Starter Kit

Knowledge-base - Starter kit

Version 1

09 2019

D.T2.1.1: Knowledge-base – Starter kit

A.T2.1 Starter kit

Issued by:	**Partner Nr. 10 – BWCON**
Reviewed by:	**Partner Nr. 1 – TUKE**
Version date:	**30.09.2019**
Version. Revision	**1.2**
Circulation	**Public**

Document History

Date	Version	Description of Change
06.07.2019	v. 1.0	Content outline issued by PP10
16.09.2019	v. 1.1	Full version circulated by PP10
30.09.2019	v. 1.2	Document finalised by PP10

Content

Reader's Guide

Chapter I Introduction describes the objective of the Starter Kit and its target. It introduces the concept of the circular economy and briefly lists some of the EU strategic policy documents relevant to the CE. In this chapter we introduce a definition of the CE and the 9R framework around which the Starter Kit is structured. In this chapter we discuss the CE as a multi-governance approach and pinpoint the role of the cities and their levers.

Chapter II defines the concept of Circular Business Models and introduces a classification of CBM depending on the actors involved and the stage of the sourcing, production and consumption cycle. In this chapter we give several examples of CBM which we later elaborate. The role of the cities with regards of CBM is briefly explained.

Chapter III, Section 1 we elaborate on the concepts of **industrial symbiosis** and urban metabolism. We introduce different typologies of networks as well as different territorial policies for IS. In the chapter there are number of examples of both IS and urban metabolism.

Chapter III Section 2 is dedicated to the **sharing (collaborative) economy** which is often considered a part of the circular economy as it optimises available accommodation, transport and other stock and forgoes the necessity of additional consumption.

Chapter III Section 3 elaborates concepts and issues around the **smart and circular design**. The 8 R framework is applied to design. We also describe how cities can apply the notion of smart and circular design for their purposes.

In Chapter III Section 4 we talk about **extending lifetime of products and materials**. While we addressed repair and repairability from the point of view of smart and circular design in this chapter it is approached as a practice with social dimensions. The chapter elaborates on concepts such as product durability, planned obsolescence. The section also includes remanufacturing of as a trend to increase the life of industrial products such as engines.

Chapter III Section 5 is introducing some basic concepts associated with regenerative sources, the bioeconomy and water reuse. Bioplastics is also addressed as a topic.

Chapter III Section 6 elaborates on the **waste management** as a key pillar of the transition to the circular economy. It talks of the waste hierarchy and the instruments in the hands of cities for optimising waste management.

In Chapter IV we introduce a methodology for **developing a CE strategy in a territory**. It includes instructions on how to assess local context and potential and provides tips on analysing enabling conditions and hindering factors. The chapter finishes with defining a vision and priorities for the city in its transition to the circular economy.

I. Introduction

1. Objectives and scope of the Starter kit

This Starter Kit has been developed within the CITY CIRCLE project. It is targeted at urban practitioners and policy makers and is meant to introduce concepts and notions related to the circular economy. The Starter Kit does not have the ambition to cover all sectors of the economy which are of relevance of the circular economy. Its scope has been agreed with the participants in the project and covers sectors close to their reality. These could be subsequently explored more in-depth.

2. Why circular economy

The concept of the circular economy has been studied for many years. However, it only became a mainstream concept in the European Union with the adoption of the EU Circular Economy Package in 2015. Before that time the notion of 'greening the economy', 'greening different economic sectors' was much more common. One of the proofs for that is that circular economy was missing in all documents associated with the Programming Period 2014-2020 of the European Structural and Cohesion Funds (ESIF).

The ambition of the **Circular Economy Package** was to "help European businesses and consumers to make the transition to a stronger and more circular economy where resources are used in a more sustainable way". The package includes new and revised legislation with focus on waste prevention and management, with clear timeframe for implementation and financing. The actions aim to contribute to "closing the loop" of product lifecycles through greater recycling and re-use. The Circular Economy Package[1] refers to five priority areas to be addressed in a targeted way: plastics, food waste, critical raw materials, construction and demolition, as well as biomass and bio-based products.

Since the adoption of the Circular Economy Package circular economy has gained enormous traction in EU discourse but also in national, regional and urban policy making. Circular economy strategies and action plans are mushrooming on all governance levels. Businesses are also exceedingly considering 'going circular'. This whole activity is praiseworthy and is a proof of a growing attention to global problems. However, in order to avoid a situation where circular economy becomes just an empty buzz word, experts and policy makers need to keep filling it with concrete action and meaning.

This Starter kit's ambition is exactly this. It addresses the circular economy from the point of view of cities and more specifically it focuses on what cities can concretely do in order to make certain sectors of their economy 'more circular'.

[1] http://ec.europa.eu/environment/circular-economy/index_en.htm

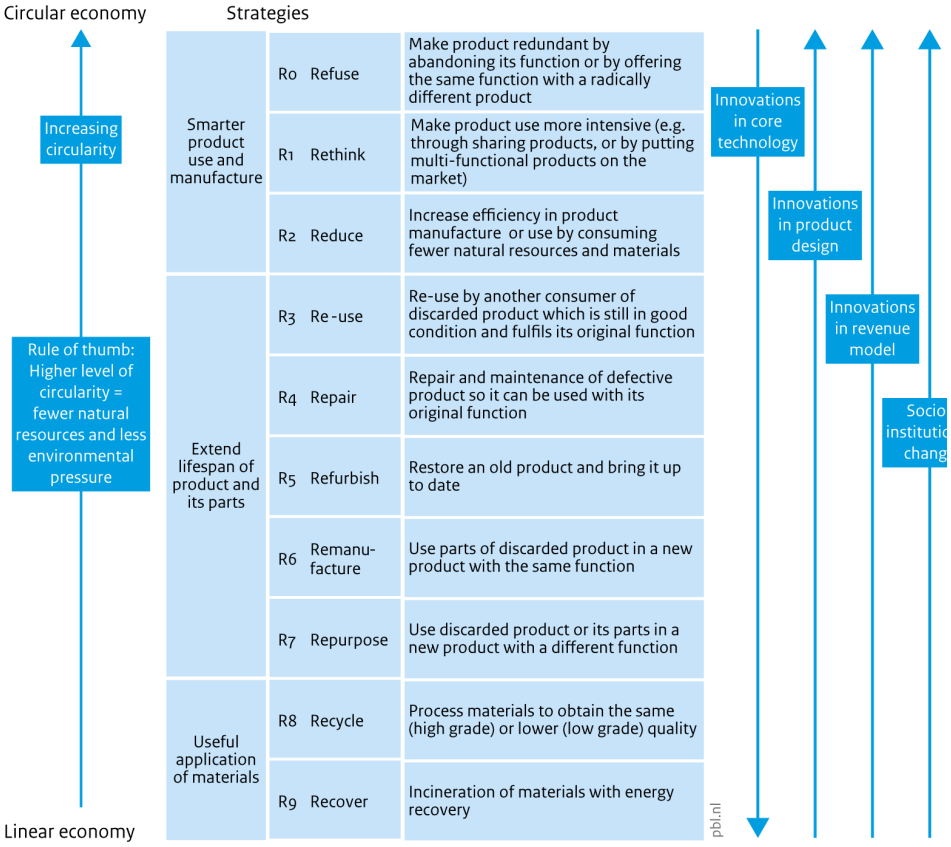
Definition of the circular economy

The **Circular Economy (CE)** can be defined in numerous ways and there are more than 100 definitions in use. While the knowledge on CE is growing, scientists are yet to get to grips with different aspects, implications and impacts of the circular economy. Overall, the CE adopts a systems approach and aims at **reducing the societal production-consumption systems' linear material and energy throughput flows.** It promotes high value material cycles and cooperation of producers, consumers and other societal actors in sustainable development work. (Source: Korhonen et al. (2018b)).

Several circularity strategies exist that can be ranked by level of circularity and hence - environmental priority. The underlying logic of this circular hierarchy is that the higher a strategy is, the more circular it is. Different chapters of the Starter Guide deal with different circular strategies.

The model suggested by the PBL Netherlands Environmental Assessment Agency (2017) is presented in Figure 1. The model which defines ten strategies for circularity that can be used to build a successful circular product and material flows across the EU: Refuse (R0), Rethink (R1), Reduce (R2), Reuse (R3), Repair (R4), Refurbish (R5), Remanufacture (R6), Repurpose (R7), Recycle (R8), Recover energy (R9). Each strategy is based on making use of different business models, infrastructures, relationships with different stakeholders, and potentially also policies.

Figure 1 Circularity strategies within the production chain actors in order of priority



Source: based on Potting et al. (2017)

Smarter product use and manufacture

R0 Refuse: Refuse the use of raw materials, design production processes to avoid waste. On consumers' side it is about choosing to buy and use less, reject packaging waste.

R1 Rethink: Make product use more intensive (e.g. through sharing products, or by putting multi-functional products on the market). This strategy engages producers in a process of re-designing or 'rethinking' their products, in order to minimise the environmental footprint and reduce the amount of resources used in the production process.

- Product as a service;
- Sharing of assets;
- Industrial symbiosis;
- Performance-based input sharing.

R2 Reduce: Increase efficiency in product design or manufacturing by using fewer natural resources and materials as inputs. The strategy of reducing the products' ecological footprint by increasing resource efficiency can involve different levels of ambition in the transformation of the products.

- Deploying different processes or technologies that use less energy, water, raw materials, etc.,
- Re-organising logistical chains and suppliers (e.g. buying from more local suppliers).

Strategies extending the lifespan of products and its parts

- **R3 Reuse** of discarded products by another consumer. This strategy is key to supporting material flows in the economy, and advocates the designing of products with longer lifespans, more robust composition, and which are easily repaired.
- **R4 Repair** and maintenance of a defective product so it can be used for its original purpose, and
- **R5 Refurbish** to bring an old product up to date are further strategies that can be used along the same thinking lines of prolonging the lifespan of products.
- **R6 Remanufacturing** or using parts of a discarded product in new products with the same functions.
- **R7 Repurposing** or using parts of a discarded product in a new product with different functions.

Useful application of materials

- **R8 Recycling:** Treating waste to generate secondary raw materials as inputs for processed materials.
- **R9 Recover:** Incineration of materials with energy recovery. Incineration of materials is a waste-treatment technology, based on the combustion of waste that is used for energy recovery. It is one of the last waste management resorts used before landfilling

3. The Circular economy as a multi-governance approach

3.1. The circular economy within strategic EU documents. Current policy debates

As previously described, the notion of circular economy quickly finds its way in EU policy making. In the section below, we will briefly sketch some of the EU policy documents closely linked to the circular economy. In the subsequent chapters dedicated to different sectors and circular approaches we will also briefly remind the key EU policies linked to the sector.

One of the key policies that supports the move towards a circular economy is the EU's five-step waste hierarchy established in the **2008 EU Waste Framework Directive**. It sets the basic concepts and definitions related to waste management and includes two new recycling and recovery targets to be achieved by 2020: 50% preparing for re-use and recycling of certain waste materials from households and other origins similar to households, and 70% preparing for re-use, recycling and other recovery of construction and demolition waste.

The EU Action Plan for the Circular Economy (CEAP), provides the backbone of Europe's Circular Economy Package. It outlines a series of measures that aim to boost global competitiveness, foster sustainable economic growth and generate new jobs. It also mentions product design, production processes, consumption, food waste, critical raw materials and biomass and bio-based products. Eco-innovation and investment are also highlighted as horizontal measures. The Final Circular Economy Package can be found here.

The CEAP establishes a concrete and ambitious programme of action, with measures covering the whole cycle: from production and consumption to waste management and the market for secondary raw materials and a revised legislative proposal on waste. The update of the waste management rules was approved in 2018. The package includes, among others, clarified legal status of recycled materials, strengthened waste prevention and waste management measures, including for marine litter, food waste, and products containing critical raw materials. New recycling targets for different waste streams were introduced, among which recycling target for plastic waste: 50% (by 2025) and 55% (by 2030). The EC will also take measures to restrict the use of microplastics in products.

On 4 March 2019, the Commission reported on the complete implementation of the CEAP. All 54 actions included in the 2015 plan have now been delivered or are being implemented.

Box 1 Implementing the actions: circular economy benefits

In 2016, sectors relevant to the circular economy employed more than four million workers, a 6% increase compared to 2012. Additional jobs are bound to be created in the coming years in order to meet the expected demand generated by fully functioning markets for secondary raw materials.

In 2016, circular activities such as repair, reuse or recycling generated almost €147 billion in value added while standing for around €17.5 billion worth of investments. In Europe, recycling of municipal waste during the period 2008-2016 has increased and the contribution of recycled materials to the overall materials demand shows continuous improvement.

Source: https://ec.europa.eu/environment/circular-economy/pdf/report_implementation_circular_economy_action_plan.pdf

Circular economy has been organically fostered upon the earlier resource efficiency related policy developments, namely Europe's **Roadmap to a Resource Efficient Europe** (European Commission 2011) – a core instrument of the **Resource Efficient Europe Flagship Initiative** of the **Europe 2020 Strategy** promoting agenda for growth and jobs with an emphasis on smart, sustainable and inclusive growth.

Building upon previous efforts to tackle the problem of plastic pollution, in January 2018 the EU adopted the **European Strategy for Plastics in a Circular Economy**. The Strategy aims to protect the environment and citizens from plastic pollution and to demonstrate the business case for transforming the way that products are designed, produced, used and recycled. Under the new plans, all plastic packaging on the EU market will be recyclable by 2030, the consumption of single-use plastics will be reduced and the intentional use of microplastics will be restricted. The strategy highlights the main commitments for action at EU level but also emphasizes the important role of businesses, together with national and regional authorities, and citizens.

As a next step towards transition to circular economy, more efforts will be needed to implement the revised waste legislation and develop markets for secondary raw materials. As noted in report on the implementation of CEAP, many other sectors with high environmental impact and potential for circularity such as IT, electronics, mobility, the built environment, mining, furniture, food and drinks or textiles could benefit from a similar holistic approach to become more circular. The European Strategy for Plastics in a Circular Economy can serve as a good example in this regard.

