead positive environmental impacts and reduced CO_2 emissions. Expected outcomes: - At the end of the project, 5% reduction in the emissions of CO2 related to extraction, processing and transportation (incl. logistics) of construction materials (replacement of virgin soil material with crushed concrete).
	7	Methodology	Saved GHG emission pr. year when using crushed concrete instead of virgin soil material Direct GHG emissions pr. year city level
	8	Unit	Tonnes CO2-equivalents / year
Data	9	Baseline data / definition	CO2 emissions of average consumption of virgin soil material and crushed concrete before the project´s start. The baseline is calculated using the same method and data sources as the values at the end of the project. Direct GHG emissions pr. year city level from year 2019. The baseline is calculated using the same method and data sources as the post demonstration action values.
	10	Data Sources / Relevant Databases	Calculated CO2 emissions of used virgin soil material and crushed concrete per year in city level. Amount of used virgin soil material and crushed concrete from authorities Direct GHG emissions pr. year city level from https://www.mikkeli.fi/sisalto/palvelut/ymparisto/ilmasto or https://paastot.hiilineutraalisuomi.fi/. Open data.
	11	Overall accuracy	Moderate level of uncertainty (calculated values)
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City of Mikkeli, City level
	14	Reference period	Project period 1.10.2019 – 30.9.2023 City-level: Data will be collected and analysed on an annual basis and will be compared to a baseline established for the year 2019. Demo-level: GHG-emissions will be calculated after the demonstration actions

	15	SDG Reference	
Other	16	Comments	

2. Evaluation plan for BW

2.1. Introduction (BW)

In the CityLoops project, Mikkeli is undertaking a series of demonstration actions, aimed at improving the recovery of nutrients from biowaste streams for new products and business models. Mikkeli also plans to improve the quality of the biowaste it collects from households by implementing new collection and sorting processes in collaboration with its citizens. Only 38% of the 6,900 tonnes of biowaste Mikkeli's citizens produce yearly is recycled, mainly as compost.

Mikkeli pursues to pioneer in the transition for a more circular economy. The city has been building EcoSairila development platform to enable closing material loops and to help create new sustainable businesses. Mikkeli has promoted and invested especially on the research, development and infrastructure of water technology, material cycles and renewable energy such as biogas from the new biogas plant BioSairila.

The focus of BW demonstration actions in Mikkeli will be on improving the recovery of nutrients from BW streams into recycled products, creating business opportunities for local companies. Based on a thorough analysis of BW streams and potential valorisation pathways, a series of innovative collection, treatment and product optimisation processes and techniques will be demonstrated. New collection and sorting processes will be implemented in a pilot district in collaboration with local citizens to upgrade the quality of BW collected. Below are the main biowaste demonstration actions in Mikkeli.

2.1.1. BW collection and sorting: pilot project

In collaboration with citizens and local companies the collection of biowaste from the Mikalo Ltd apartment building area in the Peitsari district of Mikkeli will be improved. The goal is to increase the collection of biowaste in quality and quantity and simultaneously reduce the biowaste percentage in the collected mixed waste that is currently disposed of by incineration.

A new collection and sorting approach will be tested in a series of apartment buildings in the Peitsari district. The seven buildings, with a total of 278 apartments, are owned by the Mikalo Ltd municipal housing company. The aim is to increase the volume of quality biowaste collected separately, rather than ending up in the municipal solid waste collection.

The demonstration action was co-designed in collaboration with local residents and stakeholders, and will consist of:

- Distributing paper bags to residents for the collection of biowaste, which are less problematic for the new biogas plant in Mikkeli than biodegradable plastic bags which are often currently used.
- An information campaign to encourage residents to separate their biowaste.

To complement this demonstration there will be a series of ongoing dialogue process with key stakeholders to investigate further forms and models of separate biowaste collection and sorting, to analyse their potential in different areas of Mikkeli, and to establish whether viable business cases underlie these approaches. Potentially new ideas and approaches may be integrated into the Peitsari demonstration project, or in other parts of the city.

Expected outcomes:

Below are the expected outcomes to be achieved in connection with demo action 1:

- Improved interactions in the field of biowaste collection and sorting between citizens, waste management companies and public authorities, through the establishments of stakeholder groups, i.e. one on biowaste and one on collection and sorting.
- New collection and sorting concepts and tools have been tested for biowaste, leading to improved opportunities in recycling and use of the material flow in Mikkeli.
- New collection and sorting concepts (i.e. distributing paper bags) for biowaste tested in the demonstration site.
- New circular job opportunities created in the area of biowaste collection and sorting
- Increase in quantity of biowaste collected at city level
- 15% increased separate collection rate of biowaste within the demonstration site.
- 10% reduction in the amount of organic waste landfilled or incinerated in Mikkeli by the end of project
- The recycling rate of organic waste has improved, which enables a 15% reduction in the greenhouse gas emissions

2.1.2. BW treatment: pilot and laboratory scale experiments

Collected biowaste will be used to produce biogas as fuel for local buses, trucks and cars. The nutrients present in the residual streams from the biogas production will be used as soil amendments. On pilot and laboratory scale experiments will be performed to enhance the

production of biogas by mechanical pre-treatment and combining biowaste from households with the biowaste from gardens. Different processes will be tested to increase the value of the soil amendments. A techno-economic evaluation of the new processes will be performed to obtain possible business cases for Mikkeli.

This demonstration action explores new processing and end-product optimization techniques in a laboratory- and pilot-scale.

- The development and tests of mechanical pre-treatment methods such as crushing, mixing and sieving. The aim of these is to prepare biowaste flows before the actual waste treatment, biogas digestion.
- One area of research is the combined use of bio- and garden waste in biogas production.
- To increase the value of the remaining streams after biogas production at least five methods/technologies will be tested, with the aim of permanently establishing at least two innovative nutrition extraction and product creation technologies and related business models with local companies.
- One of the tested new methods/technologies will certainly be using biochar as an additive for organic material, which enables more complex functional properties of the produced fertilizer (e.g. water and nutrient storage).
- A second technology will be using electrochemical methods for the recovery of nutrients from rejection waters of dry digestion process.

Expected outcomes:

Below are the expected outcomes to be achieved in connection with demo action 2:

- Improved interactions in the field of treatment between citizens, waste management companies and public authorities, through the establishment of stakeholder groups, i.e. on treatment and products.
- Promotion of circularity in the biowaste sector is embedded in Mikkeli's procurement practices.
- At least 5 new treatment and product optimization methods/technologies have been tested and evaluated (at demonstration level), considering technical viability, financial viability, and productivity. At least two treatment and product optimization methods/technologies will be established.
- New circular job opportunities created in the biochar, biogas and fertilizer business
- Consumption of virgin materials reduced by 5% at city level (compared to the start of the project)
- Increase in upcycled amount of organic waste by 50% by end of project (mass, volume or %) in the city of Mikkeli

- 10% reduced emissions of CO2 related to reduced transport needs as well as substitution of fossil fuels (trucks) by biogas
- Validated potential to reduce consumption of virgin materials by 5% at city level (compared to the start of the project).
    - At least 5 new treatment and product optimization methods/technologies have been tested and validated (at demonstration level), considering technical viability, financial viability, and productivity. At least two treatment and product optimization methods/technologies are established in Mikkeli.
    - Promotion of circularity in the biowaste sector are embedded in Mikkeli's procurement practices.
    - Improved interactions in the field of treatment between citizens, waste management companies and public authorities, through the establishments of stakeholder groups, i.e. on treatment and products.
    - New business- and circular job opportunities created in the recycling of biowaste into new products such as biogas, fertilizers and soil improvers.
    - Increase in upcycled amount of organic waste 50% by end of project (mass, volume or %) in the city of Mikkeli.
    - 10% reduction of CO2-emissions related to reduced transport needs as well as substitution of fossil fuels (trucks) with biogas.

2.2. Indicators to be monitored (BW)

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 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 CityLoops project plans (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 8 to table 11 list the selected indicators for each of the four Vision Elements in the CityLoops circular city definition (Vangelsten et al., 2021). The tables describe at which level the indicators will be applied (Demonstration Action or City level) and which Demonstration Actions they will evaluate.

Table 8: List of indicators related to Vision Element 1 "Local Stakeholder Actions"

Indicator #	Indicator name	Scope (Demo/City)	Demo action 1	Demo action 2
6	Circularity related stakeholder activities	D and C	x	x
11	Communication measures on circular transformations and waste prevention	D and C	x	x
12	Circularity requirements in procurement beyond existing levels	D		x
15	Procurement with circularity requirements beyond existing levels: Impact	D		x
21	New planning instruments/tools for improved circularity: Qualitative description	D and C	x	x
22	New planning instruments/tools for improved circularity: Impact	D and C	x	x

Table 9: List of indicators related to Vision Element 2 "Circular business models and behaviour patterns".

Indicator #	Indicator name	Scope (Demo/City)	Demo action 1	Demo action 2
23	Eco-innovation: Qualitative description	D		x
24	Eco-innovation: Impact	D		x
33	CE-based employment	C	x	x

Table 10: List of indicators related to Vision Element 3 "Closing material loops and reducing harmful resource use"

Indicator #	Indicator name	Scope (Demo/City)	Demo action 1	Demo action 2
35	Domestic material consumption (DMC) of virgin materials	C		x
52	Quantity of material subjected to recycling	D /C	x	
53	Quantity of material for anaerobic digestion	C	x	
55	EOL-RR (End of Life Recycling Rate).	D/C	x	x
59	Incineration rate	C	x	
61	Landfilling rate	C	x	

Table 11: List of indicators related to Vision Element 4 "Improving human wellbeing and reducing environmental impacts"

Indicator #	Indicator name	Scope (Demo/City)	Demo action 1	Demo action 2
85	GHG emissions per year	C and D	x	x

Links between the selected indicators and the expected outcomes for both Demonstration Actions are shown in table 12 and 13:

Table 12: Linking expected outcomes to the selected indicators for demonstration action 1. Biowaste collection and sorting.

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Improved interactions in the field of biowaste collection and sorting between citizens, waste management companies and public authorities, through the establishments of stakeholder groups, i.e. one on biowaste and one on collection and sorting.	6. Circularity related stakeholder activities 11. Communication measures on circular transformations and waste prevention
	New collection and sorting concepts and tools have been tested for biowaste, leading to improved opportunities in recycling and use of the material flow in Mikkeli.	21. New planning instruments/tools for improved circularity: Qualitative description 22. New planning instruments/tools for improved circularity: Impact
	New collection and sorting concepts (i.e. distributing paper bags) for biowaste tested in the demonstration site.	21. New planning instruments/tools for improved circularity: Qualitative description

Vision Element	Expected outcome	Indicator
		22. New planning instruments/tools for improved circularity: Impact
2 Circular business models and behaviour patterns	New circular job opportunities created in the area of biowaste collection and sorting	33. CE-based employment
3 Closing material loops and reducing harmful resource use	Increase in quantity of biowaste collected at city level	52. Quantity of material subjected to recycling (city-level)
	15% increased separate collection rate of biowaste within the demonstration site.	52. Quantity of material subjected to recycling
	10% reduction in the amount of organic waste landfilled or incinerated in Mikkeli by the end of project	59. Incineration rate 61. Landfilling rate
4 Improving human wellbeing and reducing environmental impacts	The recycling rate of organic waste has improved, which enables a 15% reduction in the greenhouse gas emissions	85. GHG emissions per year

Table 13: Linking expected outcomes to the selected indicators for demonstration action 2. biowaste treatment: pilot and laboratory scale experiments

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Improved interactions in the field of treatment between citizens, waste management companies and public authorities, through the establishment of stakeholder groups, i.e. on treatment and products.	6.Circularity related stakeholder activities 11. Communication measures on circular transformations and waste prevention
	Promotion of circularity in the biowaste sector is embedded in Mikkeli's procurement practices.	12. Circularity requirements in procurement beyond existing levels 15. Procurement with circularity requirements beyond existing levels

Vision Element	Expected outcome	Indicator
2 Circular business models and behaviour patterns	At least 5 new treatment and product optimization methods/technologies have been tested and evaluated (at demonstration level), considering technical viability, financial viability, and productivity. At least two treatment and product optimization methods/technologies will be established.	23. Eco-innovation: Qualitative description 24. Eco-innovation: Impact
	New circular job opportunities created in the biochar, biogas and fertilizer business	33. CE-based employment
3 Closing material loops and reducing harmful resource use	Consumption of virgin materials reduced by 5% at city level (compared to the start of the project)	35. Domestic material consumption (DMC) of virgin materials
	Increase in upcycled amount of organic waste by 50% by end of project (mass, volume or %) in the city of Mikkeli	53. Quantity of material for anaerobic digestion
4 Improving human wellbeing and reducing environmental impacts	10% reduced emissions of CO2 related to reduced transport needs as well as substitution of fossil fuels (trucks) by biogas	85. GHG emissions per year

2.3. Plan for monitoring BW

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 that they will test.

2.3.1. Circularity related stakeholder activities

Metadata group	#	Metadata category	Fill in data for indicator
Identifier	1	Indicator number	6
	2	Indicator name	Circularity related stakeholder activities
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	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 # of people involved
	6	Rationale	Several stakeholder actions are conducted during the CityLoops project and demonstration projects in the City of Mikkeli in order to develop tools and circular economy in close collaboration with local authorities and companies. Awareness raising and promotional actions – Undertaking awareness raising and capacity building for improving the collection and further use of biowaste in developed products. The qualitive description on the involvement of different stakeholder groups: 1. Collection and sorting, 2. treatment and final product, 3. BW group. Expected outcome: • Improved interactions in the field of treatment between citizens, waste management companies and public authorities, through the establishments of stakeholder groups, i.e. on treatment and products (DA2) • Improved interactions in the field of biowaste collection and sorting between citizens, waste management companies and public authorities, through the establishments of stakeholder groups, i..e one on biowaste and one on collection and sorting (DA1)
	7	Methodology	a) Identify stakeholder activity (3 groups of stakeholders) b) Describe process and when stakeholders are involved (process is described in the stakeholder engagement plan) c) Identify dialogue methods used (meetings/workshops)

			d) Number of people involved
	8	Unit	Qualitative data Potential quantitative impact data
Data	9	Baseline data / definition	Baseline 0, only activities during the project are measured, previous similar activities are not known/measured in Mikkeli.
	10	Data Sources / Relevant Databases	Memos of meetings, participant lists.
	11	Overall accuracy	reliable data, number of stakeholders involved
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	City of Mikkeli, demo-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023, constant data collection.
	15	SDG Reference	
Other	16	Comments	DA1 and DA2

2.3.2. Communication measures on circular transformations and waste prevention

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	11
	2	Indicator name	Communication measures on circular transformations and waste prevention
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	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	Several communication measures are conducted for general public and companies during the CityLoops project in the City of Mikkeli in order to increase knowledge on CE of BW. Strategy of the City of Mikkeli 2018-2021:

			Increasing the recycling of bio-waste by improving sorting and collection- Residential waste, waste recycling: Baseline 98.6% / Target 99% Expected outcome: • Improved interactions in the field of biowaste collection and sorting between citizens, waste management companies and public authorities, through the establishments of stakeholder groups, i.e. one on biowaste and one on collection and sorting (DA1) • Improved interactions in the field of treatment between citizens, waste management companies and public authorities, through the establishments of stakeholder groups, i.e. on treatment and products (DA2)
	7	Methodology	a) Number of communication measures towards general public on CE transformation (e.g. webinars organised by the project, CityLoops presentations in other webinars, residential workshops, press releases, articles in media, published research articles, newsletter, web pages,) b) Number of people reached
	8	Unit	Number of communication measures Number of people
Data	9	Baseline data / definition	Baseline 0, only activities during the project are measured. Only CityLoops activities are appropriate for this indicator.
	10	Data Sources / Relevant Databases	• Published press releases and articles in media. Potential number of readers through circulation volume or edition of paper • Participant lists of webinars and other events. • Number of visitors in web pages: number of hits on website. Internet visitor counter on the pages/articles of City Loops -project in www.mikseimikkeli.fi and www.xamk.fi/cityloops on CL • Number of leaflets are handed out
	11	Overall accuracy	medium accuracy as whole indicator, exact or estimated number of participants/readers. For articles data collected based on circulation/volume /edition.
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	City of Mikkeli, demo-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023. constant data collection (some automated in internet) and once for published articles.
	15	SDG Reference	

Other	16	Comments	Barriers/obstacles and framework conditions that may determine whether and to what extent the expected impacts will be achieved: in Mikkeli, monitoring to the obstacle of citizens not being active enough in improving recycling. DA1 and DA2

2.3.3. Circularity requirements in procurement beyond existing levels

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	12
	2	Indicator name	Circularity requirements in procurement beyond existing levels
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	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	Procurement guidelines are prepared as a result of CityLoops project for City of Mikkeli to increase circularity of organic waste streams in public procurement processes. Procurement guidelines include new circular economy requirements beyond standard practice. The impacts are assessed as demonstration level (more efficient use of the end product of the biogas plant in landscaping in the city of Mikkeli and utilization of biomethane from biogas plant in urban transport). Indicator 12 is selected together with indicator 15. Strategy of the City of Mikkeli 2018-2021: Reducing traffic emissions -increasing the use of biofuels in the city for transportation and in transport contracts with stakeholders. Adding coverage of the biofuel distribution network and the number of biofuel vehicles used in the city. Expected outcomes: • Promotion of circularity in the biowaste sector are embedded in Mikkeli's procurement practices

	7	Methodology	e) Decide which procurements are relevant for analysis (e.g. demo action focused procurements only or a wider range of procurements) f) Describe current standard practice in terms of CE requirements g) For each procurement case, describe additional requirements beyond standard practice h) In case of several relevant procurements, summarize relevant progress beyond existing levels
	8	Unit	Qualitative data Potential quantitative impact data
Data	9	Baseline data / definition	Existing level in year 2019 on current circular economy requirements in transportation procurement contracts used.
	10	Data Sources / Relevant Databases	Public transportation service contracts and documents of the demo procurement.
	11	Overall accuracy	not relevant
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	Demo level
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG Reference	
Other	16	Comments	DA2

2.3.4. Procurement with circularity requirements beyond existing levels: Impact

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identi-fier	1	Indicator number	15
	2	Indicator name	Procurement with circularity requirements beyond existing levels: Impact
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	4	Category	Regulation and incentives

Indicator definition and description	5	Definition / Description of indicator	# of procurements with circularity requirements Value of procurement with circularity requirements
	6	Rationale	Procurement guidelines are prepared as a result of CityLoops project for City of Mikkeli to increase circularity of organic waste streams in public procurement processes. Procurement guidelines include new circular economy requirements beyond standard practice. The impacts are assessed as demonstration level (more efficient use of the end product of the biogas plant in landscaping in the city of Mikkeli and utilization of biomethane from biogas plant in urban transport). Indicator 15 is selected together with indicator 12. Strategy of the City of Mikkeli 2018-2021: Reducing traffic emissions -increasing the use of biofuels in the city for transportation and in transport contracts with stakeholders. Adding coverage of the biofuel distribution network and the number of biofuel vehicles used in the city. Expected outcome: • Promotion of circularity in the biowaste sector are embedded in Mikkeli's procurement practices
	7	Methodology	For each action: • Type of procurement action • Value of procurement For the whole period considered: • Time period • Number of procurement contracts • Sum up the total value of these contracts
	8	Unit	Number of actions (procurement contracts) Number of clean buses Amount of biogas plant end product used for landscaping (tonnes)
Data	9	Baseline data / definition	Year 2019: Number of clean buses in local transportation service, amount of biogas plant end product used for landscaping
	10	Data Sources / Relevant Databases	Based on the city procurement documents and measuring the masses of end-products used for landscaping (demo level). Data collected based on communication with city officials.
	11	Overall accuracy	reliable data,
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	Demo level
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG Reference	
Other	16	Comments	DA2

2.3.5. New planning instruments/tools for improved circularity: Impact

Metadata group	#	Metadata category	Fill in data for indicator
Identifier	1	Indicator number	21
	2	Indicator name	New planning instruments/tools for improved circularity: Impact (see also #22)
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	4	Category	Vision and urban management
Indicator definition and description	5	Definition / Description of indicator	Define and select planning instruments/ tools relevant to improve circularity. (To be selected together with indicator #22)
	6	Rationale	Several planning instruments/tools are developed and/or demonstrated during the CityLoops project in the City of Mikkeli in order to improve OW circularity. Strategy of city of Mikkeli 2018-2021: Establishing new opportunities from the use of material flows in Mikkeli. Expected outcome: • New collection and sorting concepts and tools have been tested for biowaste, leading to improved opportunities in recycling and use of the material flow in Mikkeli. (City-level) • New collection and sorting concepts (i.e. distributing paper bags) for biowaste tested in the demonstration site (Demo-level)
	7	Methodology	Qualitative description of each instrument/tool 5. OW quality assessment and business cases 6. Procurement guidelines for OW products 7. OW collection and sorting processes 8. Treatment and final product optimization
	8	Unit	Qualitative data

Data	9	Baseline data / definition	Baseline 0, only activities during the project are measured. Only CityLoops activities are appropriate for this indicator.
	10	Data Sources / Relevant Databases	The reports: tools fact sheets/description of tools, project reports.
	11	Overall accuracy	Not relative
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	City of Mikkeli, demo-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023, constant collection of data during project.
	15	SDG Reference	
Other	16	Comments	DA1

2.3.6. New planning instruments/tools for improved circularity: Impact

Metadata group	**#**	**Metadata category**	**Fill in data for indicator**
Identifier	1	Indicator number	22
	2	Indicator name	New planning instruments/tools for improved circularity: Impact (see also #21)
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	4	Category	Vision and urban management
Indicator definition and description	5	Definition / Description of indicator	Quantify impact of all planning instruments/tools described in indicator # 21. (To be selected together with indicator #21)
	6	Rationale	Several planning instruments/tools are developed and/or demonstrated during the CityLoops project in the City of Mikkeli in order to improve OW circularity. Strategy of Mikkeli city 2018-2021: Establishing new opportunities from the use of material flows in Mikkeli. Expected outcomes: • New products, service concepts and business models relating to the reuse/recycling of the specific material flows

			addressed, leading to new business opportunities and job creation • New collection and sorting concepts and tools have been tested for biowaste, leading to improved opportunities in recycling and use of the material flow in Mikkeli. (City-level) • New collection and sorting concepts (i.e. distributing paper bags) for biowaste tested in the demonstration site (Demo-level)
	7	Methodology	For each instrument/tool: # of projects where tool was used (procurement guidelines) Total mass of materials that the tool has impacted on per year Recirculated mass of materials that the tool has impacted on per year
	8	Unit	Number of tools and tonnes/year or % of material
Data	9	Baseline data / definition	-amount of biowaste collected in Mikkeli. Baseline year 2019. -Share (%) of biowaste within municipal solid waste (collected in demo-area, in sorting tests) year 2020 -number procurement guidelines made for OW-sector during project implementation. Baseline 0.
	10	Data Sources / Relevant Databases	-Waste companies' data on mass: collected amount of biowaste in Mikkeli. This data is collected and published in Metsäsairila´s annual report. -Data collected in Peitsari area sorting tests (demo). Procurement guidelines used during project for additional data in city-level. Data collected based on communication with city officials.
	11	Overall accuracy	medium accuracy. Estimates of tonnes/year or % for masses, and number of projects.
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	City of Mikkeli, demo-level
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data collected from Metsäsairila 1/year, Demo 2/project, city: 1/project
	15	SDG Reference	
Other	16	Comments	DA1

2.3.7. Eco-innovation: Qualitative description

Identi-fier	1	Indicator number	23
	2	Indicator name	Eco-innovation: Qualitative description

Link to Circular City Definition	3	Vision Element	2. Circular business models and behavioral patterns
	4	Category	Private investments, jobs and gross value added
Indicator definition and description	5	Definition / Description of indicator	Describe the business model, including how it contributes to moving up the waste hierarchy (To be selected together with indicator #24)
	6	Rationale	Business cases for reuse, recycling and valorisation of OW are developed during the CityLoops project in the City of Mikkeli. Strategy of the City of Mikkeli 2018-2021: Increasing the recycling of bio-waste by improving sorting and collection- Residential waste, waste recycling: Baseline 98.6% / Target 99% Expected outcome: • At least 5 new treatment and product optimization methods/technologies are tested and evaluated (in demonstration level), considering technical viability, financial viability, and productivity. At least two treatment and product optimization methods/technologies will be established.
	7	Methodology	# of new CE business models For each model, a qualitative description of model, its circular strategy. Qualitive description of the business models used to upgrade and sell the products made from biowaste such as biogas, fertilizers, and soil products and how the recycled raw material has been valorised to rise in the waste hierarchy (instead of being incinerated).
	8	Unit	Qualitative data
Data	9	Baseline data / definition	Baseline 0, only activities during the project are measured. Only CityLoops activities are appropriate for this indicator.
	10	Data Sources / Relevant Databases	Project reports
	11	Overall accuracy	not relative
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	Demo level
	14	Reference period	Project period 1.10.2019 – 30.9.2023, constant data collecting during project.
	15	SDG Reference	
Other	16	Comments	DA2

2.3.8. Eco-innovation: Impact

Identi-fier	1	Indicator number	24
	2	Indicator name	Eco-innovation: Impact
Link to Circular City Definition	3	Vision Element	2. Circular business models and behavioral patterns
	4	Category	Private investments, jobs and gross value added
Indicator definition and description	5	Definition / Description of indicator	For each case of implementation of CE business models in indicator #23, describe impact in terms of value creation and material flow
	6	Rationale	Business cases for reuse, recycling and valorisation of OW are developed during the CityLoops project in the City of Mikkeli. Strategy of the City of Mikkeli 2018-2021: Establishing new opportunities from the use of material flows in Mikkeli. Expected outcomes: • At least 5 new treatment and product optimization methods/technologies are tested and evaluated (in demonstration level), considering technical viability, financial viability, and productivity. At least two treatment and product optimization methods/technologies will be established.
	7	Methodology	For each case of implementation of CE business models a) The monetary value (in euros) for biogas, soil improvement products (Phosphorus, nitrogen, potassium) and soil products.) b) materials impact amount of biowaste handled
	8	Unit	Monetary value, tons/year
Data	9	Baseline data / definition	Baseline year 2020,
	10	Data Sources / Relevant Databases	Number of new business models created Theoretical potential of business cases (estimated monetary value and material flow, included to project´s reports) Realized business cases (monetary value and material flow, data from collaboration companies)
	11	Overall accuracy	Estimated values, medium accuracy
Context	12	Sector coverage	OW
	13	Reference area / Spatial	Demo level

		implementation scale	
	14	Reference period	Project period 1.10.2019 – 30.9.2023, once/project
	15	SDG Reference	
Other	16	Comments	DA2

2.3.9. CE-based employment

Identi-fier	1	Indicator number	33
	2	Indicator name	CE-based employment
Link to Circ	3	Vision Element	2. Circular business models and behavioral patterns
	4	Category	Private investments, jobs and gross value added
Indicator definition and description	5	Definition / Description of indicator	Assess the impact of demonstration actions or at sector/city level by estimating the increase in CE related jobs
	6	Rationale	Project activities promoting circular economy and new business cases aim to provide new jobs in the City of Mikkeli. Valorisation of biowaste into new products through preliminary- and technical treatment is to enhance its regional market opportunities. In this process new job opportunities are being created. Strategy of Mikkeli city 2018-2021: Establishing new opportunities from the use of material flows in Mikkeli. Expected outcome: • New circular job opportunities created in the area of biowaste collection and sorting (DA1) • New business- and circular job opportunities created in the recycling of biowaste into new products such as biogas, fertilizers, and soil improvers (DA2)
	7	Methodology	For a selected time period (e.g. year, project period etc) estimate: # of new CE related jobs # of existing jobs becoming circular If deemed practical for the evaluation, jobs that have a range of responsibilities, of which some are related to circularity and some are not, can be assigned a “percentage of circularity”. Using this principle, a change in the percentage can be assigned for existing jobs that become more circular.
	8	Unit	number of Jobs or estimated, % of jobs becoming circular-related.
Data	9	Baseline data / definition	Number of circular jobs (% of jobs) from year 2019

	10	Data Sources / Relevant Databases	Number of jobs and job descriptions of Metsäsairila Ltd and Biosairila Ltd, and other relevant companies from year 2019
	11	Overall accuracy	Accurate. Exact number of jobs or estimated, % of job responsibility being circular
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	City of Mikkeli, ~~sector-level~~
	14	Reference period	Project period 1.10.2019 – 30.9.2023, two times during project.
	15	SDG Reference	
Other	16	Comments	DA1 and DA2

2.3.10. Domestic material consumption (DMC) of virgin materials

Identi-fier	1	Indicator number	35
	2	Indicator name	Domestic material consumption (DMC) of virgin materials
Link to Circular City Definition	3	Vision Element	3. Closing material loops and reducing harmful resource use
	4	Category	Material/energy flow
Indicator definition and description	5	Definition / Description of indicator	The total amount of virgin materials directly used.
	6	Rationale	Project activities aim to increase utilization of reused and recycled organic materials instead of virgin materials (e.g. phosphorus, nitrogen and potassium, biogas instead of using virgin fossil fuels). Strategy of Mikkeli city 2018-2021: Establishing new opportunities from the use of material flows in Mikkeli. Expected outcome: • Potential to reduce consumption of virgin materials by 5% at city level (compared to the start of the project)
	7	Methodology	In producing soil improvement, using nutrients from biowaste saves virgin material such as phosphorus, nitrogen and potassium.

