




CDW circular toolkit for local and regional governments

Replication Packages

Capital Region of Denmark | ICLEI Europe



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Abstract	The Replication Packages are meant to make the experiences from CityLoops demonstration actions and instruments available for other cities in Europe to use and replicate.
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A few words on CityLoops

Cities throughout Europe are increasingly recognising that the transition from a linear to a circular economy is crucial in the fight against climate change and biodiversity loss. In practice, this means that cities need to move away from the take-make-waste approach towards an economy based around closed material loops, where resource consumption is decoupled from growth. Aiming to address these challenges, CityLoops brought together seven European cities – Apeldoorn (The Netherlands), Bodø (Norway), Mikkeli (Finland), Porto (Portugal), Seville (Spain), and Høje-Taastrup and Roskilde (Denmark) – to pilot a series of demonstration actions to “close the loop” in Construction and Demolition Waste (CDW) and biowaste, identified in the European Circular Economy Action Plan as two of the most important waste streams in Europe.

Over the past four years, these seven cities implemented a total of ten demonstration actions, testing over 30 new instruments and processes. These range from instruments for predicting future excavated construction and demolition waste and soil production, to awareness-raising campaigns, and from circularity decision making support tools, to simulation of impacts 3D visualisation tools and procurement guidelines for bio-waste products. The wide variety of these solutions reflect the different needs and contexts of the cities participating in the project. While Bodø was demolishing its old military airport to build a new part of the city in the cleared area, Porto was focusing on making its social economy and tourism sector more circular. And while Apeldoorn was experimenting with soil improver bokashi, Seville was implementing waste collection awareness campaigns for school children. As such, CityLoops has highlighted the great potential of circular approaches, showing that they can be applied effectively in many different industries and with many different objectives.

Apeldoorn, Bodø, Mikkeli, Porto, Seville, Høje-Taastrup and Roskilde have the ultimate aim to become circular cities, where no resource goes to waste. After four years of work in CityLoops, they are not there yet, but the demonstration actions implemented during the project have brought them closer to that goal. They contributed to the further integration of circular principals within municipal policy strategies, an increased use of circular public procurement to increase market demand for circular products and services, and a better understanding of the resources that flow through their city.

Several publications produced within CityLoops provide local and regional governments in Europe with guidance, recommendations, and practical examples on the circular transition for CDW, bio-waste and procurement. The [handbooks series](#) aims to provide cities with a comprehensive overview of how the lessons learnt and main insights from the project can be most effectively applied in their own contexts. The CDW handbook is an evidenced-based and practical guidance on how to implement a circular construction strategy for cities and regions approaching the topic, supported with various concrete tools, methods, and case studies for inspiration. To provide more granular support on the CDW instruments and experiences carried out over the four years of the project, Replication Packages have been created with detailed information to allow replication of specific actions within circular construction.

The Replication Packages

Within CityLoops, several instruments addressing circular construction and demolition projects have been developed and used by the project cities in their demonstration actions. As part of the legacy of the project, the Replication Packages are meant to make these experiences from demonstration actions and instruments in CityLoops available for other cities in Europe to use and replicate. They address specific actions within circular construction, for instance guiding cities in choosing a method for registering data and creating a material passport, helping them in the creation of a flow for recycling concrete, or giving them instruments for evaluating the possibilities of reusing soil on-site.

To provide this information in a structured and easily consultable way, the instruments for circular construction and demolition developed and used in CityLoops have been grouped in the following Replication Packages:

1. Planning and decision making
2. Stakeholder Engagement
3. Circular demolition
4. Data and material passports
5. Material banks and marketplaces
6. Recycling concrete
7. Circular soil handling
8. Circular procurement
9. Business cases

Each of these Replication Package consists of:

1. An *introduction*, outlining the context and the challenges that can be addressed through that specific Replication Package.
2. *Recommendations from lessons learnt*, which list concisely the important information that the partners have learned while using certain instruments and that needs to be taken into consideration when replicating.
3. *CityLoops instruments*, where all the instruments related to that Replication Packages are briefly introduced and linked.
4. *CityLoops demonstration experiences*, containing a short summary of the experience of each city in using one or more of those instruments and the link to extended reports describing these experiences.

All the Replication Packages produced within CityLoops are contained in this document and they have been published on the [CityLoops website](#) to promote their dissemination.

Planning and decision-making

Public authorities can engage in construction and demolition activities through multiple roles that require different kinds of expertise. Additionally, public strategies targeting the built environment often pursue many competing objectives. Adopting new practices within local public authorities and promoting inter-departmental collaboration is critical to the operationalisation of the circular economy at the local level.

Demonstration cities in CityLoops had initially identified poorly structured internal logistics and communication practices, or lack of political mandate as critical barriers to increased circularity in municipal activities for the built environment. This Replication Package provides an overview on how organisational changes within a local authority could address such challenges and support circular projects.

Recommendations from lessons learnt

Public authorities face different challenges in the pursuit of circularity for the built environment which can be addressed by acting on four interconnected fronts:

- **Interdisciplinary collaboration:** it is crucial for the success of a project, to ensure from the early stages, that sustainability aspects are taken into account, that stakeholders are involved in a structured manner and that responsibilities and financial resources are allocated clearly. Pursuing interdisciplinary collaboration is also directly linked to goal alignment within local authorities, as it implicates early-stage communication, and it avoids frustration deriving from conflicting agendas across departments.
- **Knowledge and skills:** parallel to interdisciplinary collaboration, securing joint learning as a basis for dialogue and allowing room for experimentation and time for reflection and evaluation are practices, that not only support the success of current and future projects but also increase circular thinking within an organisation.
- **Economic measures:** implementing circular projects is strictly dependent upon adequately allocating financial resources, whereby it is also needed to take into consideration the value of sustainability – including a quantification of environmental social benefits.
- **Policy and management:** Political mandate has been clearly identified as an essential precondition for the successful implementation of circular strategies in the built environment, as it secures support in the execution of political visions and facilitates goal alignment between overlapping or competing strategies

CityLoops instruments

- **Decision-making and planning guidelines:** Within the CityLoops project, Roskilde University has developed a guidance on planning and decision-making that supports the systematic internal incorporation of circularity. It is based on a framework to map key decisions across the phases of demolition and construction, and it consists of 1) a visual mapping framework - designed to identify when key decisions in urban transformation projects are to be taken, which stakeholders are involved, and what knowledge inputs are needed during different stages of the planning process and 2) an operationalisation of the planning and decision-making framework, focused on how to engage organisational change on the strategic, operational and competencies levels. It facilitates the establishment of an ongoing network/ group to embed organisational transformation and thus securing a sustained commitment, avoiding a fallback to business as usual.

This instrument is [available here](#).

CityLoops demonstration experiences

- **Bodø:** The CityLoops team in Bodø has had a substantial role in the preparation of new city district development policies for mass handling and circular treatment of materials, part of an overall environmental program created and manifested for the development of the new city district. In soil management, Bodø has noted the importance of using all available knowledge and digital tools to contribute to decisions in the planning of mass handling, and to establishing guidelines and best practices for handling clean and contaminated masses.
Read about Bodø's [experience here](#).
- **Mikkeli:** Mikkeli used the planning and decision-making methodology internally in the CityLoops project team. The city administration was not involved, as the language barrier could have a negative effect on the internalisation of the goals. Instead, a set of workshops and strategy formulation activities was tailored to the specific needs of Mikkeli and managed by the Miksei Ltd. Team, with support from Roskilde University. CityLoops has strengthened knowhow and human resource base in CE issues within Miksei Ltd, while contributing to the preparation of the City Strategy 2022-2023 and the Municipal Climate Program. Mikkeli now recognizes how:
 - It is crucial to ensure a strategic view of Circular Economy and incorporate this into the city strategy.
 - The different administrative units must have a common goal in facilitating circular thinking which traverses the different departments, bureaus and activities.