3.2. Dedicated national strategies for circular economy

The circular economy has also gained momentum in the policies of Members States, largely due to the political priority given to it by the EU in recent years. Some MS have developed dedicated circular economy strategies and roadmaps (e.g. France, Netherlands, Finland, etc.). A growing number of regions (Flanders, the Basque country, etc.) are now acting to develop a circular

economy and they have been joined by a number of cities (e.g. Amsterdam, London, etc.). Some have adopted circular economy strategies, while others have introduced the circular economy in their sectoral policies on waste, economy, agriculture, bio-economy, construction etc., as well as in their Smart Specialisation Strategies (RIS3). This is now triggering the deployment of various types of circular business models.

Box 2 The Dutch Programme "A circular economy in the Netherlands by 2050"

The Netherlands set up an ambitious plan to become a totally circular country by 2050. Its ambition is to realise, together with a variety of stakeholders, an (interim) objective of a 50% reduction in the use of primary raw materials (minerals, fossil and metals) by 2030. Agendas have been formulated for five key raw material chains to make this shift towards circularity: biomass and food (1); plastics (2); manufacturing (3); construction (4); and consumer goods (5).

The following barriers for the transition to a circular economy are mentioned: regulations, the non-internalisation of external effects, the lack of knowledge for technical, social and system innovation, non-circular behaviour of citizens and professionals, adaptation problems in the production chain, consolidated investments and interests, limited influence in the international playing field. Interventions to address these barriers are focused on improving the regulatory framework, introducing smart market incentives, financing, stimulating knowledge and innovation.

Source: Dutch Ministry of Infrastructure and the environment

https://www.government.nl/documents/policy-notes/2016/09/14/a-circular-economy-in-the-netherlands-by-2050

Box 3 The Roadmap towards the Circular Economy in Slovenia

The Roadmap towards the Circular Economy in Slovenia sets the path for Slovenia to become a circular economy front runner in the region. Designed through an inclusive, multi-stakeholder approach, it identifies four priority sectors, give recommendations to the government and identifies best practices. The Roadmap introduces the Circular Triangle, a model which unites three inseparable elements – Circular Economy (business models), Circular Change (government policies) and Circular Culture (citizens), three interdependent aspects that are at the core of systemic change from a linear to a circular economy in Slovenia.

Sources: https://circulareconomy.europa.eu/platform/en/strategies?page=1

3.3. Circular economy on regional and city levels. Some examples of regional and urban policies

In times of dwindling resources transition to a **circular economy is both a necessity and an opportunity for cities**, with the potential to offer long-lasting economic, environmental and social benefits. Many local authorities are already making efforts towards a more circular economy by setting clear framework conditions, fostering innovation and collaborating with local and regional stakeholders.

European city and region may take different paths on the way to circular economy, depending on geographic, environmental, economic or social factors. The industrial profile of a city or region plays is important, with, for example, service and resource-intensive sectors each calling for different types of support. Implementing more resource-efficient transport systems, district heating systems or a sharing economy could be a greater challenge for less accessible than for metropolitan areas. The diversity of territorial contexts translates into different needs and opportunities that circular economic approaches should address. The territorial dimension of a region is an important factor in the transition process (ESPON GREECO).

While national strategies or roadmaps towards circular economy provide the general framework for the transition to circular economy at national level, regions and cities still need to adapt their instruments and actions to their local resources, economic and social realities. Examples of efforts in this regard at city and regional level are presented below.

Circular economy is also a theme of one of the **Urban Agenda for the EU (Pact of Amsterdam)** partnerships. This is one of the four new partnerships approved in October 2016. One of the 12 themes included in the Pact of Amsterdam, circular economy is linked to waste management, sharing economy and resource efficiency. The partnership will work to develop an Action Plan to achieve better regulation, better funding and better knowledge, aiming to increase the re-use, repair, refurbishment and recycling of existing materials and products.

Box 4 Amsterdam on the way to circular economy

Amsterdam, one of the leaders in the application of circular economy concepts to city governance, follows seven principles in its transition towards a circular economy. These principles can be extended to define a vision and an action roadmap on circularity in cities:

- **Closed loop** – all materials enter into an infinite cycle (technical or biological).
- **Reduced emissions** – all energy comes from renewable sources.
- **Value generation** – resources are used to generate (financial or other) value.
- **Modular design** – modular and flexible design of products and production chains increases adaptability of systems.
- **Innovative business models** – new business models for production, distribution and consumption enable the shift from possession of goods to (use of) services.
- **Region-oriented reverse logistics** – logistics systems shift to a more region-oriented service with reverse logistics capabilities.
- **Natural systems upgradation** – human activities positively contribute to ecosystems

Amsterdam launched the initiative Amsterdam Smart City (ASC) which is a partnership between different stakeholders to offer a common ground for cooperation towards a sustainable urban model. ASC works as a facilitator and an open platform which is able to connect citizens, businesses, government and knowledge institutes. It is also a living lab to test solutions in a real setting.

One of the themes of the initiative is circular city. Specifically, the city of Amsterdam aims to redesign twenty product- or material chains. The implementation of material reuse strategies has the potential to create a value of €85 million per year within the construction sector and €150 million per year with more efficient organic residual streams. By converting waste into electricity, urban heating and construction materials, the Amsterdam Electricity Company generates 900 kWh per 1000 kg of waste. 75% of the sewage system is separated for waste and rain water and the silt which remains after treating waste water is converted into natural gas.

Sources: Circle Economy, TNO and Fabric, 2016,
www.amsterdamsmartcity.com/circularamsterdam

Box 5 Circular economy route map, London, United Kingdom

With the capital's population predicted to reach over 11 million by 2050, London needs a more flexible and sustainable approach to products, housing, office space and critical infrastructure. In June 2017, London Waste and Recycling Board launched its Circular Economy Route Map to accelerate London's transition to become a circular city. The document outlines a vision of a capital city thriving through the adoption of the principles of circular economy.

By 2036, the circular economy could provide London with net benefits of at least £7bn every year in the sectors of built environment, food, textiles, electricals and plastics, as well as 12,000 net new jobs in the areas of re-use, remanufacturing and materials innovation.

The Route Map recommends actions for a wide range of stakeholders, including London's higher education, digital and community sectors as well as London's businesses, social enterprises and finance sector.

Source:

https://www.lwarb.gov.uk/what-we-do/circular-london/circular-economy-route-map/

Box 6 Regional road map to circular economy of Päijät-Häme region, Finland

For the Päijät-Häme region in Finland it all started with including circular economy in their regional innovation strategy for smart specialisation (RIS3 strategy), thus defining circular economy as a priority sector for the region. The biggest city of Lahti also included circular economy in its urban development strategy. Hence, a decision was taken to create a regional road map (launched in Oct 2017) which would serve as a joint regional circular economy strategy

for the nine municipalities in Päijät-Häme. Local stakeholders were involved in the definition of a common vision, goals and concrete actions. The Lahti University of Applied Sciences coordinated the process on behalf of the regional council.

The Päijät-Häme roadmap has five main themes and regional level goals, which provide the framework for the actions to be implemented.

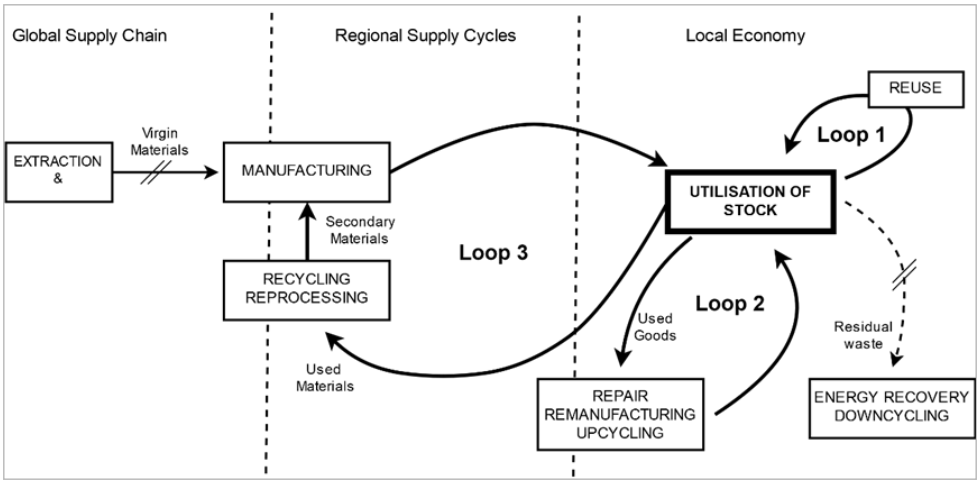
- **Closed loops of technical streams to create added value**. Actions: Digital platforms to optimise logistics, material collection pilots, circular material library, inclusion of circular economy criteria in public procurement.
- **Sustainable business from bio circular economy**. Actions: Closing of nutrient loops, support for new R&D innovations, promotion of open databanks on biological side streams, awareness raising on consumer choices, and reducing food waste.
- **Towards energy self-sufficiency by sustainable transport and energy solutions**. Actions: decentralised renewable energy solutions, biomass power plant, adapting building construction regulations, promotion of electric and biogas vehicles.
- **Shared economy generates new consumption models and business opportunities.** Actions: energy and material efficient solutions for everyday life, digital platform for circular economy services; support to local sharing platforms, piloting of consumer repair services and food solutions.
- **Piloting and demonstrating innovative circular economy solutions.** Actions: promotion of internationally interesting reference sites, circular economy training and education.

Source: Interreg Europe BIOREGIO project

Positioning of the urban dimension of the circular economy

In order to pinpoint those aspects of the circular economy which could be addressed at an urban level there is a need to illustrate different levels of the supply chain starting from the global supply chain through the regional one down to the local supply chain.

Figure 2 The basic loops of a circular economy



Source: modified from on Stahel and Clift (2016)

- ✓ **Loop 1** focuses on product *reuse*, through second-hand markets and/or platforms as well as commercial and private reuse of goods. While most of these activities take place on a local level this is not always the case.
- ✓ **Loop 2**, includes product *repair*, *remanufacturing* to meet new technical requirements and *upgrading* to meet new uses and markets. These may be local activities (e.g. *refurbishing* of domestic appliances) or may be carried out via regional service centres (e.g. *remanufacturing* of industrial equipment).
- ✓ **Loop 3** represents recycling in which materials are reprocessed to substitute secondary materials for return to the production system for same or another use(*recycling*).

Urban levers

When discussing the circular economy in cities we have to be fully aware which are those elements of the system which city authorities can influence through their ambition and action. We start with the possibility of the city to formulate a long-term vision of the city system and to engage stakeholders with this vision. Cities are in charge of urban management and wield the instruments of urban planning. Cities are also in the position to adopt certain policies and regulations. In each of the chapters in this Starter Guide we try to draw the attention to this. Cities can also mobilise its coordination power to generate long-term partnerships between different kinds of actors for the achievement of the vision. Cities can also fuel the transition to the circular economy by creating financial incentives for business actors and households to modify their consumption and production behaviour.

Figure 3 Urban policy levers

Source: https://www.ellenmacarthurfoundation.org/our-work/activities/circular-economy-in-cities/policy-levers

II. Introduction to Circular business models

Circular Business Models (CBM) are those types of innovative (business) consumption and production which **put into practice the circular economy processes and principles**. These models could be business-to-business (B2B), business-to-consumer (B2C) and consumer-to-consumer (C2C). Usually, these offer new opportunities for companies and transform the relation between producers and consumers. **Product/service systems** and **service-based business models** are concepts which are close to CBM.

Figure 4 Types of CEBM according to the production and consumption cycle and main actors

CE Strategic Areas	Single firms and consumers	Industries, clusters, regions
Material sourcing and circular input	Material substitution Energy neutrality	Diversity and cross-sector linkages Bio-based materials Urban mining
Production (design, manufacturing, distribution)	**Cleaner Production** Eco-Design, including de-materialization, design for disassembly, design for modularity, design for reparability, etc	**Industrial symbiosis** Eco-industrial park/networks
Consumption and use	**Green Purchase and consumption** Renting service Product re-use Virtualization	Community involvement Sharing economy Socially responsible consumption Eco-labelling schemes Stewardship Product-Service-System
Waste-as-a-resource (collection, recycling, recov-ery, remanufacturing)	Product recycle system Element/substance recovery Energy recovery Upgrading, Maintenance and Re-pair	Separation Take-back and trade-in systems Upcycling/Downcycling

Source: ESPON CIRCTER project

The figure above is a nice summary of possible CBM in line with the production and consumption cycle. It is organised by actors involved in the model. While within single firms there is a possibility for precise, targeted actions like material substitution or cleaner production activities, groups of industries can create systems of industrial symbiosis for example.

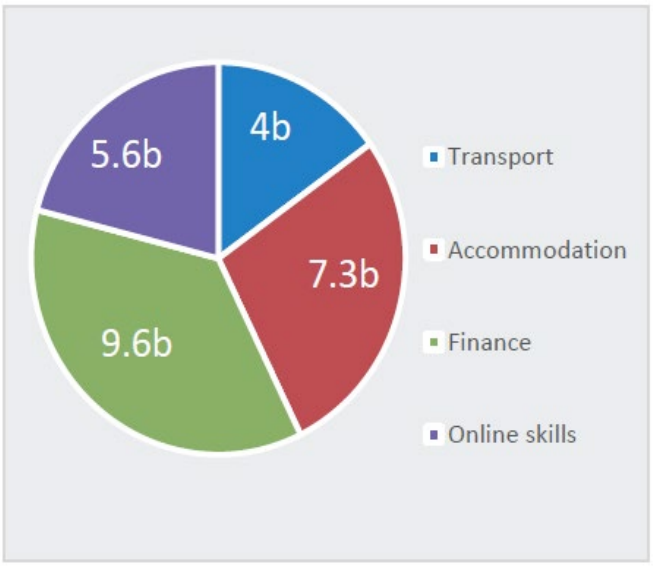
Examples of CBM

In the section below, we are presenting a short summary of several of the **main types of CBM**. This is not an exhaustive list. The presented models comply with the CBM aspect of changing the relationship between producers and consumers. It has to be noted that sometimes action as simple as recycling can be considered as CBM. These are not presented below.