			In producing biogas from biowaste instead of using virgin fossil fuels, how much virgin material is saved/year ~~and what is its market value.~~
	8	Unit	tonnes/year, m^3/year
Data	9	Baseline data / definition	Products sold/tons/2020/2021
	10	Data Sources / Relevant Databases	Metsäsairila, Biosairila, Etelä-Savon Energia • Amount of sold soil improvement, Metsäsairila • Amount of sold biogas, Etelä-Savon Energia Data available through communication to stakeholders.
	11	Overall accuracy	estimates of tons/year and euros/year
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	City of Mikkeli, ~~sector level~~
	14	Reference period	Project period 1.10.2019 – 30.9.2023, 2 times/project
	15	SDG Reference	
Other	16	Comments	DA2

2.3.11. Quantity of material subjected to recycling

Identi-fier	1	Indicator number	52
	2	Indicator name	Quantity of material subjected to recycling
Link to Circular City Definition	3	Vision Element	3. Closing material loops and reducing harmful resource use
	4	Category	Re-use and recycling
Indicator definition and description	5	Definition / Description of indicator	Estimate material subjected to recycling at demo, ~~sector and city~~ level. 'Recycling' means processing of materials to achieve the original high-quality or reduce to low quality6.
	6	Rationale	Several project activities/tools aim to promote the recycling and upcycling of OW materials in Mikkeli. Strategy of Mikkeli city 2018.2021: Establishing new opportunities from the use of material flows in Mikkeli. Expected outcomes: • 15% increased separate collection rate of biowaste within the demonstration site

			• Increase in quantity of biowaste collected at city level
	7	Methodology	At demo level it is needed to explore the share of biowaste in sorting tests and the mass of separately collected biowaste from weighing tests from demo area (amount in %).
	8	Unit	%
Data	9	Baseline data / definition	2020 first sorting test
	10	Data Sources / Relevant Databases	Demo -data on collected mixed waste and amount of biowaste.
	11	Overall accuracy	% amount
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	Demo level
	14	Reference period	Twice/year for demo level.
	15	SDG Reference	
Other	16	Comments	E.g. OW: share of biowaste in sorting tests, mass of separately collected biowaste from weighing tests from demo area. DA1

2.3.12. Quantity of material for anaerobic digestion

Identi-fier	1	Indicator number	53
	2	Indicator name	Quantity of material for anaerobic digestion
Link to Circular City Definition	3	Vision Element	3. Closing material loops and reducing harmful resource use
	4	Category	Re-use and recycling
Indicator definition and description	5	Definition / Description of indicator	Estimate mass of materials going to anaerobic digestion.
	6	Rationale	Several project activities/tools aim to promote the recycling and upcycling of OW materials in Mikkeli. Strategy of the City of Mikkeli 2018-2021: Reducing traffic emissions -increasing the use of biofuels in the city for transportation and in transport contracts with stakeholders. Adding coverage of the biofuel distribution network and the number of biofuel vehicles used in the city. Expected outcomes:

			• Increase in upcycled amount of organic waste 50% by end of project (mass, volume or %) in the city of Mikkeli
	7	Methodology	Sum of organic material going to anaerobic digestion. Data may come from waste management companies Weigh of biomass used in Biosairila´s biogas plant/tonnes/year.
	8	Unit	tonnes/year
Data	9	Baseline data / definition	starting from year 2020 the mass of organic material used in biogas plant of Biosairila
	10	Data Sources / Relevant Databases	Data from Biogas plant of Biosairila. Acquired through direct communication with Biosairila.
	11	Overall accuracy	Medium-good accuracy. Tonnes/year, weighted/estimate
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	City of Mikkeli
	14	Reference period	1.1.2020 – 30.9.2023, once/year
	15	SDG Reference	
Other	16	Comments	DA2

2.3.13. Incineration rate

Identi-fier	1	Indicator number	59
	2	Indicator name	Incineration rate
Link to Circular City Definition	3	Vision Element	3. Closing material loops and reducing harmful resource use
	4	Category	Waste generation/management
Indicator definition and description	5	Definition / Description of indicator	Mass percentage of waste which incinerated.
	6	Rationale	- Several project activities/tools aim to promote the recycling and upcycling of OW materials in Mikkeli instead of incineration. - Strategy of the City of Mikkeli 2018-2021: Increasing the recycling of bio-waste by improving sorting and collection- Residential waste, waste recycling: Baseline 98.6% / Target 99%

			Expected outcomes: • 10% reduction in the amount of organic waste landfilled or incinerated in Mikkeli by the end of project
	7	Methodology	Mass of materials incinerated divided by total amount of waste. Data from waste management companies.
	8	Unit	% of mass
Data	9	Baseline data / definition	demo-action data from 2020 and Metsäsairila´s data from 2019
	10	Data Sources / Relevant Databases	Metsäsairila´s waste company (annual report), demo actions report.
	11	Overall accuracy	Medium accuracy, estimated
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	City of Mikkeli, ~~demo level~~
	14	Reference period	1.10.2019– 30.9.2023, Metsäsairila once a year, demo twice during project.
	15	SDG Reference	
Other	16	Comments	Demo information of the % of biowaste within MSW would be used to estimate the incineration rate at city level. Not very accurate, but interesting. Not possible to get accurate information of biowaste going to incineration at city level. (This is already measured in ind. 52 in a way for demo level.) DA1

2.3.14. Landfilling rate

Identifier	1	Indicator number	61
	2	Indicator name	Landfilling rate
Link to Circular City Definition	3	Vision Element	3. Closing material loops and reducing harmful resource use
	4	Category	Private investments, jobs and gross value added
Indicator definition and	5	Definition / Description of indicator	Mass percentage of waste which is landfilled.
	6	Rationale	- Project activities aim to increase reusing, recycling and upcycling of materials instead of landfilling.

			- Strategy of the City of Mikkeli 2018-2021: Increasing the recycling of bio-waste by improving sorting and collection- Residential waste, waste recycling: Baseline 98.6% / Target 99% Expected outcomes: • 10% reduction in the amount of organic waste landfilled or incinerated in Mikkeli by the end of project
	7	Methodology	Mass of materials landfilled divided by total amount of waste. Data from waste management companies.
	8	Unit	tons/year or %
Data	9	Baseline data / definition	amounts collected/landfilled from year 2019
	10	Data Sources / Relevant Databases	Yearly statistics of waste management company Metsäsairila Ltd.
	11	Overall accuracy	Accurate, exact values
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	City of Mikkeli, sector level
	14	Reference period	1.10.2019 – 30.9.2023, once/year
	15	SDG Reference	
Other	16	Comments	DA1

2.3.15. GHG emissions per year

Identi-fier	1	Indicator number	85
	2	Indicator name	GHG emissions per year
Link to Circular City Definition	3	Vision Element	4. 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 CO_2 emissions in the demonstration actions.
	6	Rationale	- Developing processes and products that are more environmentally friendly, helps the city in its way of sustainability. - The amount of biogas sold instead of fossil fuel gas and its reduced greenhouse gas emissions.

			- The amount of biogas used in waste transportation (used public transportation if data available) instead of using fossil fuels and how it reduced emissions of GHGs - Strategy of the City of Mikkeli 2018-2021: Sustainable development and combating climate change -favoring the introduction of energy solutions that are less harmful to the environment (solar, geothermal, hydro and district heating) -favoring the use of local biogas and electricity in city vehicles. indicators: - baseline CO2 equals 2017 is 5.5 - The target for 2021 is 4.8 t CO2eq / inhabitant Expected outcomes: • The recycling rate of organic waste have improved, which enables a 15% reduction in the greenhouse gas emissions (DA1) • 10% Reduced emissions of CO2 related to reduced transport needs as well as substitution of fossil fuels (trucks) with biogas (DA2)
	7	Methodology	Direct GHG emissions pr. year demo level Direct GHG emissions pr. year city level
	8	Unit	Tonnes CO_2-equivalents / year
Data	9	Baseline data / definition	Etelä-Savon Energia: sold amount of biogas from year 2020 demo-action data from 2020. (Slightly changed to suit demo level.)
	10	Data Sources / Relevant Databases	Etelä-Savon Energia on amount of biogas sold (through direct communication). Amount % increase in collected biowaste in demo site and how much biofuel can be produced from it. Demo-data (project reports), and literary knowledge on the amount of GHGs emitted through Biogas vs fossil fuels. (Slightly changed to suit demo level.)
	11	Overall accuracy	Medium-good accuracy. Tonnes CO_2-equivalent/year
Context	12	Sector coverage	OW
	13	Reference area / Spatial implementation scale	Demo level
	14	Reference period	Project period 1.10.2019 – 30.9.2023, 2 times/project
	15	SDG Reference	
Other	16	Comments	The outcome (DA1) moved from DA2 to DA 1 and changed to suit DA1. The original text from amendment: The recycling rate and treatment techniques of organic waste have improved, which enables a 15% reduction in the greenhouse gas emissions after the end of the project. DA1 and DA2

3. 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.

4. Annex 1: City Loops 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

5. 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.

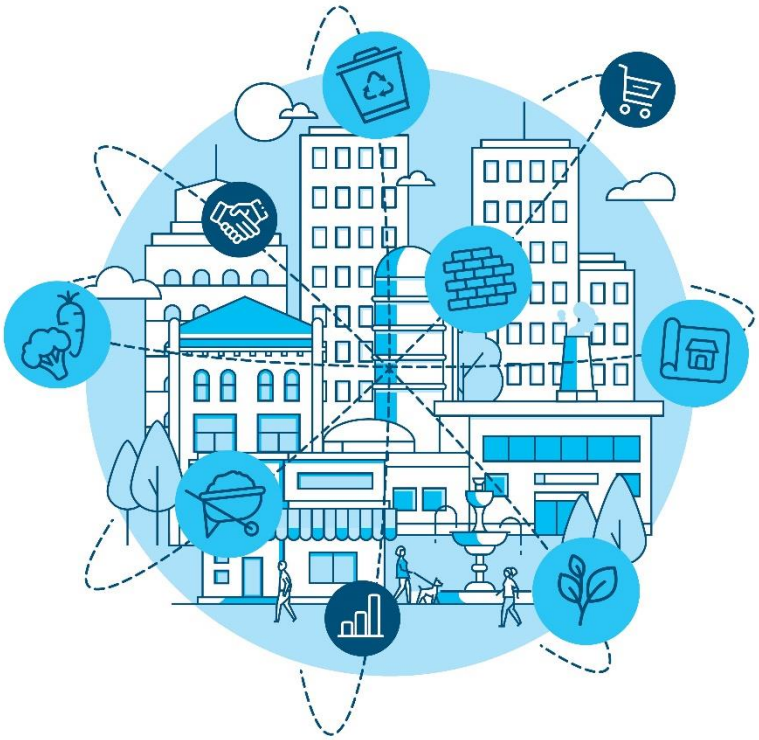
CityLoops runs from October 2019 until September 2023.

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

Evaluation Plan: Biowaste sector, Porto

Deliverable 6.2

2GO OUT Consulting



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Abstract	This report details how the City of Porto will evaluate the impact of the CityLoops tools and demonstration activities aimed at improving the circularity of the Biowaste sector.
Keywords	Evaluation, Indicators, Porto, Biowaste
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Contents

1. Introduction

The objective of the CityLoops evaluation work is to ensure that 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). 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.

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.

During the process of evaluation of the demonstration actions key stakeholders will be involved to discuss the interim and the final results of the demonstration actions, such as the representatives of the tourism and social economy sectors, universities and R&D units (like University of Porto and Polytechnic Institute of Porto), Porto Municipality departments and regional entities (like CCDR-N and AMP – Porto Metropolitan Area).The results of the project will be integrated into the Roadmap to Porto City Circular in 2030.

About the City of Porto

Located in the north coast of Portugal, along the river Douro, Porto is the second most important city of the country, with around 217 000 inhabitants (PORDATA 2019) and an average population density of 5 229.5 persons/km^2 (INE 2019). Surrounded by 16 other municipalities (AMP – Porto Metropolitan Area) that combine a unique range of assets, from industries and universities to agricultural land, gives it an innovative profile and a unique position to improve the food system through circular economy.

Porto has suffered high population decline in recent decades. However, it has seen a small population growth since 2017, in part as a result of the city's rising reputation as a place to live. There is, however, a continuous influx of population for reasons of work or study, equivalent to 72.3% of the population living in Porto (INE 2011). The City of Porto is one of the main economic drivers of the northern region, driven by a highly developed transport network for products. The economic activities of Porto are mainly focused on the tertiary sector, especially

financial activities, real estate and services. In the last years, there was a galloping growth in the tourism sector, with a record of growth in overnight stays, making tourism a more economically appealing sector of activity. The primary sector activity in the Municipality is of little economic relevance, employing only 0.27% of the working population.

In 2020 and in the first quarter of 2021, due to the COVID-19 crisis and the associated health restrictions imposed in Portugal, there was a large reduction in tourism activities in the City, with low hotel and restaurant reservations and related business closures. Other economic activities were also restricted, leading to an increase in unemployment in the Porto Municipality.

About the biowaste sector

Regarding the biowaste sector in Porto, an estimated 38.350 tonnes of biowaste were generated in 2019 (Porto Ambiente), of which only 30% was collected separately. All the biowaste collected separately was forwarded for organic valorisation at LIPOR composting plant, however there is yet a high potential of biowaste recovery and recycling from unsorted biowaste amounting to around 38%, which currently is being sent to LIPOR waste-to-energy plant. Both of these LIPOR facilities are located outside of the Porto Municipality boundary.

The management of biowaste has become a major concern in the City of Porto and is a priority in its urban agenda, due to increasing touristic activity and large numbers of work and study related commuters and the resulting generation of waste with its adverse impacts on public health and the environment. For the City of Porto, the reduction of food waste is also a great opportunity to decrease social inequalities, promote healthier food, generate new business opportunities and close the biomass cycle. It's also important to create mechanisms to support and scale up innovations that could boost practices to promote local and organic food, food waste prevention and urban food growing initiatives that help reduce environmental negative impacts, increase resources efficiency and reduce external dependencies of raw materials. Some steps were already taken to increase circularity in the city biowaste sector: Project 'Horta à Porta', Project 'Dose Certa'; Project 'Embrulha', 'Zero Desperdício' Network.

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

One of Porto's ambitions is to boost the transition to a circular economy, especially in the food system, addressed in its Roadmap to Porto Circular City in 2030, developed in 2017. This roadmap is a process in constant update and already included some food system guidelines.

The transition to a circular economy in food system came from the previous work that Porto Municipality developed with Ellen MacArthur Foundation, Calouste Gulbenkian Foundation

and other relevant local stakeholders, related with *'Cities and Circular Economy for Food'* report (Ellen MacArthur Foundation 2019), launched in 2019, in which Porto was one of the study cities. Currently, Porto Municipality looks to detailed aspects of the food sector, identify priority initiatives considering the contributions of the several stakeholders and design a municipal program for the transformation to a regenerative food system based on the priorities of the Municipality to accelerate the transition.

CityLoops tools and preparation actions

The tools and preparation work are the basis of the Demo Actions that will be implemented in City of Porto. These demonstration actions will fill specific gaps, while promoting the transition to circularity in the management of biowaste in the social economy and tourism sectors (restaurants, hotels and associations) and also in residential neighbourhoods with high-rise buildings, mostly by reducing biowaste production, improving biowaste separate collection systems and facilitating valorisation as well as local treatment (home and community composting). In this context, the demonstration actions can be summarised as follows in next sub-chapters.

1.1. Demo Action 1: Biowaste selective collection and local treatment model

Short Description

Improvement of waste collection, specifically biowaste, through the implementation of 120 containers for biowaste separation that will be integrated in the surface bins network of the City of Porto. These containers will be complemented with the Smart Collection System tool that will allow to identify and locate every container.

At the same time, and as a complement to the biowaste selective collection, two community composting islands will be created in two neighbourhoods, together with food cultivation beds.

Both the biowaste selective collection and the community composting island will be supported with the implementation of the awareness campaigns to engage the citizens of Porto City in these activities.

Expected Outcomes

- A new separate collection optimized system connected with city sensors network (SCS Tool);
- 25.500 inhabitants of the City of Porto engaged in the biowaste separate collection;
- Collection of 1,500 t/year of biowaste (total of 3.250 tonnes by M44);
- 1 t/year/composting bin unit of local biowaste treatment (15 in total);
- 210.17 kg of avoided CO_2 eq. emissions for 1 ton of biowaste treated on composting islands;
- Improved awareness of citizens and stakeholders on circular BW management;
- New local stakeholder partnerships to promote biowaste selection collection and local treatment new models;
- Decreased costs associated with the waste treatment through increased selective collection of BW from residential sectors;
- Increased circular jobs at ratio: 1 BW separate collection system = 3 new jobs.

1.2. Demo Action 2: Biowaste Circularity Models, new CP practices and Training Courses

Short Description

Both tourism (hotels and restaurants) and social economy sectors (canteens) are big local producers of food waste and, at the same time, a source of opportunity for waste reduction and prevention, still under-explored.

A BW circularity model were developed for both tourism and social economy sector with the aim of support the implementation of several actions that will promote the change citizen behaviour towards biowaste while reducing its production, closing the loop of organic matter from farm to fork.

The models conceptualized aggregate a set of measures to be implemented along the biowaste life cycle. Most of the proposed measures are the result of the experience of the entities involved in waste management at City of Porto (LIPOR and Porto Ambiente).

In this Demo Action, two tools (the Food Demand Management Tool and the Circularity Decision Making Support Tool) will be tested. Furthermore, training courses about circular procurement in social economy and tourism sector will be offered as part of the demonstration action.

Expected Outcomes

- Local vegetable production of around 3 kg *per* month with a growbed kit;
- Food waste avoided ~30% in the pilot comparing with baseline (M44);
- ~300 g of food waste avoided *per* Embrulha package;
- Increased separate biowaste collection by 50 t/year *per* pilot;
- Local treatment by 400 kg/year of biowaste per compost bin (300 l capacity);
- Application of two new tools to promote circularity in BW management: (1) Food demand management tool, (2) Decision making support tool, validated and ready for replication and upscaling;
- Capacity building of circularity models pilots' staff on circular procurement, to promote the new guidelines for BW circular procurement;
- Two new local stakeholder partnerships to promote new biowaste circularity models and circular procurement practices;
- Reduced costs from waste collection due to demonstration action;
- Decreasing the GHG emissions related with BW production, collection and treatment – this outcome will be quantified after the calculation of baseline values.

1.3. Demo Action 3: Launch of Green Space Certification System

Short Description

A certification system guideline for urban green spaces, designed during preparation phase, will be launched and implemented in City of Porto during demonstration phase. The Certification System will disseminate dedicated gardening practices to promote and reuse the compost produced at LIPOR's composting plant or at home and community composting.

First the urban green spaces will be identified and one selected to be analysed for its gardening practices. After filling a check list with the gardening practices already in use, we will produce an action plan to improve sustainable urban garden practices.

This Demo Action intends to highlight the importance of returning biowaste to the soil, in the form of compost, and of applying sustainable management practices in public and private green spaces.

After identification, selection, analysis and implementation of the system in an urban green space of Porto Municipality, the certification will be attributed and the certification system disseminated.

Expected Outcomes

- A new certification of Sustainable Green Spaces, promoting the use of compost produced by LIPOR, is in place, validated and ready to be replicated and upscaled;

- Increased cost effectiveness in management and maintenance of green spaces;
- Reused nutrients present in compost on Porto City Green Spaces (kg NPK/m2);
- Reduction of garden waste generation and maintenance costs (kg/m2);
- Quantity of material for composting (local or centralised option) (kg/m2).

With exception of the first, the other outcomes of Demo Action 3 will be quantified after selection of pilot green space and calculation of baseline values.

1.4. Demo Action 4: Circular Entrepreneurship Initiatives

Short Description

A contest for circular ideas, designed during the preparation phase, will be implemented in the city during the demonstration phase in order to promote circular transition on biowaste and more broadly on the food system, following Porto's environmental strategy and the Porto's Roadmap for Circular Economy to become circular by 2030, that aims to encourage, support and empower entrepreneurs to turn environmental and social challenges into circular business opportunities and to bring together key players to co-create responses to the challenges and raise awareness of best practices.

The contest is directed not only to local entrepreneurs or companies but also to citizens and social institutions in order to create synergies between new ideas and established organizations with the purpose to upscale environmental, social and economic positive impacts at the city and contribute to a helathier and sustainable food system, applying the principles of circular economy. Ideas that encourage the creation of synergies between the several sectors and actors, mainly social and tourism sectors, promote and support food waste management innovative ideas, improve food donation circuits, satisfying the nutritional needs of vulnerable communities and, at the same time, reducing food waste, promote local/regional agri-food circuits and strengthen the multi sector and multi actor to raise awareness and fight against food waste will be valued.

During the implementation of the contest, 20 of the submitted ideas/teams will go through a bootcamp in order to improve and optimise ideas and business plan. The 5 winning ideas, after the evaluation of bootcamp results, will receive 6 months of high-quality mentorship from a multiple range of specialists, according to the needs of each idea/project. By the end of the contest, the objective is that each organisation can connect to similar projects and empower each other and be able to implement the project and make it sustainable and viable.

Expected Outcomes

- Generation 20 new business projects/ideas of which 5 will be winners;
- Improving the understanding of circular economy principles, by the participating teams;
- Improving the capacity of transforming challenges into opportunities through the design and implementation of circular business models, by the participating teams;

- Winning projects/ideas have developed detailed business plans ready to get financed.

Winning ideas will have a holistic approach to a specific problem and will have the tools needed to solve it, whether these tools are funding opportunities, contacts, synergies and/or cooperations.

1.5. Demo Action 5: Reducing food waste via a donation network

Short Description

This will support and expand the food donation network, already occurring in the city, which connects food distribution and social economy sectors to support citizens with low income and social needs in the city of Porto. This action will allow food waste reduction in the city.

Partnerships with Zero Desperdício will be promoted to expand the network, not only near Porto Municipality (to promote the involvement of municipal services related to social and school canteens and to events promoted by the municipality) but also near small, medium and large companies as food donors that are concerned with their ecological and social responsibility, such as: restaurants and similar, hotels and companies in the wholesale and retail sector; and social organizations as receivers, so that they can redistribute food with quality to citizens in unfavourable living conditions. The network partners will be identified (restaurants, supermarkets, festivals, events, social institutions and social canteens) and will receive food safety and security training in order to be entitled to be a food donor or a food receiver within the Zero Desperdício Network.

Expected Outcomes

Data related to the donation network with key indicators:

- Food donation network increment achieving at least 75 tonne/year of food donation and 2.000 benefited families;
- Tonnes of CO2 emissions avoided through the donation programme;
- Increment of the number of supported families.

2. 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: Each selected indicator will monitor specific processes and impacts related to the Demonstration Action activities 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 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 CityLoops project plans (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 to Table 4 list the selected indicators for each of the four vision elements in the CityLoops Circular City Definition (Vangelsten, et al. 2021). The tables describe at which level the indicators will be applied (Demonstration Action or City level) and which Demonstration Actions they will evaluate.

Table 1. List of indicators related with Vision Element 1 "Local Stakeholder Actions"

Indicator #	Indicator name	Scope (demo/city)	1. Biowaste selective collection and local treatment model	2. Biowaste circularity modes, new CP practices and training courses	3. Launch of green space certification system	4. Circular entrepreneurship initiatives	5. Reducing food waste by donation
#3	New tools for better mapping of resources and their location: For each tool, qualitative description	D/C	X				
#4	CE-related knowledge building campaigns: Qualitative description	D	X	X		X	
#5	CE-related knowledge building campaigns: Impact	D	X	X		X	
#6	Circularity related stakeholders' activities	D/C	X	X			X
#10	Stakeholder contribution to improved circularity	D/C	X				
#19	Progress towards circular city strategy objectives	C					
#21	New planning instruments/tools for improved circularity: Qualitative description	D		X			
#27	Reduced waste generation	D					X
#67	Open certified green space area ratio per 100.000 inhabitants	D			X		
#71	Percentage of city population with regular biowaste collection (residential)	D	X				

Table 2. List of indicators related with Vision Element 2 "Circular business models and behaviour patterns"

Indicator #	Indicator name	Scope (demo/city)	1. Biowaste selective collection and local treatment model	2. Biowaste circularity modes, new CP practices and training courses	3. Launch of green space certification system	4. Circular entrepreneurship initiatives	5. Reducing food waste by donation
#13	Increased provision of local, sustainable and healthy food	D		X			
#23	Eco-innovation: # of new CE business models/cases. This includes a qualitative description of model, its circular strategy (material, component, product, function)	D				X	

#24	Eco-innovation: Qualitative description	D				X	
#32	Reduced costs due to improved circularity	D	X	X	X		
#33	CE-based employment	D	X				
#89	Increased provision of local, sustainable and healthy food	D		X			

Table 3. List of indicators related to Vision Element 3 "Closing material loops and reducing harmful resource use"

INDICATOR #	INDICATOR NAME	SCOPE (DEMO/CITY)	1. BIOWASTE SELECTIVE COLLECTION AND LOCAL TREATMENT MODEL	2. BIOWASTE CIRCULARITY MODES, NEW CP PRACTICES AND TRAINING COURSES	3. LAUNCH OF GREEN SPACE CERTIFICATION SYSTEM	4. CIRCULAR ENTREPRENEURSHIP INITIATIVES	5. REDUCING FOOD WASTE BY DONATION
#27	Reduced waste generation	D		X	X		
#56	Quantity of material for composting	C/D	X	X	X		
#59	Waste-to-Energy rate	C					
#60	Waste-to-Energy rates per material fractions	C					
#88	Quantity of biowaste for collection avoided	C/D	X	X	X		X
#90	Reused nutrients present in compost on Green Spaces	D			X		

Table 4. List of indicators related to Vision Element 4 "Improving human wellbeing and reducing environmental impacts"

INDICATOR #	INDICATOR NAME	SCOPE (DEMO/CITY)	1. BIOWASTE SELECTIVE COLLECTION AND LOCAL TREATMENT MODEL	2. BIOWASTE CIRCULARITY MODES, NEW CP PRACTICES AND TRAINING COURSES	3. LAUNCH OF GREEN SPACE CERTIFICATION SYSTEM	4. CIRCULAR ENTREPRENEURSHIP INITIATIVES	5. REDUCING FOOD WASTE BY DONATION
#71	Percentage of city population with regular solid waste collection (residential)	D/C	X				
#85	GHG emissions per year	D/C	X	X			X
#86	Annual CO2 equivalent emissions per capita	C					
#87	Annual CO2 emissions per unit of GDP	C					

Links between the selected indicators and the expected outcomes for the specific Demonstration Actions are shown in the tables below.

Table 5: Linking expected outcomes to the selected indicators for Demonstration Action 1 "Biowaste selective collection and local treatment Model"

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	A new BW separate collection optimized system connected with city sensors network (SCS Tool)	New tools for better mapping of resources and their location
	Improved awareness of citizens and stakeholders on circular BW management	CE-related knowledge building campaigns
	New local stakeholder partnerships to promote biowaste selection collection and local treatment new models;	Circularity related stakeholders' activities
		Stakeholder contribution to improved circularity
2 Circular business models and behaviour patterns	Decreased costs associated with the waste treatment through increased selective collection of BW from residential sectors	Reduced costs due to improved circularity
	Increased circular jobs at ration: 1 BW separate collection system = 3 new jobs.	CE-based employment
3 Closing material loops and reducing harmful resource use	Collection of 1 500 t/year biowaste (total of 3.250 tonnes by M44)	Quantity of material for centralised composting
	1 t/year/composting bin unit of local biowaste treatment (15 in total)	Quantity of material for local composting Quantity of biowaste for collection avoided
4 Improving human wellbeing and reducing environmental impacts	21.660 of the population of the City of Porto engaged in the biowaste separate collection	Percentage of city population with regular solid waste collection (residential)
	210.17 kg of avoided CO_2 eq. emissions for 1 ton of biowaste treated on composting islands	GHG emissions per year

Table 6: Linking expected outcomes to the selected indicators for Demonstration Action 2 "Biowaste Circularity Models, new CP practices and training courses"

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Capacity building of circularity models pilots' staff on circular procurement, to promote the new guidelines for BW circular procurement	CE-related knowledge building campaigns
	Two new local stakeholder partnerships to promote new biowaste circularity models and circular procurement practices.	Circularity related stakeholders' activities
	Application of two new tools to promote circularity in BW management: (1) Food demand management tool, (2) Decision making support too, validated and ready for replication and upscaling;	New planning instruments/tolls for improved circularity

Vision Element	Expected outcome	Indicator
2 Circular business models and behaviour patterns	Local vegetable production of around 3 kg per month with a growbed kit	Increased provision of local, sustainable and healthy food
	Reduced costs from waste collection due to demonstration action;	Reduced costs due to improved circularity
3 Closing material loops and reducing harmful resource use	Food waste avoided ~30% in the pilot comparing with baseline (M44)	Quantity of biowaste for collection avoided
	~300 g of food waste avoided per Embrulha package;	
	Increase separate biowaste collection by 50 t/year per pilot	Quantity of material for centralised composting
	Local treatment by 400 kg/year of biowaste per compost bin (300 l capacity);	Quantity of material for local composting Quantity of biowaste for collection avoided
4 Improving human wellbeing and reducing environmental impacts	Decreasing the GHG emissions related with BW production, collection and treatment – this outcome will be quantified after the calculation of baseline values.	GHG emissions per year

Table 7: Linking expected outcomes to the selected indicators for Demonstration Action 3 "Launch of Green Space Certification System"

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	A new certification of Sustainable Green Spaces, promoting the use of compost produced by LIPOR, is in place, validated and ready to be replicated and upscaled	Open certified green space area ratio per 100.000 inhabitants
2 Circular business models and behaviour patterns	Increased cost effectiveness in management and maintenance of green spaces;	Reduced costs due to improved circularity
3 Closing material loops and reducing harmful resource use	Reused nutrients present in compost on Porto City Green Spaces (kg NPK/m2)	Reused nutrients present in compost on Green Spaces
	Reduction of garden waste kg/m2)	Quantity of biowaste for collection avoided
	Quantity of material for composting (local or centralised option) (kg/m2)	Quantity of material for composting
4 Improving human wellbeing and reducing environmental impacts	N.A.	N.A.