- Working with technical staff and political decision makers requires employing different technologies and interaction tools - more innovative for the former and traditional for the latter.

Read about Mikkeli's [experience here](#).

- **Høje-Taastrup:** Høje-Taastrup participated in developing the planning and decision-making methodology. In the co-development process, the framework was used to map key actions in the different phases of the demonstration projects in both cities. This exercise facilitated a reflection process on aggregated learning from the projects, helping formalise circular procedures for future projects. The mapping can in the future be used prior to projects instead of retrospectively. The workshop concept to promote organisational change helped Høje-Taastrup in facilitating a joint space for reflection, to discuss strategic and operational actions to promote circular construction, demolition and urban development. The results directly support the development of a new political sustainability strategy in an interdisciplinary sustainability group.

Read about Høje-Taastrup's [experience here](#).

Stakeholder engagement

Achieving a circular economy is a multifaceted and complex challenge which requires actions from different societal constituencies. For this reason, local governments – as well as companies or citizens – cannot create it on their own; all of us have a role to play in any circular project. Pursuing stakeholder engagement is crucial to successfully design a project or intervention as it allows to develop a process which inspires individuals, groups, businesses, institutions, and others to improve how they interact. Stakeholder engagement can be defined as finding people with whom to cooperate most effectively to accomplish goals. The effect of stakeholder engagement is not limited to one project or process, as making people feel involved can generate a positive trickle-down effect leading to a higher impact in all actions.

The term 'stakeholders' refers to individuals or groups who have an interest or concern in an organisation, project, or decision-making process. These stakeholders can be internal or external, depending on whether they are directly associated with the internal structure. Moreover, it is important to clarify that while citizens can be stakeholders in certain contexts, not all stakeholders are necessarily citizens, thus citizens engagement actions can be more targeted.

The term actor refers to individuals or entities that participate actively in a situation, process, or event. Actors can include stakeholders, but they can also encompass other participants who may not have a significant interest in the outcome. To best assess how to involve stakeholders, cities need to be aware of these distinctions as well as the different levels of involvement and interaction, ranging from lower and passive engagement to higher levels of active engagement and commitment.

CityLoops cities designed stakeholder engagement plans in the early stages of the project, detailing how to involve all relevant stakeholder groups from planning to evaluation within the demonstration actions. Benefits of stakeholder involvement range from future planning facilitation and risk minimisation to understanding and addressing criticism, as well as reducing constraints on business and increasing license to operate.

Recommendations from lessons learnt

Stakeholder involvement activities are deemed relatively easy to implement and replicate. Planning these activities requires methodologies, both for identifying stakeholders and understanding their relationships, and for effectively integrating them in a development process. CityLoops demonstration cities have concluded the following from the development of stakeholder engagement activities:

- Stakeholder engagement activities are easily replicable, and manhours are often the biggest resource needed to execute them. It is recommended to start by joining forces

with other departments, projects, and initiatives with the same ambitions for stakeholder and citizen involvement in city development.

- Stakeholders should be involved throughout the project as this increases their ownership and sense of responsibility in the process. It also facilitates sharing of insights within the stakeholders' organisations.
- Know who your target is. Before choosing which participation instrument or method to employ, it is important to assess the characteristics of the citizens and stakeholders to be engaged as this will guide the choice, for example when deciding between digital or analogue tools.
- It is important to keep an open mind for opportunities to include actors with different levels of expertise. This could mean organisations working with knowledge and instruments relevant to a project, as well as stakeholders who have an interest in the outcome of the project but are not participating in the construction processes or do not have any related expertise.
- Citizen involvement is great for creating political attention and boosting a project's political and local support. Also, citizens – as potential users of the spaces that are sites to the project – can provide valuable input to address concerns on functionality, and bring to the table different competences, knowledge, and perspectives.
- Engaging stakeholders and other actors in construction projects in an early dialogue and in recurring meetings throughout the projects creates trust and helps foresee and solve problems, as well as overcome barriers as they arise.
- Different competences and knowledge brought by the different actors and stakeholders are key in handling responsibility and risk within the project. For this reason, it is highly important to retain the knowledge created as the project continues and base subsequent decisions on it.

CityLoops instruments

CityLoops has used a participatory planning approach which emphasizes the involvement of all relevant stakeholder groups throughout the entire project. This approach has resulted in the creation of blueprints and a report on involving stakeholders and citizens in the planning phases of a demonstration action:

- **CityLab stakeholder platform:** Bodø is using a physical and virtual platform for stakeholder engagement on city development. It integrates the 3D visualisation to stimulate imagination and opinions on the city's future and offers an information portal to solicit inputs from citizens, civil society organisations and local businesses to involve them in planning and decision making. The CityLab is supported by a communications and social media strategy for recruiting stakeholders (such as professionals, local businesses, or civil society organisations) and citizens. This instrument will soon be available on this page; here you can find more information about it: [Factsheet](#)

- **Co-design process for public space:** Apeldoorn has used this instrument to develop a process journey, which is an overview of the involved actors per process phase with the roles and tasks of each actor in each deliverable. Thus, the process journey can be used as a manual to accomplish circularity in a project. A description of the co-design process and Apeldoorn's process journey is available [here](#).
- **City simulation platform:** Seville has created a centralised virtual hub for software tools and datasets to support its sustainability goals. It includes:
 - CDW Flow optimisation instrument that supports managers on deciding new locations for future clean points, while giving citizens access to a map with the location of the optimal clean points. The CDW flow optimisation for citizens is [available here](#), while a report on the development of this instrument is [available here](#).
 - Wellbeing monitoring tool that determines the relationship between wellbeing and the demonstration actions. The tool is focused on circularity, giving managers access to a simulation framework that quantifies the influences of circular actions on well-being, while providing citizens with data about the well-being circularity indicator, demonstration actions, and impact estimations on the city's well-being. The well-being simulation for citizens is [available here](#), while a report on the development of this instrument is [available here](#).

Combining these tools in a platform supports cross-sectoral dialogue and facilitates data exchange between municipal departments, research institutions, and relevant business partners. The platform can be used during stakeholder engagement events to promote an informed, flexible, and balanced transition to circularity.

Try out Seville's simulation platform by clicking [here](#).

CityLoops demonstration experiences

- **Apeldoorn:** Apeldoorn developed a process journey together with Koos Design. The co-design process was used to map collaboration across actors in multiple phases of a road renovation project. Actors with a profound knowledge of road quality and road materials were involved, increasing knowledge, and raising awareness within the municipality. A participation ladder was used to design communication plans, while experienced communication experts designed and deployed participation trajectories by advising project leaders and policy officers. Initially, Apeldoorn considered using a digital instrument to collect feedback on the current state of the road and new designs by residents but results of a survey showed that many residents are digitally illiterate and prefer analogue communication methods. The Municipality then organized a Sustainable Activity Day. Read about Apeldoorn's [experience here](#).
- **Bodø:** Bodø organized two Reuse Lab events, which allowed the citizens to provide input on what the new part of the city could look like and what to prioritize in the city development. They also initiated a forum, focusing on sustainable city development, for all involved actors in the construction of the new airport. Lastly, Bodø circulated to

its inhabitants a survey investigating how the new part of the city should look like and function. Results were interpreted, visualised using the 3D instrument, and presented at the New City Festival in 2020. The city's younger generation was challenged to create their new city concept in Minecraft and the best solutions were presented to politicians and decision makers in the municipality. Read about Bodø's [experience here](#).

- **Mikkeli:** Mikkeli organized 30 stakeholder meetings to highlight the importance of upcycling of construction and demolition materials, as well as 5 workshops for decision makers, procurement personnel and other professionals of the construction and demolition sector in Mikkeli. In these workshops the participants developed ideas and solutions for better upcycling of building parts and materials. Read about Mikkeli's [experience here](#).
- **Seville:** Seville organized nine workshops and seminars/webinars during which participants developed ideas and solutions for better circular CDW management. Seville also developed a city simulation platform with a wellbeing monitoring tool and a CDW flow optimisation tool that can be used by citizens to find and access data on the "clean points" for different types of CDW waste, as well as managers who will provide the data and access decision-support functions. When launching this instrument, Seville conducted a communication campaign targeting citizens and SMEs. Read about Seville's [experience here](#).