Industrial symbiosis (IS) is an approach that engages several organisations across different fields in a process of developing mutually beneficial transactions to reuse waste and by-products. This often involves finding innovative solutions to identify business opportunities that capture the value of underutilised resources and or optimise the value of the industrial processes in question benefits. IS is a system which maintains the highest value of materials and products.

The **collaborative economy** is rapidly emerging across Europe. It consists in a new way of offering and using products and services, mostly through online platforms. Transactions usually involve three parties: the service provider, the online plat-form and the customer. It covers a great variety of sectors, from sharing houses and domestic services to car journeys and it often encompasses the development of new business models. The collaborative/sharing economy changes the utilisation patterns. A Technopolis Group study from 2018 estimated the potential of the collaborative economy at more than 26 billion EUR.

Figure 5 Sectors in collaborative economy



Source: Technopolis Group

Reverse logistics is managing the return flows of materials in a circular economy. It is mainly driven by Extended Producer Responsibility (EPR) policies which are gaining importance in the European Union. Reverse logistics is essential in closing the loop in a circular economy.

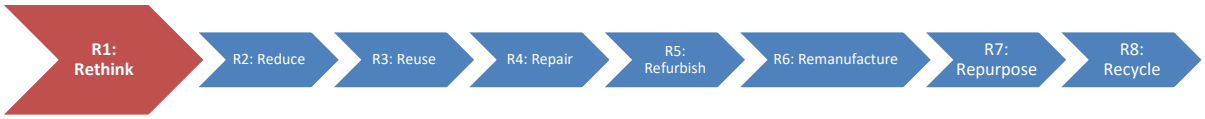
While recycling processes recover only a portion of the materials and embedded energy from a product, much of the industrial phases of new product development and production can be avoided via **remanufacturing**. Through remanufacturing, a used product is brought to at least the quality level of a new product through a treatment process consisting of e.g. dismantling, cleaning, testing, processing and remounting collected old parts (VDI ZRE 2017). In this way, the highest value of materials and products are maintained.

Obstacles to regional and municipal authorities

- Key challenges that hinder further adoption of CEBMs are related to measuring profitability and financial benefits, missing exchange of information on material flow data, perception of CEBMs as well as technological and operational issues. **Financial challenges** are considered the most pressing. Consequently, in order to overcome the current constraints, financial benefits and CBM parameters need to be demonstrated through **concrete examples and sectoral analysis**.

- CBM are incompatible with current procurement rules, taxation rules and infrastructural barriers (EEA, 2017). These are enabling factors/barriers which need to be addressed in order to trigger a stronger uptake of CBMs. An example of a policy measure with the potential to tackle institutional barriers related to product-service systems is the German state of Baden-Württemberg's promotion of car-sharing parking spaces (which are marked and cannot be used by private cars)

III. Circular and collaborative business models. Concepts and definitions. EU framework. What can cities do? Examples.



1. Industrial symbiosis and urban metabolism

Concept

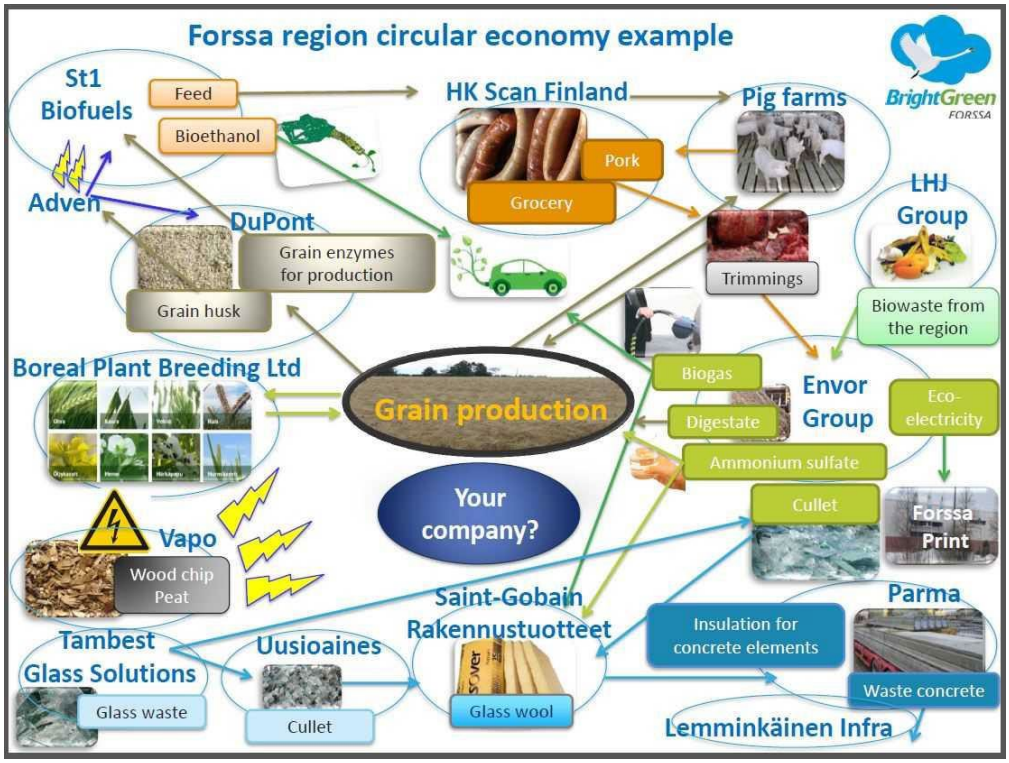
Industrial symbiosis (IS) is an approach that engages several organisations across different fields in a process of developing mutually beneficial transactions to reuse waste and by-products. This often involves innovative solutions to identify business opportunities that capture the value of underutilised resources and / or optimise the value of the industrial processes in question benefits (Domenech et al, 2018, Lombardi & Laybourn, 2012).

Making industrial symbiosis happen depends on many governance and policy factors. Market conditions for by-products and reused materials are often not favourable and specific materials are strongly regulated. Symbiotic initiative originate in two ways:

- As self-organised activities (e.g. with the well-documented example in Kalundborg, Denmark)
- as managed processes.

Self-organised activities usually emerge in industrial clusters and in a limited geographical perimeter.

Box 7 Forssa circular economy system



Source: Interreg Europe SYMBI project

Managed (and especially facilitated networks) networks can have a larger geographic scope.

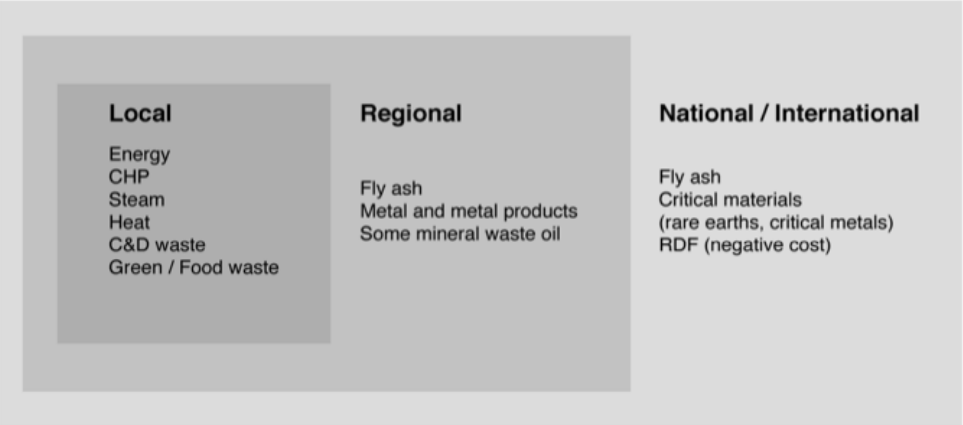
Domenech et al. (2018) distinguish between two types of managed IS initiatives:

a) **facilitated networks:** a coordinating entity promotes the development of the network and works with existing companies to identify IS opportunities.

b) **planned networks:** within legally and territorially well-defined areas (i.e. eco-industrial parks), where businesses are attracted to shared infrastructures and services. Often times these planned networks are developed in eco-industrial parks.

IS synergies can be implemented in any type of regions or area, depending of the types of resources transacted. Overall, IS activity has been found to be common in manufacturing clusters across Europe, whether as self-organised or as facilitated networks (Domenech et al, 2018). Clusters show high opportunities for facilitating resource efficiency improvements and industrial symbiosis in companies (Cluster Observatory, 2015).

Figure 6 Types of resources transacted by area



Source: Domenech et al, 2018

In a context of urban development, Industrial symbiosis could be one way to support urban planning for sustainable development, although systemic IS initiatives at urban level are not numerous, specifically in EU (Mulder et al, 2016).

Box 8 Japan's eco-towns programme

Eco-towns in Japan were developed in the last 10 years by utilizing regional technology and industry in Japan. Local governments and enterprises have worked in partnership to build such complexes. Eco-towns have enabled a number of developmental objectives to be met simultaneously. It has helped to stimulate the local economy, secure employment, as well as dispose waste in an environmentally sound manner, and protect air and water resources.

The eco-towns programme is a government-led approach to facilitating IS at urban level. The initiative established 26 eco-towns across Japan, providing support for investments in innovative recycling projects, resulting in industry savings and improved environmental results (Van Berkel, 2009).

Van Berkel finds that opportunities for IS can be facilitated at city level through engaging separate urban cycles in urban areas, to create local circular flows of energy and materials, that give rise to more sustainable urban development (ibid).

Source: UN Environment https://www.unenvironment.org/resources/report/research-eco-towns-japan-implications-and-lessons-developing-countries-and-cities

In EU, the concept of urban symbiosis has been linked to the concept of urban metabolism, which maps the existing flows of materials and energy in a city. The practice could be a very useful impact to urban planning.

Box 9 Urban metabolism project in Amsterdam

For instance, the city of Amsterdam has initiated an urban metabolism project. The project is implemented by the Technical University (TU) Delft and the Amsterdam Institute of Advanced Metropolitan Solutions (AMS). It focuses on the field of flow analysis and urban design and aims at making urban metabolism an integral part of urban design and associated goals such as circularity and sustainability in an urban context.

As a result, it presents possible interventions for each flow with the goal of:

- replacing the current source;
- re-use the flow.

New sources need to be renewable. Reuse concerns the reuse of residual flows and efficient use of depletable resources.

These interventions are on an urban level as they can be implemented by urban designers and planners.

Source: https://amsterdamsmartcity.com/projects/meaningful-circular-metabolism

Box 10 "Metabolism of cities" platform

The global platform "Metabolism of cities" is a source of valuable information on urban metabolism and material flow analysis. Among other things, it offers the so-called city platforms including an overview of the city; a presentation of different sectors relevant for the city (i.e. energy, transport, waste, etc.). It also offers a Starter Kit and a Massive Open Online Course (MOOC).

Source: https://metabolismofcities.org

Box 11 Urban symbiosis in Hammarby Sjöstad

In 1996, an environmental programme for Hammarby Sjöstad was approved by Stockholm City Council, in order to develop a sustainable urban district primarily by implementing innovative technologies, such as urban symbiosis strategies. The programme was about the revitalisation of a former large industrial and harbour area in southern Stockholm as a locale for sustainable urban development. The goal was to be at least twice as good as any other urban district built in 1995. The Hammarby Sjöstad programme is an example of urban symbiosis as a strategy for achieving environmental goals.

The case study demonstrates how combining the experience from facilitating Industrial Symbioses projects, the utilisation of the urban metabolism methodology, as well as encouraging the participation of citizens at district levels can be a route for implementing urban symbiosis (see Iveroth, 2014). The case study finds that formulating an environmental programme at the

level of the city, together with formulating goals for the city-level symbiosis was fundamental in achieving a holistic vision for the city and supported the achievement of environmental benefits (ibid). Nevertheless, the success of the programme depends on radical changes in household energy consumption, the implementation of new more efficient technologies and the introduction of stricter anti-landfilling rules.

Source: S. Iveroth, 2014, Industrial ecology for sustainable urban development - the case of Hammarby Sjöstad

Box 13 Example of an institution providing support for the uptake of CBM

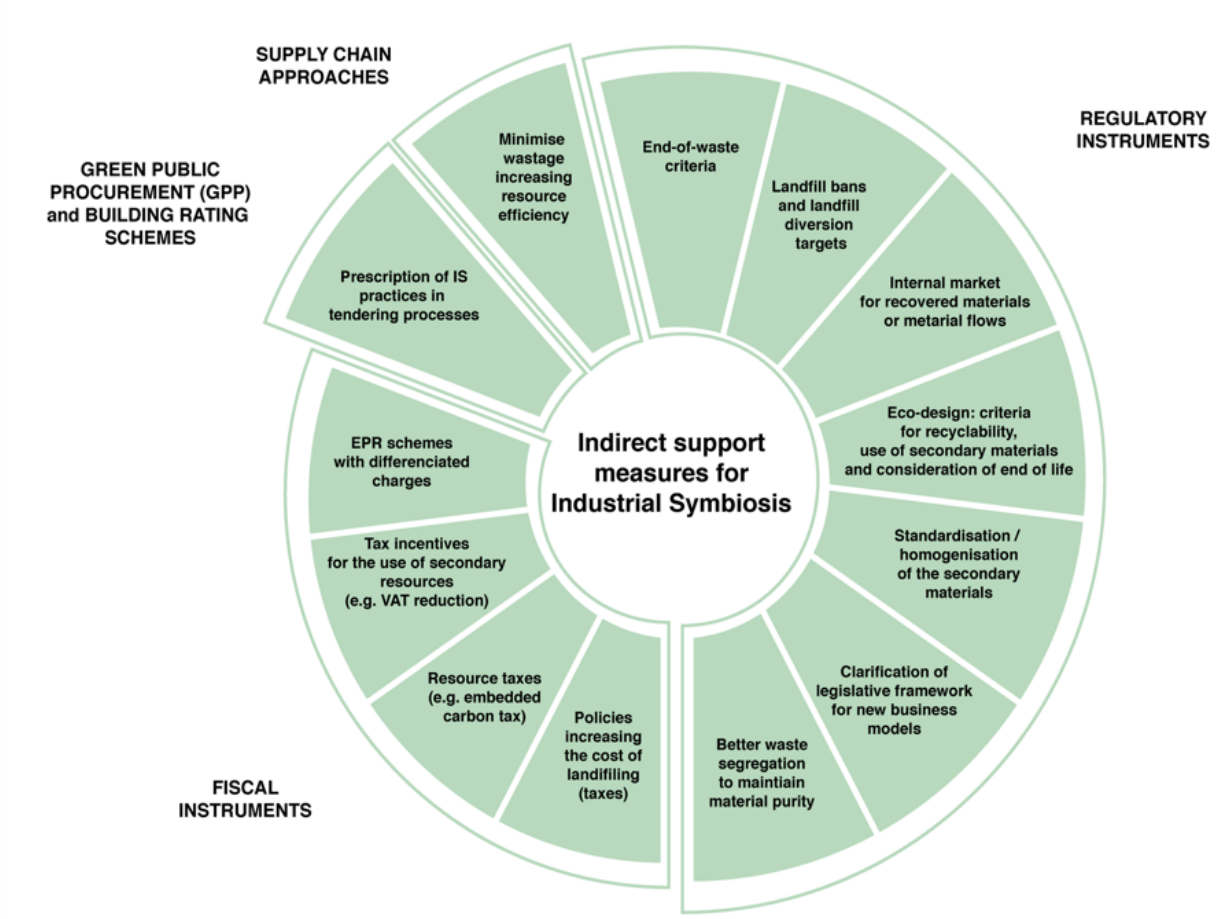
Zero Waste Scotland is an excellent example of an institution providing support for the uptake of CBM. It manages an 18 million pound Circular Economy Investment Fund for SMEs 'development and adopting innovative business models for new circular economy products and services. The Fund is well-linked with Scotland's strategic framework namely the Smart Specialisation Strategy (RIS3), A Manufacturing Future for Scotland – a programme for Government commitment and Making Things Last, Scotland's circular economy strategy.