Table 8: Linking expected outcomes to the selected indicators for Demonstration Action 4 "Circular Entrepreneuship Initiatives"

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Improving the understanding of circular economy principles, by the participating teams	CE-related knowledge building campaigns
	Improving the capacity of transforming challenges into opportunities through the design and implementation of circular business models, by the participating teams	
2 Circular business models and behaviour patterns	Generation of 20 new business projects/ideas of which 5 will be winners	Eco-innovation: # of new CE business models/cases.
	Winning projects/ideas have developed detailed business plans ready to get financed.	
3 Closing material loops and reducing harmful resource use	N.A.	N.A.
4 Improving human wellbeing and reducing environmental impacts	N.A.	N.A.

Table 9: Linking expected outcomes to the selected indicators for Demonstration Action 5 "Reducing food waste by a donation network"

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Increment of the number of supported families	Circularity related stakeholders' activities
2 Circular business models and behaviour patterns	N.A.	N.A.
3 Closing material loops and reducing harmful resource use	Food donation network increment achieving at least 75 tonne/year of food donation and 2.000 benefited families	Quantity of biowaste for collection avoided
4 Improving human wellbeing and reducing environmental impacts	Tonnes of CO2 emissions avoided through the donation programme;	GHG emissions per year

3. 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 that they will test.

3.1. New tools for better mapping of resources and their location: Qualitative description

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	3
	2	Indicator name	New tools for better mapping of resources and their location: Qualitative description
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	4	Category	Engagement and capacity building Regulation and incentives Vision and urban management
Indicator definition and description	5	Definition / Description of indicator	Qualitative description of individual tools, including scope and scale (e.g. demonstration vs city level), target users.
	6	Rationale	New containers to biowaste selective collection and composting islands will be georeferenced allowing to know the source of material to compost production (DA1). The new smart sensor collection system will allow to collect information on the quantity of waste collected, together with data on usage patterns, and maintenance operations. This will be used to help optimise biowaste selective collection from the connected containers, to promote interaction with users and will also be made publicly available for businesses and the general public to enable other potential applications. At city level, both demo actions will contribute to know better the resources within the city. *(Selected together with indicator #20)*
	7	Methodology	Qualitative description
	8	Unit	Qualitative data
Data	9	Baseline data / definition	The tools are new and aren't implemented yet, so the baseline won't have information.

Metadata group	#	Metadata category	Description/comments
	10	Data Sources / Relevant Databases	The data related with qualitative description of the new tools will be given by LIPOR (DA1) and Porto Ambiente (DA1).
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste
	13	Reference area / Spatial implementation scale	City: Porto Demonstration Actions: DA1
	14	Reference period	Yearly Availability of data: Quarterly
	15	SDG Reference	12 - The local authority's capacity to encourage the establishment and successful operation of repair and reuse platforms and secondary material markets on their territory.
Other	16	Comments	

3.2. CE-related knowledge building campaigns: Qualitative description

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	1. Local stakeholder actions
	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	Training courses and workshops will be performed to boost the transition to circular economy on individual actions and business. In DA1 composting workshops will be performed allowing citizens to contribute to the composting community islands. In DA2 training courses will be performed at several levels: to promote circular procurement practices, and to help the transition to circular economy on pilots (Hotel and IPSS) with training on the different actions that will be implemented. In DA4 a bootcamp and mentoring will be developed to allow the winners of the contest developing their business models. (Selected together with indicator #5)
	7	Methodology	a) Identify and categorise knowledge campaigns b) Identify groups reached
	8	Unit	Qualitative data

Metadata group	#	Metadata category	Description/comments
Data	9	Baseline data / definition	The baseline will be defined with the description of the training courses and workshops planned.
	10	Data Sources / Relevant Databases	The data related with qualitative description of the knowledge campaigns will be given by CMP (DA4) and LIPOR (DA1 and DA2).
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste, Tourism Sector (hotels and restaurants), Social Economy Sector and Entrepreneurship
	13	Reference area / Spatial implementation scale	Demonstration Actions: DA1, DA2 and DA4
	14	Reference period	Biannual Availability of Data: Quarterly
	15	SDG Reference	17 – The provision of training and other capacity building activities for public sector employees, as well as other stakeholders (such as local businesses) to increase skills relevant to fostering the circular transition.
Other	16	Comments	

3.3. CE-related knowledge building campaigns: Impact

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	1. Local stakeholder actions
	4	Category	Engagement and capacity building
Indicator definition and description	5	Definition / Description of indicator	# of campaigns # of people reached for each campaign
	6	Rationale	Training courses and workshops will be performed to boost the transition to circular economy on individual actions and business. In DA1 composting workshops will be performed allowing citizens to contribute to the composting community islands In DA2 training courses will be performed at several levels: to promote circular procurement practices, and to help the transition to circular economy on pilots (Hotel and IPSS) with training on the different actions that will be implemented. In DA4 a bootcamp and mentoring will be developed to allow the winners of the contest developing their business models. (Selected together with indicator #4)
	7	Methodology	a) Number of campaigns b) Number of people reached

Metadata group	#	Metadata category	Description/comments
	8	Unit	Number of campaigns Number of people
Data	9	Baseline data / definition	The baseline will be zero as no knowledge campaigns have yet been taken
	10	Data Sources / Relevant Databases	The data needed will be given by CMP (DA4) and LIPOR (DA1 and DA2).
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste, Tourism Sector (hotels and restaurants), Social Economy Sector and Entrepreneurship
	13	Reference area / Spatial implementation scale	Demonstration Actions: DA1, DA2 and DA4
	14	Reference period	Biannual Availability of Data: Quarterly
	15	SDG Reference	17 – The provision of training and other capacity building activities for public sector employees, as well as other stakeholders (such as local businesses) to increase skills relevant to fostering the circular transition.
Other	16	Comments	

3.4. 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	1. Local stakeholder actions
	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 # of people involved
	6	Rationale	Porto Municipality has a previous work done in circularity related stakeholder activities and is strategic for Porto continuing this work. The indicator will be monitoring for all Demo Actions.
	7	Methodology	a) Identify stakeholder activity b) Describe process and when stakeholders are involved c) Identify dialogue methods used d) Number of people involved
	8	Unit	Qualitative data Number of people

Metadata group	#	Metadata category	Description/comments
Data	9	Baseline data / definition	The baseline related with Demo Actions will be zero. For City Level, the baseline will be considered the number of stakeholders engaged on development of Roadmap and involved on activation of local community for circular economy – food system.
	10	Data Sources / Relevant Databases	The data needed will be provided by CMP (City Level), LIPOR (DA1, DA2 and DA5) and Porto Ambiente (DA1) in accordance with each Demo Action and the stakeholders activities developed.
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste, Tourism Sector (hotels and restaurants), Social Economy Sector, Residential Sector (citizens), Schools, Universities and R&D Units
	13	Reference area / Spatial implementation scale	City: Porto Demonstration Actions: DA1, DA2 and DA5
	14	Reference period	Biannual Availability of Data: Quarterly
	15	SDG Reference	17 – Increased involvement of, and collaboration with, relevant stakeholders (including civil society, businesses, the research community, and other public sector actors) at the local and regional level at all different stages of CE planning, implementation, monitoring, reviewing, as a fundamental prerequisite to systemic transformation. This objective thus refers to the degree and quality of interaction and collaboration. This includes actions aimed at developing or upscaling activities to the regional level where appropriate.
Other	16	Comments	

3.5. Stakeholder contribution to improved circularity

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	10
	2	Indicator name	Stakeholder contribution to improved circularity
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	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	Porto Municipality has a previous work done in circularity related stakeholder activities and is strategic for Porto continuing this work. The indicator will be monitoring for all Demo Actions.

Metadata group	#	Metadata category	Description/comments
	7	Methodology	a) List of inputs from stakeholders b) Describe how it has been used by those that promoted the stakeholder activity c) Describe how it has contributed to improved circularity
	8	Unit	Qualitative data + potential quantitative impact data
Data	9	Baseline data / definition	The baseline related with Demo Actions will be zero. The City Level baseline will take in consideration the inputs from stakeholders during roadmap development and constitution of local community for circular economy.
	10	Data Sources / Relevant Databases	CMP (City Level) Porto Ambiente (DA1)
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste, Tourism Sector (hotels and restaurants), Social Economy Sector, Residential Sector (citizens), Schools, Universities and R&D Units
	13	Reference area / Spatial implementation scale	City: Porto Demonstration Actions: DA1
	14	Reference period	Biannual Availability of Data: Quarterly
	15	SDG Reference	17 – Increased involvement of, and collaboration with, relevant stakeholders (including civil society, businesses, the research community, and other public sector actors) at the local and regional level at all different stages of CE planning, implementation, monitoring, reviewing, as a fundamental prerequisite to systemic transformation. This objective thus refers to the degree and quality of interaction and collaboration. This includes actions aimed at developing or upscaling activities to the regional level where appropriate. 17 – Given that the circular transition will require the adjustment of policy and regulatory frameworks at all levels of government, multi- level governance collaboration will be crucial. Local governments must be proactive in sharing experiences, knowledge, and good practices within the national and European arena.
Other	16	Comments	

3.6. Progress towards circular city strategy objectives

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	19
	2	Indicator name	Progress towards circular city strategy objectives
Link to Circ...	3	Vision Element	1. Local stakeholder actions

Metadata group	#	Metadata category	Description/comments
	4	Category	Vision and urban management
Indicator definition and description	5	Definition / Description of indicator	Describe to which degree the city is making progress towards its circularity objectives. Identify categories of relevant strategy documents, select documents and relevant selected CE targets.
	6	Rationale	Understand the progress towards Porto 2030 Roadmap objectives, related with biowaste, with CityLoops Project implementation it is an important analysis to make since it is possible to know the progress towards its circularity objectives. The ambition is to move from “little progress” to some “progress” on reaching Porto 2030 Roadmap objectives related with CityLoops Project.
	7	Methodology	For each of the identified targets: Describe ambition and judge on scale 1. No progress, 2. Little progress, 3. Some progress, 4. Ambition nearly reached, 5. Ambition reached or beyond
	8	Unit	Score on categorical scale (1-5)
Data	9	Baseline data / definition	The baseline to be considered will be 2. Little progress
	10	Data Sources / Relevant Databases	CMP (Porto Circular 2030 Roadmap)
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste and Public Sector
	13	Reference area / Spatial implementation scale	City: Porto
	14	Reference period	Yearly Availability of Data: Yearly
	15	SDG Reference	11, 16 – The existence of a city-wide strategy on the development of a local circular economy and/or local contribution to a more circular economy in general, including specific objectives and measures, as a key enabler, based on scientific/evidence-based (metabolic) analysis.
Other	16	Comments	

3.7. New planning instruments/tools for improved circularity: Qualitative description

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	21
	2	Indicator name	New planning instruments/tools for improved circularity: Qualitative description
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	4	Category	Vision and urban management

Metadata group	#	Metadata category	Description/comments
Indicator definition and description	5	Definition / Description of indicator	Define and select planning instruments/ tools relevant to improve circularity
	6	Rationale	New tools will be tested in DA1 and DA2 in order to improve circularity of biowaste. *(Selected together with indicator #22)*
	7	Methodology	Qualitative description of each instrument/tool
	8	Unit	Qualitative data
Data	9	Baseline data / definition	Since the tools are new, the baseline will be zero as no actions have yet been taken.
	10	Data Sources / Relevant Databases	The information related with tool description will be provided by LIPOR (DA2).
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste, Tourism Sector and Social Economy Sector
	13	Reference area / Spatial implementation scale	Demonstration Actions: DA2
	14	Reference period	Yearly Availability of Data: Quarterly
	15	SDG Reference	9, 11 - This objective refers to the aim to include circularity principles into public asset management, including for instance publicly owned land, buildings and infrastructure. Such principles could have manifold aims but can sensibly be determined as those that increase the use of secondary materials, extend product/stock lifetimes or intensify their use. Including such principles in urban asset management means in practice to give those principles a certain importance, if not prioritise them among other existing principles. Examples of relevant outputs are e.g. asset management procedures and guidelines, procurement, maintenance, assessment schemes etc.
Other	16	Comments	

3.8. New planning instruments/tools for improved circularity: Impact

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	22
	2	Indicator name	New planning instruments/tools for improved circularity: Impact
Link to Circular City Definition	3	Vision Element	1. Local stakeholder actions
	4	Category	Vision and urban management

Metadata group	#	Metadata category	Description/comments
Indicator definition and description	5	Definition / Description of indicator	Quantify impact of all planning instruments/tools described in indicator # 21.
	6	Rationale	New tools will be tested in DA2 in order to improve circularity of biowaste. *(Selected together with indicator #21)*
	7	Methodology	For each instrument/tool: # of projects where tool was used Total mass of materials that the tool has impacted on per year Recirculated mass of materials that the tool has impacted on per year
	8	Unit	Number of tools Tonnes/year
Data	9	Baseline data / definition	Since the tools are new the baseline will be zero as no actions have yet been taken.
	10	Data Sources / Relevant Databases	The information related with tool description will be provided by LIPOR (DA2).
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste, Tourism Sector and Social Economy Sector
	13	Reference area / Spatial implementation scale	Demonstration Actions: DA2
	14	Reference period	Yearly Availability of Data: Yearly
	15	SDG Reference	9, 11 - This objective refers to the aim to include circularity principles into public asset management, including for instance publicly owned land, buildings and infrastructure. Such principles could have manifold aims but can sensibly be determined as those that increase the use of secondary materials, extend product/stock lifetimes or intensify their use. Including such principles in urban asset management means in practice to give those principles a certain importance, if not prioritise them among other existing principles. Examples of relevant outputs are e.g. asset management procedures and guidelines, procurement, maintenance, assessment schemes etc. 9, 11 - The inclusion of CE principles in urban planning decisions, such as zoning and planning decisions, construction and demolition permits, and mobility planning. Such principles could have manifold aims but can sensibly be determined as those that increase the use of secondary materials, extend product/stock lifetimes or intensify their use. Systematically incorporating such principles in urban planning decisions is one of the most important levers for local authorities in promoting the transition to a CE on their territory.
Other	16	Comments	

3.9. Eco-innovation: Qualitative description

Metadata group	#	Metadata category	Description/comments
Indicator definition and description	1	Indicator number	23

Metadata group	#	Metadata category	Description/comments
	2	Indicator name	Eco-innovation: Qualitative description
Link to Circular City Definition	3	Vision Element	2. Circular business models and behavioural patterns
	4	Category	Circular design and business models Private investments, jobs and gross value added
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	Under Circular Entrepreneurship Initiatives a contest will be promoted in order to acquire new business ideas that contribute to circular economy. *(Selected together with indicator #24)*
	7	Methodology	# of new CE business models For each model, a qualitative description of model, its circular strategy
	8	Unit	Qualitative data
Data	9	Baseline data / definition	The initiatives have yet been taken so the baseline is zero.
	10	Data Sources / Relevant Databases	The information about new business ideas/models will be provided by CMP (DA4).
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste, Social Economy Sector and Tourism Sector
	13	Reference area / Spatial implementation scale	Demonstration Action: DA4
	14	Reference period	Yearly Availability of Data: Yearly
	15	SDG Reference	9, 12 - Increasing the lifetime of assets (equipment, machinery, buildings, infrastructure and consumer goods) in order to reduce waste generation and resource use. This can occur through different kinds of interventions, induced by different urban actors, including e.g. permit extensions, eco-design, modular design & design for repair, maintenance etc. 3, 12 - Recognising that local food production and distribution entails clear health and climate benefits, this objective refers to increasing the share of locally produced and consumed food. 9, 12 - Increasing the exploitation rate of assets (e.g. equipment, machinery, buildings, infrastructure and consumer goods), intensifying their use and increasing their utility. One of the main mechanisms, through which this can occur, is through sharing activities (e.g. car sharing, sharing office- or production space). An increased rate of exploitation of assets is a key circularity objective as it increases the utility of existing assets for society and counteracts the use of virgin materials.
Other	16	Comments	

3.10. Eco-innovation: Impact

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	24
	2	Indicator name	Eco-innovation: Impact
Link to Circular City Definition	3	Vision Element	2. Circular business models and behavioural patterns
	4	Category	Circular design and business models Private investments, jobs and gross value added
Indicator definition and description	5	Definition / Description of indicator	For each case of implementation of CE business models in indicator #23, describe impact in terms of value creation and material flow
	6	Rationale	Under Circular Entrepreneurship Initiatives a contest will be promoted in order to acquire new business ideas that contribute to circular economy. It is expected that will be generated 20 new business project/ideas of which 5 are winners. *(Selected together with indicator #23)*
	7	Methodology	For each case of implementation of CE business models a) Turnover b) Materials impacted
	8	Unit	Monetary value Tonnes/year
Data	9	Baseline data / definition	The initiatives have yet been taken so the baseline is zero.
	10	Data Sources / Relevant Databases	The information about new business ideas/models will be provided by CMP (DA4).
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste, Social Economy Sector, Tourism Sector
	13	Reference area / Spatial implementation scale	Demonstration Action: DA4
	14	Reference period	Yearly Availability of Data: Yearly

Metadata group	#	Metadata category	Description/comments
	15	SDG Reference	9, 12 - Increasing the lifetime of assets (equipment, machinery, buildings, infrastructure and consumer goods) in order to reduce waste generation and resource use. This can occur through different kinds of interventions, induced by different urban actors, including e.g. permit extensions, eco-design, modular design & design for repair, maintenance etc. 3, 12 - Recognising that local food production and distribution entails clear health and climate benefits, this objective refers to increasing the share of locally produced and consumed food. 9, 12 - Increasing the exploitation rate of assets (e.g. equipment, machinery, buildings, infrastructure and consumer goods), intensifying their use and increasing their utility. One of the main mechanisms, through which this can occur, is through sharing activities (e.g. car sharing, sharing office- or production space). An increased rate of exploitation of assets is a key circularity objective as it increases the utility of existing assets for society and counteracts the use of virgin materials.
Other	16	Comments	

3.11. Reduced costs due to improved circularity

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	32
	2	Indicator name	Reduced costs due to improved circularity
Link to Circular City Definition	3	Vision Element	2. Circular business models and behavioural patterns
	4	Category	Private investments, jobs and gross value added Well-being
Indicator definition and description	5	Definition / Description of indicator	For selected cost type(s) (e.g. transport, virgin material costs, waste treatment costs), direct impacts on costs should be estimated.
	6	Rationale	Improve circularity it's a way to reduce costs mainly related with acquisition of new materials and waste treatment. A serial of analyses will be taken under demonstrations actions developed in the City of Porto. In DA1 will be analysed the avoided costs related with the biowaste local treatment, that will be not collected and transported to centralised treatment. It will also be analysed the avoided costs with biowaste selective collection instead of mixed waste collection. In DA2 will also be analysed the avoided costs with biowaste selective collection instead of mixed waste collection, but most important will be analysed the costs avoided with implementation with waste prevention projects, that will allow reduce costs on business related with food waste. In DA3 will be analysed the avoided costs with more sustainable practices in management and maintenance of green spaces.
	7	Methodology	Quantification of cost savings for the selected cost type using a practical method. The estimate should be accompanied by a qualitative description of the method, which cost items are included and which are excluded, with a justification of the choice.

Metadata group	#	Metadata category	Description/comments
	8	Unit	Monetary value
Data	9	Baseline data / definition	For DA1 and DA2, the baselines will be the cost of mixed waste collection and valorisation instead of biowaste selective collection and valorisation.
	10	Data Sources / Relevant Databases	The data needed will be provided by LIPOR (DA2), Porto Ambiente (DA1 and DA2), CMP (DA3) and LIPOR (DA3). From Porto Ambiente the database where the data will be extracted is the tonnes of waste collected. From LIPOR the database where data will be extracted is that related with Dose Certa, Embrulha initiatives; community composting islands and Zero Desperdício network.
	11	Overall accuracy	Estimative will be calculated through the tonnes of mixed waste collection and valorisation avoided. .
Context	12	Sector coverage	Biowaste
	13	Reference area / Spatial implementation scale	Demonstration Actions: DA1, DA2 and D3.
	14	Reference period	Yearly Availability of Data: Biannual
	15	SDG Reference	8 - Increasing the value generated by local economic activities that increase repair, reuse, sharing and recycling of materials and products including recovery and exploitation of waste. The continued, gradual increase of value added from those activities, is a potential indication for reduced resource use, and highlights the growing economic significance of the sector.
Other	16	Comments	

3.12. CE-based employment

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	33
	2	Indicator name	CE-based employment
Link to Circular City Definition	3	Vision Element	2. Circular business models and behavioural patterns
	4	Category	Private investments, jobs and gross value added Well-being
Indicator definition and description	5	Definition / Description of indicator	Assess the impact of demonstration actions or at sector/city level by estimating the increase in CE related jobs
	6	Rationale	Are expected to be created CE related jobs in DA1. Increased circular jobs at ratio: 1 BW separate collection system = 3 new jobs.

Metadata group	#	Metadata category	Description/comments
	7	Methodology	For a selected time period (e.g. year, project period etc) estimate: # of new CE related jobs # of existing jobs becoming circular If deemed practical for the evaluation, jobs that have a range of responsibilities, of which some are related to circularity and some are not, can be assigned a "percentage of circularity". Using this principle, a change in the percentage can be assigned for existing jobs that become more circular.
	8	Unit	Jobs
Data	9	Baseline data / definition	Considering the demo actions the value will be zero.
	10	Data Sources / Relevant Databases	The data need will be provided by LIPOR (DA1) and Porto Ambiente (DA1)
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste
	13	Reference area / Spatial implementation scale	Demonstration Action: DA1
	14	Reference period	Yearly Availability of Data: Quarterly
	15	SDG Reference	8 - Increasing the number of jobs in the local circular economy and the share of employment in the latter but also the rate of employment in general, providing an indication for both the value and size of the circular economy but also for a just transition from the linear model.
Other	16	Comments	

3.13. Quantity of material for composting

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	56
	2	Indicator name	Quantity of material for composting
Link to Circular City Definition	3	Vision Element	3. Closing material loops and reducing harmful resource use
	4	Category	Re-use and recycling
Indicator definition	5	Definition / Description of indicator	Estimate mass of materials going to composting at demo, sector and city level.

Metadata group	#	Metadata category	Description/comments
	6	Rationale	Composting is one way to give a new life to biowaste and return it to the soil contributing to improve circularity in a city. DA1 and DA2 will have biowaste selective collection which destination is the LIPOR's Organic Valorisation Plant to produce compost. For example, in DA1 the goal is to achieve a collection of 1,500 t/year of biowaste (total of 3.250 tonnes by M44) and in DA2 to increase separate biowaste collection by 50 t/year per pilot, with a total of 100 t/year in the two pilots (M44) Also, in DA1 we will produce compost in the community composting island. In DA1 the goal is to achieve 1 t/year/composting bin unit of local biowaste treatment (15 in total) and in DA2 the goal is to increase local treatment by 400 kg/year of biowaste per compost bin, with 300 l capacity (M44). In DA3, the green waste will be collected and sent to LIPOR's Organic Valorisation Plant.
	7	Methodology	Mass of organic material going to composting. Data may come from demo managers, waste management companies or the Sector Circularity Assessment Method.
	8	Unit	Tonnes/year
Data	9	Baseline data / definition	The baseline will consider the estimation for 2020 of materials going to composting at city level. Considering the demo actions the value will be 11 550 tonnes/year of biowaste (2019).
	10	Data Sources / Relevant Databases	The data needed will be provided by LIPOR (DA1, DA2 and city level), Porto Ambiente (DA1 and DA3) and CMP (DA3).
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste
	13	Reference area / Spatial implementation scale	Demonstration Actions: DA1, DA2 and DA3
	14	Reference period	Quarterly Availability of Data: Monthly
	15	SDG Reference	12 - The increase of material amounts for the next cycle of use by following the 2018 EU waste hierarchy with the preference starting from the top, namely through preserving materials and products (extending lifetimes), reusing products or materials (i.e. use of the same product and function by another user), repairing products (as to maintain its original function), repurposing products (using products or their components in a new product with different function), through refurbishing or remanufacturing, and recycling of products or materials (obtaining higher or lower grade recycled materials for the same function or for inferior products (backfilling)).
Other	16	Comments	Mandatory in accordance with D4.3

3.14. Waste-to-Energy rate

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	59
	2	Indicator name	Incineration rate (original name) Note: the name of this indicator to the City of Porto is “Waste-to-Energy rate”
Link to Circular City Definition	3	Vision Element	3. Closing material loops and reducing harmful resource use
	4	Category	Waste generation/management
Indicator definition and description	5	Definition / Description of indicator	Mass percentage of waste which is send to Waste-to-Energy (WtE).
	6	Rationale	The implementation of CityLoops project, will contribute to the prevention of food waste production (DA2, DA3, DA5) and to increase the percentage of biowaste treated locally or collected (DA1, DA2) that will be organically treated to produce compost that will be return to soil, closing the loop. This will contribute to the reduction of the WtE rate of waste produced at Porto City (from 78,45% to 77,35% in 2019).
	7	Methodology	Mass of materials send to LIPOR WtE Plant divided by total amount of waste. Data from waste management companies.
	8	Unit	%
Data	9	Baseline data / definition	The baseline will consider the estimation for 2019 of materials going to LIPOR WtE Plant, at city level. The baseline will be 78,45% of undifferentiated waste send to WtE, in 2019.
	10	Data Sources / Relevant Databases	The data needed will be provided by LIPOR.
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Waste, Biowaste
	13	Reference area / Spatial implementation scale	City: Porto
	14	Reference period	Biannual Availability of Data: Quarterly
	15	SDG Reference	12 - Reduced waste generation, assessed according to different waste fractions, including biodegradable material (e.g. zero avoidable food 12 waste). 12 - Reduced amounts of (waste) materials, assessed according to different waste fractions, including biodegradable materials, subjected to final destinations such as incineration, WtE and landfilling.
Other	16	Comments	

3.15. Waste-to-Energy rates per material fractions

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	60
	2	Indicator name	Incineration rates per material fractions (original name) Note: the name of this indicator to the City of Porto is “Waste-to-Energy rates per material fractions”
Link to Circular City Definition	3	Vision Element	3. Closing material loops and reducing harmful resource use
	4	Category	Waste generation/management
Indicator definition and description	5	Definition / Description of indicator	Mass percentage of waste which is send to Waste-to-Energy (WtE) for each material fraction as defined by local waste management companies.
	6	Rationale	The implementation of CityLoops project, will contribute to the prevention of food waste production (DA2, DA3, DA5) and to increase the percentage of biowaste treated locally or collected (DA1, DA2) that will be organically treated to produce compost that will be return to soil, closing the loop. This will contribute to the reduction of the WtE rate of biowaste produced at Porto City (from 69,6% to 65,7% in 2019).
	7	Methodology	Per fraction: Mass of materials send to WtE divided by total amount of waste. Data from waste management companies.
	8	Unit	%
Data	9	Baseline data / definition	The baseline will consider the estimation for 2019 of biowaste going to LIPOR WtE Plant, at city level.
	10	Data Sources / Relevant Databases	The data needed will be provided by LIPOR.
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Waste, Biowaste
	13	Reference area / Spatial implementation scale	City: Porto
	14	Reference period	Yearly Availability of Data: Yearly
	15	SDG Reference	12 - Reduced waste generation, assessed according to different waste fractions, including biodegradable material (e.g. zero avoidable food waste).
Other	16	Comments	Mandatory in accordance with D4.3