Circular demolition

This Replication Package describes the performance of the two CityLoops guides, *Pre-Demolition Audit Guide* and *Guide for Selective Demolition*, in total and partial demolition. The purpose of the pre-demolition audit is to prepare for selective demolition by providing a detailed assessment of building material fractions with respect to their amount, quality, purity, and suitability for circularity (reuse, recycling, recovering). The purpose of selective demolition is to sort the demolition materials in clean fractions for optimisation of circularity of the materials, according to the highest level of the waste hierarchy.

The pre-demolition audit guide explains how a pre-demolition inventory and material audit can be conducted to identify building components and materials with reuse or recycling potential. The guide can be used, when planning demolition projects, with sufficient time and coordination among actors, to make a pre-demolition screening (and subsequent selective demolition) required in the procurement of a demolition contractor. The screening procedure aims to recognize reusable and recyclable materials and building elements and to give recommendations for how to handle them. Identification of materials (as containing harmful substances, or as having residual value and potential for other uses) is the key first step to preventing their treatment as waste.

The selective demolition guide explains how a selective demolition can be conducted to select and preserve value of building components and materials with reuse or recycling potential, following a series of chronological steps to dismount components or materials without damaging them. The guide can be used, when planning demolition projects, with sufficient time and coordination among actors, to ensure that selective demolition is required in the procurement of a demolition contractor. The selective demolition procedure guide gives recommendations to manage material removal and treatment. By removing harmful substances and salvaging construction materials with recoverable value, a more circular demolition can take place, thus reducing the total CDW generated on site and creating secondary construction material supply.

Recommendations from lessons learnt

The two guides have been tested and evaluated in the CityLoops demonstration actions and recommended for replication in all renovation and demolition projects.

A general recommendation is that the screening and selective demolition both need to be planned for well in advance and are incorporated when tendering. Once contracted, contractors will not voluntarily carry out the screening – so any foreseen use should be clearly intended in the demolition planning phase.

Pre-demolition audit

1. Reuse of building materials cannot be promoted without a pre-demolition audit.
2. The audit guide presents a structure of how to perform screening of hazardous waste and circular resources before demolition and renovation of buildings. Details of performance and set-up of documentation, e.g., excel sheets are not included.
3. The audit is an important activity early in the value chain for planning, design and contracting demolition and renovation works.
4. Pro-active and early audit in advance of the demolition work is important to ensure all possible opportunities for reuse/recycling of materials.
5. Depending on the amount and quality of the demolition materials, the audit should be split up in different stages to optimise the timing and opportunities in accordance with the project planning and implementation.
6. The audit should be done in cooperation with various stakeholders, so that recycling and reuse of materials can be connected to the design processes.
7. Using a drone for visual inspection and mass calculation can be a useful tool during the pre-demolition audit before the demolition work begins.
8. It is necessary to consider how to digitalise data when you choose the method for the audit, in order to use the data for material passports and marketplaces.
9. Effective implementation requires education and experience.
10. The Pre-Demolition Audit Guide presents general principles which must be combined with other tools and aspects related to national legislation, e.g., legislation on hazardous materials.

Selective demolition

1. Selective demolition is an implementation method ensuring the best opportunities for on-site sorting of hazardous materials and circular resources, and for reducing the amount of mixed CDW waste.
2. Selective demolition should be mandatory in all kinds of demolition projects.
3. Selective demolition should be applied when planning demolition projects with sufficient time and coordination among actors, so that selective demolition can be required in the procurement of a demolition contractor.
4. Optimisation of building material circularity requires early removal of hazardous materials and sorting/separation of individual material fractions aiming at the highest level of the waste hierarchy (reuse, recycling, recovering).
5. The soft stripping phase must be executed promptly after the last user of the premises has moved out and organising the reuse of items should occur before moisture and vandalism ruins them.
6. Selective demolition can be significantly more time-consuming and expensive than traditional demolition – however, the cost savings are in waste management and material recovery. Financial and management models should account for the redistribution of costs and savings accordingly.

CityLoops instruments

These are the two guidelines for pre-demolition audit and selective demolition used in the CityLoops demonstration projects:

- **The Pre-Demolition Audit Guide** helps prepare selective demolition and covers both the environmental audit focusing on identification of hazardous materials, and the circular audit focusing on elements for reuse and materials for recycling. This instrument is [available here](#).
- **The Guide for Selective Demolition** explains how a selective demolition can be conducted to select and preserve the value of building components and materials with reuse or recycling potential. This instrument is [available here](#).

CityLoops demonstration experiences

- **Roskilde - Partial demolition of factory Hall 12:** The pre-demolition audit guide has been used to full extent for planning the demolition of the Hall 12 building of the Musicon development. This was documented by a hired consultant, Golder Associates A/S. The audit started with a documentation desk study followed by a field study. Focusing on hazardous materials, a detail inventory assessment of all materials in the building was performed. On this basis a report with recommended management of each waste stream was provided for the following selective demolition of Hall 12 and for the circularity of the materials, including preparation of a material bank. Read about Roskilde's [experience here](#).
- **Høje-Taastrup - Circularity requirements in sale of town hall for demolition:** The sale and development of the city hall estate required total demolition of all existing buildings. The two guides have been introduced as framework conditions in the purchase documents for handing over the old townhall buildings to a private company. Circularity requirements comprised a pre-demolition audit consisting of mapping of hazardous materials and screening of resources suitable for circularity. Based on the identification of resources and the preparation of a resource mapping report, selective demolition will be carried out, ensuring that min. 80 percent by weight of the uncontaminated materials from the demolition of the city hall must be reused, recycled, or recovered. Read about Høje-Taastrup's [experience here](#).
- **Mikkeli - Demolition of Pankalaampi HealthCare Centre and Tuukkala Hospital.** The demolition was prepared and performed in accordance with the two CityLoops guides, and the guides were tested. Different waste fractions were sorted and at both demonstration sites, the amount of mixed CDW was minimal, as the legislation and

waste prices guided sorting. However, it was found that there is some variation in the implementation of selective demolition between different contractors and demolition sites. The waste fractions that must be sorted at source should be stated in the demolition contract and compliance should be monitored during the implementation. Selective demolition was implemented well in the demonstration projects and the sorting rate in the demonstration sites was over 99%. The soft stripping procedure must be formalized with clear roles and duties for each participant.

Read about Mikkeli's [experience here](#).

The business case of applying selective demolition had a positive outcome. The Mikkeli business case is [described here](#).

- **Apeldoorn - Demolition of brick-road:** The contract for the road project was prepared and implemented, following the principles of selective demolition. Considering that this renovation project mainly involves waste material groups such as concrete, bricks, tiles, ceramics, stones and (dredging) soil, the demolition is not as complicated as for some buildings. Selective demolition received the necessary attention in this project. Read about Apeldoorn's [experience here](#).

Data and material passports

A material passport is used to document the amount, quality, accessibility and reusability of construction and demolition waste for reuse or recycling. This Replication Package describes the CityLoops definition of a material passport, as well as different methods for gathering data of materials, products, or components in order to create a material passport.

Material passports share the same objective, namely quantifying and qualifying the materials on site. However, they differ in the level of detail and number of aspects taken into account. The top five requirements for a material passport in CityLoops are:

- A bill of materials with quantities, material composition, and location of the materials on site.
- Inspection and maintenance history of the materials.
- Technical lifetime expectancy of the materials.
- 'End of life options' of the materials.
- A uniform system for data storage for structured output.