Source: https://www.zerowastescotland.org.uk/

Territorial policies in support of IS

The figure below is a good illustration of the fact that Industrial Symbiosis is connected to a big number of policies. While this Starter Kit is not the place for exploring all links we would like to draw the attention of urban policy makers to the importance of policy enablers. Policy makers can either act directly on those policies which they could influence or work with national authorities on policies which could be decided and modified at national level.

Figure 7 Types of policies to support IS at EU, national and regional level



Source: Domenech et al, 2018.

There have been several initiatives in the EU and in the MS which are promoting the facilitation of IS transactions. Regions and cities wanting to support IS can take either a direct or indirect route to supporting the implementation of synergies.

One of the early programmes, which has been replicated in the past years in several MS, is the National Industrial Symbiosis Programme (NISP) in UK, which managed to achieve substantial economic and environmental results, due to its lean approach to managing the network and communicating with businesses, but also significant government contributions. Similar programmes have followed in Ireland (i.e. SMILE Resource Exchange, already disconnected), Finland (FISS), France (PNSI), or Flanders (Symbiose Platform), with public financial support in the form of grants.

Role of the cities and selected city-level policies/measures

How to get started?

Based on a study on the role of IS coordination (Domenech et al, 2018), the main added value of supporting IS facilitator organisations has been to:

- **Mobilise network members and raise awareness about the opportunities of reusing resources and waste steams generated by others;**

- **Support the matchmaking, knowledge sharing and connection of companies;**
- **Support the assessment of benefits of specific IS synergies identified, e.g. through offering funding for feasibility studies, legal advice or access to technology experts, researchers or consultants for e.g. assessing materials flows.**

Cities or regions may launch facilitation programmes, however, such an initiative should be based on assessing the potential for IS synergies in the region, as well as good practices in other countries. Employing consultants with strong technical expertise and industry experience is key.

Regions and cities can take the example of several other instruments that can be incentivising IS activities and emphasise circularity aspects. The difficulties faced by IS facilitators in scaling up and in becoming commercially viable largely stem from the policy environment and creating incentives for the private sector.

Cities can influence the following policies:

- Prescription of IS practices in tendering processes;
- Better waste segregation to keep material purity;
- Level of landfill taxes and other policies increasing the cost of landfilling
- Policy incentives for the reuse;

Minimise wastage

In the box below we have elaborated a set of recommendations for concrete actions both for cities with some experience with Industrial Symbiosis and for cities who are at early stage of IS development.

Box 4 Recommended actions for cities who want to engage in Industrial Symbiosis

For cities more advanced in IS:

- **Raise awareness of companies** on the potential benefits of engaging in IS such as increased competitiveness, productivity and resource efficiency, enhanced innovation capacity and knowledge about alternative business models. Environmental and social benefits to be emphasized as well. Initiatives like FRUSH (see below) help to address this knowledge gap. Including the concept of circular economy in the curriculum and sharing of good examples (as mentioned in the Finnish roadmap to circular economy) can also contribute to improving knowledge, raising awareness of potential benefits and mind-set change in companies.
- **Further exchange on information** on the experiences with closed database vs. open database will be useful.

For cities that are at an early stage with IS development:

- **Organise campaigns** that aim to raise awareness of companies about circular economy, and the benefits of IS.
- Start with small first steps such as **mapping the industrial ecosystem** and potential opportunities for IS synergies. Waste flow mapping could support in identifying areas of potential. Targeting the biggest emitters in a database is also important.
- **Map the most important stakeholders** that can support bringing companies together and facilitate IS synergies.

- **Mapping legislation**: it is important to make an inventory of legislation that could be an obstacle and communicate this to the respective authorities. The Green Deals example from the Netherlands can be helpful in this regard. Make efforts to include IS and circular economy activities in regional strategies. The Finnish Roadmap to Circular economy can serve as a good example.
- **Develop a simple waste exchange platform** (either open or closed) in the beginning and upgrade it on the way. The scope of the platform depends on the ambition of the IS system. Very often the platform is developed on a national level within a national IS system (i.e. FISS). However, when such a central platform is missing cities can develop their own solutions.
- With regards to **matchmaking**: start small and scale up gradually contacting companies one by one. The question of building trust in IS is crucial for creating IS synergies and can be addressed by adopting an inclusive approach, promoting open data as well as an open-minded communication.

Source: Workshop on Industrial Symbiosis, Interreg Europe, Helsinki, Finland, May 2019

Box 5 Example of a city-level action for facilitating Industrial Symbiosis

FRUSH - Circular economy and IS event for start-ups and growth enterprises, Finland, SYMBI project

FRUSH originates from the results of SYMBI project, as from the studies conducted within the project a general lack of knowledge among businesses about circular economy and IS was noticed. It aims to boost the development of start-ups and create and promote new business opportunities around circular economy and IS. Since its launch in 2017 the number of participants quadrupled. The pitching competition has helped start-ups and growth enterprises to get funding and promotion. The competition has also helped some businesses to launch their products.

Source: SYMBI project

Box 12 Example Industrial Symbiosis on city level (Waste Exchange System, Valencia, Spain)

The Spanish Chambers of Commerce have set up a regional waste exchange scheme (Bolsa de residuos) that allows companies to easily exchange waste as by-products. The Chamber of commerce of Valencia began working on the By-product Exchange in 1989 in collaboration with the regional government. In 2017, 219 offers and 59 requests have been processed by these programmes in the region. The five Valencian Chambers of Commerce were involved in the dissemination and management of the by-product exchange.

Source: TRIS project, https://www.interregeurope.eu/policylearning/good-practices/item/653/waste-exchange-scheme/

Box 13 Green Deals, the Netherlands. Possibility of green growth agreements with local governments

The Green Deal approach in the Netherlands is an accessible way for companies, local and regional government and interest groups to work with the Central Government on green growth and social issues. A Green Deal is a mutual agreement or covenant under private law between a coalition of companies, civil society organizations and local and regional government to supplement existing regulation and legislation. It is a flexible method for jointly finding solutions to regulatory barriers experienced by companies trying to introduce new sustainable products, technologies or services to the market. The Green Deal approach is particularly suitable when innovations are put into practice, a phase during which projects often encounter barriers. In the period between 2011 and 2014, 176 Green Deals were closed in the Netherlands, involving a total of 1,090 participants.

Source: https://www.greendeals.nl/english

2. The sharing (collaborative) economy

The sharing (collaborative) economy is considered to be a part of the circular economy. The sharing economy entails the "peer-to-peer-based activity of obtaining, giving, or sharing the access to goods and services". It can be coordinated within a local community or network, or function on a larger-scale "coordinated through community-based online services" (Hamari et al., 2015). It mostly covers consumer to consumer (C2C) business relationships. The concept is not novel per se but the novelty of the current sharing economy concept is that it is taking place digitally on a far larger scale, extending the geographical constraints of a peer to peer (P2P) community.[2]

The sharing economy also deals with the ways in which people and businesses organize themselves to create social and environmental benefits (e.g. community supported agriculture, repair cafés). Although environmental protection is usually not the main purpose of sharing platforms, in some cases sharing economy models help achieve circular economy goals. Examples from transport and housing sector is presented below.

The collaborative economy can create new opportunities for consumers and entrepreneurs that could contribute to competitiveness, jobs and growth. As a disruptive innovation, it can also generate tensions between existing operators and innovative service providers. One major difference between platforms is their underlying commercial or non-commercial activities: platforms can be established for profit or non-profit purposes. In addition, the collaborative economy business model could cover the following types of exchanges: peer-to-peer (P2P) services; peer-to-business (P2B) services; and business-to-business (B2B) services.

Recognising the rapid uptake of these new practices, the European Commission issued a European Agenda for the Collaborative Economy in 2016. The document aimed at providing insights on key issues, such as market access requirements, liability regimes, protection of users, self-employed

[2] https://www.ceps.eu/wp-content/uploads/2016/07/SR%20No143%20Circular%20Economy_0.pdf

and workers and taxation, but also set the base for the establishment of a monitoring framework.

A recent study carried out by Technopolis Group estimated the size of the collaborative economy in the EU in 2016 at EUR 26.5 billion and number of jobs at 314,000.

Sharing of buildings

Roughly half of owner-occupied homes are 'under-occupied', with at least two bedrooms more than needed. Airbnb is an example of increasing the "utility" of the floor space by launching its peer-to-peer platform for housing space in 2008. Since then Airbnb's booking rates has grown by 80–90% in the last few years and is expected to overtake worldwide hotel listings in four to five years Meanwhile, a number of not-for-profit communities for sharing living space are growing rapidly, such as Hoffice and Couchsurfing. The concept of Hoffice can be seen as a hybrid in floor-space sharing, where higher utilisation of living space leads to a reduced demand for office space.[3]

60–65% of European office space is under-utilised even during working hours. Business already rethink the role of the office and working remotely is encouraged. This would entail increased desk sharing and reduced need for floor space. Another option is to temporarily rent out unused space, an idea Liquidspace[4] capitalises on by connecting people in need of desks or conference rooms with nearby suppliers, much like an Airbnb for office space.

Increased repurposing of existing floor space would make it possible to better utilise old buildings and change the use of freed-up office space to, e.g. residential housing, in a cost-efficient way and reduce the need for demolition and renovation. This is particularly relevant since ~80% of Europeans live in buildings that are at least 30 years old.

Complementary to repurposing, which changes the sequential use of a building, public buildings could be multi-purposed for parallel use of the floor space, meaning that different activities can take place during a short and repetitive time cycle.

Box 14 The example of Denmark

By 2035, Danish companies could be expected to reduce their need for office space due to shared desk policies and increased teleworking, which together with multi-purposing of public buildings, repurposing of old buildings and freed-up office space, and the accelerating sharing of residential floor space could increase the overall utilisation of buildings by 60% (20%) by 2035 (2020). This could lead to a reduced demand for new buildings by 9–10% (3–4%) by 2035 (2020), saving the Danish economy an estimated EUR 300–450 million.

Source: Ellen MacArthur Foundation

https://www.ellenmacarthurfoundation.org/assets/downloads/20151113_DenmarkCaseStudy_FINALv02.pdf

[3] https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_PolicymakerToolkit.pdf

[4] https://liquidspace.com/

In the transport sector the societal, economic, and environmental effects of peer-to-peer transport platforms such as Uber are only just starting to emerge. With regards to sharing privately owned cars there is in increasing trend in recent years. Nowadays, 14% of EU car sharing services are taking care of facilitating the shared use of private cars. Despite the potential for some short-term benefits there are some concerns as well, e.g. whether the commercial objectives of those who have developed and own these platforms align with the public interest of cheap, clean, efficient transport.

Box 15 Car sharing business models

An analysis of car sharing business models in Europe was carried out as part of the H2020 STARS project. Initial results reveal five basic types, but a huge diversity of interpretations. Despite mixed strengths and weaknesses, as well large differences in the scale and scope of operations, it is unlikely that any one model will become dominant in the near future – but ultimately some rationalisation seems inevitable. The five business model types are:

1. Free-floating within an operational area (e.g. Car2Go)
2. Free-floating with pool stations (e.g. Autolib)
3. Round trip, home zone based (e.g. Partago)
4. Round trip, pool station based (e.g. Greenwheels)
5. Peer-to-peer and community schemes (e.g. Drivy)

Source: H2020 STARS project

The sharing economy is increasingly associated with governance aspects, such as participative urban governance. Sharing economy solutions can drive new business opportunities and generate social benefits. However, if not managed appropriately in relation to the local context, unintended negative consequences might arise - such as a reduction in long-term rental accommodation availability. Some of the policy measures that cities could consider could focus on:

- Understanding commercial digital platforms (e.g. Uber and AIRBNB) and their cultural context, and relevant multilevel policies. This will help to identify evidence-based policy options and develop place-based strategies.
- Clarifying the legislation governing sub-letting residential and office space, and sharing business platforms (like Airbnb) by defining unambiguously who is entitled to practice it (private tenants, commercial players) and which regulation they need to follow.

- Creating financial incentives or financial support to local public-sector entities such as schools and other public infrastructure could help overcome hesitance towards renting out their properties when not in use.