3.16. Open certified green space area rate

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	67
	2	Indicator name	Open green space area ratio per 100,000 inhabitants (original name) Note: the name of this indicator for the City of Porto is “Open certified green space area rate”
Link to Circular City Definition	3	Vision Element	4. Improving human well-being and reducing environmental impacts
	4	Category	Well-being
Indicator definition and description	5	Definition / Description of indicator	Define requirements for an open green space, for example using the EEA definition for publicly accessible green space per inhabitant.
	6	Rationale	With implementation of Demo Action 3 the goal is to promote sustainable practices in green spaces management, as using composting instead of chemical fertilizers in order to improve the environment as well as the well-being of the citizens. The indicator was divided in two to understand the impact of the Demo Action 3.
	7	Methodology	#67.1 (original) The total area of green spaces divided by number of inhabitants multiplied by 100 000. #67.2 The total area of certified green spaces per total area of green spaces.
	8	Unit	#67.1 (original) hectare / 100 000 people #67.2 %
Data	9	Baseline data / definition	The baseline for #67.1 will be the actual total area of green spaces divided by number of inhabitants multiplied by 100 000. The baseline for #67.2 will be zero since the demo action aren’t take yet.
	10	Data Sources / Relevant Databases	The data needed will be provided by CMP (DA3) and LIPOR (DA3).
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Social economy, public and tourism (hotel and restaurant) sectors
	13	Reference area / Spatial implementation scale	City: Porto Demonstration Action: DA3
	14	Reference period	Yearly Availability of Data: Yearly
	15	SDG Reference	11, 15 - Improving recreational ecosystem services is a key component of human well-being. This objective refers to the impacts of integrated urban planning measures on the quantity and quality of green spaces in the city.
Other	16	Comments	

3.17. Percentage of city population with regular biowaste collection (residential)

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	71
	2	Indicator name	Percentage of city population with regular solid waste collection (residential) (original name) Note: the name of this indicator to the City of Porto is “Percentage of city population with regular biowaste collection (residential)”
Link to Circular City Definition	3	Vision Element	4. Improving human well-being and reducing environmental impacts
	4	Category	Well-being
Indicator definition and description	5	Definition / Description of indicator	Total houses getting regular waste management service (namely of biowaste stream). Total inhabitants living in these houses.
	6	Rationale	The implementation of CityLoops project, mainly DA1, will contribute to increase the percentage of city population with regular solid waste collection (namely of biowaste stream), achieving the goal of 25.500 inhabitants of the City of Porto engaged in the biowaste separate collection. This will allow increase the circularity of the city, since the biowaste collected will be organically treated to produce compost that will be return to soil, closing the loop.
	7	Methodology	Population connected with regular waste management service divided by city population. The indicator will be disaggregated to know the city population covered by biowaste selective collection.
	8	Unit	%
Data	9	Baseline data / definition	The baseline to be considered will be the percentage of city population covered with regular solid waste collection (residential), highlighting and individualising the information on biowaste collection
	10	Data Sources / Relevant Databases	The data needed will be provided by Porto Ambiente (DA1), from their registries of operational service.
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Waste, Biowaste
	13	Reference area / Spatial implementation scale	City: Porto Demonstration Action: DA1
	14	Reference period	Yearly Availability of Data: Biannual
	15	SDG Reference	6,7,9,11 - This objective refers to the impact the circular economic model has on people’s access to basic services such as sanitation, drinking water, shelter etc.
Other	16	Comments	

3.18. GHG emissions per year

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	85
	2	Indicator name	GHG emissions per year
Link to Circular City Definition	3	Vision Element	4. Improving human well-being and reducing environmental impacts
	4	Category	Environment impacts (global)
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	All demonstration actions have an impact on the reduction of emissions of GHG associated with the management of biowaste, through diversion from landfill or Waste-to-Energy promoted by selective collection and local treatment (DA1), as well as measures to reduce food waste (DA2 and DA5).
	7	Methodology	Direct GHG emissions pr. year demo level Direct GHG emissions pr. year city level
	8	Unit	Tonnes/year of CO_2-equivalents
Data	9	Baseline data / definition	For city level analysis the baseline will take in consideration the "Annual Report of Energy and Emissions (Agência de Energia do Porto 2018)" of the City of Porto, developed by Agência de Energia do Porto (AdE Porto - Local Energy Agency). For city level, will be considered GHG emissions (CO_2e) related with energy consumption. At demo level will only be accounted the CO_2 emissions taking in account the quantity of biowaste that are not sent to landfill that is diverted by biowaste prevention projects (DA2 and DA5) or diverted from undifferentiated collection (DA1 and DA2). It will also be considered the information from entrepreneurship projects.
	10	Data Sources / Relevant Databases	The data related with biowaste selective collection will be provided by Porto Ambiente (DA1). The data related with the implementation of biowaste prevention projects and biowaste local treatment will be provided by LIPOR (DA1, DA2, DA5). The data related with the estimates related with the entrepreneurship initiatives will be provided by CMP (DA4). The data at city level will be provided by AdEPorto (CO_2 emissions).
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste
	13	Reference area / Spatial implementation scale	City: Porto Demonstration Action: DA1, DA2 and DA5
	14	Reference period	City: Yearly | Availability of data: Yearly Demonstration Action: Biannual | Availability of data: Biannual
	15	SDG Reference	7, 13 - Reducing emissions locally through shifting from a linear to a more circular production and consumption model, realizes its impact globally through reduced global warming potential. This objective thus aims at achieving a reduction of GHG-emissions through CE interventions, in line with local agendas and EU targets.

Metadata group	#	Metadata category	Description/comments
Other	16	Comments	

3.19. Annual CO_2 equivalent emissions per capita

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	86
	2	Indicator name	Annual CO_2 equivalent emissions per capita
Link to Circular City Definition	3	Vision Element	4. Improving human well-being and reducing environmental impacts
	4	Category	Environment impacts (global)
Indicator definition and description	5	Definition / Description of indicator	The indicator measures annual emissions of the so called 'Kyoto basket' of greenhouse gases per capita at city level.
	6	Rationale	For benchmarking opportunities at city level will be calculated the annual GHG emissions per capita
	7	Methodology	Direct GHG emissions per year at city level divided by the number of inhabitants
	8	Unit	Tonnes CO_2-equivalents / capita / year
Data	9	Baseline data / definition	The baseline will be calculated for 2018 (year) with the total GHG emissions from indicator #85 and the total of inhabitants in that year.
	10	Data Sources / Relevant Databases	The data related with number with inhabitants in year 2018 will be from INE databases.
	11	Overall accuracy	The total population is an annual estimate made by INE (Statistic National Institute)
Context	12	Sector coverage	Biowaste
	13	Reference area / Spatial implementation scale	City: Porto
	14	Reference period	Yearly Availability of Data: Yearly
	15	SDG Reference	7, 13 - Reducing emissions locally through shifting from a linear to a more circular production and consumption model, realizes its impact globally through reduced global warming potential. This objective thus aims at achieving a reduction of GHG-emissions through CE interventions, in line with local agendas and EU targets.
Other	16	Comments	

3.20. Annual CO_2 emissions per unit of GDP

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	87
	2	Indicator name	Annual CO_2 emissions per unit of GDP
Link to Circular City Definition	3	Vision Element	4. Improving human well-being and reducing environmental impacts
	4	Category	Environment impacts (global)
Indicator definition and description	5	Definition / Description of indicator	The indicator measures annual direct emissions of CO_2 at city level per GDP at city level.
	6	Rationale	For benchmarking opportunities at city level will be calculated the annual GHG emissions per GDP
	7	Methodology	Direct CO_2 emissions divided by GDP at city level. Calculated per year.
	8	Unit	Tonnes CO_2 eq./ Monetary unit
Data	9	Baseline data / definition	The baseline will be calculated for 2018 (year) with the total GHG emissions from indicator #85 and the GVA (Gross Value Added) at city level. There is no information of GDP at city level.
	10	Data Sources / Relevant Databases	The data related with GVA at city level in year 2018 will be from INE databases.
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste
	13	Reference area / Spatial implementation scale	City: Porto
	14	Reference period	Yearly Availability of Data: Yearly
	15	SDG Reference	7, 13 - Reducing emissions locally through shifting from a linear to a more circular production and consumption model, realizes its impact globally through reduced global warming potential. This objective thus aims at achieving a reduction of GHG-emissions through CE interventions, in line with local agendas and EU targets.
Other	16	Comments	

3.21. Quantity of biowaste for collection avoided

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	88
	2	Indicator name	Quantity of biowaste for collection avoided
Link to Circ...	3	Vision Element	3. Closing material loops and reducing harmful resource use

Metadata group	#	Metadata category	Description/comments
	4	Category	Waste generation/management
Indicator definition and description	5	Definition / Description of indicator	Amount of biowaste generation for collection avoided with the promotion of biowaste prevention and local treatment projects, assessed according to biowaste fractions (food waste and garden waste).
	6	Rationale	DA1 and DA2 will promote local composting treatment. For example, in DA1 the goal is to achieve 1 t/year/composting bin unit of local biowaste treatment (15 in total). DA1 will promote the production of compost in the community composting island, avoiding the generation of biowaste for collection. In DA2 the goal is to avoid food waste generation, with prevention reaching ~30% in the pilot comparing with baseline (M44), including a specific goal of ~300 g of food waste avoided per Embrulha package. In addition, it was defined a specific goal for local treatment of biowaste in the two pilots: 400 kg/year of biowaste per compost bin (300 l capacity). In DA3 one of the outcomes is the reduction of garden waste (kg/m2), through sustainable practices in the management and maintenance of green spaces. In DA5 the goal is to promote food donation network increment achieving at least 75 tonne/year of food donation and 2.000 benefited families, avoiding the generation of food waste with this DA.
	7	Methodology	Mass of biowaste going to local treatment (like community composting islands) and avoided through biowaste prevention projects (like Embrulha project) and avoided by entering a new cycle of use (Food donation network). Data may come from demo managers.
	8	Unit	Tonnes/year
Data	9	Baseline data / definition	Considering the demo actions the value will be zero.
	10	Data Sources / Relevant Databases	The data need will be provided by LIPOR (DA1, DA2 and DA5), Porto Ambiente (DA1) and CMP (DA3).
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste
	13	Reference area / Spatial implementation scale	Demonstration Actions: DA1, DA2, DA3 and DA5.
	14	Reference period	Yearly Availability of Data: Biannual
	15	SDG Reference	12 - The increase of material amounts for the next cycle of use by following the 2018 EU waste hierarchy with the preference starting from the top, namely through preserving materials and products (extending lifetimes), reusing products or materials (i.e. use of the same product and function by another user), repairing products (as to maintain its original function), repurposing products (using products or their components in a new product with different function), through refurbishing or remanufacturing, and recycling of products or materials (obtaining higher or lower grade recycled materials for the same function or for inferior products (backfilling)).
Other	16	Comments	New indicator created.

3.22. Increased provision of local, sustainable and healthy food

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	89
	2	Indicator name	Increased provision of local, sustainable and healthy food
Link to Circular City Definition	3	Vision Element	2. Circular business models and behaviour patterns
	4	Category	Circular business models
Indicator definition and description	5	Definition / Description of indicator	Recognising that local food production and distribution entails clear health and climate benefits, this indicator will quantify the amount of locally produced and consumed food in two DA2 pilots (tourism and social sector).
	6	Rationale	In DA2 the goal is to achieve a local vegetable production of around 3 kg per month with a growbed kit.
	7	Methodology	Mass of local vegetable production in two DA2 pilots (tourism and social sector). Data may come from demo managers.
	8	Unit	Tonnes/year
Data	9	Baseline data / definition	Considering the demo actions the value will be zero.
	10	Data Sources / Relevant Databases	The data need will be provided by LIPOR (DA2).
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste
	13	Reference area / Spatial implementation scale	Demonstration Actions: DA2.
	14	Reference period	Biannual Availability of Data: Quarterly
	15	SDG Reference	
Other	16	Comments	New indicator created.

3.23. Reused nutrients present in compost on Green Spaces

Metadata group	#	Metadata category	Description/comments
Identifier	1	Indicator number	90
	2	Indicator name	Reused nutrients present in compost on Green Spaces
Link to Circ	3	Vision Element	3. Closing material loops and reducing harmful resource use

Metadata group	#	Metadata category	Description/comments
	4	Category	Re-use and recycling
Indicator definition and description	5	Definition / Description of indicator	Recognising that the re-use of nutrients present in compost in green spaces entails clear climate benefits, this indicator will quantify the amount of re-use of nutrients present in compost applied in Porto City green spaces in DA3.
	6	Rationale	In DA3 the goal is to promote the re-use of nutrients present in compost on Porto City Green Spaces
	7	Methodology	Mass of reused nutrients present in compost on Porto City Green Spaces (kg NPK/m2). Data may come from demo managers.
	8	Unit	Kg NPK/m2
Data	9	Baseline data / definition	Considering the demo actions the value will be zero.
	10	Data Sources / Relevant Databases	The data need will be provided by CMP (DA3).
	11	Overall accuracy	n.a.
Context	12	Sector coverage	Biowaste
	13	Reference area / Spatial implementation scale	Demonstration Actions: DA3.
	14	Reference period	Biannual Availability of Data: Quarterly
	15	SDG Reference	
Other	16	Comments	New indicator created.

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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 and reduced heavy-duty transport
- Recycling of OW
- Reduced landfill
- Reduced greenhouse gas emissions

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, eco-design)

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, Waste-to-Energy 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.

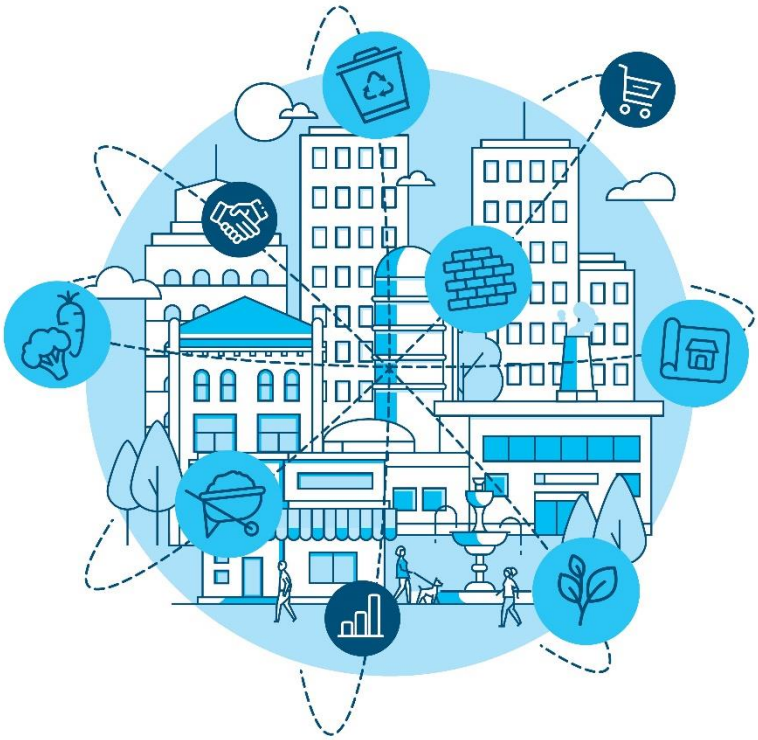
CityLoops runs from October 2019 until September 2023.

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

Evaluation Plan: CDW sector, Roskilde

Deliverable 6.2

Roskilde Municipality and Gate 21



Version	2.0
WP	6
Deliverable	6.2 (Evaluation Plan: Construction and Demolition Waste, Roskilde)
Date	18 February 2022
Dissemination level	Public
Deliverable lead	Gate 21
Authors	Klaus Kellerman, Roskilde Pia Winther Bjergaarde, Roskilde Line Bech, Gate 21 Caroline Juel Fritzen, Gate 21 Josephine Mikkelsen, Gate 21
Reviewers	Bjarne Lindeløv, NRI Megan Palmer-Abbs, NRI Jens Ørding Hansen, NRI
Abstract	This report details how Roskilde Municipality will evaluate the impact of the CityLoops tools and demonstration activities aimed at improving the circularity of the Construction and Demolition Waste sector.
Keywords	Evaluation, Indicators, Roskilde Municipality, Construction and Demolition Waste
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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). 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 mainly on the demonstration actions but impacts at city scale are also included.

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 Roskilde. 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.

Roskilde Municipality is located in the Greater Copenhagen Area in Denmark. The demonstration area in Roskilde is Musicon, a 200,000 m^2 former concrete factory and gravel pit, which Roskilde Municipality (RK) bought in 2003. The ambition is to create a new neighbourhood like no place else. No grand 'master plan' that locks the development of the area in a specific direction has ever been made. Instead, the different projects are created step-by-step in collaboration between citizens, developers, architects, cultural institutions, local businesses and the municipality, which means that Musicon is a dynamic site in constant movement and change. In Musicon, existing buildings are being refurbished or demolished and structures, construction materials and soil are being used in new constructions.

The Evaluation Plan for Roskilde Municipality will be presented in this report. In the CityLoops project Roskilde Municipality is focusing on the CDW sector. 3 demonstration actions and 6 different tools will be developed and tested during the CityLoops project in Roskilde Municipality. The demonstration actions and tools will focus on soil management and circular building projects.

1.1. Demolition of Hall 11/12 area, preserving the building structure and facilitating reuse of CDW

Short description

Hall 11/12 will be partly demolished and materials from the demolition will be incorporated into other construction projects. The function of hall 12 was and will remain a skate hall. Beams and pillars and the main steel structure of hall 12 will be preserved.
Pre-demolition screening and selective demolition will take place, keeping reusable elements in storage for reuse in new buildings and creating material passports documenting their quality and possible use. Furthermore, a virtual material bank will be created through design for disassembly using Building Information Modelling (BIM).
Circular soil strategies will be implemented in the project by minimising soil movement and facilitating reuse on site.
Tools tested: 1, 2, 8 and 9

Expected outcomes

- Improved mapping of CDW and soil resources in Hall 11/12. The use of tools in the demo project is expected to have a significant impact on recycling and reuse of CDW and soil.
- New working procedures for cooperation between planning, building and environmental departments and authorities in Roskilde Municipality as well as more user involvement leading to more and new potentials for circularity and sustainability.
- New business models for the valorisation of CDW and soil developed and validated. The focus of the business models is on keeping methods, working procedures, and use of materials simple.
- Increased number of CE jobs locally, through migration of costs, including a significant budget going to local craftsmen.
- Materials (structures and soil) retained on demonstration sites. At project's end: 25% of the total mass of building is retained on site. Soil: 5800 tons are retained on site.
- 25% of CDW from demo site is prepared for reuse or high-value recycling.
- Reduced emissions of CO2 related to extraction, processing, and transportation (incl. logistics) of construction (%). At project's end: CDW: 30% CO2 emission reduction. 11 tons of CO2 savings from minimizing excavating and moving soil, by achieving soil balance in the project area instead of normal procedure.

1.2. Construction of Parking Houses

Short description

Demo 2a: Construction of Parking House 1 'Indfaldet'. The concrete found in the ground will be kept on site and crushed into a mixed fraction. Design for disassembly.

Demo 2b: Construction of Parking House 2 'Pulsen'. The house will be built as a steel structure. Design for disassembly. Roskilde will create a physical construction material bank on the ground floor of P-house 2.
Tools tested: 1 and 9

Expected outcomes

- Improved mapping of soil resources in the construction of parking garages. The use of tools in the demo project is expected to have a significant impact on recycling and reuse of soil and to minimise the CO2 impact of the construction projects.
- New working procedures for cooperation between planning, building and environmental departments and authorities leading to more circularity. More user involvement leading to new potentials for circularity and sustainability through increased knowledge and social sustainability.
- Changed tendering procedures, shifting emphasis from lowest cost to a fixed cost and quality in the award criteria.
- New business models for reuse and valorisation of soil developed and validated with focus on soil balance for whole areas instead of individual plots.
- Soil retained on demonstration sites. Pulsen: 1,500 m3 of soil is expected to be kept on site.
- Reduced virgin gravel from multi-storey car park, Pulsen. The reduction is expected to amount to 1500 m3 of virgin gravel in comparison to normal procedure.
- Soil is reused and large uniform fractions of CDW are reused/recycled, e.g. concrete and roof tiles.
- Reduced emissions of CO2 related to extraction, processing, and transportation (incl. logistics) of construction (%). Indfaldet: CO2 savings from keeping soil on site in multi-storey car park Indfaldet is expected to be 6.7 tons of CO2e. Future CO2 saving potential is 326 tons for building the parking garage as design for disassembly. Pulsen: Target CO2 savings from keeping soil on site is 5-10 tons of CO2e.

1.3. Circular soil management (part of the other demo sites)

Short description

Tools which in the demonstration project shows operational and which give a positive impact on the soil balance inside the demonstration area will be part of a future Circular soil management at city level in order to keep excavation of soil to a minimum and use excess soil locally, instead of driving it further away. A template for soil strategy including the relevant tools is developed, for instance a tool predicting barriers against soil balance and an instrument for predicting how much soil will be excavated in the city.
Tools tested: 1, 2, 4, 5

Expected outcomes

- Strategic approach to circular soil management in the municipality. It is expected that the tools will be scaled and integrated in normal procedure in Roskilde and that the project managers using the tools have the adequate competence level to use to tools.
- Raised awareness of circular practices across our administration and amongst local citizens and businesses. Internal sustainability group will focus on increased communication, both internally and externally.

1.4. CityLoops Tools

Tools 1, 2, 4, 5, 8 and 9 tested in the demonstration actions:

CityLoops Tools	Description
1. LCA	LCA tool for building materials and soil. Estimates the potential CO2-savings of keeping soil or reuse/recycle building materials.
2. Screening procedure and selective demolition	Resource mapping with detailed screening for selective demolition. Guidelines for pre-demolition audit and selective demolition. Identifies materials with potential for reuse.
4. Instrument for predicting future excavated soil production	Predict annual volumes of future excavated soil within a period of 12 years (2020-2031). It will be evaluated by comparing predicted soil volumes with annual soil volumes reported for a period of 12 years.

5. Assessing soil reuse potential	Geotechnical drilling tests will show what kinds of soil are present on site, to identify the types of soil and the reuse potential for different purposes.
8. Databank and digital marketplace for recovered materials	The circular procurement strategy includes use of the virtual material bank to source and supply secondary construction materials. The data is extracted from BIM models and kept in a database.
9. Construction material passport and CDW materials databank	When designing for disassembly material passport and materials databank can be useful. Categorisation of materials from demolished buildings for reuse or recycling. For materials going out (from selective demolition) and in (in new projects)

2. Indicators to be monitored

16 indicators have been chosen to evaluate the three demonstration actions and the seven tools. The indicators represent both the different aspects of circular economy in the CityLoops project, and the different elements for a sustainable development where the environmentally, socially, and economically aspects also have to be considered. Furthermore, the indicators are chosen to represent the expected impacts from the project plan. The key impacts from the project plan includes scientific impacts, innovation/economic impacts, societal impacts, and environmental impacts. The indicators chosen in the evaluation plan can support a standardised documentation of the conductive elements with circular economy. The documentation can support replication of other CDW projects.

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 and evaluate specific processes and impacts related to the Demonstration Action activities and/or the use of the Tools. 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 towards improved circularity and the effectiveness of the CityLoops Tools and Activities.
- Data availability and quality: Through dialogue with local stakeholders internally 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: 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).

Tables 1 to 4 list the selected indicators for each of the four Vision Elements in the CityLoops circular city definition (Vangelsten et al., 2021). The tables describe at which level the indicators will be applied (Demonstration Action or City level) and which Demonstration Actions they will evaluate.

Table 1: List of indicators related to Vision Element 1 "Local Stakeholder Actions"

Indicator #	Indicator name	Scope (Demo/City)	Demo action 1	Demo action 2	Demo action 3
3/20	New tools for better mapping of resources and their location: Qualitative description and Impact	D	X	X	X
9	New formal CE-based collaboration platforms/networks	C			
10	Stakeholder contribution to improved circularity	D	X	X	
12/15	Circularity requirements in procurement beyond existing levels: Qualitative and Impact	D		X	
19	Progress towards circular city strategy objectives	C			

Table 2: List of indicators related to Vision Element 2 "Circular business models and behaviour patterns".

Indicator #	Indicator name	Scope (Demo/City)	Demo action 1	Demo action 2	Demo action 3
23	Eco-innovation: Qualitative description[1]	D	X	X	
30/31	New digital material databank/market place: Qualitative description and impact	C			

[1] CE business model refers for example to moving up the waste ladder/hierarchy described in D6.1 Figure 10 (page 40)

33	CE-based employment	D	X		

Table 3: List of indicators related to Vision Element 3 "Closing material loops and reducing harmful resource use"

Indicator #	Indicator name	Scope (Demo/City)	Demo action 1	Demo action 2	Demo action 3
27	Increased share of materials retained and reused on demonstration sites	D	X	X	
34	Reduced use of virgin materials	D		X	
49/52	Quantity of material subjected to reuse or recycling	D	X	X	

Table 4: List of indicators related to Vision Element 4 "Improving human wellbeing and reducing environmental impacts"

Indicator #	Indicator name	Scope (Demo/City)	Demo action 1	Demo action 2	Demo action 3
85	GHG emissions per year	D	X	X	

Links between the selected indicators and the expected outcomes for the specific Demonstration Actions (and if relevant, application of tools outside the scope of the demonstration actions) are shown in the tables below.

Table 5: Linking expected outcomes to the selected indicators for Demonstration Action 1.

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Improved mapping of CDW and soil resources in Hall 11/12. The use of tools in the demo project is expected to have a significant impact on recycling and reuse of CDW and soil.	3/20. New tools for better mapping of resources and their location: Qualitative description and impact
	New working procedures for cooperation between planning, building and environmental	10. Stakeholder contribution to improved circularity

Vision Element	Expected outcome	Indicator
	departments and authorities in Roskilde Municipality as well as more user involvement leading to more and new potentials for circularity and sustainability.	
2 Circular business models and behaviour patterns	New business models for the valorisation of CDW and soil developed and validated. The focus of the business models is on keeping methods, working procedures, and use of materials simple.	23. Eco-innovation: Qualitative description[2]
	Increased number of CE jobs locally, through migration of costs, including a significant budget going to local craftsmen.	33. CE-based employment
3 Closing material loops and reducing harmful resource use	Materials (structures and soil) retained on demonstration sites. At project's end: 25% of the total mass of building is retained on site Soil: 5800 tons are retained on site	27. Increased share of materials retained and reused on demonstration sites
	25% of CDW from demo site is prepared for reuse or high-value recycling	49/52. Quantity of material subjected to reuse or recycling
4 Improving human wellbeing and reducing environmental impacts	Reduced emissions of CO2 related to extraction, processing, and transportation (incl. logistics) of construction (%). At project's end: CDW: 30% CO2 emission reduction 11 tons of CO2 savings from minimizing excavating and moving soil, by achieving soil balance in the project area instead of normal procedure	85. GHG emissions per year

[2] CE business model refers for example to moving up the waste ladder/hierarchy described in D6.1 Figure 10 (page 40).

Table 6: Linking expected outcomes to the selected indicators for Demonstration Action 2.

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Improved mapping of soil resources in the construction of parking garages. The use of tools in the demo project is expected to have a significant impact on recycling and reuse of soil and to minimise the CO2 impact of the construction projects.	3/20. New tools for better mapping of resources and their location: Qualitative description and impact
	New working procedures for cooperation between planning, building and environmental departments and authorities leading to more circularity. More user involvement leading to new potentials for circularity and sustainability through increased knowledge and social sustainability.	10. Stakeholder contribution to improved circularity
	Changed tendering procedures, shifting emphasis from lowest cost to a fixed cost and quality in the award criteria.	12/15. Circularity requirements in procurement beyond existing levels:
2 Circular business models and behaviour patterns	New business models for reuse and valorisation of soil developed and validated with focus on soil balance for whole areas instead of individual plots.	23. Eco-innovation: Qualitative description[3]
3 Closing material loops and reducing harmful resource use	Soil retained on demonstration sites. Pulsen: 1500 m3 of soil is expected to be kept on site.	27. Increased share of materials retained and reused on demonstration sites
	Reduced virgin gravel from multi-storey car park, Pulsen. The reduction is expected to	34. Reduced use of virgin materials

[3] CE business model refers for example to moving up the waste ladder/hierarchy described in D6.1 Figure 10 (page 40)

Vision Element	Expected outcome	Indicator
	amount to 1500 m3 of virgin gravel in comparison to normal procedure.	
	Soil is reused and large uniform fractions of CDW are reused/recycled, e.g. concrete and roof tiles.	49/52. Quantity of material subjected to reuse/recycling
4 Improving human wellbeing and reducing environmental impacts	Reduced emissions of CO2 related to extraction, processing, and transportation (incl. logistics) of construction (%). Indfaldet: CO2 savings from keeping soil on site in multi-storey car park Indfaldet is expected to be 6.7 tons of CO2e. Future CO2 saving potential is 326 tons for building the parking garage as design for disassembly. Pulsen: Target CO2 savings from keeping soil on site is 5-10 tons of CO2e.	85. GHG emissions per year

Table 7: Linking expected outcomes to the selected indicators for Demonstration Action 3.

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Strategic approach to circular soil management in the municipality. It is expected that the tools will be scaled and integrated in normal procedure in Roskilde and that the project managers using the tools have the adequate competence level to use to tools.	3. New tools for better mapping of resources and their location: Qualitative description
	Raised awareness of circular practices across	19. Progress towards circular city strategy objectives

Vision Element	Expected outcome	Indicator
	our administration and amongst local citizens and businesses. Internal sustainability group will focus on increased communication, both internally and externally.	

Table 8: Linking expected outcomes to the selected indicators for City level.

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Internal and external CE-based collaboration platforms/networks established: - Internal: A new environmental group is formed in the municipality focusing on implementing CE in the strategy of the city. The expected outcome from this group/network is to strengthen stakeholder engagement and create a better dialogue between the different departments in the municipality. - External: Scaling the results from the demo projects to other municipalities.	9. New formal CE-based collaboration platforms/networks
2 Circular business models and behaviour patterns	BIM Model will function as a digital material bank for new construction. In renovation projects, screenings will be used to map materials, and materials from the physical material bank will be a part of the digital databank.	30/31. New digital material databank/marketplace: Qualitative description and Impact

3. 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 that they will test.