The Replication Package describes and compares four methods used in different demonstrations to gather and store data on CDW materials for reuse or recycling. The data in all demonstrations was stored in local databanks or Excel-sheets and used to document the quality and reusability of the materials, thus functioning as material passports. Two cities also developed digital marketplaces, which can use this type of data for materials classification (for more information, visit the Replication Package ['Material banks and marketplaces'](#)).

Recommendations from lessons learnt

Four cities in CityLoops tested different methods of gathering data on materials for reuse or recycling purposes. Based on their experience, we have prepared some generic and method-specific recommendations that can help cities select and efficiently use the right methods for their construction projects:

- It is valuable to have a standard procedure in place for mapping and documenting the reusability/recyclability of materials in demolition projects.
- The [pre-demolition audit](#) should be done well in advance of the demolition and in cooperation with various stakeholders, so that the reusable or recyclable materials and elements are identified, included in the tendering of the selective demolition and connected to the design processes.
- For all data gathering methods a more advanced resource mapping system is needed, e.g., a pre-demolition audit reporting software program to be used to report and archive audit findings.

- In the demo actions local systems were adapted and used for data storage, but integration between the database storing information about the materials and a digital marketplace can be difficult. Thus, some cities have moved on to external systems that can handle this.
- It is useful to make a market-oriented material passport so that in the bidding and tender phase the external partners can include and work with the information about the secondary materials.
- It may not be possible to find or describe all the wanted information for a Material Passport. Especially the expected lifetime and the estimated value can be a challenge.
- **The 3D visualization tool (digital twin)** is useful for large urban development projects, but also suitable for 3D modelling of buildings. It can be used for gathering data on masses and materials, and to plan how new buildings can be made with on-site resources. It interprets complex data efficiently, while the visualisation can also help with making decisions based on real data. Data for the 3D visualization came from e.g., excel sheets, traffic API and Circulus. There were many different types of data, which were entered manually. This process can be optimised if it becomes possible to connect data between different systems.
- **The drone scan** can produce useful data for the pre-demolition audit and planning of the demolition work. Volumetric measurements based on 3D imaging can be a useful tool for contractors, building owners, consultants, and designers. The drone scan is useful and quick for mapping the materials in a building or construction site, but you need humans to inspect the results. The scan cannot recognize materials, but from photos you can calculate masses, number of windows, bitumen on roof, etc. If you have the proper equipment, you can do both outside and inside scanning.
- **The road scan with cameras and sensors on vans** can collect data on the amount and quality of materials available from the road. It can provide additional insights in the status of road materials, but developments are still needed to interpret the data and automate data storage. It is especially useful for asphalt roads, as it cannot assess the quality of concrete pavers yet – in this case a drone may be a better option. It was not possible to assess data on lifetime expectancy and re-use options of materials, products, and components from the road scan, but a visual inspection on-site can provide this knowledge.
- **The simple excel sheet** is an easy way to get started with screening buildings and gathering data on elements or materials for reuse and recycling. You visit the building/construction site and enter data on materials for reuse/recycling in an excel sheet with photos. Afterwards you identify which materials are relevant for reuse or recycling, and whether you need to gather more information about them or test them for hazardous substances. The more different stakeholders you involve in the tour of the area, e.g., environmental advisors, architects, contractors and engineers, the more ideas you will get on the reusability of elements and materials.

CityLoops instruments

- **Material passport definition:** Five requirements for a material passport were developed in the CityLoops report “*Construction material passports and databanks*”, which also describes different approaches to material passports. Furthermore, the report dives into how a material passport can be applied to a circular road renovation project.
The report with the definition of a material passport is [available here](#).
- **Procedure for CDW to obtain a Material Passport:** Roskilde has developed a simple five-step procedure for demolition materials to obtain a material passport and be approved for use in future construction.
This procedure can be found in Roskilde’s demonstration report extract on data and material passports, [available here](#).
- **Replication report for 3D visualization solutions (Digital Twin):** The digital twin of the city of Bodø has proven to be a useful tool for urban planners, policymakers, and researchers alike. It holds mass quality data from demonstration sites, material data from buildings on demonstration sites and pilot buildings, visualisation of transport, infrastructure and emission data and identified loose sediments and potential sea level rise at the demonstration site. This report describes the software and equipment used, the technical and physical requirements as well as the gathering and visualization of data. In order to replicate Bodø’s activities, it is not necessary to be in possession of the tools mentioned here. However, it is necessary to use tools that can geographically place data. In extension of this, the replicator should be in possession of a software that can manage data e.g., Excel.
[Here](#) you will find a short introduction to the 3D visualization
- **Blueprint for drone scan and 3D modelling tool:** The use of a 3D modelling tool to monitor demolition waste flows can be a cost-effective alternative in evaluating the amounts of material flows on-site when compared to traditional methods, e.g., tachymeter. The data capturing process with drones on the demolition sites demonstrated in the project takes on average less than an hour.
This instrument is [available here](#).
- **Guide for replication of road scans and data storage:** Road scans can provide additional insights in the status of road materials, but developments are still needed to interpret the data and automate data storage. The LiDaR system with high resolution imaging seems to be able to provide data that is closer to the traditional process of a visual inspection on site. It was not possible to assess data on lifetime expectancy and re-use options of materials, products, and components from the street scan.
A guide for replication of the road scans and data storage can be found in the report “*Collecting and storing data in a circular road renovation process*”, [available here](#).

CityLoops demonstration experiences

- **Bodø - 3D visualization in a digital twin:** Bodø mapped the masses and structures of the old airport and entered the data on quantity, quality and reusability in a digital twin. The digital twin technology delivers 3D visualization solutions for designing a new part of the city using existing structures and resources. This is a great demonstration action to replicate for other cities that are facing large urban development projects. [Here you can read](#) about experiences from using the digital tools in relation to the demolition of the military airport, mapping and visualizing masses and structures.
- **Mikkeli - Drone scan of buildings and construction site:** Mikkeli scanned buildings and demolition sites with drones using a 3D modelling tool for tracking the flows of on-site CDW. The scans provided 3D models and digital imagery from each of the monitoring sessions done on site during the demolition process.
Read about Mikkeli's [experience here](#).
More information of Mikkeli's demonstration results in using the drone scan can be [found here](#).
- **Apeldoorn - Road scan with cameras on vans:** Apeldoorn collected data on the amount and quality of materials available from Grieffiersveld road through scans with cameras and sensors mounted on vans, using two different road scanning processes: One scan was done with an IDS RIS Hi-Pave ground penetrating radar system at the back and a gamma spectrometer at the front of the van and another scan collected Light Detection and Ranging (LiDaR) data and panoramic high resolution images. Apeldoorn's GBI databank was adapted to store the data.
Read about Apeldoorn's [experience here](#).
- **Roskilde - Simple data registration in excel-sheets:** Roskilde conducted a manual resource inspection of the buildings to be partly demolished, identifying materials for reuse or recycling. A simple digital databank and material passport was then created for selected materials from the demolished buildings, consisting of an Excel sheet for each material. The databank describing the material's lifespan, what kind of testing it has to go through, and where it could end up in future uses. This is a very simple, cheap and low-key solution that is easy to replicate. However, the data would need to be uploaded digitally if the materials were to be added to a marketplace. Roskilde has afterwards moved on to using the Upcycling Forum databank and marketplace.
Read about Roskilde's [experience here](#).

Material banks and marketplaces

The starting point for circular construction is to transform buildings or reuse structures on-site, so that we do not have to handle CDW. When we do have to demolish or construct a building, a main challenge for circularity is to match supply and demand: to get the right amount of reused or recycled construction materials in the right quality and at the right time for a renovation or construction project. Physical material banks and digital marketplaces are essential to connect the materials from demolition sites (supply) with construction sites (demand).

This replication package presents the CityLoops experiences from establishing and running physical material banks for CDW and soil, as well as experiences with digital marketplaces.