There is a need to develop a 'common language' across Europe regarding sharing economy. Also there is a need to increase understanding how the collaborative economy can be better understood, communicated, and implemented across Europe. Cities can play an important role in this regard. In addition, initiatives aiming at promoting collaborative economy need to be encouraged. Funding for such type of be activity could be obtained for example from Urban Innovative Actions (UIA), an initiative of the EU that provides urban areas throughout Europe with resources to test new and unproven solutions to address urban challenges.

Box 16 Amsterdam's Sharing Economy Action Plan

Amsterdam's Sharing Economy Action Plan outlines five pillars to focus on: supporting pilot projects, leading by example, extending the sharing economy to all Amsterdam residents, developing rules and regulations, and establishing a sharing city. It addresses multiple opportunity areas including housing, office space and product sharing, and transport.

The action plan supports Amsterdam to ensure:

- ✓ This new market has the freedom to innovate and grow
- ✓ The city's citizens and visitors, and businesses have increased access and use of resources in the city
- ✓ Unintended adverse effects are mitigated

The city's Sharing Economy Action Plan sits alongside other city initiatives, such as StartupAmsterdam, that are designed to grow and improve the startup and business environment in Amsterdam. There are currently over 150 sharing economy platforms active in Amsterdam. Local platforms include, for example: 1/ Peerby - an app that connects people who need to borrow or rent an item; 2/ MotoShare - an app that connects motorbike and car owners to those in need of temporary use of one; 3/ LENA - a 'fashion library' where customers can rent high quality fashion items on a one-off basis or gain access to the clothing offered via a subscription service

Source: https://www.ellenmacarthurfoundation.org/assets/downloads/Amsterdam_-Case-Study_Mar19.pdf

3. Smart and circular design

Concepts

Smart and circular design is a horizontal concept which is relevant to several of the Rs which we adopted earlier as a methodological framework.

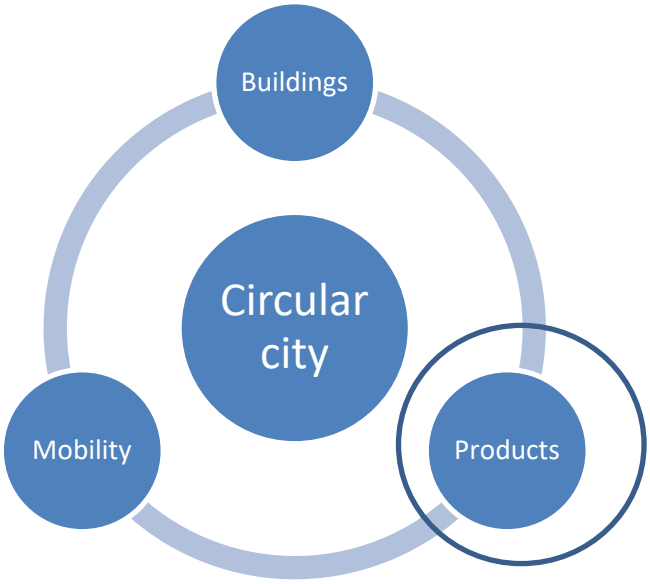
Table 1

What	Who
R1 Rethink:	Producers rethink and redesign their products. Service providers redesign their offers. Local authorities rethink the design of urban ecosystem.
R2 Reduce:	Producers increase efficiency in product design or manufacturing by using fewer natural resources and materials as inputs. Local authorities reduce the impact of their activities.
R3 Reuse:	Consumers reuse discarded products. Businesses and local authorities support reuse of material flows in the economy. Producers design products with longer lifespans, more robust composition and easily repaired.
R4 Repair:	Businesses and communities organise repair services. Local authorities support the repair and maintenance services.
R8 Recycling:	Treating waste to generate secondary raw materials as inputs for processed materials.

Design and the cities. A vision.

In parallel to the urban plan, **circular economy principles transform the design of elements within cities**. Infrastructure, vehicles, buildings, and products need to be designed to be a combination of durable, adaptable, modular, and easy to maintain and repurpose elements. Ideally, materials should be locally sourced and from renewable feedstocks where appropriate. These need to be composted, recycled, and reused. Cities should be powered on renewable energy. (based on Ellen Macarthur)

Figure 8 The pillars of a circular city



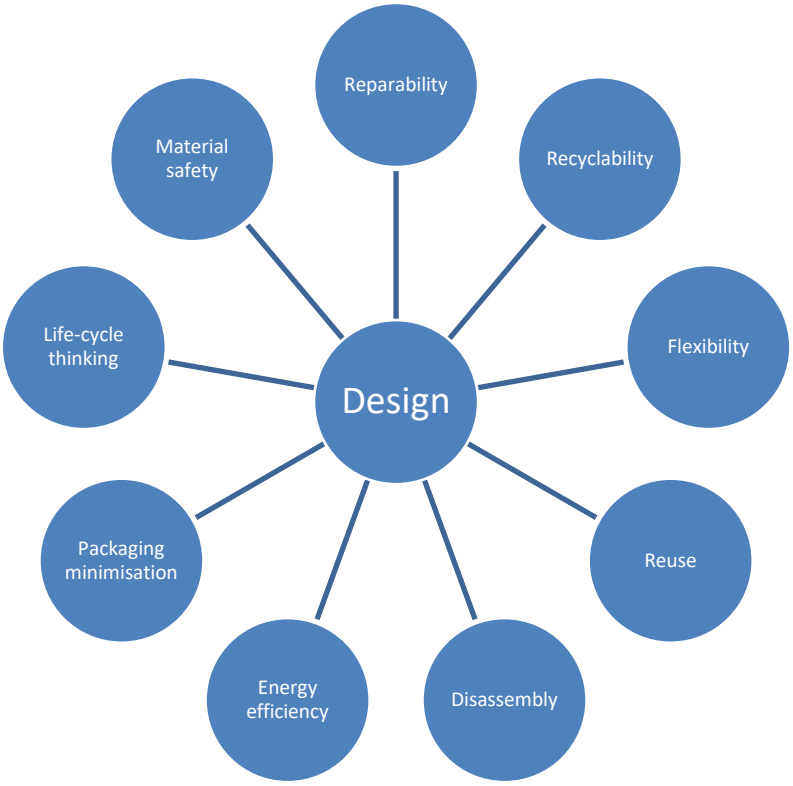
Source: based on Ellen Macarthur

Because of the limited scope of this Smart Kit in this chapter we will only focus on smart and circular design for products. The principles are applicable for many of the services provided by the city. In addition, knowing the principles of eco-design allows cities to engage in more sustainable procurement also known as Green Public Procurement (GPP).

Design for the environment (eco-design)

Eco-design is a principle that calls for minimizing the negative environmental impacts of a product across its life cycle. It includes other design principles including:

Figure 9 Principles for smart and circular design



Source: own elaboration

When working on circular design both companies and local authorities can decide on which elements to focus. While companies are in the position to address all of these issues local authorities have the mandate and the possibility to focus only on some of these directly and on the others – to a smaller extent.

EU policy framework

At the EU level, smart and circular design legal requirements remain limited, and have not, until recently, been the main focus of policy-makers. Currently, the **Eco-design directive** (2009/125/EC) is the piece of legislation that offers excellent prospect for the future. It was adopted in 2005 to target energy-using products and extended in 2009 to include all energy-related products (air conditioners, computers, household devices, etc.). It mainly focuses on energy efficiency, but also incorporates some elements of resource efficiency (see requirements on weight and volume of product in Annex I). However, these requirements have largely been left aside, due to lack of standards, fear of regulatory burden and lack of cost-efficiency (*EC, 2015a*).

In its **Circular Economy Action Plan (CEAP)**, the EC mentioned both the extension of the Eco-design directive and additional actions to boost repair and reuse. Three main lines of action are foreseen: inclusion of requirements for the availability of spare parts and repair information in the Eco-design directive revision, a testing programme against premature obsolescence under Horizon 2020, and the development of reuse activities as part of the revised Waste proposals. The Action plan acknowledged the role that can be played by Member States, but also regional and local authorities (*RREUSE, 2015*).

In parallel, the **Eco-design Working Plan 2016-2019** includes actions to develop requirements for

product durability, reparability, upgradeability, design for disassembly, information and ease of reuse and recycling. A circular economy toolbox for Eco-design will also be prepared to help manufacturers. In order to develop the missing standards in the domain, the European Commission has also published calls for the development of new standards.

While the Eco-design directive and EU policy on repairability in general act at the production level, other types of policies have been implemented at the national and local level to boost repair at a later stage of the product's life-cycle. Tax incentives for the development of repair services and jobs have been introduced in Member States (*see below examples*). Additionally, the development of the repair and reuse sector is being widely supported and is likely to develop in the following years. This is also illustrated by the trend in repair cafés and second-hand shops.

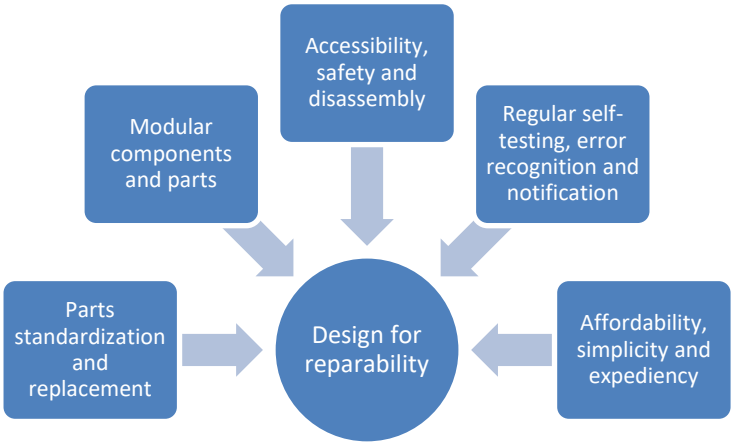
Box 17 Italian policy on smart and circular design

Apart from binding targets, Member States have implemented a number of measures to improve reparability and reuse. In 2016, Italy adopted the Decree 140/2016, which aims to boost reuse and recycling possibilities of electrical and electronic equipment by incentivising producers to adopt eco-design strategies. The objectives include optimising reparability and increasing durability of products. The incentive comes as a possibility for producers to request a reduction of their eco-contribution.

Design for maintainability/reparability

Design for maintainability or reparability prolongs product use, extending its useful lifetime. While this is not directly applicable to local authorities, they have to be aware of the principles of design for reparability in order to be able, for example, to include it as a requirement within Green Public Procurement (GPP). There are multiple elements that designers should consider in this case:

Figure 10 Design for maintainability and reparability



Source: own elaboration

In addition, in order to improve the recoverability and recyclability there are multiple things to consider when optimising the recyclability products. This is especially relevant for local authorities as they are ultimately in charge of waste recycling:

- Recyclable materials
- Limit the number of material types and composites
- Modularity and ease of disassembly
- Limit use of adhesives, dyes, paints and coatings
- Limit or eliminate hazardous materials and contamination

In the absence of legislation, designers and producers are in the position to decide how easy to recover and recycle their products. In line with existing legislation on separate collection and recycling there are huge possibilities for working together with producers in order to improve the recoverability and recyclability of products.

Smart design in the building sector

The design principles described above can be applied by cities in the building sector. In Circular Amsterdam (A Vision and Action Agenda for the City and the Metropolitan Area) the municipality has taken up the smart design concept and has translated it in the following directions:

➢ Modular and flexible design

In this particular case modular and flexible design means easy adaptability to new users and applications leading to a more functional and durable real estate. Flexibly designed houses can adapt to changing lifestyles. Flexibly designed offices are also more appealing to businesses.

➢ 3-D printing

New technologies can play a significant role in reducing cost and material use. These can lead to less waste and open up the possibilities to using new, bio-based materials.

➢ Bio-based materials

Materials with biological origin can be used for construction of smarter buildings. For this purpose cities can use the residues of agricultural activities around the cities. These applications are still in early stages of development but there are more and more examples of efforts in this direction, i.e. generating building composites from bio-waste.

➢ Experimental construction areas

In order to be able to experiment freely with smarter building design, municipalities have to make the rules more flexible allowing the testing of innovative building designs.

➢ Dismantling of buildings

The end-of-life of a building is often ignored by local authorities. By organizing building demolition in a smarter way high-quality, reusable materials can be separated. From a smart design point of view decommissioning has to be incorporated early on in the design phase. Efficient separation of waste streams is also needed in order to facilitate recycling and reuse of materials.

Box 18 The example of a company recycling building demolition material

For example, the company SmartCrusher has developed a technique for recovering the sand, the gravel and the cement from concrete. It creates almost climate-neutral new concrete from the concrete waste.

Source: https://www.slimbreker.nl/smartcrusher.html

Additional concepts

In the section below we are presenting some additional concepts which could be explored and applied by local authorities when applying Eco-design principles.

- **Biomimicry**

Biomimicry is when designers and policy makers get inspired from nature to address human challenges. The concept revolves around the idea that many of the challenges that business faces have already been solved in nature. From material engineering and product design, to business models and infrastructure development, nature has derived solutions that can spark innovation. The concept can be adapted to the functioning of a city, the construction of buildings, etc. To integrate biomimicry into your design process, answer the following questions:

- What challenge am I trying to address?
- How does nature address this challenge?
- Does this solution account for context (how, where, and by whom the solution will be used)?