3.1. New tools for better mapping of resources and their location: Qualitative description

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	3		
	2	Indicator name	New tools for better mapping of resources and their location: Qualitative description		
Link to Circular City Definition	3	Vision Element	x	1. Local stakeholder actions	
				2. Circular business models and behavioural patterns	
				3. Closing material loops and reducing harmful resource use	
				4. Improving human well-being and reducing environmental impacts	
	4	Category	1	x	Engagement and capacity building
				x	Regulation and incentives
				x	Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)

			☐ Economic impacts ☐ Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	Qualitative description of individual tools, including scope and scale (e.g. demonstration vs city level), target users.
	6	Rationale	The tools that are being used/tested in the demonstration actions will help make the demo projects more circular. The mapping of resources and their location can help the municipality with planning, reuse/recycling and get an overview of the resources in the area. On demonstration level, the tools will be described in detail. On city level, the tools will be described in a more general manner. Indicator 3 is selected together with indicator 20. The expected outcome is that the six tools listed above will be used to improve mapping of CDW and soil resources in Roskilde municipality. It is expected that the tools will be scaled and integrated in normal procedure in Roskilde and that the project managers using the tools have the adequate competence level to use to tools. The use of tools in the demo projects is expected to have a significant impact on recycle and reuse of CDW and soil and minimise the CO2 impact of the construction projects.
	7	Methodology	Qualitative description + quantitative description (number of tools used)
	8	Unit	Qualitative data
Data	9	Baseline data / definition	Short qualitative and quantitative description of tools available before the CityLoops tools were developed.
	10	Data Sources / Relevant Databases	Roskilde Municipality will provide the qualitative and quantitative description needed for the tools. The qualitative description will focus on: 1. How the tools are integrated in normal procedure in Roskilde Municipality (procedure description). 2. How the tools are used by the project managers and assessment of capacity and knowledge to use the tools (interview). The quantitative description will focus on 1. How many of the tools are used (number)
	11	Overall accuracy	Reasonably accurate local level qualitative insights.
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City: Roskilde Municipality Demonstration actions: D1, D2 and D3
	14	Reference period	1.10.2019 – 30.9.2023, three times of monitoring (baseline, interim - M36/Sept22, final - M44/May23)
	15	SDG Reference	12

Other	16	Comments	Corresponds to the project plan: Impact 1, Indicator 1a. *Reduced consumption of virgin construction and organic materials.*

3.2. New formal CE-based collaboration platforms/networks

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	9		
	2	Indicator name	New formal CE-based collaboration platforms/networks		
Link to Circular City Definition	3	Vision Element	x	1. Local stakeholder actions	
				2. Circular business models and behavioural patterns	
				3. Closing material loops and reducing harmful resource use	
				4. Improving human well-being and reducing environmental impacts	
	4	Category	1	x	Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	# of CE-based collaboration platforms/networks # of members in CE-based collaboration platforms/networks		
	6	Rationale	It is important to know how the demo projects influence relevant stakeholders. Therefore, the indicator will be divided into internal and external CE-based collaboration platforms/networks. Internal: A new environmental group is formed in the municipality focusing on implementing CE in the strategy of the city. The expected outcome from this group/network is to strengthen stakeholder engagement and create a better dialogue between the		

			different departments in the municipality. External: Learning network with other municipalities in Denmark. The expected outcome of the network is to share know-how and experience by working with CE in the construction sector in municipalities with the objective of scaling the results from the demo actions.
	7	Methodology	a) Number of formalised CE-based collaboration platforms/networks b) Number of people in formalised CE-based collaboration platforms/networks and their position/department in the municipality
	8	Unit	Number of networks Number of people (position/department)
Data	9	Baseline data / definition	Baseline is 0 (only activities during the project are measured)
	10	Data Sources / Relevant Databases	The data needed for the internal CE-based collaboration platforms/network will be provided by Roskilde Municipality. The data needed for the external CE-based collaboration platforms/network will be provided by Gate 21. Participants lists, interviews with stakeholders, and lists of networking meetings will be used. Gate 21 provides a template for both.
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	The reference area for the internal network is: City: Roskilde Municipality taking point of departure in city level The reference area for the external network is: Greater Copenhagen.
	14	Reference period	1.1.2021 – 30.9.2023, Data collected continuously (data will be filled in in the template after each meeting)
	15	SDG Reference	15
Other	16	Comments	Corresponds to the project plan: Impact 4, Indicator 4b. *Improved stakeholder collaboration in relation to CDW and soil reuse and recycling*

3.3. Stakeholder contribution to improved circularity

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	10		
	2	Indicator name	Stakeholder contribution to improved circularity		
Link to Circular City Definition	3	Vision Element	x		1. Local stakeholder actions
					2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1	x	Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
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	The dialogue and collaboration between the municipality and the stakeholders are strategically important for the city. Both the internal and external CE-related stakeholder activities contribute to know-how, knowledge sharing and an increased awareness of CE. Expected outcome: New local stakeholder partnerships and procedures. Improved stakeholder collaboration in relation to CDW and soil reuse and recycling. The indicator will be used in the same way with all the demonstration actions.		
	7	Methodology	a) List inputs from stakeholders		

			b) Describe how it has been used by those that invited the stakeholder activity c) Describe how it has contributed to improved circularity Both the internal and external stakeholder activities will incorporate interviews from the participants in the network. The focus will be on barriers and solutions. The information can be used as inspiration for other CE building projects.
	8	Unit	Qualitative data + potential quantitative impact data
Data	9	Baseline data / definition	Baseline is 0 (only activities during the project are measured)
	10	Data Sources / Relevant Databases	The data needed for the internal stakeholder contribution to improved circularity will be provided by Roskilde Municipality and RUC. The data needed for the external stakeholder contribution to improved circularity will be provided by Gate 21. The data will be based on interviews with stakeholders.
	11	Overall accuracy	Reasonably accurate local level qualitative insights
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	The reference areas for the internal network are: City: Roskilde Municipality taking point of departure in the demonstration actions: D1 and D2 The reference area for the external network is: Greater Copenhagen.
	14	Reference period	1.1.2021 – 30.9.2023, Data collected continuously
	15	SDG Reference	15
Other	16	Comments	Corresponds to the project plan: Impact 4, Indicator 4b. *Improved stakeholder collaboration in relation to CDW and soil reuse and recycling*

3.4. Circularity requirements in procurement beyond existing levels

Metadata group	#	Metadata category	Fill in data for indicator	
Identi-fier	1	Indicator number	12	
	2	Indicator name	Circularity requirements in procurement beyond existing levels	
Link to	3	Vision Element	x	1. Local stakeholder actions

					2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
				x	Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	Description of requirements in procurements going beyond what is current standard practice		
	6	Rationale	Procurement requirements are important to increase circularity in public CDW projects. The requirements will be tested in the demonstration actions in Roskilde Municipality. The indicator will be used in the same way with all the demonstration actions. Indicator 12 is selected together with indicator 15.		
	7	Methodology	The methodology is a four-step approach: 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. 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 + potential quantitative impact data		
Data	9	Baseline data / definition	The baseline data will be a description of the current circularity requirements. The data will be described with the same methodology as used in this indicator.		
	10	Data Sources / Relevant Databases	The data needed will be provided by Roskilde Municipality. Construction and demolition tenders and contracts will be used. Qualitative description from project manager (interview) supported by specific criteria tenders.		

	11	Overall accuracy	Reasonably accurate local level qualitative insights but not scalable data.
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	Demonstration actions: D2
	14	Reference period	1.1.2021 – 30.9.2023, three times of monitoring (baseline, interim - M36/Sept22, final - M44/May23)
	15	SDG Reference	12
Other	16	Comments	Corresponds to the project plan: Impact 4, Indicator 4a. *New Decision making guidelines and Circular procurement methods and guidelines*

3.5. Procurement with circularity requirements beyond existing levels: Impact

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	15		
	2	Indicator name	Procurement with circularity requirements beyond existing levels: Impact		
Link to Circular City Definition	3	Vision Element	x		1. Local stakeholder actions
					2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
				x	Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)

			☐ Economic impacts ☐ Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	# of procurements with circularity requirements Value of procurement with circularity requirements
	6	Rationale	Procurement requirements are important to increase circularity in public CDW projects. The requirements will be tested in the demonstration actions in Roskilde Municipality. The outcome of the increased CE in procurement requirements are listed above under demo actions. The indicator will be used in the same way with all the demonstration actions. Indicator 15 is selected together with indicator 12.
	7	Methodology	For each action: ● Type of procurement action ● Value of procurement For the whole period considered: ● Time period ● Number of procurement contracts ● Sum up the total value of these contracts
	8	Unit	Number of actions Monetary value of procurements
Data	9	Baseline data / definition	The baseline will be 0
	10	Data Sources / Relevant Databases	The data needed will be provided by Roskilde Municipality. Construction and demolition contracts and data from authorities will be used.
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	Demonstration actions: D2
	14	Reference period	1.1.2021 – 30.9.2023, three times of monitoring (baseline, interim - M36/Sept22, final - M44/May23)
	15	SDG Reference	12
Other	16	Comments	Corresponds to the project plan: Impact 4, Indicator 4a. *New Decision making guidelines and Circular procurement methods and guidelines* Impact 3. *Value creation, Cost effectiveness and Cost savings*

3.6. Progress towards circular city strategy objectives

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	19		
	2	Indicator name	Progress towards circular city strategy objectives		
Link to Circular City Definition	3	Vision Element	x	1. Local stakeholder actions	
				2. Circular business models and behavioural patterns	
				3. Closing material loops and reducing harmful resource use	
				4. Improving human well-being and reducing environmental impacts	
	4	Category	1		Engagement and capacity building
					Regulation and incentives
				x	Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	Describe to which degree the city is making progress towards its circularity objectives. Identify categories of relevant strategy documents, select documents and relevant selected CE targets.		
	6	Rationale	Roskilde Municipality will significantly contribute to the awareness of reuse and recycling. In 5 years, the circular procurement will be a standard in all projects and demand for reuse and recycling will be a central focus point. The municipality will be able to calculate the environmental effect of different CDW actions with the CityLoops tools. In 25 years, the effect of public circular procurement will have spread to all levels of the construction practice in the municipality and general construction practice will have changed.		
	7	Methodology	For each of the identified targets: Describe ambition and judge on scale 1. no progress, 2. little progress, 3. some progress, 4. ambition nearly reached, 5. ambition reached or beyond		
	8	Unit	Score on categorical scale (1-5)		

Data	9	Baseline data / definition	The baseline (2019) will be defined on the categorical scale used in this indicator.
	10	Data Sources / Relevant Databases	The data needed will be provided by Roskilde Municipality. The city's strategy documents, decisions and commitments on the promotion of CE will be used.
	11	Overall accuracy	Reasonably accurate local level qualitative insights.
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City: Roskilde Municipality
	14	Reference period	1.1.2021 – 30.9.2023, three times of monitoring (baseline, interim - M36/Sept22, final - M44/May23)
	15	SDG Reference	12
Other	16	Comments	The circular city strategy objectives from the project plan can be found in 'Key impacts of CityLoops aimed for in the years following the conclusion of the project'

3.7. New tools for better mapping of resources and their location: Impact

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	20		
	2	Indicator name	New tools for better mapping of resources and their location: Impact		
Link to Circular City Definition	3	Vision Element	x		1. Local stakeholder actions
					2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
					Regulation and incentives
				x	Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)

				Environment impacts (local) Economic impacts Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	Describe impact of CityLoops tools described in indicator # 3 on material flows.	
	6	Rationale	The tools that are being used/tested in the demonstration actions will help make the projects more circular. The mapping of resources and their location can help the municipalities with planning, reuse/recycling and get an overview of the resources in the area. The expected outcome of the use of tools is listed above under demo actions. The indicator will be used in the same way with all the demonstration actions. Indicator 20 is selected together with indicator 3.	
	7	Methodology	For each tool (estimate) Volume of materials impacted per year	
	8	Unit	Tonnes / year	
Data	9	Baseline data / definition	The baseline will be 0 (no data and little experience)	
	10	Data Sources / Relevant Databases	The data needed will be provided by Roskilde Municipality. Reports from e.g. Golders and COWI will be used.	
	11	Overall accuracy	Reliable data	
Context	12	Sector coverage	CDW	
	13	Reference area / Spatial implementation scale	Demonstration actions: D1 and D2	
	14	Reference period	1.1.2021 – 30.9.2023, three times of monitoring (baseline, interim - M36/Sept22, final - M44/May23)	
	15	SDG Reference	12	
Other	16	Comments	Corresponds to the project plan: Impact 1, Indicator 1a. *Reduced consumption of virgin construction and organic materials.*	

3.8. Eco-innovation: Qualitative description

Metadata group	#	Metadata category	Fill in data for indicator

Identi-fier	1	Indicator number	23		
	2	Indicator name	Eco-innovation: Qualitative description		
Link to Circular City Definition	3	Vision Element			1. Local stakeholder actions
			x		2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2	x	Circular design and business models
					Circular value chains and infrastructure
				x	Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
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	Business cases for reuse, recycling, and valorisation of CDW are developed during the CityLoops project in Roskilde Municipality. Business models for building materials and soil will be developed and validated. The expected outcome is a business case on the demo actions. The indicator will be used in the same way with all the demonstration actions.		
	7	Methodology	For each model, a qualitative description of model, its circular strategy		
	8	Unit	Qualitative data		
Data	9	Baseline data / definition	Baseline is 0		
	10	Data Sources / Relevant Databases	The data needed will be provided by Roskilde Municipality and the Danish Association of Construction Clients. Interviews with stakeholders will be used.		
	11	Overall accuracy	Reasonably accurate local level qualitative insights		
Conte xt	12	Sector coverage	CDW		
	13	Reference area / Spatial	Demonstrations actions: D1 and D2		

		implementation scale	
	14	Reference period	Project period 1.1.2021 – 30.9.2023, baseline data (2019) and in the end of the project (2023).
	15	SDG Reference	
Other	16	Comments	Corresponds to the project plan: Impact 4, Indicator 4c. *New products, service concepts and business models relating to the reuse/recycling of the specific material flows addressed, leading to new business opportunities and job creatio*

3.9. Increased share of materials retained and reused on demonstration sites

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	27		
	2	Indicator name	Increased share of materials retained and reused on demonstration sites		
Link to Circular City Definition	3	Vision Element			1. Local stakeholder actions
			x		2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
				x	Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
				x	Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definition and	5	Definition / Description of indicator	The relative share of materials retained and reused on demonstration sites, measured for selected/key on-site waste material fractions and the total mass of waste materials.		

	6	Rationale	Roskilde Municipality strives to increase reused/recycled materials in building projects. It is relevant to keep the materials and the soil on site, to reduce the CO2 emissions from both transportation and from consumption of virgin resources. The expected outcome is listed above under demo actions. The indicator will be used in the same way with all the demonstration actions.
	7	Methodology	For selected waste fractions and total mass of waste materials: Retained and reused mass of materials / total mass of (waste) materials at demonstration site
	8	Unit	Mass %
Data	9	Baseline data / definition	The mass % of retained and reused materials from similar projects previously done by Roskilde Municipality
	10	Data Sources / Relevant Databases	The data needed will be provided by Roskilde Municipality and other relevant organizations involved in the project. Data from BIM models will be used.
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	Demonstration actions: D1 and D2
	14	Reference period	Evaluation period 1.10.2019 – 30.9.2023, three times of monitoring (baseline, interim - M36/Sept22, final - M44/May23)
	15	SDG Reference	
Other	16	Comments	Corresponds to the project plan: Impact 1, indicator 1e. *Materials retained on demonstration sites.*

3.10. New digital material databank / marketplace: Qualitative description

Metadata group	#	Metadata category	Fill in data for indicator	
Identi-fier	1	Indicator number	30	
	2	Indicator name	New digital material databank/marketplace: Qualitative description	
Link to Circular City Definition	3	Vision Element		1. Local stakeholder actions
			x	2. Circular business models and behavioural patterns
				3. Closing material loops and reducing harmful resource use
				4. Improving human well-being and reducing environmental impacts
	4	Category	1	Engagement and capacity building

					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
				x	Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
				x	Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	Description of the digital material databank/marketplace in term of objective, type, scope, stage of development, target/user groups and other aspects deemed relevant		
	6	Rationale	The digital material databank/marketplace is an important element in reusing and recycling more components from demolished buildings. The databank can support the circular procurement strategy in the municipalities. The expected outcome is a digital material databank in Roskilde. Indicator 30 is selected together with indicator 31		
	7	Methodology	Qualitative description		
	8	Unit	Qualitative data		
Data	9	Baseline data / definition	Qualitative description of how materials from demolished buildings were handled in term of objective, type, scope, target/user groups and other aspects deemed relevant in 2019 (same procedure as the definition describes)		
	10	Data Sources / Relevant Databases	The data needed will be provided by Roskilde Municipality. Project reports and previous strategies from the municipality will be used.		
	11	Overall accuracy	Accurate		
Context	12	Sector coverage	CDW		
	13	Reference area / Spatial implementation scale	City: Roskilde Municipality		
	14	Reference period	Evaluation period 1.11.2021 – 30.9.2023, in the end of the project		
	15	SDG Reference	12		
Other	16	Comments	Correspondence to the project plan: Indicator 4c. *Development of business cases and establishment of a materials Databank and market place to allow an effective assessment of the CE opportunities where waste is generated, facilitate traceability, and enable a trading system.*		

3.11. New digital material databank/marketplace: Impact

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	31		
	2	Indicator name	New digital material databank/marketplace: Impact		
Link to Circular City Definition	3	Vision Element			1. Local stakeholder actions
			x		2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
				x	Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
				x	Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	The impact of the digital marketplace is assessed by estimating the mass and value of material registered and traded per time period.		
	6	Rationale	The digital material databank/marketplace is an important element in reusing and recycling more components from demolished buildings. The databank can support the circular procurement strategy in the municipalities. Indicator 31 is selected together with indicator 30		
	7	Methodology	Mass of materials registered per time period Mass of materials traded per time period Value of materials traded per time period Time period can be month or year		

			Total mass should be registered, and optionally key material fractions
	8	Unit	Tonnes / year Monetary value/time
Data	9	Baseline data / definition	Qualitative description of how materials from demolished buildings were handled in term of objective, type, scope, target/user groups and other aspects deemed relevant in 2019 (same procedure as described in the definition) No quantitative data available. Baseline will be 0.
	10	Data Sources / Relevant Databases	The data needed will be provided by Roskilde Municipality Data from the material databank/marketplace
	11	Overall accuracy	Reliable data
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	City: Roskilde Municipality
	14	Reference period	Evaluation period 1.1.2021 – 30.9.2023, yearly
	15	SDG Reference	12
Other	16	Comments	Correspondence to the project plan: Indicator 4c. *Development of business cases and establishment of a materials Databank and market place to allow an effective assessment of the CE opportunities where waste is generated, facilitate traceability, and enable a trading system.*

3.12. CE-based employment

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	33		
	2	Indicator name	CE-based employment		
Link to Definition Circular City	3	Vision Element			1. Local stakeholder actions
			x		2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure

				x	Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4	x	Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	Assess the impact of demonstration actions or at sector/city level by estimating the increase in CE related jobs		
	6	Rationale	Creating CE related jobs is important for a social and economic sustainable development for Roskilde Municipality. The new business models in the demonstration actions creates new types of CE jobs. The indicator will be used in the same way with all the demonstration actions.		
	7	Methodology	For a selected time period (e.g. year, project period etc) estimate: # of new CE related jobs # of existing jobs becoming circular If deemed practical for the evaluation, jobs that have a range of responsibilities, of which some are related to circularity and some are not, can be assigned a "percentage of circularity". Using this principle, a change in the percentage can be assigned for existing jobs that become more circular.		
	8	Unit	Jobs		
Data	9	Baseline data / definition	CE related jobs in the beginning of the project (2019). The same methodology as used in this indicator will be used.		
	10	Data Sources / Relevant Databases	Statistics from Roskilde Municipality, personal communication and other relevant companies/organizations involved in the projects		
	11	Overall accuracy	Reliable data (number of jobs) Estimated data (percentage of circularity)		
Context	12	Sector coverage	CDW		
	13	Reference area / Spatial implementation scale	Demonstration actions: D1		
	14	Reference period	Project period 1.10.2019 – 30.9.2023, three times of monitoring (baseline, interim - M36/Sept22, final - M44/May23).		
	15	SDG Reference			
Other	16	Comments	Corresponds to the project plan: Impact 3, job creation. *New jobs in "disassembly" as opposed to demolition.*		

3.13. Reduced use of virgin materials

Metadata group	#	Metadata category	Fill in data for indicator		
Identifier	1	Indicator number	34		
	2	Indicator name	Reduced use of virgin materials		
Link to Circular City Definition	3	Vision Element		1. Local stakeholder actions	
				2. Circular business models and behavioural patterns	
			x	3. Closing material loops and reducing harmful resource use	
				4. Improving human well-being and reducing environmental impacts	
	4	Category	1		Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3	x	Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	Estimate the reduced use of virgin materials		
	6	Rationale	It is important to reduce (harmful) raw material consumption The expected outcome for the indicator is listed above under table 6		
	7	Methodology	Sum of reduced use of virgin materials		
	8	Unit	m3/tonnes		
Data	9	Baseline data / definition	The use of virgin materials from similar projects previously done by Roskilde Municipality		
	10	Data Sources / Relevant Databases	The data needed will be provided by Roskilde Municipality and other relevant organizations involved in the projects		
	11	Overall accuracy	Reliable with some estimation uncertainties.		
Context	12	Sector coverage	CDW		
	13	Reference area / Spatial	Demonstration action: D2		

		implementation scale	
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected three times (baseline, interim - M36/Sept22, final - M44/May23)
	15	SDG Reference	
Other	16	Comments	Corresponds to the project plan: Impact 2, Indicator 2a. *Increased recycling/reuse rate of CDW/soil and organic matter within the city boundaries.*

3.14. Quantity of material subjected to reuse

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	49		
	2	Indicator name	Quantity of material subjected to reuse		
Link to Circular City Definition	3	Vision Element			1. Local stakeholder actions
					2. Circular business models and behavioural patterns
			x		3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
				x	Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definiti	5	Definition / Description of indicator	Estimate mass of materials being reused at city/sector level. 'Reuse' means reuse of discarded yet still usable product, for the same purpose, by a different user.		

	6	Rationale	Reusing materials are important for a sustainable development for Roskilde Municipality. Several of the demonstration projects aim to promote reuse of demolition materials. The expected outcome is listed above under demo actions. The indicator is merged with indicator 52 and will be used in the same way with all the demonstration actions.
	7	Methodology	Sum up mass of each waste material category subjected to recycling. Data may come from contractors, statistical offices, waste management companies or the Sector Circularity Assessment Method. The aim is to develop a methodology to differentiate high-value and low value recycling. CDW is already recycled in Denmark but to a low value. The aim is to increase the level of high-value recycling.
	8	Unit	tonnes/year
Data	9	Baseline data / definition	The quantity of material subjected to reuse from similar projects previously done by Roskilde Municipality
	10	Data Sources / Relevant Databases	The data needed will be provided by Roskilde Municipality and other relevant organizations involved in the projects
	11	Overall accuracy	Reliable with some estimation uncertainties.
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	Demonstration action: D1 and D2
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected three times (baseline, interim - M36/Sept22, final - M44/May23)
	15	SDG Reference	12
Other	16	Comments	Corresponds to the project plan: Impact 2, Indicator 2a. *Increased recycling/reuse rate of CDW/soil and organic matter within the city boundaries.*

3.15. Quantity of material subjected to recycling

Metadata group	#	Metadata category	Fill in data for indicator

Identi-fier	1	Indicator number	52		
	2	Indicator name	Quantity of material subjected to recycling		
Link to Circular City Definition	3	Vision Element			1. Local stakeholder actions
					2. Circular business models and behavioural patterns
			x		3. Closing material loops and reducing harmful resource use
					4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
				x	Re-use and recycling
					Waste generation/management
			4		Well-being
					Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definition and description	5	Definition / Description of indicator	Estimate material subjected to recycling at demo, sector and city level. 'Recycling' means processing of materials to achieve the original high-quality or reduce to low quality.		
	6	Rationale	Recycled materials are important for a sustainable development for Roskilde Municipality. Several of the demonstration projects aim to promote recycling of demolition materials. The expected outcome is listed above under demo actions. The indicator is merged with indicator 49 and will be used in the same way with all the demonstration actions.		
	7	Methodology	Sum up mass of each waste material category subjected to recycling. Data may come from contractors, statistical offices, waste management companies or the Sector Circularity Assessment Method. The aim is to develop a methodology to differentiate high-value and low value recycling. CDW is already recycled in Denmark but to a low value. The aim is to increase the level of high-value recycling.		
	8	Unit	tonnes/year		
Data	9	Baseline data / definition	The quantity of material subjected to recycling from similar projects previously done by Roskilde Municipality		
	10	Data Sources / Relevant Databases	The data needed will be provided Roskilde Municipality and other relevant organizations involved in the projects.		
	11	Overall accuracy	Reliable with some estimation uncertainties.		

Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	Demonstration actions: D1 and D2
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Data will be collected three times (baseline, interim - M36/Sept22, final - M44/May23)
	15	SDG Reference	12
Other	16	Comments	Corresponds to the project plan: Impact 2, Indicator 2a. *Increased recycling/reuse rate of CDW/soil and organic matter within the city boundaries.*

3.16. GHG emissions per year

Metadata group	#	Metadata category	Fill in data for indicator		
Identi-fier	1	Indicator number	85		
	2	Indicator name	GHG emissions per year		
Link to Circular City Definition	3	Vision Element			1. Local stakeholder actions
					2. Circular business models and behavioural patterns
					3. Closing material loops and reducing harmful resource use
			x		4. Improving human well-being and reducing environmental impacts
	4	Category	1		Engagement and capacity building
					Regulation and incentives
					Vision and urban management
			2		Circular design and business models
					Circular value chains and infrastructure
					Private investments, jobs and gross value added
			3		Material/energy flow
					Re-use and recycling
					Waste generation/management
			4		Well-being
				x	Environment impacts (global)
					Environment impacts (local)
					Economic impacts
					Impacts on urban resilience
Indicator definiti	5	Definition / Description of indicator	The indicator measures annual emissions of the so called 'Kyoto basket' of greenhouse gases. The indicator is calculated for demonstration actions. Focus is on direct emissions.		

	6	Rationale	All the actions in the CityLoops project aim to have an impact on the reduction of GHG. Roskilde Municipality is part of 'DK2020', a partnership between Danish municipalities, that aims to develop climate action plans in line with the Paris Agreement and C40 framework. The reduction of GHG is an important element in this strategy. The expected outcome is listed above under demo actions. The indicator will be used in the same way with all the demonstration actions.
	7	Methodology	Direct GHG emissions per demo-project
	8	Unit	Tonnes CO2-equivalents / year
Data	9	Baseline data / definition	Demonstration level: Baseline 0
	10	Data Sources / Relevant Databases	Statistics from Roskilde Municipality. The green account, scope 3 and the CO2-calculator tools will be used.
	11	Overall accuracy	Medium accuracy, estimated
Context	12	Sector coverage	CDW
	13	Reference area / Spatial implementation scale	Demonstration actions: D1 and D2
	14	Reference period	1.10.2019 – 30.9.2023, yearly (or per demonstration case)
	15	SDG Reference	
Other	16	Comments	Corresponds to the project plan: Impact 1, Indicator 1c. *Reduced emissions of CO2, NOx and PM related to extraction, processing and transportation (incl. logistics) of construction and organic materials.*

4. 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.

5. 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

6. 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.

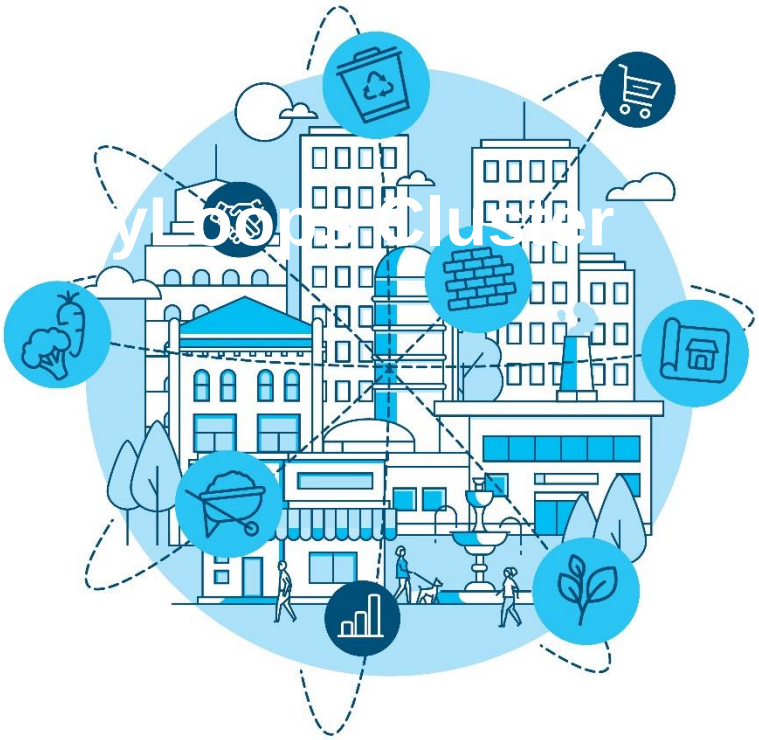
CityLoops runs from October 2019 until September 2023.