Considering the tight and overlapping timelines in the construction industry, storage of secondary materials is necessary until their destination and onward use are confirmed. Local authorities may allocate space and explore local sites for the possibility of providing storage space as part of a reuse hub, but storage can also be provided by demolition or material handling companies. Many business models are currently under development e.g., land provided by local authorities, temporary land use prior to an urban project, private landlords and public-private co-operations. In CityLoops the examples are based on the municipalities allocating an area for temporary material storage in urban development areas.

Digital marketplaces are essential drivers for tracking and mapping resources. They enable matches between suppliers and procurers, by allowing the materials visibility and availability (where and when), and providing information (quantity, quality, cost). However, digital platforms do not have to be developed by local authorities themselves. Many of them are already headed by private companies and sometimes by public ministries. If possible, it is highly recommended to plug in to an existing one, as it will take time and money to develop a new website and it can be hard for one city to provide enough materials to attract users. The CityLoops cities started out by using digital databanks to provide an overview of their own accessible materials for their own projects, not for selling or exchanging resources with others – but this has already started to change.

Recommendations from lessons learnt

Physical material banks

- It is recommended to connect to a well-known digital marketplace instead of creating your own as it can be challenging for the buyers to find local platforms it will take time and money to develop a new website and to attract users.
- Incentives to buy reused materials are lacking but demands in tendering will push the market.

- Different types of material banks require different set-ups and are useful in different scenarios. With temporary/pop-up material banks you can have fewer rigid rules, but with permanent/central material banks you need very rigid rules for what materials enter, their documentation (material passport), and who has access to these materials.
- Temporary material banks for large construction projects or urban development are recommended to avoid transport and support local reuse.
- Contractors are more likely to perceive less risk if they can see the materials.
- Local material banks can create large CO2 and economic savings from reduced transport. However, sometimes longer transport is preferable for the best treatment of the resources.
- Contractors are very interested in using the temporary material banks for storing or collecting materials.
- Preparing the materials for reuse or recycling is a valuable service for a material bank – e.g., crushing concrete or measuring the quality of sand.
- EOW criteria apply when the materials leave the demolition site. Testing is a crucial part of dealing with the materials, some testing is needed to be allowed to put materials in a material bank, otherwise they are classified as waste.
- The environmental risk, as well as assessing usability should be handled before entering the material bank.
- It can be a challenge and takes some effort to digitalize the materials to make them visible to possible users and thus get a faster turn-over of the materials in storage.
- A material storage that is supported by automated sensors and a proper digital infrastructure linked to databases would be a great improvement.

Digital marketplaces

- It is recommended to connect to a well-known digital marketplace instead of creating your own as it will take time and money to develop a new website and to attract users.
- When comparing different digital marketplaces, it is recommended to consider the following points:
 - The rates of effectiveness and efficiency of the matching process strongly differ.
 - Differences can be found in input and output.
 - Handling costs of the products offered are a traditional point of concern.
 - The ease with which one can upload the specifications of materials onto the platform is being tackled in different ways.
 - Insights in the environmental costs and benefits of reusing materials are not yet provided by every platform.
- Integration between the database storing information about the materials and the marketplace is difficult. Finding ways to automate and standard data entry is important to limit labour.
- The stakeholders are often sceptical to risk, insurance policies and legal issues. The marketplace should have a standard agreement between the seller/buyer under

standard regulations that addresses the legal risk: the responsibility of failure of materials.

CityLoops instruments

- **Blueprint for replication: Databank and digital marketplace for recovered materials:** Mikkeli created their own databank and marketplace. It combines data from the 3D scanning tool (using drone imaging) and Miksei's demolition planning on construction materials (CDW) from demolition sites around the city of Mikkeli. The databank stores information on materials such as volume, location, date available, material composition and basic characteristics. This data about material stocks is then fed into the digital marketplace.
This instrument is available [here](#).
- **The digital marketplace DuSpot in Apeldoorn:** Different possibilities were investigated by the municipality, and they ended up choosing to use the existing digital material bank "DuSpot" DuSpot is already used by several municipalities in the Netherlands. DuSpot is used to facilitate the reuse of materials needed and becoming available from Apeldoorn's construction projects in public space. DuSpot is also used to show the inventories of the material depots Apeldoorn is operating.
[Read more here](#) about why and how Apeldoorn is using DuSpot.

CityLoops demonstration experiences

- **Apeldoorn - Experiences with physical material banks and digital marketplace:** In Apeldoorn, the municipality operates soil sites and sand sites for temporary storage of multiple qualities and different quantities of soil and sand. Two new material banks were established to store other materials for public constructions. Pavers and other concrete products are being stored if they are destined for reuse within one year. Due to the depots limited size concrete for crushing and recycling is not stored at this site. Apeldoorn looked into designing their own digital marketplace but ended up by choosing to use the already existing marketplace DuSpot.
Read about Apeldoorn's experience [here](#) and in the [report](#) on facilitating a local soil and sand site .
- **Bodø - Intermediate storage and sorting area for soil and masses:** Bodø needed an area for this to enable reuse in project and between projects. They found an area close to Bodø city centre that can be used for four to five years before it will be regulated for industrial use, and they applied for concession to manage and store masses without heavy contamination. The storage will be used for several construction projects.
Read about [Bodø's experience here](#).

- **Mikkeli - Digital marketplace:** In Mikkeli, the databank stores information on materials. This data about material stocks is then fed into the digital marketplace. In the marketplace, currently available materials are listed. Relevant construction value chain stakeholders were involved in determining the functional characteristics needed. Read about [Mikkeli's experience here](#).
- **Roskilde - Reusing materials locally and exchanging them with neighbouring municipalities:** Roskilde has established temporary material banks locally to reuse and recycle resources on-site in the urban development project in the Musicon area. They have now moved on to use a commercial digital marketplace, Upcycling Forum, and have meetings with neighbouring municipalities and the Roskilde Festival about exchanging materials. The platform has a public area for sale and a restricted area with materials to be exchanged. Procurement and risk management is addressed. Read about [Roskilde's experience here](#).

Recycling concrete

Crushed concrete can replace stones and sand in new concrete. In many European countries the regulation allows for crushed concrete to replace 20% of the stone fraction and 10% of the sand fraction. In 2020, Denmark approved the special standard DS/EN 206 DK NA:2020, which allows for up to 100% of the stone and sand to be replaced with crushed concrete. The CityLoops demonstration actions in Høje-Taastrup and Roskilde helped push this development in Denmark.

This Replication Package describes how to replace up to 100% of the stones/coarse aggregate and up to 50% of the sand in new concrete with recycled concrete. It contains a guide describing the process, legal framework, barriers, and opportunities when recycling concrete; interviews with key actors; as well as business cases and descriptions of the activities in two demonstration projects demolishing buildings and crushing concrete for use in new constructions.

Recommendations from lessons learnt

- If it is not possible to procure recycled concrete, the first step is to establish the value chain including the donor of concrete, the demolisher, the transformation actors and the new construction receiving the recycled concrete.
- Reflect on incoming flows as well as outgoing flows regarding concrete: for instance, where do you get the aggregates and for what should the concrete be used? Which recipes do you need?
- Recycling concrete the first time is labour intensive as it demands active management, but this will become less when it becomes a standard procedure.
- Close dialogue and coordination across the value chain: a key factor ensuring the success of both demonstration cases was the willingness of all value-chain actors to engage in close dialogue and coordination throughout the projects, looking to help each other solve the problems rather than placing costs and risk somewhere else.
- Early risk management: This was ensured by up-front dialogue concerning potential risks and how to manage them as well as efforts to clarify the type of documentation each partner required. Roskilde's demonstration action holds a particularly good example of this dialogue and risk management.
- The right expertise: The process behind the production of recycled concrete – including demolition, crushing, sieving and pile building – requires knowledge and attention. The demonstration projects included actors with prior experience of recycling concrete in these steps of the process, but if this is not possible, it is important to build such experience by following the guidelines.
- Procurement as driver: To create strong business cases and mainstream the use of recycled concrete, it is necessary to increase the amount of recycled concrete

procured. Both demonstration cases highlight the considerable opportunity public procurers have in driving this demand. In case that the National or European Standards are not covering the recycling wanted, additional risk may apply.