- **Life cycle thinking**

Life cycle thinking means considering and minimizing the economic, environmental and social impacts across all stages of a product or process life cycle. It is not simple for companies (as producers) or local authorities (as users) to decide which is the better design alternative. Life cycle thinking could rely on some form of Life Cycle Assessment (LCA), such as:

- Environmental LCA
- Social LCA
- Life cycle cost analysis or total cost of ownership
- Streamlined LCA

The typical life cycle stages companies consider when evaluating the impacts of a product or service are listed below. Transportation between all stages should be included as well:

1. Raw material extraction
2. Material processing
3. Manufacturing
4. Use
5. End-of-Life[5]

[5] Life Cycle Initiative, UN Environment & SETAC

Smart Material Choices: Materials play an essential role in a circular economy. Hence, a local authority should have a say on the materials used in city infrastructure projects such as public building renovations; playgrounds for kids; public space renovation, etc. Preference should go to safe ingredients that can be continuously cycled. By designing or using products with materials that come from, and safely flow, into their respective nutrient cycles, one can be part of creating an optimised materials economy that eliminates the concept of waste. (Circular Economy Practitioners Guide)

What can cities do about it? City-level policies/measures/initiatives

Repair and reuse policies can have some territorial implications. Although nation-wide sectors can (and will likely develop), the collect and resell of second-hand products is currently mostly organised at a local level. In Flanders for example, products are collected by the nearest reuse and repair centre[6], and usually redistributed in the area. Repair services are also locally embedded. In both cases, mapping the surface of the functional urban area helps in establishing centres in the right location

The capacity of regions and cities to set up economic incentives depend on their power and budget. However, they can play a strong role in the management of local relationship between producers, shops, consumers and waste management centres, but also in the testing of policy pilots before they are implemented at a larger scale. In the case of Graz, the pilot benefited from being implemented in a city with a population large enough to show some results, even though Graz is located in a predominantly rural region. It also shows that pilots need not be implemented in one of the most dynamic parts of the country. The link between circularity and eco-design on one hand and the territory on the other hand is visible in the case of buildings, public spaces, etc. (*ADEME, 2017*).

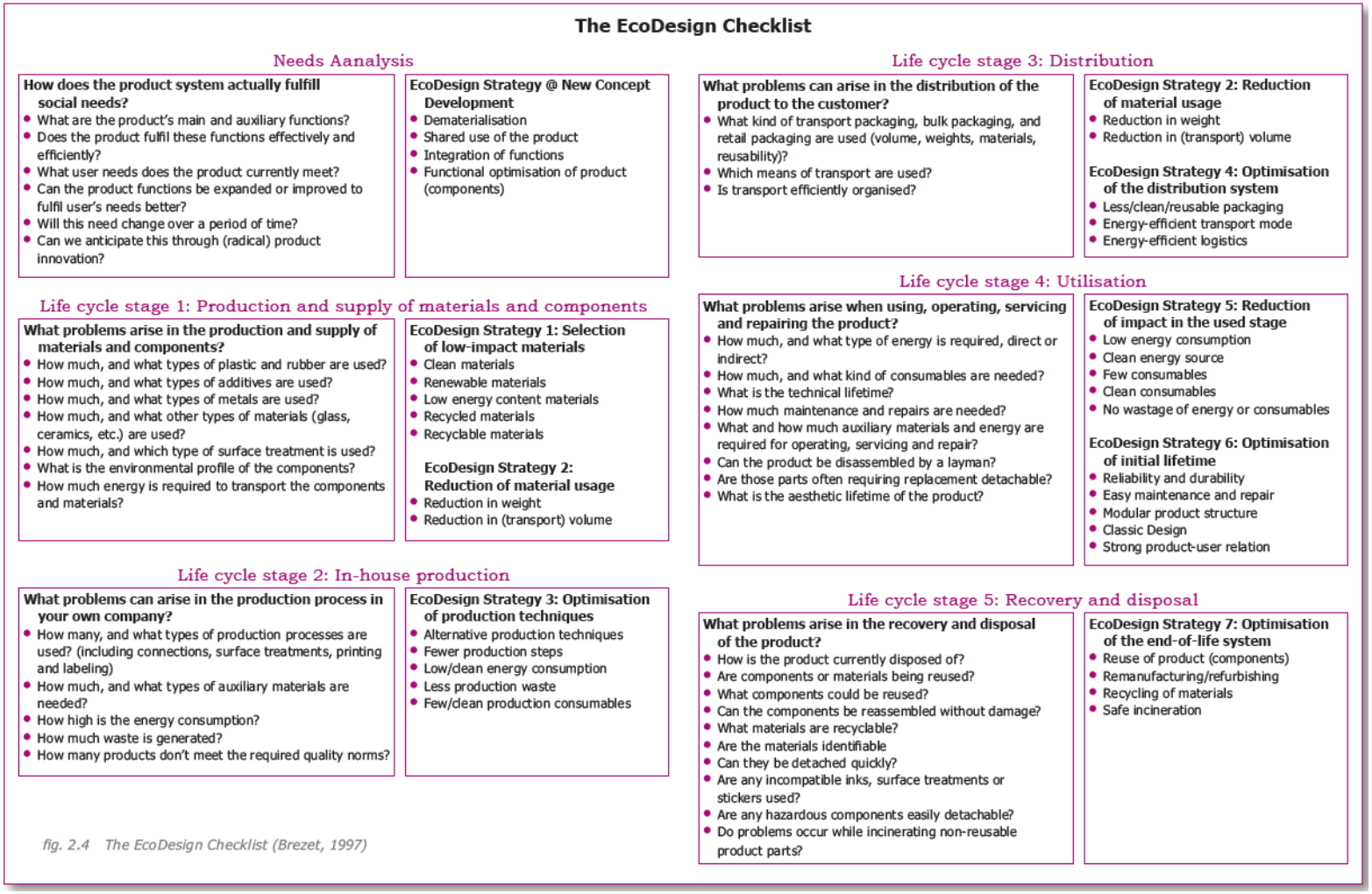
As described earlier in this section, cities can explore the endless possibilities for making the building and construction sector more circular. They can start by addressing the barriers which, for the time being, make this relatively difficult. These barriers include: financing (it could be more expensive to implement new systems); technological (i.e. 3-D printing is a very recent innovation); conservative approach in the sector; lack of information on design for decommissioning and reuse, etc.

Additionally, cities can explore the following possible actions:

- Assigning pilot projects in new areas
- Tender criteria for smart design principles in soil, road and water construction
- Challenge start-ups to develop solutions for smart design
- Establish procurement criteria for separation for demolition projects
- Initiate dialogue for better dismantling and waste separation in demolition projects
- Encourage local companies in the processing and reverse logistics of waste
- Adjust zoning plans for allow for multi-functional buildings
- Aim for high-value reuse in waste processing contracts
- Initiative a ‘materials showroom’ for construction waste
- Facilitate the exchange and use of high value building materials
- Encourage companies to use a materials passport

6 https://www.dekringwinkel.be/

Figure 11 The Eco-design checklist



The EcoDesign Checklist

Needs Aanalysis

How does the product system actually fulfill social needs?
- What are the product's main and auxiliary functions?
- Does the product fulfil these functions effectively and efficiently?
- What user needs does the product currently meet?
- Can the product functions be expanded or improved to fulfil user's needs better?
- Will this need change over a period of time?
- Can we anticipate this through (radical) product innovation?

EcoDesign Strategy @ New Concept Development
- Dematerialisation
- Shared use of the product
- Integration of functions
- Functional optimisation of product (components)

Life cycle stage 1: Production and supply of materials and components

What problems arise in the production and supply of materials and components?
- How much, and what types of plastic and rubber are used?
- How much, and what types of additives are used?
- How much, and what types of metals are used?
- How much, and what other types of materials (glass, ceramics, etc.) are used?
- How much, and which type of surface treatment is used?
- What is the environmental profile of the components?
- How much energy is required to transport the components and materials?

EcoDesign Strategy 1: Selection of low-impact materials
- Clean materials
- Renewable materials
- Low energy content materials
- Recycled materials
- Recyclable materials

EcoDesign Strategy 2: Reduction of material usage
- Reduction in weight
- Reduction in (transport) volume

Life cycle stage 2: In-house production

What problems can arise in the production process in your own company?
- How many, and what types of production processes are used? (including connections, surface treatments, printing and labeling)
- How much, and what types of auxiliary materials are needed?
- How high is the energy consumption?
- How much waste is generated?
- How many products don't meet the required quality norms?

EcoDesign Strategy 3: Optimisation of production techniques
- Alternative production techniques
- Fewer production steps
- Low/clean energy consumption
- Less production waste
- Few/clean production consumables

fig. 2.4 The EcoDesign Checklist (Brezet, 1997)

Life cycle stage 3: Distribution

What problems can arise in the distribution of the product to the customer?
- What kind of transport packaging, bulk packaging, and retail packaging are used (volume, weights, materials, reusability)?
- Which means of transport are used?
- Is transport efficiently organised?

EcoDesign Strategy 2: Reduction of material usage
- Reduction in weight
- Reduction in (transport) volume

EcoDesign Strategy 4: Optimisation of the distribution system
- Less/clean/reusable packaging
- Energy-efficient transport mode
- Energy-efficient logistics

Life cycle stage 4: Utilisation

What problems arise when using, operating, servicing and repairing the product?
- How much, and what type of energy is required, direct or indirect?
- How much, and what kind of consumables are needed?
- What is the technical lifetime?
- How much maintenance and repairs are needed?
- What and how much auxiliary materials and energy are required for operating, servicing and repair?
- Can the product be disassembled by a layman?
- Are those parts often requiring replacement detachable?
- What is the aesthetic lifetime of the product?

EcoDesign Strategy 5: Reduction of impact in the used stage
- Low energy consumption
- Clean energy source
- Few consumables
- Clean consumables
- No wastage of energy or consumables

EcoDesign Strategy 6: Optimisation of initial lifetime
- Reliability and durability
- Easy maintenance and repair
- Modular product structure
- Classic Design
- Strong product-user relation

Life cycle stage 5: Recovery and disposal

What problems arise in the recovery and disposal of the product?
- How is the product currently disposed of?
- Are components or materials being reused?
- What components could be reused?
- Can the components be reassembled without damage?
- What materials are recyclable?
- Are the materials identifiable
- Can they be detached quickly?
- Are any incompatible inks, surface treatments or stickers used?
- Are any hazardous components easily detachable?
- Do problems occur while incinerating non-reusable product parts?

EcoDesign Strategy 7: Optimisation of the end-of-life system
- Reuse of product (components)
- Remanufacturing/refurbishing
- Recycling of materials
- Safe incineration

Source: Delft Design Guide, The EcoDesign Checklist

4. Extending the lifetime of products and materials

Extending the lifetime of products is a central enabler of the circular economy, and reusing products and their components, as well as remanufacturing, is one of its key strategies. Reuse conserves the physical assets of raw materials as well as the energy embedded in products or components.

While in the previous chapter we approached repair and repairability from a smart and circular design point of view here we are sharing several policies which emphasise repair as a business model with social dimensions. Cities has a significant role to play.

To this day, Spain is the only Member State with a national binding target for reuse. Adopted in 2016 as part of the national 2016-2022 waste management plan, it sets a 50% target of all waste to be recycled and prepared for reuse, and a minimum of 2% of furniture, textiles and electrical items to be sent for repair and resale. This follows a previous law which set a 2% reuse target for large electrical goods and 3% reuse target for IT equipment by 2017 (McDowall, 2016).

Apart from binding targets, Member States have implemented a number of measures to improve reparability and reuse. We are sharing some policies and initiatives below.

Examples of policies on extending the life of products

Box 19 Swedish tax refund system

Sweden currently has two main forms of tax-based incentives to increase the use of repairs and in extension increase the life span of products and mitigate consumption of new products. These incentives are one attempt to help steer the Swedish economy from a linear economy to a circular economy and redirect parts of the workforce from production of new products to repair and maintenance. The Swedish RUT, an acronym for the Swedish words for Cleaning, Maintenance and Laundry, enables tax deductions for the cost of labour when employing businesses for domestic work. There are in particular two aspects of RUT of significance for the enablement of a more circular economy. The first is the deduction one can make when conducting repairs of major appliances (such as refrigerators or dishwashers) and the second is the deductions possible when conducting repairs, maintenance or installation of computer- or IT-equipment in or in close connection to your residence. With the RUT-system one has the possibility to make tax deduction of up to 50% of the labour cost. Another form of tax-based incentive is the VAT reduction for services which carries out repairs of bicycles, shoes, leather goods our household linen. The VAT was reduced from 25% to 12% January 1st of 2017.

Source: https://www.skatteverket.se/

Box 20 National or sectoral targets for repair and reuse, Flanders

The initiative 'network conscious use of consumer goods' aims at stimulating the reuse and repair of consumer goods. The network organises a variety of projects such as for example: repair meetings and share and trade fairs. The network has a wide reach and is supported by the Flemish regional government. The networks aims to empower the consumer in making a more conscious purchasing decision. The repair meetings take place over the entire country. The initiatives have a regional character and are entirely voluntary.

Besides preventing waste and stimulating reuse the initiative is also working on the general opinion on how to use resources in the most efficient way.

Source: https://www.bewustverbruiken.be/waarom

Box 21 Example of Repair cafe

A repair café is a meeting in which people repair household electrical and mechanical devices, computers, bicycles, clothing, etc. They are organised by and for local residents. Repair cafés are held at a fixed location where tools are available and where they can fix their broken goods with the help of volunteers. Its objectives are to reduce waste, to maintain repair skills and to strengthen social cohesion. The first repair café was held in Amsterdam in 2009 and since then has become a global movement. Repair cafes are mainly relevant where the cost of labour is high and where repair through the regular channels usually does not make any sense. One of the most important impacts of the Repair cafes is the change of mentality.

Source: https://repaircafe.org/en/

Box 22 Tax-based incentives on repair and reuse in Austria

In general, tax-based incentives for repair and reuse are set up at the national level. However, other economic incentives can be implemented at a regional or local level depending on public budget. In the case of Austria, the reimbursement of repair services was first organised at city level in Graz. In addition, the development of repair and reuse centres, fostering relations between producers and waste management companies, and the support of the repair and reuse community (e.g. repair shops) offers a bigger opportunity for regional and local authorities.

Source: http://www.rreuse.org/wp-content/uploads/RREUSE-position-on-VAT-2017-Final-website_1.pdf

Extending the lifetime of products is also associated with several other debates like the one on fighting premature (or planned) obsolescence together with increasing the durability of products. It includes a wide

range of techniques that certain manufacturers might use to shorten the functional lifespan of products and force consumers to make premature replacements in order to continue selling in saturated markets" (BEUC, 2015),

France is the first Member State to adopt a law on the topic. The Act on Consumption and Prevention of Planned Product Obsolescence (2015), provides for prison and fines up to EUR 300 000 or 5% of annual turnover for companies who have deliberately reduced their products' lifetime. Cities play little or no role in fighting planned obsolescence.