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

Evaluation Plan: Biowaste sector, Seville

Deliverable 6.2

City Council of Seville - Seville CityLoops Cluster



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Deliverable lead	Ayuntamiento de Sevilla
Authors	Pedro Cruces González, LIPASAM César Gallardo Soler, Ayuntamiento de Sevilla
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Abstract	This report details how the city of Seville will evaluate the impact of the CityLoops tools and demonstration activities aimed at improving the circularity of the Biowaste sector.
Keywords	Evaluation, Indicators, Seville, Biowaste
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Contents

1. Introduction

As part of the CityLoops project, and associated with the implementation of the demonstration actions to be carried out in the city of Seville, evaluation work will be done for both waste flows, biowaste and construction/demolition waste (BW and CDW), which are addressed in CityLoops.

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). 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.

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.

This is the evaluation plan for the BW sector in the city of Seville, developing the rest of the cities participating in the project, a personalized plan for their demonstration actions and particular tools, but with a common base.

The means of this plan is to measure and monitor the progress of the cities involved, committing in becoming more circular.

CONTEXT

The city of Seville, located in the south of Spain, has around 700,000 inhabitants and a surface area of 140.42 km2. It is the most populated city in Andalusia, the fourth in Spain. The municipal solid waste management is one of the main concerns of the city management and a critical area of its circular economy approach.

Biowaste (BW) represents up to 37% of the total amount of municipal solid waste generated in the city, i.e., 110,000 tonnes of BW yearly. Currently, only 5% of BW is recycled, mostly as compost.

The demonstration actions of the CityLoops project represent another step towards advancing Seville's path towards a more circular city, which is aligned with the declaration that the city itself led in 2017, together with more than 200 municipalities in Spain in the which underlines the importance of Local Governments to put into practice the commitment, the need to implement the Circular Economy.

Seville's declaration for the Circular Economy is also aligned with its City Model of the Seville 2030 Strategic Plan.

On the other hand, the city of Seville understands its commitment to the 2030 Agenda for sustainable development of the United Nations, and assumes it as the standard of its strategic and sectoral planning. Likewise, the Seville 2030 Strategic Plan is aligned with the Sustainable Development Goals (SDG).

Other local and sectoral initiatives and plans converge in the Seville 2030 Strategic Plan, such as the Local Waste Management Program, currently the draft, which will incorporate, if the results are satisfactory, the actions piloted within the framework of the project CityLoops.

Seville's CityLoops cluster consists of the Municipality of Seville, LIPASAM (Municipal Solid Waste Management Company), EMASESA (Municipal Wastewater Treatment Management Company) and IDENER (Private Research Company). Together it is committed with the CityLoops' approach to close the loops of waste material in the city promoting a circular economy approach to the city's development.

Image 1. Example of surface container of high capacity (2,200 L) for biowaste installed in the city of Seville

The demonstration actions to monitor are described below.

1.1. Demonstration Action 1: Implementation of a biowaste collection route in a neighbourhood of Seville

DESCRIPTION

A selective biowaste collection route will be demonstrated within CityLoops in a city neighbourhood by LIPASAM, the municipal waste management company of Seville.

This project aims to improve both the quantity and purity of the biowaste collected by the city. A set of biowaste collection containers will be installed, for exclusive access to neighbourhood citizens and commercial establishments, with an information and awareness raising campaign to accompany this. A software tool designed to optimise the logistics of biowaste collection is also being developed and will be tested in the demonstration neighbourhood.

Alongside the demonstration action a further (mainly digital) awareness raising campaign will be launched across the whole city aimed at encouraging people, mainly large generators such as hotels, restaurants, etc. (the HORECA sector), to reduce food waste.

If the demonstration action is successful, recommendations will be developed for upscaling across the city.

OBJECTIVES & KEY ACTIVITIES

This demonstration action will be supported by two tools elaborated during the inception phase of the project:

- ***A Preliminary diagnosis report.*** The report analysing the current flow of biowaste in the city (in terms of quantity and quality – both separate biowaste collection and organic matter in mixed waste), together with an overview of current collection and treatment systems. It concludes with an implementation plan for the CityLoops demonstration actions.
- ***An OMSW flow optimisation tool.*** The software tool developed is based on Material Flow Analysis (MFA) to model different scenarios in terms of routes, as well as the location and expansion of containers. This should serve to improve the management of biowaste and efficiency of the routes implemented.

The key activities that conform the demonstration action are:

- ***Installation of 100 separate waste collection containers in one neighbourhood.*** 100 side-loading containers of 2,200 litre with electronic locks will be installed (with circularity criteria taken into account in their procurement) in a neighbourhood of Seville. Citizens who want to participate in the system will be able to open the

container with a card, in order to guarantee, in the long term, the purity of the waste fraction, which is essential for its subsequent valorisation.

- ***1 Neighbourhood communication campaign on the separated collection system.*** Associated with the installation of containers in the neighbourhood yet to be selected, a communication campaign will be developed. Various actions will be carried out, focused on improving citizen engagement.
- ***1 Citywide communication campaign on reducing food waste.*** It is considered necessary to carry out a pilot experience consisting of a communication campaign, aimed mainly at hotels, restaurants, etc. (the HORECA sector) in order to reduce food waste.
- ***Testing of OMSW flow optimisation tool.*** The tool will be tested in real conditions of operation. Also it is expected that it will support the analysis of biowaste collection in order to improve the efficiency of the different routes deployed in Seville. Ultimately, the tool is intendeds to be used to increase the biowaste collection separately to the whole city, including households and large generators.
- ***Analysis of the results.*** If the demonstration action is successful, recommendations will be developed for upscaling across the city, being integrated in the Local Plan for Waste Management of Seville.

EXPECTED OUTCOMES

- Strengthened alliances with relevant local and regional actors in the field of biowaste circularity.
- Raised awareness among citizens about the collection and segregation at source of biowaste, as well as its benefits.
- Raised awareness among large biowaste generators, mainly in the HORECA sector (hotels, restaurants and catering), about minimizing food waste.
- More sustainable street furniture deployed in the city as a result of the inclusion of circular specifications in tender documents and contracts.
- Increased amount of material that is recovered/recycled, and therefore reduced amount of material that is deposited in landfills. In particular:
    - 0.6% increase in the separate collection of biowaste in the city compared to the amount collected in 2020.
    - Reduced food waste from HORECA entities.
    - Increased quality of biowaste collected compared to the quality of biowaste at the start of the DA.
- Significant transport energy and cost savings in the waste management system, which will serve as the basis for assessing the potential expansion of the DA to the rest of the city.
- Reduced carbon emissions from waste collection activities.

In general, the DA will help Seville fulfil the European, national, and regional objectives related to selective collection, recycling, and landfilling disposal marked by EU Directives 851/2018 and 850/2018.

DEVIATIONS FROM THE PROPOSAL

In relation to the expected impact in terms of job creation, the adoption of a specific indicator is scrapped, due to the difficulty of collecting such data reliably. The initial employment estimate is based mainly on indirect employment, as a result of the activities to be carried out within the project (production and manufacture of containers and smart-locks, personnel for communication campaigns, etc.)

No other major deviations from what was originally foreseen in the proposal have been detected.

1.2. Demonstration Action 2: Biomethane production from biowaste in co-digestion with sludge

DESCRIPTION

The methane production capacity of the biowaste collected from Demo Action 1 will be tested through a process of co-digestion with sewage sludge in a wastewater treatment plant (WWTP). This is being tested as an alternative to the current collection and transportation of biowaste for composting in a treatment plant more than 32 km away from the city.

The aim of this action is to reduce the distance travelled by the biowaste (and consequent fuel consumption and CO2 emissions), and increase the energy self-sufficiency of the WWTP, which is significantly closer to the city. Furthermore, following this action, feasibility studies will likely be carried out to evaluate the use of biowaste, as source of biogas to be used as fuel for the fleet of municipal vehicles, urban buses and heavy-duty vehicles for waste collection, among others. If the demonstration action is successful, recommendations will be developed for upscaling across the city.

OBJECTIVES & KEY ACTIVITIES

- ***Physical characterisation of the biowaste collected.*** Several physical characterisations, to determine the purity of the biowaste fraction collected will be done.

- ***Lab analysis of COD, BMP and other parameters.*** Several chemical characterisations for COD, BMP, etc. to determine the capacity of methane production will be done using samples of biowaste collected from the route of the Demo 1.
- ***Pilot of energy generation from biowaste collected and sludge.*** Once these characterizations have been done, the dose of biowaste to introduce in the pilot plant can be calculated. The biowaste will be mixed with WWTP sludge before introducing it into the pilot digester. During the course of the test, the production of methane will be measured. The quality of the gas produced will also be analysed, in order to determine the amount of hydrogen sulphide, methane, CO2 and other gas concentrations.
- ***Revision of the results obtained.*** Data obtained will be used to define the methane production potential of the biowaste, in order to design the pre-treatment system or the process strategies for managing the anaerobic digestion of the WWTP.
- ***Economic and environmental benchmarking analysis.*** Economic and environmental comparison between the base scenario (transport to treatment plant for composting) and the demo action (and potential expansion) will be done, as part of the analysis results of the demo action.

EXPECTED OUTCOMES

- Increased amount of material recovered for biogas production purposes, and therefore reduced amount of material that is deposited in landfills.
- Increased efficiency of production of biogas per facility/unit.

In addition to the concrete outcomes above, the DA will also generate information that will be used to assess the potential for expanding the pilot to an industrial stage, such as the increment of quantity of sludge produced after the anaerobic digestion.

DEVIATIONS FROM THE PROPOSAL

No major deviations from what was originally foreseen in the proposal have been detected for DA2.

2. 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 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 CityLoops project plans (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 to Table 4 group the indicators selected by Seville according to which of the four Vision Elements in the CityLoops circular city definition they belong to (Vangelsten et al., 2021). The tables describe at which level the indicators will be applied (Demonstration Action or City level) and which Demonstration Actions and tools they will evaluate.

The total number of indicators selected reflects an attempt to strike a balance between enabling a comprehensive evaluation and keeping the complexity of the evaluation task within manageable limits.

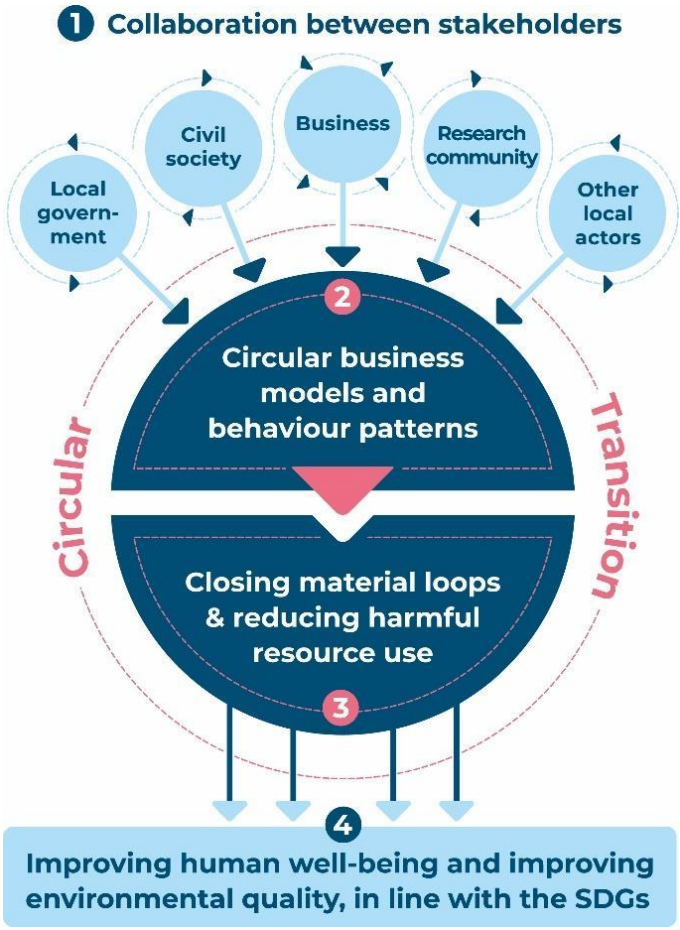


Figure 1. The four Vision Elements of the Circular City vision and causal links for CE transition. Source: D.6.1 Evaluation framework and indicator

The indicators were selected considering the impact of the demonstration actions and their relevance for analysing the circularity progress.

Many of the indicators refer to pilot actions that are going to take place in the city for the first time so that no previous data are available. In addition, it will be necessary to create new datasets.

Also, the indicators selected will allow comparison with other cities in the project in order to detect areas for improvement.

Table 1. List of indicators related to Vision Element 1 "Local Stakeholder Actions".

INDICATOR #	INDICATOR NAME	SCOPE (DEMO/CITY)	DEMO ACTION 1	DEMO ACTION 2
4	CE-related knowledge building campaigns: Qualitative description	D	X	
5	CE-related knowledge building campaigns: Impact	D	X	
6	Circularity-related stakeholder activities	D	X	
11	Communication measures on circular transformations and waste prevention	D	X	

Table 2. List of indicators related to Vision Element 2 "Circular business models and behaviour patterns".

INDICATOR #	INDICATOR NAME	SCOPE (DEMO/CITY)	DEMO ACTION 1	DEMO ACTION 2
15	Procurement with circularity requirements beyond existing levels: Impact	D	X	
32	Reduced costs due to improved circularity	D	X	
36	Total energy demand	D	X	

Table 3. List of indicators related to Vision Element 3 "Closing material loops and reducing harmful resource use".

INDICATOR #	INDICATOR NAME	SCOPE (DEMO/CITY)	DEMO ACTION 1	DEMO ACTION 2
52.1	Quantity of material collected for composting destination	D	X	
52.2	Quantity of material collected per inhabitant	D	X	
53.1	Quantity of material for anaerobic digestion	D		X
53.2	Quantity of sludge produced after anaerobic digestion	D		X
53.3	Quantity of biogas produced	D		X

58	End of Life Processing Rate	C/D	X	X
58.1	Quantity of pure biowaste mass collected	D	X	
52.3	Reduction in food waste	D	X	
61	Landfilling rate	C	X	

Table 4. List of indicators related to Vision Element 4 "Improving human wellbeing and reducing environmental impacts".

INDICATOR #	INDICATOR NAME	SCOPE (DEMO/CITY)	DEMO ACTION 1	DEMO ACTION 2
85	GHG emissions per year	D	X	

Links between the selected indicators and the expected outcomes for the specific Demonstration Actions (and, if relevant, application of tools outside the scope of the DAs) are shown in the tables below.

Table 5. Linking expected outcomes to the selected indicators for Demonstration Action 1: Implementation of a biowaste collection route in a neighbourhood of Seville.

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Strengthened alliances with relevant local and regional actors in the field of biowaste circularity.	**6. Circularity-related stakeholder activities**
	Raised awareness among citizens about the collection and segregation at source of biowaste, as well as its benefits.	**4. CE-related knowledge building campaigns: Qualitative description** **5. CE-related knowledge building campaigns: Impact**
	Raised awareness among large biowaste generators, mainly in the HORECA sector (hotels, restaurants, and catering), about minimizing food waste.	**11. Communication measures on circular transformations and waste prevention**
2 Circular business models and behaviour patterns	More sustainable street furniture deployed in the city as a result of the inclusion of circular specifications in tender documents and contracts.	**15. Procurement with circularity requirements beyond existing levels: Impact**

Vision Element	Expected outcome	Indicator
	Significant transport energy and cost savings in the waste management system, which will serve as the basis for assessing the potential expansion of the DA to the rest of the city.	**32. Reduced costs due to improved circularity** **36. Total energy demand**
3 Closing material loops and reducing harmful resource use	0.6% increase in the separate collection of biowaste in the city compared to the amount collected in 2020.	**52.1 Quantity of material collected for composting destination** **52.2 Quantity of material collected per inhabitant** **61. Landfilling rate**
	Reduced food waste from HORECA entities.	**52.3 Reduction in food waste**
	Increased quality of biowaste collected compared to the quality of biowaste collected at the start of the DA.	**58 End of Life Processing Rate** **58.1 Quantity of pure biowaste mass collected**
4 Improving human wellbeing and reducing environmental impacts	Reduced carbon footprint from waste collection activities.	**85. GHG emissions per year**

Table 6. Linking expected outcomes to the selected indicators for Demonstration Action 2: Biomethane production from biowaste in co-digestion with sludge.

Vision Element	Expected outcome	Indicator
3 Closing material loops and reducing harmful resource use	Increased amount of material recovered for biogas production purposes, and therefore reduced amount of material that is deposited in landfills.	**53.1 Quantity of material for anaerobic digestion** **58 End of Life Processing Rate**
	Increased efficiency of production of biogas per facility/unit.	**53.3 Quantity of biogas produced**
	Information generated that allows the evaluation of the potential for expanding the pilot to an industrial stage.	**53.2 Quantity of sludge produced after anaerobic digestion**

3. 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 are 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) are particular for the demo actions scope and objectives for the city of Seville.

The Seville team involved in the evaluation work is presented below:

Table 7. Evaluation team for Seville

EVALUATION TEAM		
Role	**Tasks**	**Organizations**
Evaluation manager	▪ Data collection ▪ Monitoring and analysis	Seville city council – César Gallardo Sóler
Supporters	▪ Data reporting ▪ Analysis	Demo manager wp3: LIPASAM – Pedro Cruces González Rest of the Seville CityLoops Cluster
Local stakeholder groups	▪ Analysis and data reporting ▪ Results sharing	Treatment plant, waste and water managers (private and public), suppliers, public administration, universities, merchant associations, distributors, social organizations, and citizens

3.1. CE-related knowledge building campaigns: Qualitative description | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	4
	2	Indicator name	CE-related knowledge building campaigns: Qualitative description

Metadata group	#	Metadata category	Description / comments
Link to Circular City Definition	3	Vision element	Local stakeholder actions
	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, mailing, information points, and education workshops. Describe type of groups reached and type of knowledge building campaign. (To be selected together with indicator number 5)
	6	Rationale	During the CityLoops project, communication campaigns will take place in order to improve the circularity of BW in the city of Seville. In those campaigns, awareness will be raised and knowledge will be disseminated about this issue. In DA1, communication campaigns will be performed allowing citizens to contribute to the new collection system to be implemented and to build up this capacity in order to learn more sustainable daily practices with the aim of promoting the segregation at source.
	7	Methodology	1. Identify and categorise knowledge campaigns 2. Identify groups reached
	8	Unit	Qualitative data
Data	9	Baseline data / definition	Baseline 0 (only activities during the project are measured)
	10	Data sources / relevant databases	Report of actions carried out within the communication campaign. Meetings minutes. Participant lists. List of other networking meetings and interviews (date and participants).
	11	Overall accuracy	Exact number of actions within the campaigns done. Estimated and/or number of groups reached (depends on the action).
Context	12	Sector coverage	BW

Metadata group	#	Metadata category	Description / comments
	13	Reference area / spatial implementation scale	Demonstration Actions: DA1.
	14	Reference period	Project period 1.10.2019 – 30.9.2023. Report Frequency: Yearly.
	15	SDG reference	17. Partnerships for the Goals.
Other	16	Comments	

3.2. CE-related knowledge building campaigns: Impact | Demonstration action

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	Local stakeholder actions
	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	During the CityLoops project, several campaigns will take place in order to improve the circularity of BW in the city of Seville. In those campaigns, awareness will be raised and knowledge will be disseminated about this issue. In DA1, communication campaigns will be performed allowing citizens to contribute to the new collection system to be implemented and to build up this capacity in order to learn more sustainable daily practices with the aim of promoting the segregation at source.

Metadata group	#	Metadata category	Description / comments
			(Selected together with indicator #4)
	7	Methodology	1. Number of campaigns 2. Number of people reached
	8	Unit	Number of campaigns, Number of people
Data	9	Baseline data / definition	Baseline 0 (only activities during the project are measured).
	10	Data sources / relevant databases	Report of actions carried out within the communication campaign. Meetings minutes Participant lists List of other networking meetings and interviews (date and participants)
	11	Overall accuracy	Exact number of campaigns done Exact or estimated number of people
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	Demonstration Actions: DA1.
	14	Reference period	Project period 1.10.2019 – 30.9.2023. Report Frequency: Yearly.
	15	SDG reference	17. Partnerships for the Goals.
Other	16	Comments	

3.3. Circularity-related stakeholder activities | Demonstration action

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	Local stakeholder actions
	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	Participation in CE-related activities makes local and regional stakeholders (local business, civil society associations, etc) more aware of the impact and benefits of improving Circular Economy in the City. During the CityLoops project, several workshops, meetings, events and communication actions will be carried out with the Local Stakeholder Group and the Collaborative Learning Network established by the Seville cluster in order to boost circularity in the city.
	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	During February 2020, a workshop was held aimed at involving local stakeholders previously identified in the demonstration actions as well as in the work package related to the evaluation of the circularity of the city's materials. Likewise, prior to this workshop, several preparatory actions took place: - Personalized emailing explaining project and purpose of the workshop. No. of people reached: 13.

Metadata group	#	Metadata category	Description / comments
			- Individual phone calls and snowball sampling: No. of people reached: 13. - First round of preparation meeting for workshops: No. of people reached: 13. - Workshop: No. of people reached: 24.
	10	Data sources / relevant databases	Meetings minutes, participant lists, list of other networking meetings and interviews (date and participants)
	11	Overall accuracy	Exact or estimated number of stakeholders involved
Context	12	Sector coverage	BW.
	13	Reference area / spatial implementation scale	Region of Andalusia mainly City of Seville Local Stakeholder group.
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Report Frequency: Yearly.
	15	SDG reference	17. Partnerships for the Goals.
Other	16	Comments	Reference: *Seville Stakeholder Engagement Plan.* *Local Stakeholder Group* *Collaborative Learning Network*

3.4. Communication measures on circular transformations and waste prevention | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	11

Metadata group	#	Metadata category	Description / comments
	2	Indicator name	Communication measures on circular transformations and waste prevention
Link to Circular City Definition	3	Vision element	Local stakeholder actions
	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	In DA1, a communication campaign will focus mainly on the HORECA sector (hotels, restaurants, and catering) with the aim of building up their capacity in order to learn more sustainable daily practices in the field of avoiding food waste.
	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	Baseline 0 (only activities during the project are measured)
	10	Data sources / relevant databases	Reports of communications actions List of communications (date and participants)
	11	Overall accuracy	Exact or estimated number of communications actions done Exact or estimated number of people reached
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	Demonstration Actions: DA1.
	14	Reference period	Project period 1.10.2019 – 30.9.2023. Report Frequency: Yearly.

Metadata group	#	Metadata category	Description / comments
	15	SDG reference	17. Partnerships for the Goals.
Other	16	Comments	

3.5. Procurement with circularity requirement beyond existing levels

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	15
	2	Indicator name	Procurement with circularity requirements beyond existing levels: Impact
Link to Circular City Definition	3	Vision element	Local stakeholder actions
	4	Category	Regulation and incentives
Indicator definition and description	5	Definition / description of indicator	# of procurements with circularity requirements Value of procurement with circularity requirements
	6	Rationale	The implementation of circular procurement practices is a vehicle for making the city more circular. Parts of the demonstration actions to be carried out in the city of Seville require the purchase of equipment, materials, etc. In the cases that are mandatory, clauses will be established that result in a greater circularity of the elements / solutions to be purchased. Circular procurement practices will be applied in DA1 in the tenders related to the acquisition of containers, materials for communication campaigns, etc.

Metadata group	#	Metadata category	Description / comments
	7	Methodology	For each action: ● Type of procurement action ● Value of procurement For the whole period considered: ● Time period ● Number of procurement contracts ● Sum up the total value of these contracts
	8	Unit	Number of indicators
Data	9	Baseline data / definition	In January 2021, the procurement of 100 side-loading containers for Demo Action 1 was launched. In the specifications it was mentioned that it would be valuable to incorporate recycled material in the manufacture of the containers to be purchased. The specification included in the tender about this issue was: "*When materials from recycled materials are used in the manufacturing process, the proportion of these materials with respect to virgin material, the origin of these recycled materials and the cleaning and granulation process. The incorporation of recycled material will be positively valued, provided that the technical characteristics required in the European regulations EN 12574 are maintained".*
	10	Data sources / relevant databases	Reports of contracts, agreements and grants by: LIPASAM, EMASESA and City Council of Seville. Procurement of 100 containers: https://contrataciondelestado.es/wps/wcm/connect/e2e197d9-d747-4f0e-98b1-c781b4c2b4ce/DOC_CD2021-752328.pdf?MOD=AJPERES
	11	Overall accuracy	Description of the specifications established in procurement tenders:
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	Demonstration Actions: DA1.
	14	Reference period	Project period 1.10.2019 – 30.9.2023

Metadata group	#	Metadata category	Description / comments
			Report Frequency: Yearly.
	15	SDG reference	12 – Sustainable Consumption and Production.
Other	16	Comments	

3.6. Reduced costs due to improved circularity | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	32
	2	Indicator name	Reduced costs due to improved circularity
Link to Circular City Definition	3	Vision element	Circular business models and behavioural patterns
	4	Category	Private investments, jobs and gross value added
Indicator definition and description	5	Definition / description of indicator	For selected cost type(s) (e.g. transport, virgin material costs, waste treatment costs), direct impacts on costs should be estimated.
	6	Rationale	Improving circularity is also a way to reduce costs. The demonstration actions to be carried out aim to optimize mainly the logistics of biowaste collection. That is why, during the demonstration action, the logistics costs will be evaluated. A comparison will be done between a scenario with a fixed frequency collection and the alternative (to be piloted) where the frequency will be determined from the correlation between the volume of waste disposed in the containers and the number of times that they have been used. In DA1 the avoided costs related to optimization of the logistics of the biowaste collection will be analysed, using the OMSW optimization tool developed by IDENER.
	7	Methodology	Quantification of cost savings for the selected cost type using a practical method. The estimate should be accompanied by a qualitative description of the

Metadata group	#	Metadata category	Description / comments
			method, which cost items are included and which are excluded, with a justification of the choice.
	8	Unit	Monetary value
Data	9	Baseline data / definition	Baseline: 0% (only activities during the project are measured)
	10	Data sources / relevant databases	Internal Benchmarking report elaborated ad hoc for the project by LIPASAM and IDENER.
	11	Overall accuracy	%; €/tons waste collected
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	Demonstration Actions: DA1
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Report Frequency: At the end of DA1.
	15	SDG reference	12 – Sustainable Consumption and Production.
Other	16	Comments	

3.7. Total energy demand | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	36
	2	Indicator name	Total energy demand
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	Material / energy flow

Metadata group	#	Metadata category	Description / comments
Indicator definition and description	5	Definition / description of indicator	Total energy demand for all sectors in the city.
	6	Rationale	Part of the demonstration actions are based on achieving greater optimization of the collection logistics, fundamentally, so it is considered appropriate to control the energy demanded from the biowaste management activity. In DA1, the energy demand (litres of fuel) related with optimization of the logistics of the biowaste collection will be analysed using the OMSW optimization tool developed by IDENER.
	7	Methodology	Total energy demand in the city, if possible, broken down by key sectors. Data from statistical offices/power companies.
	8	Unit	KWh/year
Data	9	Baseline data / definition	Baseline: 0% (only activities during the project are measured)
	10	Data sources / relevant databases	Internal Benchmarking report elaborate ad hoc for the project by LIPASAM and IDENER.
	11	Overall accuracy	TEP/ton of waste
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	Demonstration Actions: DA1.
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Report Frequency: At the end of DA1.
	15	SDG reference	12 – Sustainable Consumption and Production.
Other	16	Comments	

3.8. Quantity of material collected for composting destination | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	52.1
	2	Indicator name	Quantity of material collected for composting destination
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	Re-use and recycling
Indicator definition and description	5	Definition / description of indicator	Amount of material collected in containers for the fraction of separate collection of biowaste destined for composting.
	6	Rationale	The main objectives of actions related to biowaste in the project are recycling this fraction and increasing its purity. DA1: Biowaste mass will be collected through the installation of a separate collection system in an area of Seville.
	7	Methodology	Sum up mass of biowaste material collected. Data come from LIPASAM and ABORGASE, operator of the treatment plant to which the biowaste will be destined.
	8	Unit	Tonnes/year
Data	9	Baseline data / definition	Baseline: 0 (only activities during the project are measured)
	10	Data sources / relevant databases	Internal report of the monitoring of demo action 1 (biowaste collected) By LIPASAM. ABORGASE Supporting.
	11	Overall accuracy	tonnes/year,
Context	12	Sector coverage	BW

Metadata group	#	Metadata category	Description / comments
	13	Reference area / spatial implementation scale	Demonstration Actions: DA1.
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Report Frequency DA1: Once DA 1 runs, monthly.
	15	SDG reference	11. Sustainable Cities and Communities.
Other	16	Comments	

3.9. Quantity of material collected per inhabitant | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	52.2
	2	Indicator name	Quantity of material collected per inhabitant.
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	Re-use and recycling
Indicator definition and description	5	Definition / description of indicator	Estimation of amount of biowaste material generated in the demo area per inhabitant covered.
	6	Rationale	DA1: Biowaste mass will be collected through the installation of separate collection containers with smart-

Metadata group	#	Metadata category	Description / comments
			locks. It is considered interesting to measure the mass of biowaste disposed by users (citizens) in order to get information about the participation in the collection system.
	7	Methodology	Data come from the smart-lock management platform procured in the framework of DA1.
	8	Unit	Tonnes per Inhabitant (user).
Data	9	Baseline data / definition	Baseline: 0 (only activities during the project are measured)
	10	Data sources / relevant databases	Smart-lock management platform, operated by LIPASAM. In addition, work will be done so that this information feeds the platform developed by IDENER.
	11	Overall accuracy	Tonnes/Kilograms per user.
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	Demonstration Actions: DA1.
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Report Frequency DA1: Once DA 1 runs, monthly.
	15	SDG reference	11. Sustainable Cities and Communities
Other	16	Comments	

3.10. Reduction in food waste | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	52.3

Metadata group	#	Metadata category	Description / comments
	2	Indicator name	Reduction in food waste
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	Waste generation / management
Indicator definition and description	5	Definition / description of indicator	Estimation of reduced or non-generated biowaste, thanks to the communication campaign aimed at avoiding food waste.
	6	Rationale	Within DA1, an action campaign will be carried out mainly aimed at the HORECA sector, with the aim of minimizing food waste. It is considered appropriate and interesting to try to evaluate the mass of non-generated biowaste, thanks to the impact of said campaign.
	7	Methodology	To be defined. The methodology is being discussed between LIPASAM and a potential stakeholder, within the food sector, with great power of mobilization within the HORECA sector. The plan is to define the methodology before mid-February 2022.
	8	Unit	To be defined
Data	9	Baseline data / definition	Baseline: 0 (only activities during the project are measured)
	10	Data sources / relevant databases	Report of the monitoring of demo action 1. LIPASAM
	11	Overall accuracy	%, estimation
Context	12	Sector coverage	BW.
	13	Reference area / spatial implementation scale	Demonstration Actions: DA1.
	14	Reference period	Project period 1.10.2019 – 30.9.2023. Report Frequency: At the end of DA 1.