- Pay attention to meet the demands for End of Waste criteria.
- Support the development of a functioning recycled concrete flow, so you do not have to establish the value chain with donor concrete every time.
- Make sure you properly lay down the info about the concrete in the construction project for future reuse.
- CO₂-savings are much lower when recycling instead of reusing concrete, but the natural resource savings are important. However, you should not transport concrete waste for recycling more than 25 km – then there is no CO₂e gain.

CityLoops instruments

- **Guide: Recycling of concrete – from pilot project to a permanent change in practices:** The guide is aimed at public owners and describes the process, legal framework, pitfalls, and opportunities in Danish cases where the entire process of recycling concrete as aggregate for new concrete takes place on the same location. It includes examples of requirements for recycled concrete that can be directly incorporated into tendering material. The guide is [available here](#).
- **CO₂e calculator for 11 fractions of CDW:** The CO₂ calculator for concrete allows cities to estimate the potential CO₂-reductions in their specific project for “No circular actions”, “Local recycling” or “General recycling”. The calculator can be used when data on the amount of crushed concrete and the distances from the gravel pit, landfill, location for the recycling and the name of the concrete producer is available. The calculator targets 11 different fractions of CDW, including concrete. This instrument is [available here](#).

CityLoops demonstration experiences

- **Roskilde:** In Roskilde they have crushed and used dug-up concrete at the construction site to replace 100% of the coarse aggregate in the new concrete for the foundation of a parking house. Read about Roskilde’s [experience here](#). The business case for using recycled concrete had a positive outcome, saving approximately 50.000 Euro. The Roskilde business case is [described here](#).
- In Høje-Taastrup they used recycled concrete from the demolition of social housing blocks to substitute 100% of the coarse aggregate in the concrete for the foundation of the new City Hall. The concrete had to be driven away, stored, crushed and driven back to Høje-Taastrup. Read about Høje-Taastrup’s [experience here](#).

The business case shows that the price for using recycled concrete in Høje-Taastrup was approximately the same as for new concrete. The Høje-Taastrup business case is [described here](#).

Høje-Taastrup has conducted some interviews to explore the experiences of several actors involved in turning demolished building blocks into new concrete for the city hall in Høje-Taastrup. They share know-how on barriers, the current market for recycled concrete, the tendering process and other aspects worth considering when closing the loop for recycled concrete. Read the [summary of the interviews here](#).

Circular soil handling

Natural soils have important ecosystem functions, including filtering and storage of rainwater, moderation of temperatures, CO₂-storage, and hosting of plants and organisms. The environmental and economic impact of excavated soil is massive, as the amounts of soil excavated for construction often surpass the amounts of CDW. However, early soil management and geotechnical investigations can reduce the amount of soil that has to be excavated. Furthermore, if excavated and treated correctly, soil may be used for a wide range of purposes of considerable value. Circular soil handling can replace other raw materials and substantially reduce cost and CO₂-emissions compared to transporting truckloads of soil.

This Replication Package enables the identification of possible actions for circular soil handling at different stages of the construction process. It contains a roadmap that supports the implementation of sustainable soil management in the municipality or in a specific construction project; an instrument for predicting future excavated soil production in the municipality within the next 12 years; and a methodology for on-site soil reuse covering both guidelines for sustainable on-site soil management, as well as assessment of reuse potential of the excavated soil. The Replication Package also describes the use of the soil instruments in demonstration actions in Roskilde, Høje-Taastrup and Bodø.

Recommendations from lessons learnt

- The tendering of construction projects should include soil balance on-site: It is often possible to dig up less soil and to use the excess soil on-site for multiple purposes, benefitting biodiversity and cutting CO₂-emissions and costs for transporting excavated soil.
- To minimize environmental impact, it is important at an early stage of the project planning to consider how earthwork and construction may be adapted to avoid or reduce disturbing, excavating and relocating soil.
- If generation of excavated excess soil cannot be avoided, on-site soil reuse should be maximized. On-site soil reuse will reduce the environmental impact related to transport and ex-site dumping of soil.
- The municipality should evaluate possibilities for soil balance early in urban planning processes, and if needed designate an available nearby storage place.
- The roadmap for soil handling in municipalities (see the instrument described below) creates an overview for municipal management, decision makers and employees by identifying stakeholders and roles – making it clear to all who is doing what and making it possible to estimate the workload in meeting the chosen objectives. It makes it easier to pinpoint which departments play the important roles and helps secure knowledge transfer if people leave the project.

- The soil prognosis for urban development areas (see the instrument described below) can calculate the expected amounts of excess soil at an early stage, which makes the developer aware of the issue and makes it possible to start planning for circular soil handling, reducing the amounts being dug up and reusing as much as possible on site.
- Environmental geotechnical analysis at early stages will help the developer decide if soil can replace raw materials, e.g., using on-site soil or gravel as a road base.
- The soil prognosis (see the instrument described below) makes it possible to measure impact of circular soil handling in an urban development area: The actual amounts of soil being excavated and transported can easily be compared to the number in the prognosis, which calculates the expected amounts based on business as usual. A simple calculation will reveal how much soil the developer is able to keep on site. The CO2 calculator (see the instrument described below) will reveal the CO2 emissions saved.
- A great incentive for construction clients for reusing soil are the Danish DGNB criteria, since most points are given for reuse on site, less points are given for keeping soil within a certain distance from the site.
- In one demonstration project in Høje-Taastrup more than 90 % of the otherwise excess soil is being kept on site. The estimated amount of excess soil saved is more than 700.000 tonnes, saving more than 1.000 tonnes of CO2 – and of course a substantial amount of money depending on market prices for transport and soil deposit.

CityLoops instruments

- **Roadmap for sustainable soil management:** The roadmap is a simple interactive diagram to be filled in by the municipality. It can support the implementation of sustainable soil management by providing an overview of strategic objectives of a project, as well as identifying the stakeholders needed to achieve such objectives. The one-pager can be used to plan and support the implementation for a wide range of projects – from strategically anchored efforts to specific projects with concrete objectives. This instrument is [available here](#).
Bodø has used the roadmap template to make their own soil roadmap, it can be [found here](#) (in Norwegian).
- **Guidelines for sustainable soil management and assessment of reuse potential of excavated soils:** The guidelines describe how projects can be adapted to minimize impact on ecosystem functions of soil and, if treated properly, how excavated soils may be used for a wide range of purposes of considerable value. The guide describes approaches for reducing impact on ecosystem functions; maximizing on-site reuse of excavated soil; and local reuse of excavated soil. It furthermore provides an overview of whether a specific soil type is suitable for a particular purpose. This instrument is [available here](#).
- **Prognosis predicting future excavated soil production:** This instrument can be used to predict how much soil will be excavated in relation to construction works and

urban development in a city for the next 12 years. It can be used for strategic planning at a territorial scale, or in the project planning phase for a particular construction or demolition site. This instrument is [available here](#).

- **CO2 calculator for soil:** This instrument calculates the CO2 emissions from depositing soil or reusing it locally, thus making it easy to estimate CO2 reductions from local soil reuse. This instrument is [available here](#).

CityLoops demonstration experiences

- **Høje-Taastrup - Circular soil handling in urban development areas:** In the area Nærheden, the developer managed to keep approximately 90% of the excess soil on-site. In another project, soil from the construction of the new city hall was used locally in Taastrupgaard. Høje-Taastrup developed and tested the prognosis for excess soil, interviewed stakeholders about barriers to soil reuse and helped develop the guidelines for soil reuse, which are now being put to use in Urban Development Plans. Read more about Høje-Taastrup's [experience here](#).
- **Roskilde - Circular soil handling in the Musicon area:** In Roskilde circular soil handling was established in the demonstration action in Musicon. Roskilde also developed and tested the prognosis for excess soil, interviewed stakeholders about barriers to soil reuse and helped develop the guidelines for soil reuse, which are now being put to use in Urban Development Plans. Read more about Roskilde's [experience here](#).