4.1. Second-hand sale

One successful traditional type of practice (often practice in an urban setting) is the linking of reuse and second-hand sale to social employment policies, offering jobs to lower skilled or long-term unemployed workers. These kinds of synergies are demonstrated by, inter alia, the Kringloop Reuse Centres in Flanders, Belgium, presented below:

Box 23 Second-hand shops grouped in reuse centres, Flanders (Belgium)

Flanders introduced a network of reuse centres in 1992 with the primary goal of preventing waste by reselling discarded products. In more than 140 second-hand shops grouped into 31 reuse centres, products such as textiles, electronics, furniture, kitchen appliances, books, records and bicycles are sorted, repaired and resold (OVAM, 2014). Apart from saving 4 kilograms of waste per inhabitant per year, the network also guaranteed employment to more than 3 800 workers in 2012 (full-time equivalent). The majority of these have been long-term unemployed or have received only limited education, and the network's reuse centres provide them with both a stable income and practical workplace experience. Added to this, the network enables those with limited resources to obtain goods they could otherwise not afford.

Source: https://www.eea.europa.eu/publications/circular-economy-in-europe

4.2. Remanufacturing

Remanufacturing is "a comprehensive and rigorous industrial process by which a previously sold, worn, or non-functional product or component is returned to a 'like-new' or 'better-than-new' condition and warranted in performance level and quality" (Remanufacturing Industries Council, 2017). The essential steps include: disassembly, cleaning, repair/replacement of damaged components, reassembly and testing, although the emphasis on each step will vary by product. The must-have feature for a remanufactured product is the assurance that the quality and performance of the item is like that of a new product. This is where it differs from repair: in repair, only the apparent fault is rectified while in remanufacturing the whole product is prepared for a new life.

Currently, the remanufacturing industry accounts for approximately 2% of the total European manufacturing sector (VDI ZRE 2017) and remanufacturing has been largely focused on the automotive industry (Guidat et al. 2015). However, the EU market potential of remanufacturing

is higher and estimated to be EUR 90 billion by 2030 (ERN 2015), with the option of expanding onto other sectors and products such as the medical sector, aircraft and railway. Thus, remanufacturing is considered not only vital to the EU circular economy objectives, but also to preserving economic growth and employment in a dematerialised economy and making European industries more competitive on a global level. To further encourage remanufacturing business practices, EU support is available through Horizon 2020, Cohesion Policy funds and through the implementation of the Eco-Innovation Action Plan (European Commission 2015).

Box 24 Scottish Institute for Remanufacture

SIR centre of excellence to increase innovation in remanufacturing

The Scottish Institute for Remanufacture (SIR), backed by the Scottish Funding Council and Zero Waste Scotland, is a pan-Scotland centre of excellence to increase innovation in remanufacturing. They aim to do this by stimulating and co-funding collaborative projects that address industry challenges, enabling companies to increase reuse, repair and remanufacture in their manufacturing operations. If innovation or the latest technology could help a company's remanufacturing operations, SIR can match it with the right academic experts from universities across Scotland and through a matched-funding model fostering collaborative projects that apply knowledge, expertise and specialist equipment to operational improvements for Scottish businesses. SIR funding of £5,000 to £50,000 per project is available. SIR pays for the cost of a researcher's time on the project. Companies match the SIR contribution through staff time, equipment or equivalent. The partner university contributes the indirect and estate costs (FTE costs) for the researchers on the project. Alternative funding can be investigated for projects with partners outside of Scotland.

Source: http://www.scot-reman.ac.uk/, ESPON CIRCTER project

What can regions do?

There is a need for policy aiming to incentivise companies to manufacture their products for longer life, and develop more schemes to mobilise the customers to return used products. Developing eco-design strategies, such as design for recycling or disassembly, can facilitate remanufacturing and closed loops.

While remanufacturing is largely business-driven and the manufacturing industry a complex ecosystem of various (regional, national, and international) players, regions and cities can play an important role in increasing awareness. For example, public procurement policies can address the procurement of remanufactured products or local events and campaigns can sensitize the public on the benefits of remanufacturing.

Cities can help promote remanufacturing to financial institutions as well as create financial incentives for businesses wishing to take up remanufacturing.

Research plays a vital role in developing new and optimized remanufacturing methods. Thus, close

cooperation between research institutes and manufacturing industries will be increasingly important. National, regional and city authorities can facilitate this cooperation.

5. Regenerative sources – bio-based materials, regenerative water

5.1. Bioeconomy

The bioeconomy has the potential to address environmental and energy challenges by boosting the production of renewable materials and bioenergy. It contributes to the effort of transition towards a more circular and sustainable economy, by the exploitation and utilisation of renewable resources instead of fossil-based ones. Furthermore, the bioeconomy (including the blue bioeconomy in the coastal areas) is a source of growth and jobs. It is an important sector for the EU covering sectors such as agriculture, forestry, fisheries food and chemicals. The scope of the bioeconomy in 2015 was 2.3 trillion EUR and employed some 8.2% of the EU workforce. (EU Strategy, 2018)

The **European Bioeconomy Strategy and action plan** (2012) (updated in 2018) defines the bioeconomy *as 'the production of renewable biological resources and the conversion of these resources and waste streams into value-added products, such as food, feed, bio-based products as well as bio-energy*".

Box 25 Scope of the bioeconomy

> The bioeconomy covers all sectors and systems that rely on biological resources (animals, plants, micro-organisms and derived biomass, including organic waste), their functions and principles. It includes and interlinks: land and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy and services

The strategy is structured around three pillars: 1/ Investments in research, innovation and skills; 2/ Reinforced policy interaction and stakeholder engagement; 3/ Enhancement of markets and competitiveness. The renewed EU industrial policy strategy (adopted in 2017) includes elements to further support the uptake of bioeconomy.

Bioeconomy strategies have been implemented at various territorial levels in Europe. Several countries and regions have adopted national or regional bioeconomic strategies (e.g. Finland, Scotland, Saxony-Anhalt, South-west Netherlands). The approach of each region revolves approach, around its distinctive assets (terrestrial, marine and maritime biological resources) (as one of the driver was the requirement of EU smart specialisation strategies), with a main objective of economic development fostered by the bioeconomy. Each strategy could thus focus on certain types of biomass, or on certain sectors, depending on availabilities and local priorities.

According to the updated bioeconomy strategy bioeconomy deployment will has a significant potential for job creation, notably in coastal and rural areas and with the participation of primary producers. **For urban**

areas, the strategy points out that cities should become major circular bioeconomy hubs, with significant and economy gains. It concerns mostly the management of organic waste. The example of Amsterdam is provided, with the recycling of value organic residue streams that could generate 150 MEUR of added-value per year, create 1,200 new jobs and decrease CO_2 emissions by 60, 000 tonnes.

Whatever the territorial scale, several types of policy instruments can be mobilised to support the development of bio-sourced materials:

- Regulatory measures, for prohibition or obligation. The specific territorial implementation of such measures is often not relevant, as the measures are usually implemented horizontally across EU territories.
- Fiscal and financial measures. It can be financial support (e.g. subsidies, guarantee) or fiscal incentives (e.g. tax exemption). Some measures can be implemented at the territorial level, such as call for projects or R&I support scheme. In its updated bioeconomy strategy, the Commission indicate that regions and municipalities will be mobilised for pilot action to support local bioeconomy development (rural, coastal, urban) through Commission instruments and programmes;
- Procurement measures, to support the uptake of specific products. Some measures can be implemented at the territorial level;
- Communication and awareness raising measures. While the development of norms, labels or certification schemes might be more relevant at a bigger territorial scale, some communication measures can be undertaken at the territorial level;
- Sector organisation measures. The territorial level can be relevant for the implementation of such measures. The development of a regional or local bioeconomy strategy is often linked to the willingness to foster the regional industry, either because it is losing importance (A1) or they are fears that it will do in the near future, and thus that structural changes need to be supported (A3). For instance, in France, the biorefinery of Pomacle-Bazancourt (Burgundy) supported industry diversification and fostered the arrival of new industrial stakeholders. Another example is the on-going development of a local strategy in a sub-territory of the Haut-de-France region, to create new industrial activities in a crisis-affected region. (CIRCTER policy report)

5.2. Bio-plastics

The European Strategy for Plastics in a Circular Economy (2018) supports the development of alternative types of feedstock (e.g. bio-based plastics or plastics produced from carbon dioxide or methane), offering similar performance as traditional plastics. With the upcoming ban of single-use plastics the share of the market for these products will grow exponentially. The strategy also emphasises the importance of labelling, adequate waste collection and treatment. These objectives are in line with the renewed EU industrial policy strategy, with a target of having all plastics packaging placed on the EU market be reusable or recyclable in a cost-effective manner.

At the national and regional levels, it is possible to set specific objectives and requirements for bio-plastics. For instance, France set up a ban on single-use non-biodegradable plastic bags, with a periodic increase of the biodegradable content that may come from biomass. However, the lower the geographical scale, the more difficult to implement such mandatory policies. Indeed, it could generate extra charges for companies operating locally, as they are potentially forced to adopt specific and more expensive solutions. It could also

create confusion for stakeholders, with coexistence of different systems or requirements from various territories. It would thus be recommended that local policies remain non-mandatory, in order for the market to adopt them autonomously.

Link to the EU waste legislation

The revised Waste Framework Directive (in line with the Circular Economy Action Plan) allows biodegradable and compostable packaging to be collected together with the bio-waste and recycled in industrial composting and anaerobic digestion, which has already successfully been implemented in several Member States. By 2023, separate collection of bio-waste is set to be mandatory throughout Europe. Biodegradable plastics verifiably help to collect more bio-waste and ultimately contribute to reaching the new recycling targets.

The Packaging and Packaging Waste Directive acknowledges bio-based and recycled materials are equally viable solutions to make packaging more sustainable. While Member States are encouraged to promote the use of bio-based recyclable packaging and bio-based compostable packaging, the Directive still lacks concrete legislative measures stimulating their use and improving market conditions for such products.[7]

Figure 12 Bio-based plastics

Source: European Bioplastics

Box 26 Properties and applications of bio-based plastics

Properties: Bio-based or partly bio-based durable plastics, so called "drop-in bioplastics", such as bio-based or partly bio-based PE, PET or PVC, possess identical properties to their conventional versions. These bio-based plastics cannot be distinguished from conventional plastics other than by scientific analyses.

Applications: Bio-based plastics, such as starch blends, PLA, bio-PET and bio-PE, are mostly used in packaging applications. They are also used in fibres in the textiles sector. Bio-based acid is suitable for several applications in sports and footwear, automotive, packaging, agriculture, non-woven and fibres applications.

Source: Bio-Based World News, https://www.european-bioplastics.org/

[7] https://www.european-bioplastics.org/policy/circular-economy

What can cities do about it?

For the bioeconomy, the territorial perspective is important: indeed, it is linked to the distribution of terrestrial, marine and maritime biological resources. Furthermore, the bioeconomy has the potential to foster the economic development of rural areas, by opening up new opportunities for the agricultural and forestry sectors (e.g. food processing, bio-based industries, bioenergy). The development of local strategies can contribute to identifying priority resources for the territories, settle conflict of usage (e.g. competition between food crops and energy crops) and promote the development of new economic activities by sustaining the transition towards sustainable agriculture and forestry. A local strategy can create the enabling conditions for the development of the territory and can further assist in identifying the public and private resources than could encourage research and development. This recommendation is more suitable for predominantly rural and intermediate regions, as predominantly urban regions can further rely on public transport.

Box 27 Potential gains from recycling organic residue streams

The city of Amsterdam estimates that the better recycling of high value organic residue streams could generate EUR 150 million in added value per year, create new 1.200 jobs in the long run and save 600.000 tonnes of carbon dioxide annually.

5.3. Water reuse

Concept

Numerous regions and cities in Europe are subject to water stress due to over-abstraction. Over-abstraction is caused by irrigation (in the predominantly agricultural areas) and consumer demand including tourism. There is a wide agreement among scientists that, in the future, drought and water scarcity will become more frequent due to climate change and increasing population. According to a 2007 Communication on Water Scarcity and Droughts, over the past 30 years droughts have increased their intensity in the EU and at least 11% of the European population and 17% of its territory have been affected by water scarcity .

The potential role of treated wastewater reuse as an alternative source of water supply is well acknowledged and incorporated in international, European and national strategic documents. UN Sustainable Development Goal on Water (SDG 6) specifically targets a substantial increase in recycling and safe reuse globally by 2030. Water reuse is a top priority area in the **Strategic Implementation Plan of the European Innovation Partnership on Water**, and maximisation of water reuse is a specific objective in the Communication **"Blueprint to safeguard Europe's water resources"**.

Applications

There are several immediate applications of reused treated wastewater and these are:

- crop and landscape irrigation (mainly relevant for countries in Southern Europe);
- industry (relevant for all countries and mainly used by chemical industry, the steel and metallurgy industries, the pulp and paper industry);
- fire extinction (idem);
- aquifer recharge (idem);
- urban non-potable use (increasing pattern in Austria, Belgium, Italy Switzerland).

In an urban context several applications of reused water for irrigation are of the highest relevance:

irrigation for parks and green spaces; fire-fighting; golf courses; road washing; etc.