Metadata group	#	Metadata category	Description / comments
	15	SDG reference	11. Sustainable Cities and Communities.
Other	16	Comments	

3.11. Quantity of material for anaerobic digestion | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	53.1
	2	Indicator name	Quantity of material for anaerobic digestion
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	Re-use and recycling
Indicator definition and description	5	Definition / description of indicator	Estimate mass of materials going to anaerobic digestion.
	6	Rationale	Anaerobic digestion or biomethanization is considered one of the best options in the market for mature waste treatment technologies. Part of the actions planned by the city of Seville, particularly in DA2, consists in testing the methane production capacity of the biowaste collected through a process of anaerobic co-digestion with sewage sludge in a wastewater treatment plant (WWTP). Co-digestion has the benefit of taking advantage of infrastructure close to the city and lengthening the useful life of the infrastructure itself. As part of this pilot, it is essential to know the quantity of biowaste introduced in the anaerobic co-digestion plant, in order to optimize the process itself.
	7	Methodology	Sum of organic material going to anaerobic digestion. Data come from EMASESA.

Metadata group	#	Metadata category	Description / comments
	8	Unit	Kilograms per cycle of digestion
Data	9	Baseline data / definition	Baseline 0 (only activities during the project are measured).
	10	Data sources / relevant databases	Internal report of demo action 2 by EMASESA.
	11	Overall accuracy	Kilograms per cycle of digestion, weighted.
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	Demonstration Actions: DA2.
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Report Frequency DA2: At the end of the DA2.
	15	SDG reference	12 – Sustainable Consumption and Production.
Other	16	Comments	Key elements: - Physical characterisation of the biowaste collected.

3.12. Quantity of sludge produced after anaerobic digestion | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	53.2
	2	Indicator name	Quantity of sludge produced after anaerobic co-digestion.
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use

Metadata group	#	Metadata category	Description / comments
	4	Category	Re-use and recycling
Indicator definition and description	5	Definition / description of indicator	Estimate mass of sludge produced after the anaerobic digestion.
	6	Rationale	The production of residual sludge after the anaerobic digestion process is an interesting indicator when evaluating the suitability of a substrate, since higher production of this residual sludge means higher treatment management costs.
	7	Methodology	Amount of sludge produced. Data come from EMASESA.
	8	Unit	Tonnes/year
Data	9	Baseline data / definition	Baseline 0 (only activities during the project are measured).
	10	Data sources / relevant databases	Internal report of demo action 2 by EMASESA.
	11	Overall accuracy	- Kilograms per cycle of digestion, weighted or increase in % sludge compared to a standard digestion (only sludge), measured.
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	Demonstration Actions: DA2.
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Report Frequency DA2: At the end of the DA2.
	15	SDG reference	12 – Sustainable Consumption and Production.
Other	16	Comments	

3.13. Quantity of biogas produced | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	53.3
	2	Indicator name	Quantity of biogas produced.
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	Re-use and recycling
Indicator definition and description	5	Definition / description of indicator	Estimate volume of biogas produced from anaerobic co-digestion of biowaste with sewage sludge in a wastewater pilot treatment plant (WWTP).
	6	Rationale	Part of the actions planned by the city of Seville consists in testing the methane production capacity of the biowaste collected through a process of anaerobic co-digestion with sewage sludge in a wastewater pilot treatment plant (WWTP). The city's wastewater treatment plants have biogas production systems based on an anaerobic digestion of their sludge. Furthermore, in recent years, EMASESA has opted for the co-digestion, together with its sewage sludge, of other industrial effluents with significant biodegradable organic matter content, to increase the production of renewable biogas. It is considered interesting to evaluate production of biowaste obtained using biowaste as co-feedstock in the anaerobic digestion process.
	7	Methodology	Quantity of biogas produced. Increase in % of biogas produced, compared to a standard digestion (only sludge). Data come from EMASESA.
	8	Unit	Litres/day

Metadata group	#	Metadata category	Description / comments
Data	9	Baseline data / definition	Baseline 0 (only activities during the project are measured).
	10	Data sources / relevant databases	Internal report of the biogas production measured during the demo action 2 by EMASESA.
	11	Overall accuracy	Litres/day, measured.
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	Demonstration Actions: DA2.
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Report Frequency DA2: At the end of the DA2.
	15	SDG reference	12 – Sustainable Consumption and Production.
Other	16	Comments	Key elements: 1) Lab analysis of COD, BMP and other parameters to determine the capacity of methane production. 2) Measuring of the methane production. 3) Analysis of the gas produced (sulphide, methane, CO2, etc.).

3.14. End of Life Processing Rate | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	58
	2	Indicator name	End of Life Processing Rate
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	Waste generation / management

Metadata group	#	Metadata category	Description / comments
Indicator definition and description	5	Definition / description of indicator	The End-of-Life Processing Rate (EoL PR) measures the efficiency of the end-of-life processing process.
	6	Rationale	Taking into account the current local and regional ecosystem of recycling plants, it is crucial for a higher rate of recovery of materials to promote separation at source. Project activities aim to increase recycling and upcycling of materials instead of landfilling. For instance, several actions of the city of Seville in the project promote the recycling of biowaste, through the installation of a separate collection system and pilot alternatives of treatment further than composting (DA1 & DA2). For DA1, the monitoring of this indicator will help to understand how the improvement in the purity of the collected biowaste affects the performance of the subsequent composting process of the total amount of biowaste collected in the city.
	7	Methodology	Mass of material obtained (compost produced) divided by the mass of biowaste collected.
	8	Unit	%
Data	9	Baseline data / definition	EoL PR for 2020: Biowaste:12.5%. Mass collected: 1,693 / Compost produced: 212. Losses for fermentation are included.
	10	Data sources / relevant databases	Annual Declaration of Municipal Waste Collection (LIPASAM). ABORGASE Internal Management Report. Characterizations Biowaste Report (LIPASAM)
	11	Overall accuracy	%, estimated, weighted.
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	City of Seville, Demonstration Actions: DA1.

Metadata group	#	Metadata category	Description / comments
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Report Frequency: at the end of DA1.
	15	SDG reference	11. Sustainable Cities and Communities
Other	16	Comments	

3.15. End of Life Processing Rate | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	58
	2	Indicator name	End of Life Processing Rate
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	Waste generation / management
Indicator definition and description	5	Definition / description of indicator	The End-of-Life Processing Rate (EoL PR) measures the efficiency of the end-of-life processing process.
	6	Rationale	Taking into account the current local and regional ecosystem of recycling plants, it is crucial for a higher rate of recovery of materials to promote separation at source. Project activities aim to increase recycling and upcycling of materials instead of landfilling. For instance, several actions of the city of Seville in the project promote the recycling of biowaste, through the installation of a separate collection system and pilot alternatives of treatment further than composting (DA1 & DA2). For DA2, the monitoring of this indicator will help to understand what the yield is of obtaining "pulp"

Metadata group	#	Metadata category	Description / comments
			applicable to anaerobic digestion, coming from biowaste municipal collection.
	7	Methodology	Mass of material introduced into the digester, which comes from the separate collection of biowaste, divided by the mass of biowaste collected destined for co-digestion.
	8	Unit	%
Data	9	Baseline data / definition	Baseline: 0.
	10	Data sources / relevant databases	Annual Declaration of Municipal Waste Collection (LIPASAM). Characterizations Biowaste Report (LIPASAM) Report DA2 by EMASESA.
	11	Overall accuracy	%, estimated, weighted.
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	Demonstration Actions: DA2
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Report Frequency: at the end of DA2.
	15	SDG reference	11. Sustainable Cities and Communities
Other	16	Comments	

3.16. Quantity of pure biowaste mass collected | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	58.1
	2	Indicator name	Quantity of pure biowaste mass collected
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	Waste generation / management
Indicator definition and description	5	Definition / description of indicator	Mass of pure biowaste collected in the containers destined for the selective biowaste collection fraction.
	6	Rationale	The purity of the waste is an interesting parameter since it generates useful information to know if citizens are correctly separating the waste at source. The purity of the waste affects its subsequent valorization.
	7	Methodology	Physical characterization of waste from a sample of biowaste collected from the demonstration area.
	8	Unit	%
Data	9	Baseline data / definition	Baseline 0 (only activities during the project are measured)
	10	Data sources / relevant databases	Characterizations reports. LIPASAM.
	11	Overall accuracy	%; tonnes weighted/estimated.
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	Demonstration Actions: DA1.
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Report Frequency: at the end of DA1.

Metadata group	#	Metadata category	Description / comments
	15	SDG reference	11. Sustainable Cities and Communities
Other	16	Comments	

3.17. Landfilling rate | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	61
	2	Indicator name	Landfilling rate
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	Waste generation / management
Indicator definition and description	5	Definition / description of indicator	Mass percentage of waste which landfilled.
	6	Rationale	The current targets for landfill disposal state that at most only 10% of the waste may be destined for disposal. Currently, in Andalusia and Seville, this percentage is around 70%, which is why it is crucial to implement measures that limit the amounts of waste that are destined for landfilling annually, consistent with the European pyramid of waste management. Project activities aim to increase recycling and upcycling of materials instead of landfilling (DA1 and DA2). It is considered appropriate to evaluate the impact of these activities at the city level.
	7	Methodology	Mass of materials landfilled divided by total amount of waste. Data come from ABORGASE.
	8	Unit	%
Data	9	Baseline data / definition	For 2020: a) Total of waste not collected separately: 258,118 tons.

Metadata group	#	Metadata category	Description / comments
			b) Light-packaging waste collected separately: 8,800 tons. c) Material recovered + losses for fermentation: 84,721 tons. Formula: ((a+b) – c)/(a+b). Landfilling rate: 68.26%.
	10	Data sources / relevant databases	Plan de Residuos no peligrosos de la Provincia de Sevilla (Non-hazardous Waste Plan of the Province of Seville). Annual Declaration of Municipal Waste Collection (LIPASAM). ABORGASE Internal Management Report.
	11	Overall accuracy	%; weighted/estimated.
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	City of Seville, Demonstration Actions: DA1 and DA2.
	14	Reference period	Project period 1.10.2019 – 30.9.2023 Report Frequency: Yearly.
	15	SDG reference	11. Sustainable Cities and Communities
Other	16	Comments	It is estimated that the rest of the selectively collected fractions are 100% recycled.

3.18. GHG emissions per year | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	85

Metadata group	#	Metadata category	Description / comments
	2	Indicator name	GHG emissions per year
Link to Circular City Definition	3	Vision element	Improving human well-being and reducing environmental impacts
	4	Category	Environment impacts (global)
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. See here for more info on the Kyoto basket.
	6	Rationale	Parts of the demonstration actions are based on achieving greater optimization of the collection logistics, so it is considered appropriate to control the energy demanded from the biowaste management activity. In DA1, CO2 emission reductions (litres of fuel) related to optimization of the logistics of the biowaste collection will be analysed using the OMSW optimization tool developed by IDENER.
	7	Methodology	Direct GHG emissions per year at demo level
	8	Unit	Tonnes CO2-equivalents / year
Data	9	Baseline data / definition	Baseline: 0 (only activities during the project are measured)
	10	Data sources / relevant databases	Internal Report of the monitoring of the demo action 1 by LIPASAM and IDENER.
	11	Overall accuracy	Estimation of ton CO2 eq.
Context	12	Sector coverage	BW.
	13	Reference area / spatial implementation scale	Demonstration Actions: DA1
	14	Reference period	Project period 1.10.2019 – 30.9.2023.

Metadata group	#	Metadata category	Description / comments
			Report Frequency: At the end of DA 1.
	15	SDG reference	13: Climate Actions.
Other	16	Comments	

4. References

- Seville Declaration: the commitment of cities to the Circular Economy. *Declaración de Sevilla: el compromiso de las ciudades por la Economía Circular.* http://www.femp.es/sites/default/files/multimedia/declaraciondesevilladefmaquetada.pdf
- Seville 2030 Strategic Plan. *Plan Estratégico Sevilla 2030* https://www.sevilla.org/planestrategico2030/documentos/sevilla-2030/plan-estrategico-sevilla-2030/objetivos-y-estrategias-sevilla2030.pdf
- Comprehensive Waste Plan for Andalusia. Towards a Circular Economy in the 2030 Horizon. *Plan Integral de Residuos de Andalucía. Hacia una Economía Circular en el Horizonte 2030 (PIREC 2030).* *http://www.juntadeandalucia.es/medioambiente/portal_web/web/temas_ambientales/residuos/planificacion_materia_residuos/PIRec_2030.pdf*
- *Non-hazardous Waste Plan of the Province of Seville 2020 – 2035.* Plan de Residuos no peligrosos de la Provincia de Sevilla 2020 – 2035. https://www.dipusevilla.es/export/sites/diputacion-sevilla-corporativo/planderesiduos/.galleries/plan-definitivo/Plan-Provincial-Residuos_COMPLETO-docum.-final-standard.pdf
- 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.
- CityLoops - Seville Optimised Implementation Plan for Biowaste by Limpieza Pública y Protección Ambiental S.A.M.
- Plan of Action for Climate and Sustainable Energy of Seville. *Plan de Acción por el Clima y la Energía Sostenibles (PACES)*.

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.

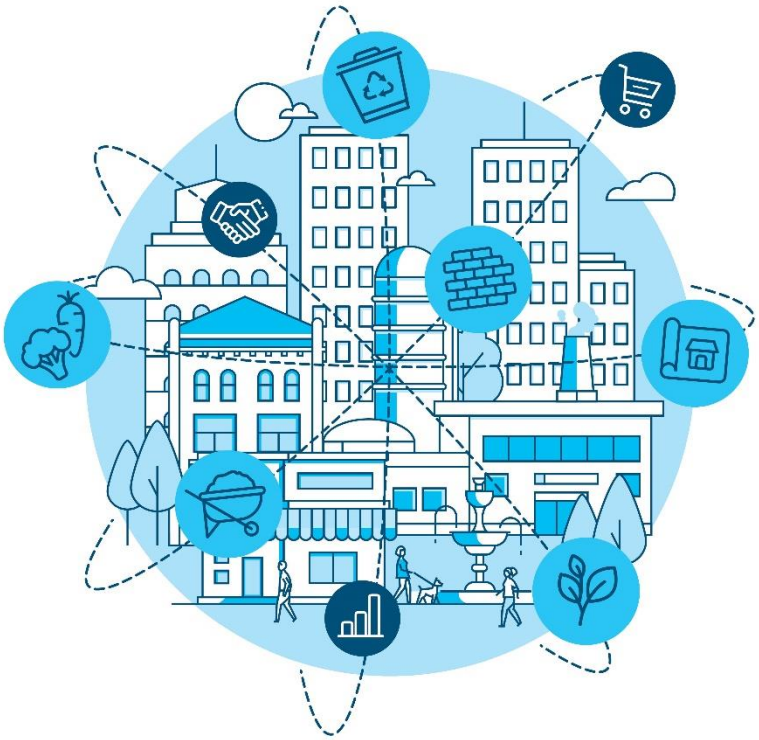
CityLoops runs from October 2019 until September 2023.

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

Evaluation Plan: CDW sector, Seville

Deliverable 6.2

City Council of Seville - Seville CityLoops Cluster



Version	3.1
WP	6
Deliverable	6.2 (Evaluation Plan: CDW, Seville)
Date	18 February 2022
Dissemination level	Public
Deliverable lead	Ayuntamiento de Sevilla
Authors	César Gallardo Soler, Ayuntamiento de Sevilla Santiago Rodríguez Pérez, IDENER
Reviewers	Graciano Carpes Hortal, EMASESA Emilio Benítez Flores; LIPASAM Pedro Cruces González, LIPASAM Jens Ørding Hansen, NRI Are Jensen, NRI Nikolai Jacobi, ICLEI Europe
Abstract	This report details how the city of Seville will evaluate the impact of the CityLoops tools and demonstration activities aimed at improving the circularity of the CDW sector.
Keywords	Evaluation, Indicators, Seville, CDW
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Contents

1. Introduction

As part of the project and associated with the implementation of the demonstration actions to be carried out in the city of Seville an evaluation plan will be made for both waste flows, biowaste and construction/demolition waste (BW and CDW) which are addressed in CityLoops.

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). 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.

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.

CONTEXT

The city of Seville, located in the south of Spain, has 700,000 inhabitants and a surface area of 140.42 km2. It is the most populated city in Andalusia, the fourth in Spain. The construction industry is one of the main economic activities that boosts the economic development of the city.

Construction and Demolition Waste (CDW) represents up to 45% of the total amount of waste generated in the city, i.e., 270,547 tonnes of CDW and 1,309,501 tonnes of excavated soil annually. Currently, only 16.1% of CDW is recycled, mostly for buildings works and road fillings.

The demonstration actions of the CityLoops project represent another step towards advancing Seville's path towards a more circular city, which is aligned with the declaration that the city itself led in 2017, together with more than 200 municipalities in Spain in the which underlines the importance of Local Governments to put into practice the commitment, the need to implement the Circular Economy.

Seville's declaration for the Circular Economy is also aligned with its City Model of the Seville 2030 Strategic Plan.

On the other hand, the city of Seville understands its commitment to the 2030 Agenda for sustainable development of the United Nations and assumes it as the standard of its strategic and sectoral planning. Likewise, the Seville 2030 Strategic Plan is aligned with the Sustainable Development Goals (SDG).

Other local and sectoral initiatives and plans converge in the Seville 2030 Strategic Plan, such as the Local Waste Management Program, currently the draft, which will incorporate, if the results are satisfactory, the actions piloted within the framework of the project CityLoops.

Seville's cluster of partners for the CityLoops project includes the Municipality of Seville, LIPASAM (Municipal Solid Waste Management company), EMASESA (Municipal Wastewater Treatment Management company) and IDENER (Private Research company). Together these partners are committed to CityLoops' approach to close the loops of waste material in the city, promoting a circular economy approach to the city's development.

Image 1. Images from a restoration pipeline work. EMASESA

The demonstration actions to be monitored are described below.

1.1. Demonstration Action 1: Renovation of water pipelines with circular material management

DESCRIPTION

EMASESA, as the public entity responsible for water and waste mater infrastructure and management in Seville, will undertake circular renovation of old water and sewage pipelines by recycling concrete, road surface, filling, and soil. The pilot focuses on water network infrastructures and the materials are concrete pipes, road surface, soil, and filling material. The CDW quality and technical properties of the dug-up pipes in the demonstration sites will be analysed and compared to required specifications, which must be met for the recovered material to be used again in construction. If it meets the quality standards, the CDW will be used to replace primary raw materials such as filling under the pavements in pipe replacement works and/or to improve soil quality in nearby municipal sites. The piloted material management approach will be incorporated into green procurement criteria that can be used in other similar public works, to ensure as much CDW as possible can be reused or recycled instead of dumped. EMASESA will work to engage construction stakeholders to mainstream the use of circular considerations in public contracts and will also publish a practical guide for quality classification and handling of CDW according to the waste hierarchy.

OBJECTIVES & KEY ACTIVITIES

This demonstration action will be supported by the tool elaborated during the inception phase of the project:

- ***Quality assessment of CDW.*** The quality assessment is a standard classification that aims to set a guideline to increase the number of bids for public infrastructure projects that contemplate CDW valorisation. In spring 2021, using the tool developed, a pilot area will be selected to compare the performance of conventional raw material versus CDW, including the physical properties within different static and dynamic contexts. Through this feedback process, the Quality Assessment tool will be iteratively improved. The classification will be applied to demolition material from multiple pipe replacement sites. Based on the result, FERMOVERT, the waste treatment company, will treat the material accordingly so that it can be used as construction aggregates.

The key activities that conform the demonstration action are:

- ***Selection of the place for pilot action.*** Among the construction and demolition works EMASESA will select 2 sites to test the Quality assessment tool.
- ***Testing phase.*** EMASESA will compare the performance of conventional raw material versus CDW, including the physical properties within different static and dynamic contexts.

- ***Transformation of materials.*** FERMOVERT will be in charge to transform the CDW to be re-used.
- ***Analysis of the results.*** Results on the procurement approach and the development of best practice guidance on CDW classification will be analysed.

EXPECTED OUTCOMES

- Strengthened awareness and knowledge of the improvement of CDW management among the main stakeholders and other socio-economic agents related to the bases of the circular economy.
- Increased share of "circular" indicators and specifications in tender documents and contracts.
- Increased use of recycled CDW by construction companies in the city.
- Increased amount of CDW that is prepared for recovery/recycling, and therefore reduced amount of material that is deposited in landfills, in accordance with Directive 851/2018 and 850/2018.
- Increased amount of recycled materials used in the construction projects, compared to similar construction projects
- Increased amount of soil reuse
- Reduced use of virgin materials

1.2. Demonstration Action 2: Optimising clean points

DESCRIPTION

IT software tools have been developed to optimise the use of Seville's five clean points for collection of CDW from citizens and small producers. Data will be shown through a web portal, with one interface for citizens to instruct them to the clean point best suited to receive their CDW, and one interface for city managers to understand the quantity of CDW at each clean point and plan for future scenarios of city growth to open new clean points. Data collected on the stocks and flows of CDW through the cities' clean points will be used to continuously optimise their management. The collected CDW will be treated by FERMOVERT if need be, to ensure its safety and quality for further future uses. LIPASAM, the waste management company of Seville, plans to analyse the composition of the CDW collected in Clean Points, to evaluate the potential uses of the material recovered and be able to take decisions with the aim of recuperating costs for the clean points management and CDW treatment. Finally, an awareness campaign will aim to introduce these tools to the public and encourage proper handling of CDW, in order to avoid the common practice of illegal dumping of CDW.

OBJECTIVES & KEY ACTIVITIES

This demonstration action will be supported by two tools elaborated during the inception phase of the project:

- ***CDW flow optimisation tool.*** This software tool was developed by IDENER and will be piloted by LIPASAM to model different scenarios regarding waste transport and routes as well as optimal use, management, and upscaling of the clean points. The objective is to improve the experience and increase the use of clean points for CDW by citizens and small producers like SMEs. Different scenario simulations will be used to plan for future city development and additional clean points.
- ***Awareness campaign on CDW management.*** One communication campaign target citizens/ SMEs - focused on prevention of illegal dumping. It will accompany the launch of the digital tools, so that users are aware and encouraged to use the tool to improve their experience using the clean points. A second campaign targets large generators of CDW (construction/ demolition contractors) - focused on the correct segregation and management of CDW.

The key activities that conform the demonstration action are:

- ***Procurement.*** Preparation and procurement of awareness campaign.
- ***Testing phase.*** Tuning the dataset to be analysed by the tool and increase the accuracy of the results.
- ***Deployment of tools.*** Launch and use of CDW optimisation tool, by citizens and by city managers.
- ***Awareness campaign.*** 1) Prevention of illegal dumping; 2) Correct segregation and management of CDW for large generators.
- ***Analysis of the results.*** Results will be analysed on potential measures to implement in the management of clean points, future clean point expansion, etc.

EXPECTED OUTCOMES

- Increased knowledge of CDW management among citizens and small producers.
- Increased use of clean points for CDW management by citizens and small producers.
- Increased amount of CDW managed through the clean points by citizens and small producers.
- Reduced illegal dumping and landfilling of CDW in the city.

1.3. Demonstration Action 3: Data-driven decision making and Best Practice Guidelines for CDW Management in Seville

DESCRIPTION

IDENER has developed IT software tools to integrate available data on environmental, economic, and social development in Seville municipality in order to facilitate data-driven decision-making and better understanding of the impacts of policies and initiatives on citizen wellbeing, and to ensure the city is on the right track towards the sustainable development goals. Citizens will also be able to access information about their waste generation, and how city initiatives are impacting a series of sustainability and wellbeing indicators. Based on the experiences in CityLoops demonstrations and the data visualised through the city simulation platform, best practice guidelines for construction and demolition waste management will be developed. These guidelines are expected to feed into a new Waste Management Plan for the city of Seville.

OBJECTIVES & KEY ACTIVITIES

This demonstration action will be supported by two tools elaborated during the inception phase of the project:

- ***Wellbeing monitoring tool.*** This software tool will collect and analyse data on public services, CO_2 emissions, waste generation, and other circularity indicators (see Evaluation Plan) and find correlations to better understand the current wellbeing of the city and citizens, and based on this will determine potential improvements, e.g., to waste management practices. The tool will also have some data and visualisation available for citizens, to engage them in more circular behaviour and inform them of forthcoming city initiatives, such as new separate waste collection routes. The interface for city managers will also be used to update data, evaluate results for prioritising and planning, and simulate some actions or improvements, in order to see how changes may impact the wellbeing of the district/city.
- ***City simulation platform.*** IDENER has developed a central virtual platform to host all the software tools developed in Seville for CityLoops and the open data generated within the project. The digital platform will be used by citizens as a source of information and by local government partners to help decision making processes. This platform will improve data exchange between the partners of the city and enable dialogue about the potentials of urban development concerning the handling of CDW and soil beyond formal governmental organisations. The results will be used to inform a new municipal waste management plan.

The key activities that conform the demonstration action are:

- ***Testing phase.*** Tuning the dataset to be analysed by the tool and increase the accuracy of the results.
- ***Deployment of tools.*** Launch and use of CDW optimisation tool, by citizens and by city managers.
- ***Best practice guidelines.*** Development of best practice guidelines for waste management based on experience of CityLoops demonstration actions and analysed data.
- ***Analysis of the results.*** If after analysis it is considered appropriate, incorporation of learnings into new Waste Management Plan for the municipality.

EXPECTED OUTCOMES

- Increased interest in the guidelines and tools among public companies and other stakeholders.
- Increased participation of stakeholders in the assessment of the guidelines.
- Increased commitment of citizens to circularity.
- Increased amount of recycled CDW.
- Increase in initiatives on circular CDW management.

2. 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 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 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 CityLoops project plans (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 to Table 4 list the indicators selected by Seville according to the four Vision Elements in the CityLoops circular city definition (Vangelsten et al., 2021). The tables describe at which level the indicators will be applied (Demonstration Action or City level) and which Demonstration Actions they will evaluate.

The total number of indicators selected is an attempt to strike a balance between accomplishing a complete vision and at the same time having a manageable number of indicators for analysis and evaluation.

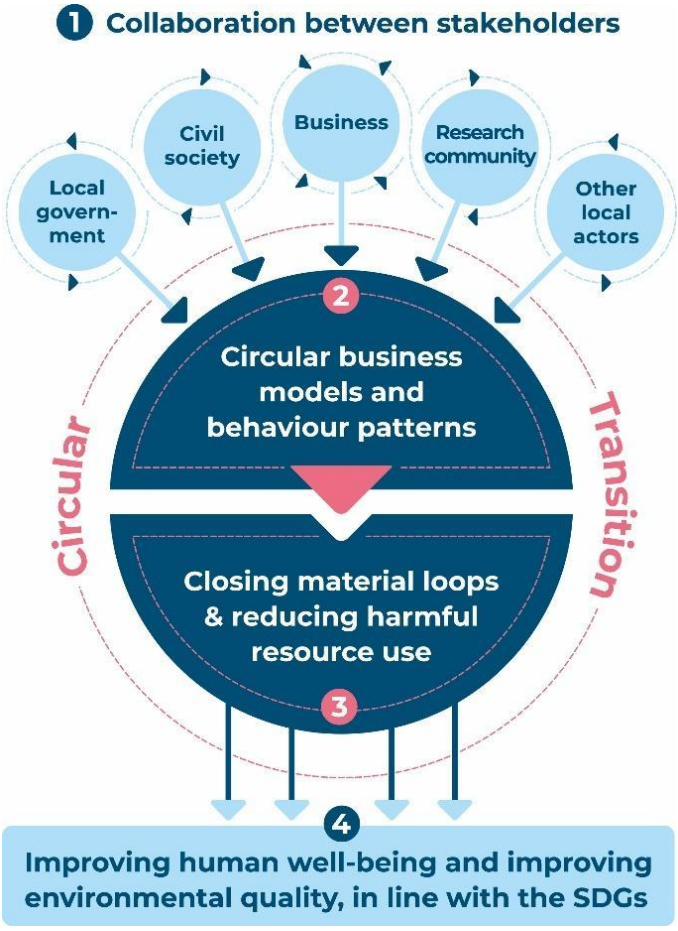

Figure 1. The four Vision Elements of the Circular City vision and causal links for CE transition. Source: D6.1 Circular city indicator set

The indicators were selected considering the impact of the demonstration actions individually and its impact in the city as a whole, and their relevance to analyse the circularity progress.