Apeldoorn - Open air soil and sand depots: The municipality of Apeldoorn runs local open-air soil and sand depots where soil and sand are being collected, processed, inspected, labelled, and even put on display. Quantities and qualities of soil are offered and requested by actors in the construction industry and are registered by the municipality. It is experienced that much of the soil offered to the depot of Apeldoorn is often of a better quality than expected. Read about Apeldoorn's [experience here](#).

Circular Procurement

As key economic actors on the demand side, local authorities and other public bodies could use public procurement as a potentially powerful strategic mechanism to promote a circular economy within their territories.

This replication package describes how public procurement activities have been used strategically to support the CityLoops demonstration actions. By digging into the different procurement strategies cities have used (such as criteria and clauses in tenders, innovation market, etc.) in each specific context, it outlines how procurement could be a tool alongside more traditional policy instruments for shifting towards circularity.

Recommendations from lessons learnt

Though public procurement has to follow rules to allow competition in the unique market, it is a tool procurers should view as strategic when it comes to achieving environmental goals. However, there are necessary pre-conditions for successful circular building procurement:

- Knowledge of the market: market research to understand capabilities and maturity of the supply chain, and especially the local companies, helps to design the project and the procurement process related to it. For instance, for resources matchmaking, it could be very useful to rely on a network of companies, as they know quite well the marketplaces for buying reused or reclaimed material.
- Starting early market dialogue and creating space for informal/formal dialogues to reach out to the right network of suppliers: in an immature market it is essential to identify as soon as possible the companies that could meet the procurers' needs. Suppliers should be perceived as partners in innovative circular projects. Thus, to define the criteria and clauses in the tender, and to adjust the expectations all along the project, dialogue between the procurers and the suppliers is recommended.
- Working with the relevant departments by breaking silos: an internal collaboration between e.g., the procurement department, urban development department, environmental department and properties department can help select the best process, based on factors such as the level of innovation that the project requires or the maturity of the market. This collaboration enables defining the common objectives to reach in the tender.
- Choosing and defining the appropriate procurement process and circular criteria: a wide range of processes and criteria (technical, evaluation and performance aspects) exist to achieve the goals and finding the appropriate contractor. Alongside choosing criteria, it is also important to set objectives, like targets for CO2 savings, targets for use of circular principles such as Design for separation or the degree of use of reused and/or recycled materials in the building. A relevant example can be found in Høje-

Taastrup, where the municipality signed a pre-purchase development agreement with IKANO. Before signing that agreement, IKANO passed a selection process. This resulted in a very fruitful collaboration with a practical and targeted vision of how the area could be developed with high criteria regarding circular construction.

- Starting an early and transparent dialogue with the contractors: defining at the early stage of the project the visions and the ambitions is essential for an easy and collaborative dialogue between the procurer and the contractor throughout the project. For instance, working on a circular construction project can be associated with several practical challenges, since secondary building materials will not always be thoroughly tested and several of the construction processes may still be relatively new. The early collaboration is particularly important in such a construction project to define the framework for innovation and the challenges, including the risk management. This should therefore already be discussed at the negotiation meetings. This dialogue is prerequisite for assessing as much as possible the circular principles in construction from both an environmental point of view and architectural value, while also taking into account costs and quality.
- Not giving up and keep trying from a common goal: CityLoops cities have seen that the hardest step is the first one. Once you manage to do it in one project, it will be a basis for embedding this in wider procurement practices within the municipality, and then it will become a norm.

CityLoops instruments

- Based on lessons learnt across all the demonstrator projects, a Circular Procurement Handbook has been developed, which includes small reports from each demonstration city to provide clues on how to adjust procurement approaches to help promote circularity. The handbook also includes a series of case studies taken from other EU projects and recommendations for European policymakers. The Circular Procurement Handbook will be published [on this page](#) in September 2023.

CityLoops demonstration experiences

- **Roskilde - Procurement and risk management:** Throughout the different demo actions, Roskilde has worked on the risk management and how to address it with the contractor at the early stage of the project. This has led to a new procurement strategy in the building department where three elements, namely risk, responsibility and consequences, are always considered in advance of deciding where a risk shall be placed in a building process.
Read about Roskilde's [experience here](#).

- **Høje-Taastrup - Procurement to sell the old city hall:** In 2016 it was decided that Høje-Taastrup will build a new city hall and sell the old one to develop a residential area. The municipality had the opportunity to impose circular conditions in the tender about how the demolition of the old city hall should take place and how soil should be handled. The municipality signed a pre-purchase development agreement with a private developer, IKANO, which showed a great interest in circularity and sustainability. They work closely with the municipality, the demolition contractor and the potential buyers of the materials from the demolition site.

Read about Høje-Taastrup's [experience here](#).

- **Mikkeli - Procurement for the selective demolition:** The main lesson learned for Mikkeli was that the organisational changes should start from the strategic level. CityLoops' experience has shown the need for improvement in Mikkeli's tendering practices to include more qualitative criteria within the tenders and to avoid the cheapest price to be the main criterion. As a direct result of the CityLoops project, new [procurement guidelines](#) have been drawn up to promote the circular economy in demolition projects (Mikkeli Development Company Miksei 2021).

- The guide proposes new qualitative requirements, benchmarks or contractual incentives to promote circularity within the tenders. It proposes to follow necessary steps all along the procurement process. However, it does not specify which qualitative criteria or detailed minimum requirements must be used in each individual case. Instead, it provides examples of such criteria.
- The best practice changes that have been highlighted by the demo actions are:
 - Adding minimum requirements in the tender documents regarding the source separation of waste.
 - The quality control of hazardous material needs to be improved so that all relevant hazardous materials will be taken into consideration.
 - Procurement units should consider separate tendering for soft stripping services and indoor demolition contracts to facilitate participation of local SMEs and to include criteria for promoting reuse.
 - Fixed price procurement with circularity being the main selecting criteria should be considered in selected cases to promote innovative contractors.

Read about Mikkeli's [experience here](#).

- **Bodø - A new sustainable procurement strategy:** Through workshops, data gathering and awareness raising campaigns, in Bodø Municipality, CityLoops has been an initiator and contributor to the preparation of a new circular procurement strategy. A selection of tenders analysed at the beginning of the project was compared to a comparable selection of tenders at the end of the project. This was done with the support of a Master student who conducted his thesis on "Indicators for smarter decision making in circular public procurement. The case of Bodø Municipality". This knowledge led the city to adopt a new sustainable procurement strategy, packed with a set of indicators to assess the progress.

Read about Bodø's [experience here](#).

- **Apeldoorn - Procurement within an already existing framework contract:** An important challenge Apeldoorn had to face in the project of the street renovation was how to integrate circularity and new measures in a framework contract that had been already established with a contractor and was already running for several years. Supported by Rijkswaterstaat, the Netherlands executive agency of the Ministry of Infrastructure and Water Management, the city worked with the contractors to propose ideas to improve circularity.
Read about Apeldoorn's [experience here](#).
- **Seville – Procurement of the renovation of pipelines:** In the development of the tender for the renovation of water pipelines in Seville, several circular evaluation criteria have been integrated and, as a result of CityLoops, are now being extended to all tenders related to pipe replacements and renovation works in the city. These criteria, such as reusing work cuts, recycling stone materials and minimizing the use of virgin resources, are being monitored by requiring contractors to develop a detailed waste management plan.
Read about Seville's [experience here](#).

Business cases

The industrial sector traditionally seizes all the opportunities to optimise each step of the production system in a linear market model, developed on a principle of abundant and available raw primary resources, without including in the final price the cost of environmental and social damages. “Closing the loop” and transitioning to a circular economy entails the development of new economic activities, by shifting the value chains of today's world, which are still structured in a linear way.