A large part of the indicators refers to pilot actions that are going to take place in the city for the first time, so there is no previous data available, in addition, it will be necessary to create new databases.

Also, the indicators selected will allow comparison with other cities in the project, in order to detect gaps of improvement.

Links between the selected indicators and the expected outcomes for the specific Demonstration Actions are shown in the tables below.

Table 1. List of indicators related to Vision Element 1 "Local Stakeholder Actions".

INDICATOR #	INDICATOR NAME	SCOPE (DEMO/CITY)	DEMO ACTION 1	DEMO ACTION 2	DEMO ACTION 3
4	CE-related knowledge building campaigns: Qualitative description	D	X		
5	CE-related knowledge building campaigns: Impact	D	X		
6	Circularity-related stakeholder activities	D	X		X
11	Communication measures on circular transformations and waste prevention	D	X	X	
18	CityLoops indicators used in procurement tenders and contracts	D	X		
18.1	Number of tenders submitted by companies offering the use of recycled CDW	C	X		

Table 2. List of indicators related to Vision Element 2 "Circular business models and behaviour patterns".

INDICATOR #	INDICATOR NAME	SCOPE (DEMO/CITY)	DEMO ACTION 1	DEMO ACTION 2	DEMO ACTION 3
32.1	Number of visits to the clean points	D		X	
32.2	Number of external agents who express interest in guideline assessment	D			X
32.3	Number of visits to the applications	D			X

Table 3. List of indicators related to Vision Element 3 "Closing material loops and reducing harmful resource use".

INDICATOR #	INDICATOR NAME	SCOPE (DEMO/CITY)	DEMO ACTION 1	DEMO ACTION 2	DEMO ACTION 3
42	Share of local secondary materials in domestic material consumption	D	X		
52	Quantity of material subjected to recycling	D	X		
52.1	Number of projects that implement CDW valorisation	C	X		
52.2	Number of companies implementing CDW valorisation measures	C			X
52.3	Number of projects that implement reused soil	C	X		
52.4	Amount of CDW collected at the clean points	D		X	
52.5	Amount of recycled CDW from large producers	C			X
61	Landfilling rate	D	X		

Table 4. List of indicators related to Vision Element 4 "Improving human wellbeing and reducing environmental impacts".

INDICATOR #	INDICATOR NAME	SCOPE (DEMO/CITY)	DEMO ACTION 1	DEMO ACTION 2	DEMO ACTION 3
61.1	Assessment of illegal dumping sites	C		X	

Links between the selected indicators and the expected outcomes for the specific Demonstration Actions are shown in the tables below.

Table 5. Linking expected outcomes to the selected indicators for Demonstration Action 1: Renovation of water pipelines with circular material management

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Strengthened awareness and knowledge of the improvement of CDW management among the main stakeholders and other socio-economic agents related to the bases of the circular economy.	**4. CE-related knowledge building campaigns: Qualitative description.** **5. CE-related knowledge building campaigns: Impact** **6. Circularity-related stakeholder activities** **11. Communication measures on circular transformations and waste prevention**
2 Circular business models and behaviour patterns	Increased share of "circular" indicators and specifications in tender documents and contracts.	**18. CityLoops indicators used in procurement tenders and contracts**
	Increased use of recycled CDW by construction companies in the city.	**18.1 Number of tenders submitted by companies offering the use of recycled CDW**
3 Closing material loops and reducing harmful resource use	Increased amount of CDW that is prepared for recovery/recycling, and therefore reduced amount of material that is deposited in landfills, in accordance with Directive 851/2018 and 850/2018.	**52. Quantity of material subjected to recycling** **61. Landfilling rate**
	Increased amount of recycled materials used in the construction projects, compared to similar construction projects	**52.1 Number of projects that implement CDW valorisation**
	Increased amount of soil reuse	**52.3 Number of projects that implement reused soil**
	Reduced use of virgin materials	**42. Share of local secondary materials in domestic material consumption**

Table 6. Linking expected outcomes to the selected indicators for Demonstration Action 2: Optimising clean points.

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Increased knowledge of CDW management among citizens and small producers.	**11. Communication measures on circular transformations and waste prevention**

Vision Element	Expected outcome	Indicator
2 Circular business models and behaviour patterns	Increased use of clean points for CDW management by citizens and small producers.	**32.1 Number of visits to the clean points**
3 Closing material loops and reducing harmful resource use	Increased amount of CDW managed through the clean points by citizens and small producers.	**52.4 Amount of CDW collected at the clean points**
4 Improving human wellbeing and reducing environmental impacts	Reduced illegal dumping and landfilling of CDW in the city.	**61.1 Assessment of illegal dumping sites**

Table 7. Linking expected outcomes to the selected indicators for Demonstration Action 3: Data-driven decision making and Best Practice Guidelines for CDW Management in Seville.

Vision Element	Expected outcome	Indicator
1 Local Stakeholder Actions	Increased interest in the guidelines and tools among public companies and other stakeholders.	**6. Circularity-related stakeholder activities**
2 Circular business models and behaviour patterns	Increased participation of stakeholders in the assessment of the guidelines.	**32.2 Number of external agents who express interest in guideline assessment**
	Increased commitment of citizens to circularity.	**32.3 Number of visits to the applications**
3 Closing material loops and reducing harmful resource use	Increased amount of recycled CDW.	**52.5 Amount of recycled CDW from large producers**
	Increase in initiatives on circular CDW management.	**52.2 Number of companies implementing CDW valorisation measures**

3. 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) are particular to the demo actions and objectives for the city of Seville.

The Seville team for the evaluation work is presented below:

Table 7. Evaluation team for Seville

EVALUATION TEAM		
Role	**Tasks**	**Organizations**
Evaluation manager	▪ Data collection ▪ Monitoring and analysis	Seville city council – César Gallardo Sóler.
Supporters	▪ Data reporting ▪ Analysis	Demo manager WP2: IDENER – Santiago Rodriguez. Rest of the Seville CityLoops Cluster.
Local stakeholder group	▪ Analysis and data reporting ▪ Results sharing	Treatment plant, waste and water managers (private and public), suppliers, public administration, universities, merchants' associations, distribution, social organizations and citizens.

3.1. CE-related knowledge building campaigns: Qualitative description | Demonstration action

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	Local stakeholder actions
	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. (To be selected together with indicator number 5)
	6	Rationale	Participation in CE related activities local stakeholders (local business, civil society associations, etc) more aware of the impact and benefices to improve Circular Economy in the City. During the CityLoops project, several campaigns will take place to improve the circularity of CDW in the city of Seville. In that campaigns, knowledge and awareness about this issue will be shown. In DA2 communication campaigns will be performed allowing citizens to contribute to the new collection system to be implemented and to build up this capacity in order to learn more sustainable daily practices with the aim of avoid food waste. In a transversal way, other workshops and communication actions will be carry out with the local stakeholder group established of Seville, to boost circularity in the city (Reference: *Seville Stakeholder Engagement Plan*). *(Selected together with indicator #5, #6, #11)*
	7	Methodology	1. Identify and categorise knowledge campaigns

Metadata group	#	Metadata category	Description / comments
			2. Identify groups reached
	8	Unit	Qualitative data
Data	9	Baseline data / definition	Baseline 0 (only activities during the project are measured)
	10	Data sources / relevant databases	Meetings minutes; participant lists; list of other networking meetings and interviews (date and participants).
	11	Overall accuracy	Exact or estimated number of campaigns done. Exact or estimated number of groups reached.
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities 17. Partnerships for the Goals.
Other	16	Comments	

3.2. CE-related knowledge building campaigns: Impact | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	5
	2	Indicator name	CE-related knowledge building campaigns: Impact
	3	Vision element	Local stakeholder actions

Metadata group	#	Metadata category	Description / comments
Link to Circular City Definition	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 (To be selected together with indicator number 4)
	6	Rationale	Participation in CE related activities local stakeholders (local business, civil society associations, etc) more aware of the impact and benefices to improve Circular Economy in the City. During the CityLoops project, several campaigns will take place to improve the circularity of CDW in the city of Seville. In that campaigns, knowledge and awareness about this issue will be shown. In DA2 communication campaigns will be performed allowing citizens to contribute to the new collection system to be implemented and to build up this capacity in order to learn more sustainable daily practices with the aim of avoid food waste. In a transversal way, other workshops and communication actions will be carry out with the local stakeholder group established of Seville, to boost circularity in the city (Reference: *Seville Stakeholder Engagement Plan*). *(Selected together with indicator #4, #6, #11)*
	7	Methodology	1. Number of campaigns 2. Number of people reached
	8	Unit	Number of campaigns, Number of people
Data	9	Baseline data / definition	Baseline 0 (only activities during the project are measured)
	10	Data sources / relevant databases	Meetings minutes; participant lists; list of other networking meetings and interviews (date and participants).
	11	Overall accuracy	Exact or estimated number of campaigns done. Exact or estimated number of people.
Context	12	Sector coverage	CDW

Metadata group	#	Metadata category	Description / comments
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities 17. Partnerships for the Goals.
Other	16	Comments	

3.3. Circularity-related stakeholder activities | Demonstration action

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	Local stakeholder actions
	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	Participation in CE related activities local stakeholders (local business, civil society associations, etc) more aware of the impact and benefices to improve Circular Economy in the City. During the CityLoops project, several campaigns will take place to improve the circularity of CDW in the city of Seville. In that campaigns, knowledge and awareness about this issue will be shown. Workshops and communication actions will be carrying out with the local stakeholder group established of Seville, to boost circularity in the city.

Metadata group	#	Metadata category	Description / comments
			(Selected together with indicator #4, #5, #11)
	7	Methodology	1. Identify stakeholder activity 2. Describe process and when stakeholders are involved 3. Identify dialogue methods used 4. Number of people involved
	8	Unit	Qualitative data, Number of people
Data	9	Baseline data / definition	During February 2020, a workshop was held aimed at involving local stakeholders previously identified in the demonstration actions as well as in the work package related to the evaluation of the circularity of the city's materials. Likewise, prior to this workshop, several preparatory actions took place: - Personalized emailing explaining project and purpose of the workshop. No. of people reached: 11. - Individual phone calls and snowball sampling: No. of people reached: 11. - First round of preparation meeting for workshops: No. of people reached: 11. - Workshop: No. of people reached: 14.
	10	Data sources / relevant databases	Meetings minutes Participant lists List of other networking meetings and interviews (date and participants)
	11	Overall accuracy	Exact or estimated number of stakeholders involved
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities 17. Partnerships for the Goals
Other	16	Comments	

3.4. Communication measures on circular transformations and waste prevention | Demonstration action

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	Local stakeholder actions
	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	Participation in CE related activities local stakeholders (local business, civil society associations, etc) more aware of the impact and benefices to improve Circular Economy in the City. During the CityLoops project, several campaigns will take place to improve the circularity of CDW in the city of Seville. In that campaigns, knowledge and awareness about this issue will be shown. In DA2 communication campaigns will be performed allowing citizens to contribute to the new collection system to be implemented and to build up this capacity to learn more sustainable daily practices with the aim of avoid food waste. In parallel, other workshops and communication actions will be carry out with the local stakeholder group established of Seville, to boost circularity in the city (Reference: Seville Stakeholder Engagement Plan). (Selected together with indicator #4, #5, #6)
	7	Methodology	1. Number of communication measures towards general public on CE transformation 2. Number of people reached

Metadata group	#	Metadata category	Description / comments
	8	Unit	Number of communication measures, Number of people
Data	9	Baseline data / definition	Baseline 0 (only activities during the project are measured)
	10	Data sources / relevant databases	Reports of communications actions List of communications (date and participants).
	11	Overall accuracy	Exact or estimated number of communications actions done. Exact or estimated number of people reached.
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities
Other	16	Comments	

3.5. CityLoops indicators used in procurement tenders and contracts | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	18
	2	Indicator name	CityLoops indicators used in procurement tenders and contracts
Link to Circular City Definition	3	Vision element	Local stakeholder actions
	4	Category	• Regulation and incentives

Metadata group	#	Metadata category	Description / comments
Indicator definition and description	5	Definition / description of indicator	For each procurement action, describe to which degree CityLoops indicators have been used as part of circularity requirements in procurements. For this, see Table on “Circularity requirements beyond standard/existing levels” in D6.1 data collection template for Circular Procurements (Appendix C)
	6	Rationale	The implementation of circular procurement practices it’s a vehicle to making the city more circular. Part of the demonstration actions to be carried out in the city of Seville, require the purchase of equipment, materials, etc. In the cases that are mandatory, clauses will be established that result in a greater circularity of the elements / solution to be purchased. Circular procurement practices will be applied in DA2 in the tenders related with containers acquisition, materials for communication campaigns, etc.
	7	Methodology	Number of indicators used in procurement tenders and contracts with similarity/link to the CityLoops indicators
	8	Unit	Number of indicators
Data	9	Baseline data / definition	Baseline 0 (only activities during the project are measured).
	10	Data sources / relevant databases	Internal report of EMASESA for demo action 1.
	11	Overall accuracy	Description of the specifications established in procurement tenders.
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	12 – Sustainable Consumption and Production.
Other	16	Comments	

3.6. Number of tenders submitted by companies offering the use of recycled CDW | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	18.1
	2	Indicator name	Number of tenders submitted by companies offering the use of recycled CDW
Link to Circular City Definition	3	Vision element	Circular business models and behaviour patterns
	4	Category	• Waste generation / management
Indicator definition and description	5	Definition / description of indicator	Number of offers that participate in the tenders implementing CDW circular management
	6	Rationale	Project activities aim to increase recycling and upcycling of materials instead of landfilling. It is considered appropriate to evaluate the impact of these activities in terms of city.
	7	Methodology	Monitoring the number of offers in the tendering process of Emasesa and checking if they offer CDW circular management. Data from Emasesa.
	8	Unit	number of offers
Data	9	Baseline data / definition	For 2021: - 12
	10	Data sources / relevant databases	Emasesa Internal Management Report.
	11	Overall accuracy	High
Context	12	Sector coverage	CDW

Metadata group	#	Metadata category	Description / comments
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities.
Other	16	Comments	Only Emasesa data will be measured with this indicator.

3.7. Number of visits to the clean points | Demonstration Action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	32.1
	2	Indicator name	Number of visits to the clean points
Link to Circular City Definition	3	Vision element	Circular business models and behaviour patterns
	4	Category	• Waste generation / management
Indicator definition and description	5	Definition / description of indicator	Number of CDW small producers and citizens managing their CDW through the clean points in a circular approach
	6	Rationale	Project activities aim to increase recycling and upcycling of materials instead of landfilling. It is considered appropriate to evaluate the impact of these activities in terms of city.
	7	Methodology	Quantifying the number of visits to the clean points and comparing with historical data.
	8	Unit	number of visits

Metadata group	#	Metadata category	Description / comments
Data	9	Baseline data / definition	For 2021: - 0
	10	Data sources / relevant databases	Lipasam & Idener Internal Management Report.
	11	Overall accuracy	
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	Demonstration Action
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities.
Other	16	Comments	Only Lipasam & Idener data will be measured with this indicator.

3.8. Number of external agents who express interest in guideline assessment | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	32.2
	2	Indicator name	Number of external agents who express interest in guideline assessment

Metadata group	#	Metadata category	Description / comments
Link to Circular City Definition	3	Vision element	Circular business models and behaviour patterns
	4	Category	• Waste generation / management
Indicator definition and description	5	Definition / description of indicator	A measure of the potential interest from Stakeholders into circular CDW management.
	6	Rationale	Project activities aim to increase recycling and upcycling of materials instead of landfilling. It is considered appropriate to evaluate the impact of these activities in terms of city.
	7	Methodology	Monitoring the initial interest and the evolution of the stakeholders' commitment with the CDW circular management by means of their involvement in the guideline development. Bi-annual workshops will be used to monitor this engagement.
	8	Unit	Number of involved stakeholders
Data	9	Baseline data / definition	For 2021: - 0
	10	Data sources / relevant databases	CLN Internal Management Report.
	11	Overall accuracy	
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities.
Other	16	Comments	CLN will be used to engage stakeholders.

3.9. Number of visits to the applications | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	32.3
	2	Indicator name	Number of visits to the applications
Link to Circular City Definition	3	Vision element	Circular business models and behaviour patterns
	4	Category	• Waste generation / management
Indicator definition and description	5	Definition / description of indicator	Monitoring the initial interest and the evolution of citizens and stakeholders' commitment with the waste circular management.
	6	Rationale	Project activities aim to increase recycling and upcycling of materials instead of landfilling. It is considered appropriate to evaluate the impact of these activities in terms of city.
	7	Methodology	Quantifying the number of visits to IT software tools and comparing with historical data.
	8	Unit	number of visits
Data	9	Baseline data / definition	For 2021: - 0
	10	Data sources / relevant databases	Idener Internal Management Report.
	11	Overall accuracy	
Context	12	Sector coverage	CDW

Metadata group	#	Metadata category	Description / comments
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities.
Other	16	Comments	Only Lipasam & Idener data will be measured with this indicator.

3.10. Share of local secondary materials in domestic material consumption | Demonstration action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	42
	2	Indicator name	Share of local secondary materials in domestic material consumption
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	• Waste generation / management
Indicator definition and description	5	Definition / description of indicator	Mass local secondary materials in domestic material consumption.
	6	Rationale	Project activities aim to reduce the use of virgin materials. It is considered appropriate to evaluate the impact of these activities in terms of demonstration action.
	7	Methodology	Amount used in the demonstration actions. Data from Constructors and Emasesa.

Metadata group	#	Metadata category	Description / comments
	8	Unit	kg
Data	9	Baseline data / definition	0 kg
	10	Data sources / relevant databases	FERMOVERT Internal Management Report. Constructors Internal Management Report. Emasesa Internal Management Report.
	11	Overall accuracy	%; weighted/estimated.
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	Demonstration action
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities.
Other	16	Comments	Only CDW from Emasesa demo actions will be measured with this indicator.

3.11. Quantity of material subjected to recycling | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	52
	2	Indicator name	Quantity of material subjected to recycling
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	• Re-use and recycling

Metadata group	#	Metadata category	Description / comments
Indicator definition and description	5	Definition / description of indicator	Estimate material subjected to recycling at demo, sector and city level. 'Recycling' means processing of materials to achieve the original high-quality or reduce to low quality. Definition from Potting; José and Aldert Hanemaaijer (eds.) (PBL), Roel Delahaye and Rutger Hoekstra (CBS), Jurgen Ganzevles and Johannes Lijzen (RIVM) (2018). Circular economy: what we want to know and can measure. Framework and baseline assessment for monitoring the progress of the circular economy in the Netherlands. PBL Netherlands Environmental Assessment Agency publication number 3217. The Hague, 2018.
	6	Rationale	Part of the actions planned by the city of Seville consists in testing the use of recycled CDW in water infrastructures building works. As part of this pilot, it is essential to know the quantity of recycled CDW used in water infrastructures building works, to optimize the process itself. It is considered interesting measure how demo action could impact in these indicators. These actions are expected to contribute to advance in the fulfilment of the European, national, and regional objectives, in the matter of selective collection, recycling and not disposal in landfill, marked by Directive 851/2018 and 850/2018.
	7	Methodology	Sum up mass of each waste material category subjected to recycling. Data may come from contractors, statistical offices, waste management companies or the Sector Circularity Assessment Method.
	8	Unit	Tonnes/year
Data	9	Baseline data / definition	CDW 252,207 tons/year (EMASESA) + 18,340 tons/year (LIPASAM) = 270,547 tons/year. Recycled CDW 25,221 tons/year (EMASESA) + 18,340 (LIPASAM) tons/year = 43,561 tons/year. Total amount of waste 333,693 tons/year (No CDW) + 270,547 tons/year (CDW) = 604,240 tons/year. Percentages: CDW vs Total waste 44.77% CDW Recycled 16.10%

Metadata group	#	Metadata category	Description / comments
	10	Data sources / relevant databases	Annual Declaration of Municipal Waste Collection (LIPASAM). EMASESA internal report of waste management for construction works.
	11	Overall accuracy	tonnes/year, % amount
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities
Other	16	Comments	

3.12. Number of projects that implement CDW valorisation | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	52.1
	2	Indicator name	Number of projects that implement CDW valorisation
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	• Waste generation / management

Metadata group	#	Metadata category	Description / comments
Indicator definition and description	5	Definition / description of indicator	Number of projects implementing CDW circular management
	6	Rationale	Project activities aim to increase recycling and upcycling of materials instead of landfilling. It is considered appropriate to evaluate the impact of these activities in terms of city.
	7	Methodology	Evaluate if there are other projects that implement CDW valorisation beyond the demonstration actions
	8	Unit	number of projects
Data	9	Baseline data / definition	For 2021: - 0
	10	Data sources / relevant databases	Emasesa Internal Management Report.
	11	Overall accuracy	
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities.
Other	16	Comments	Only Emasesa data will be measured with this indicator.

3.13. Number of companies implementing CDW valorisation measures | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	52.2
	2	Indicator name	Number of companies implementing CDW valorisation measures
Link to Circular City Definition	3	Vision element	Improving human wellbeing and reducing environmental impacts
	4	Category	• Waste generation / management
Indicator definition and description	5	Definition / description of indicator	Number of companies implementing CDW circular management
	6	Rationale	Project activities aim to increase recycling and upcycling of materials instead of landfilling. It is considered appropriate to evaluate the impact of these activities in terms of city.
	7	Methodology	Evaluate if there are other private or public company that implement CDW valorisation beyond the demonstration actions
	8	Unit	Number of companies and/or projects
Data	9	Baseline data / definition	For 2021: - 0
	10	Data sources / relevant databases	CLN Internal Management Report. Local Workshops
	11	Overall accuracy	

Metadata group	#	Metadata category	Description / comments
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities.
Other	16	Comments	Only CDW data will be measured with this indicator.

3.14. Number of projects that implement reused soil | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	52.3
	2	Indicator name	Number of projects that implement reused soil
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	• Waste generation / management
Indicator definition and description	5	Definition / description of indicator	Number of projects implementing soil circular management
	6	Rationale	Project activities aim to increase recycling and upcycling of materials instead of landfilling. It is considered appropriate to evaluate the impact of these activities in terms of city.

Metadata group	#	Metadata category	Description / comments
	7	Methodology	Evaluate if there are other projects that implement soil circular management beyond the demonstration actions
	8	Unit	Number of projects/kg soil reused
Data	9	Baseline data / definition	For 2021: - 0
	10	Data sources / relevant databases	Emasesa & Constructors Internal Management Report.
	11	Overall accuracy	
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities.
Other	16	Comments	Only Emasesa & constructors data will be measured with this indicator.

3.15. Amount of CDW collected at the clean points | Demonstration Action

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	52.4

Metadata group	#	Metadata category	Description / comments
	2	Indicator name	Amount of CDW collected at the clean points
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	• Waste generation / management
Indicator definition and description	5	Definition / description of indicator	Kilograms of CDW from small producers and citizens managed by the clean points in a circular approach
	6	Rationale	Project activities aim to increase recycling and upcycling of materials instead of landfilling. It is considered appropriate to evaluate the impact of these activities in terms of city.
	7	Methodology	Quantifying the CDW managed kilograms by clean point annually.
	8	Unit	kg CDW
Data	9	Baseline data / definition	For 2021: - 0
	10	Data sources / relevant databases	Lipasam Internal Management Report.
	11	Overall accuracy	
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	Demonstration Action
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities.

Metadata group	#	Metadata category	Description / comments
Other	16	Comments	Only Lipasam data will be measured with this indicator.

3.16. Amount of recycled CDW from large producers | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	52.5
	2	Indicator name	Amount of recycled CDW from large producers
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	• Waste generation / management
Indicator definition and description	5	Definition / description of indicator	Kilograms of CDW from large producers managed under a circular approach
	6	Rationale	Project activities aim to increase recycling and upcycling of materials instead of landfilling. It is considered appropriate to evaluate the impact of these activities in terms of city.
	7	Methodology	Quantifying the CDW managed kilograms
	8	Unit	kg CDW
Data	9	Baseline data / definition	For 2021: - 0
	10	Data sources / relevant databases	CLN Internal Management Report. Local Workshops Fermovert

Metadata group	#	Metadata category	Description / comments
	11	Overall accuracy	
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities.
Other	16	Comments	Only CDW data will be measured with this indicator.

3.17. Landfilling rate | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	61
	2	Indicator name	Landfilling rate
Link to Circular City Definition	3	Vision element	Closing material loops and reducing harmful resource use
	4	Category	• Waste generation / management
Indicator definition and description	5	Definition / description of indicator	Mass percentage of waste which is landfilled.
	6	Rationale	Project activities aim to increase recycling and upcycling of materials instead of landfilling. It is considered appropriate to evaluate the impact of these activities in terms of city.
	7	Methodology	Mass of materials landfilled divided by total amount of waste. Data from waste management companies.

Metadata group	#	Metadata category	Description / comments
	8	Unit	%
Data	9	Baseline data / definition	For 2020: a) Total of waste not collected separately: 258.118 tons) b) Light-packaging waste collected separately: 8.800 tons. c) Material recovered + losses for fermentation: 84.721 tons. Formula: ((a+b) – c)/(a+b). Landfilling rate: 68.26%.
	10	Data sources / relevant databases	Plan de Residuos no peligrosos de la Provincia de Sevilla (Non-hazardous Waste Plan of the Province of Seville). Annual Declaration of Municipal Waste Collection (LIPASAM). ABORGASE Internal Management Report. FERMOVERT Internal Management Report.
	11	Overall accuracy	%; weighted/estimated.
Context	12	Sector coverage	BW
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities.
Other	16	Comments	Only municipal waste will be measured with this indicator.

3.18. Assessment of illegal dumping sites | City

Metadata group	#	Metadata category	Description / comments
Identifier	1	Indicator number	61.1
	2	Indicator name	Assessment of illegal dumping sites
Link to Circular City Definition	3	Vision element	Improving human wellbeing and reducing environmental impacts
	4	Category	• Waste generation / management
Indicator definition and description	5	Definition / description of indicator	Evolution assessment of the illegal dumping locations on the public areas in the city.
	6	Rationale	Project activities aim to increase recycling and upcycling of materials instead of landfilling. It is considered appropriate to evaluate the impact of these activities in terms of city.
	7	Methodology	Evolution assessment of the illegal dumping locations on the public areas in the city, measuring the CDW amount collected from them annually.
	8	Unit	kg CDW
Data	9	Baseline data / definition	For 2021: - 0
	10	Data sources / relevant databases	Lipasam Internal Management Report.
	11	Overall accuracy	

Metadata group	#	Metadata category	Description / comments
Context	12	Sector coverage	CDW
	13	Reference area / spatial implementation scale	City of Seville
	14	Reference period	Project period 1.10.2019 – 30.9.2023
	15	SDG reference	11. Sustainable Cities and Communities.
Other	16	Comments	Only Lipasam data will be measured with this indicator.

4. References

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- Seville 2030 Strategic Plan. *Plan Estratégico Sevilla 2030* https://www.sevilla.org/planestrategico2030/documentos/sevilla-2030/plan-estrategico-sevilla-2030/objetivos-y-estrategias-sevilla2030.pdf
- Comprehensive Waste Plan for Andalusia. Towards a Circular Economy in the 2030 Horizon. *Plan Integral de Residuos de Andalucía. Hacia una Economía Circular en el Horizonte 2030 (PIREC 2030).* http://www.juntadeandalucia.es/medioambiente/portal_web/web/temas_ambientales/residuos/planificacion_materia_residuos/PIRec_2030.pdf
- *Non-hazardous Waste Plan of the Province of Seville 2020 – 2035.* Plan de Residuos no peligrosos de la Provincia de Sevilla 2020 – 2035. https://www.dipusevilla.es/export/sites/diputacion-sevilla-corporativo/planderesiduos/.galleries/plan-definitivo/Plan-Provincial-Residuos_COMPLETO-docum.-final-standard.pdf
- CityLoops D6.1 – Circular city indicator set. Developed by Nordland Research Institute (NRI).
- CityLoops – Seville Optimised Implementation Plan for Construction and Demolition waste.
- Plan of Action for Climate and Sustainable Energy of Seville. *Plan de Acción por el Clima y la Energía Sostenibles (PACES)*.

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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