The CityLoops project has focused on supporting the demonstration actions with sound business cases that have ensured economic viability. This replication package contains various business cases from different demonstration actions. For each developed business case, the project has been looking at cost structures and revenue streams, identifying potential customers (or end-users) and evaluating internal capacity. The examples also rely on market assessments, in particular in comparison to non-circular (or rather linear) alternatives, and include environmental, climate and social evaluations.

Recommendations from lessons learnt

There are many ways to consider if the business cases were successful, as it depends on the indicators to measure their success (economic, but also social and environmental). The economic profit, or at least the balance, remains crucial to achieve the upscaling of these innovative approaches. Even though the contexts, the cases, the steps of the value chain and the materials were different, there are common rules to underline:

- Cooperation with private companies, willing to innovate is easier to implement when public and private entities work hand in hand. Although the drivers can be environmental, local authorities also need to rely on companies that develop competitive solutions. The successful business cases demonstrate that partnerships between local authorities, public clients and private companies willing to develop circular solutions are a key success factor.
- Early market dialogue is required. It ensures the pre-selection of companies that public procurers can cooperate with, once the tendering process is launched.
- National context and demand: the national regulatory framework plays an important role in promoting circular profitable business models. By pushing demand, it drives suppliers to develop competitive circular products or services and to align the prices on linear solutions. In a free market, it is important to give incentives to shape the national market. Local authorities have the capacity to influence the national context and regulatory framework. By leading the transition with experimental projects, the demand for circular products and buildings will increase, and the market will more and more change accordingly.

- Risk management and responsibility analysis: Effective risk management is a critical component of the planning process in circular projects. The client should conduct a risk mapping exercise at the outset of the project to identify any risk elements, highlighting the responsibilities, risks, and consequences along the project. This might help to minimise the negative impacts of a triggered risk. It is recommended to maintain this open dialogue with key actors in the value chain proactively and transparently from the early stage of the project.
- Circular competitive business cases already exist: depending on the national context, the stream conditions, access to natural (virgin) resources, price formation etc., some demonstration actions have showcased that circularity could be competitive:
 - Recycling concrete can either be done for approximately the same cost as using new concrete, or it can generate savings if crushed and reused on-site (Roskilde, Høje-Taastrup and Mikkeli).
 - Keeping soil on-site or reusing it locally generates large economic and CO2 savings from reduced transport (Apeldoorn, Høje-Taastrup, Roskilde and Bodø).
 - Using a local deposit for intermediate storing of masses can be a good business case (Apeldoorn, Høje-Taastrup, Roskilde and Bodø).
 - Soft stripping and proper organisation can create business for reuse of demolition items of certain quality – often competitive with new items (Mikkeli).

CityLoops instruments

Both instruments developed in the context of this replication package can be used as inspiration for creating and evaluating business models and cases.

- The report [Business Cases for Circular Construction & Demolition Projects](#), from the Danish Association of Construction Clients, is an introduction to the circular economy and market in the construction sector. It includes a comparison to the conventional linear market and introduces a two tracked business case mode. This model looks at both the economic/commercial value chain and a broader value chain seen from a societal point of view with environmental, social, and economic aspects of the business case – as two sides of the same coin.
- The report [Developing a circular business model for the municipality of Apeldoorn](#), from SAXION University, is a locally pointed, academic analysis of [The Triple Layered Business Model Canvas](#).

CityLoops demonstration experiences

The demonstration actions have been used for studying business cases on the ground. To

ensure replicability and to highlight the challenges faced and the success factors, reports on different materials and steps of the value chain have been produced:

- **Apeldoorn:** The reuse of road foundation, old concrete pavers for parking and concrete paving slabs for flat roof photovoltaic systems has been investigated, calculated and valorised. By reusing available materials, a total reduction of 78% of greenhouse gas emissions on materials and their transport to the project could potentially be realized. In the case of Apeldoorn, the decision to use a very specific type of street paver, which was not available in reused form, led to the reduction in the Griffiersveld project of 49 tonnes CO2 equivalents, or 17% of the greenhouse gas emissions.
Read about Apeldoorn's [experience here](#).
- **Bodø:** Different alternatives for mass treatment and transport at a road development project in the midtown have been explored and analysed, finding greater savings in the solutions where reuse is practiced, either at an intermediate storage facility or at the waste management facility.
Read about Bodø's [experience here](#)
- **Høje-Taastrup:** The recycling of crushed concrete as aggregate in a new construction (Town Hall foundation) and reuse of excavated soil in the Taastrupgaard field have been evaluated positively, primarily related to the fact that the costs of recycling and re-use of concrete and soil in these cases have not been higher than the market price of new concrete and virgin materials.
Read about Høje-Taastrup's [experience here](#).
- **Mikkeli:** In Mikkeli two different business cases for the demonstration sites, (Pankalampi Health Centre and Tuukkala Hospital) have been analysed, specifically:
 1. [Stripping and organizing reuse of demolition items in a selective demolition](#)
 2. [Reuse of concrete aggregate in concrete production](#)
- **Roskilde:** The recycling of crushed concrete as gravel fill and aggregate in new construction (multi-storey parking house) has been executed, and risk management has been [analysed](#). The case has found that additional costs have been associated with the excavation of obstacles and the ramming of piles, which were inevitable, but almost **€ 53,000 excl. VAT** has been saved on demolition, loading and disposal of concrete residues, as well as delivery and installation of new gravel fill.
Read about Roskilde's [experience here](#).

Annex I – Peer review workshops

Each Replication Package has been shared with a pool of reviewers and their feedback has been collected during peer review workshops to facilitate a fruitful exchange and dynamic discussions, enabling participants to exchange ideas and clarify points, as well as to strengthen the cross-fertilization and innovative ideas generation.

The peer-review workshop participants included:

- The partners involved in the development of the instruments in the replication package.
- The demonstration managers of the cities who had experiences in the replication package.
- The replication zones who communicated an interest in the specific topic.

The nine peer-review workshops have been held between April and May, and following these workshops, CRD and ICLEI have updated the Replication Packages to include the collected feedback.

Peer-review workshops

Replication Package	Dates	Cities reviewing
1 Planning and decision making	27 Apr 2023	Bodø; Høje-Taastrup; Mikkeli; Roskilde; Ghent;
2 Stakeholder Engagement	15 May 2023	Apeldoorn; Bodø; Mikkeli; Espoo;
3 Circular demolition	28 Apr 2023	Bodø; Mikkeli; Roskilde; Ghent;
4 Data and material passports	20 Apr 2023	Apeldoorn; Bodø; Mikkeli; Roskilde; Vienna;
5 Material banks and marketplaces	20 Apr 2023	Apeldoorn; Bodø; Roskilde; Vienna;
6 Recycling concrete	16 May 2023	Høje-Taastrup; Mikkeli; Roskilde; Seville; Torres Vedras;
7 Circular soil handling	9 May 2023	Apeldoorn; Bodø; Høje-Taastrup; Mikkeli; Roskilde; Espoo;
8 Circular procurement	30 May 2023	Apeldoorn; Bodø; Høje-Taastrup; Mikkeli; Roskilde; Vallès Occidental;
9 Business cases	28 Apr 2023	Bodø; Høje-Taastrup; Mikkeli; Roskilde; Vallès Occidental;

CITYLOOPS

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

Høje-Taastrup and Roskilde (Denmark), Mikkelí (Finland), Apeldoorn (the Netherlands), Bodø (Norway), Porto (Portugal) and Seville (Spain) are the seven cities implementing a series of demonstration actions on CDW and soil, and bio-waste, and developing and testing over 30 new tools and processes.

Alongside these, a sector-wide circularity assessment and an urban circularity assessment are to be carried out in each of the cities. The former, to optimise the demonstration activities, whereas the latter to enable cities to effectively integrate circularity into planning and decision making. Another two key aspects of CityLoops are stakeholder engagement and circular procurement.

CityLoops started in October 2019 and will run until September 2023.



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