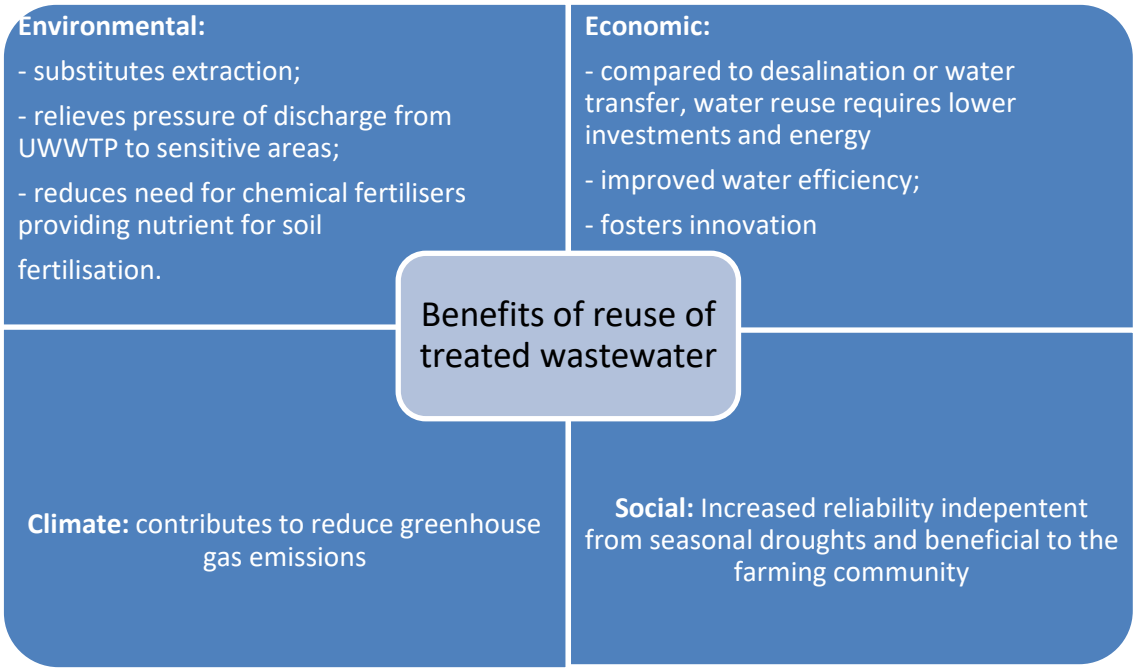
Box 28 Example of reuse of treated waste water for municipal use in Spain

Tres Cantos is a "satellite city" of Madrid, with around 40,000 inhabitants. As it has expanded, the construction of WWTPs has included the provision to treat water for reuse40. Currently, the WWTP has a treatment capacity of 37,000 m3 per day. The advanced treatment for reuse supplies 3,000 m^3 per day for the municipal area, where it is used for irrigation of green spaces such as parks. Previously, water from the drinking water supply was used for this purpose.

Source: *http://www.iagua.es/noticias/reutilizacion/14/07/11/tres-cantos-ya-riega-los-parques-de-la-ciudad-con-agua-reciclada-51951*

Benefits

Figure 13 Benefits of water reuse



Source: own elaboration

In addition, water reuse is expected to become an important part of the EU water sector and holds significant potential in terms of creating green jobs in the water industry. At present, about 1 billion cubic metres of treated urban wastewater is reused annually, which accounts for approximately 2.4% of the treated urban wastewater effluents and less than 0.5% of annual EU freshwater withdrawals. However, the potential is much higher.

EU and national policies

Both southern Member States such as Spain, Italy, Greece, Malta and Cyprus and northern Member States like Belgium, Germany and the UK already have in place a number of initiatives regarding water reuse for

irrigation, industrial uses and aquifer recharge**.** Cyprus and Malta already reuse more than 90% and 60% of their wastewater respectively, while Greece, Italy and Spain reuse between 5 and 12% of their effluents, clearly indicating a huge potential for further uptake.

Box 29 Examples of national policies driving water reuse in EU countries

- water consumption for industries is limited to a value which could be reached only through recycling water (Austria);
- There are standards for treated wastewater reuse with quality criteria for irrigation. These standards are stricter than the WHO Guidelines and take the specific conditions of Cyprus into. These criteria are followed by a code of practice to ensure the best possible application of the water for irrigation (Cyprus)
- High water prices encourage industries to recycle process and cooling water. One of the best known examples is the industrial symbiosis of Kalundborg where several companies mutually provide and recycle wastewater (Denmark)
- Health Authorities issued in 1991 the ''Health Guidelines for reuse, after treatment, of wastewater for crop and green spaces irrigation'' (CSHPF, 1991) French Guidelines impose a stringent monitoring of the microbiological and chemical quality of reclaimed waters. Financial incentives have been available from the Catchment Authorities for reuse projects in industry that demonstrate an environmental benefit (France)
- Four regional areas in Germany provide subsidies for rainwater reuse and rainwater catchment is included in building Regulations with a fee for discharging rainwater into the sewer. (Germany)
- Very stringent hygienic requirements for reused water for irrigation which pushes up the cost and makes it difficult to practice (Italy)
- With the Dutch Government imposing taxes and limits on aquifer abstraction to reinstate original groundwater level, industrial wastewater reuse is becoming increasingly interesting (Netherlands)
- Reused water for irrigation is practiced but strictly regulated. Guidelines exist. (Portugal)
- Financial incentive for industry to reuse wastewater through tax reductions under the previously applied for energy efficiency schemes (UK)

Source: EU, 2013, Typsa, Updated Report on Wastewater Reuse in the EU

1) Reuse in integrated water planning and management

There is a need to better integrate water reuse in water planning management. Water reuse is a way to address water scarcity and achieve good status under the Water Framework Directive. It can also be considered as a measure under the Urban Waste Water Treatment Directive. Therefore, in 2016, the European Commission published guidelines on Integrating Water Reuse into Water Planning and Management in the context of the WFD. They contain they contain recommendations on how to better integrate water reuse in water planning and management within the EU policy framework.

2) Minimum quality requirements for water reuse in irrigation and aquifer recharge

One of the obstacles for the more tangible take-off of wastewater reuse is the lack of comprehensive legal framework. Despite the fact that some MS have developed standards they differ from each other. This might potentially lead to distrust among the public and trade restrictions with agricultural goods. Therefore, the Commission proposed in 2018 **legislation on minimum requirements for water reuse in irrigation and aquifer recharge**. It has not been approved yet.

3) Water reuse in industrial activities

Industrial water reuse is already a common practice in many sectors. The European Commission will look into further integration of water reuse in the development and review of the Best Available Techniques Reference Documents (BREFs) under the scope of the Industrial Emissions Directive(2010/75/EU) and the Sectoral Reference Documents on best environmental management practice (BEMP) as part of the EU Eco-Management and Audit Scheme (EMAS) for relevant sectors.

4) Support to research and innovation in water reuse

Water reuse and associated wastewater treatment continue to be the object of research and innovation namely the improvement of treatment facilities, development of smart technologies and reduction in energy consumption. Within the European Innovation Partnership (EIP) on Water, several action groups set up in recent years address water reuse, such as: Industrial Water Reuse and Recycling (InDuRe), Water & Irrigated agriculture Resilient Europe (WIRE), Real Time Water Quality Monitoring (RTWQM), Verdygo - modular & sustainable wastewater treatment. Funding opportunities are also available within the European Regional Development Fund (ERDF) in line with the regional smart specialization strategies (RIS3). Specific calls on water reuse in the context of the circular economy are launched with Horizon 2020. Projects can be supported by LIFE (Programme for the Environment and Climate Action). Water reuse is subject to the first Innovation Deal signed in 2017. This voluntary cooperation between the European Commission and 14 partners from national and regional authorities, universities, knowledge centres, innovators and end-users **addresses existing regulatory barriers to innovation in this sector**.

5) EU funds for investments in water reuse

EU funding for water reuse infrastructure is **already available** under the ERDF, the Cohesion Fund (CF) and the European Agricultural Fund for Rural Development (EARDF). For the upcoming programming period Member States are envouraged to prioritise water reuse investments in their Operational Programmes. As an example, water reuse is included in the Thematic Guidance Fiche on Water Management as a **key priority for investments in the water sector and action of high European added valu**e for the ERDF and the CF. Investments in water reuse infrastructure can also be eligible for the European Fund for Strategic Investments (EFSI).

Examples

Box 30 Innovation Deal on Sustainable wastewater treatment combining anaerobic membrane technology (AnMbR) and water reuse

The Innovation Deal is about the shift from the conventional treatment of urban waste water to using it as a water resource.

The anaerobic membrane technology accelerates treated water reuse for irrigation by facilitating the extraction of energy and nutrients. The intense reuse of treated waste water will contribute to overcoming the challenge of water scarcity. In the list of innovators and authority stakeholders it is possible to find all kinds of stakeholders such as water ministries and utilities, research institutes and others: Confederación Hidrográfica del Júcar (Spain); Portuguese Waters; Sustainable Energy and Water Conservation Unit and Water Services Corporation (Malta); Consellería de Agricultura, Medio Ambiente, Cambio Climático y

Desarrollo Rural (Spain); Public Entity on Wastewater Treatment (Spain); Valencia University and Politecnical University (Spain); New University (Portugal); Institut Européen des Membranes and Laboratory on Environmental Biotechnology (France); H2020 SMART Plant project consortium; ECOFILAE (France); and Canal de Riego del Río Turia (Spain).

Source: https://ec.europa.eu/research/index.cfm?pg=newsalert&year=2017&na=na-070417

How to get started?

- Integrate water reuse in planning documents such as River Basin Management Plans; Drought Management Plans; land-use planning; irrigation plans; water supply and sanitation plans.
- Compare costs with other alternatives and define how these compare to the benefits. Determine the funding sources for the development of the operation. Who pays and who benefis?
- Determine which (legally binding) standards for the quality of reused water will be used and if national ones are not available use the guidelines of the World Health Organisation (WHO).
- Ensure practical application of standards to all relevant parties through an active communication campaign
- Develop inspection plans and programmes targeting with priority those activities which present the greatest risk to health.
- Engage with stakeholders and discuss possible legitimate public concern.

Box 31 Engaging with stakeholders in Milan

Since its operations began, the Nosedo and San Rocco WWTPs have been open to scheduled visits, particularly for schools or educational institutions and citizens from various local or non-local associations. Environmental awareness from citizens and schools is fostered through guided visits of the treatment plants. In particular, local non-profit associations have developed, in cooperation with staff of the purification plant of Nosedo, an educational pathway related to the agricultural and food environment with visits to the plant. Occasionally, farmers hold their meetings at the plant's conference room.

Several local politicians, representing the Milan town administration, province or the Lombardy regional administration, hold meetings with enterprise unions, citizens, farmers or environmental associations, in order to discuss environmental requalification, agriculture development, food safety or energy reuse. Environmental associations also organise their meetings in the plant's conference room to address issues regarding water and its reuse, as well as different environmental matters related to the research sector.

Source: Mazzini et al, 2013

6. The Waste as a Resource

The overall impact of waste-related policy on the circular economy is significant. All efforts in terms of policy and initiatives to prevent the generation of different categories of waste fit into the notion of circular economy despite the fact that there is no closing of the loop per se.

The objectives and targets set in European legislation have been key drivers to improve waste management and create incentives to change consumer behaviour. The overarching logic guiding EU policy on waste is the waste hierarchy, which prioritises waste prevention, followed by preparing for reuse, recycling, other recovery and finally disposal, including landfilling as the least desirable option.

Figure 14 Waste hierarchy

This should help Europe to extract more value from the resources it uses, reduce negative impact on the environmental associated with waste management and create jobs.

6.1. Recycling

Recycling is a well-established eco-industry for processing materials (already considered waste) to obtain new materials of different quality levels (depending on the technological process applied). In the EU, the Waste Framework Directive sets a target of 50% of selected materials in household and similar waste to be recycled and prepared for reuse by 2020 by each EU Member State for at least four categories (i.e. paper, glass, metals, plastics) of waste. The Circular Economy Package also includes ambitious targets related to recycling as illustrated below:

Box 32 New recycling targets as per the revised legislative framework on waste adopted in July 2018

The framework that entered into force in July 2018 sets clear targets for reduction of waste and among which for recycling:

- A common EU target for recycling 65% of municipal waste by 2035;
- A common EU target for recycling 70% of packaging waste by 2030;

There are also recycling targets for specific packaging materials:

- Paper and cardboard: 85 %
- Ferrous metals: 80 %
- Aluminium: 60 %
- Glass: 75 %
- Plastic: 55 %
- Wood: 30 %

Other important targets:

- A binding landfill target to reduce landfill to maximum of 10% of municipal waste by 2035;
- Separate collection obligations are strengthened and extended to hazardous household waste (by end 2022), bio-waste (by end 2023), textiles (by end 2025).

Source: Revised legislative framework on waste

Recycling rates — the amount of waste recycled as a share of waste generated — can be calculated from regularly reported European waste data for several waste streams. The amount of municipal waste being recycled has been steadily increasing in Europe thanks to investments in appropriate collection and handling, financial incentives to move away from landfilling of waste and landfill bans. It is to be noted that the data include all forms of material recovery, with no distinction between down-cycling, recycling or up-cycling. The performance of EU Member States on the recycling of municipal waste varies. Despite the progress being made in nearly all since 2004, in a number of Member States significant efforts are still needed to achieve the 2020 target.

With regards to the material flows in the recycling loop, abiotic technical materials (such as metals and minerals) and biological materials should be distinguished. In practice, technical and biological materials are often mixed, which has implications for biodegradability and recyclability. Furthermore, using more biological materials may exert additional pressure on natural capital, with impacts on ecosystem resilience.

Driven by EU waste policies many EU Member States took steps to introduce and pursue ambitious recycling targets. Examples of these are presented below.

Box 33 Examples of recycling targets adopted by EU Member States

- Recycle 50 % of organic waste, paper, cardboard, glass, wood, plastic and metal waste from households by 2022 (Denmark)
- Recycle 70 % of paper, cardboard, glass, metal and plastic packaging from the service sector by 2018 (Denmark)
- Recycle 60 % of organic waste by 2018 (Denmark)
- Recycle 80 % of phosphorus in sewage sludge by 2018 (Denmark)
- Recycle some 50 % of all municipal waste for materials and use 30 % for energy recovery by 2016, with not more than 20 % of the total deposited in landfill (Finland)
- Replace 5 % of the gravel and crushed stone used in earthworks with industrial and mining waste by 2016 (Finland)

- Increase the share of recycled quarry materials from 6 % to more than 10 % of domestic production within the next 10–15 years (France)
- Recycle 80 % of collected waste by 2030 (Latvia)
- Recycle at least 85 % of industrial waste by 2015 (Netherlands)
- Recycle at least 95 % of construction and demolition waste by 2015 (Netherlands)
- Recycle and compost 45 % of household waste by 2016 (Northern Ireland, United Kingdom)
- Recycle 60 % of household waste by 2020 and 70 % of all waste by 2025 (Scotland, United Kingdom)
- Recycle 70 % of industrial and commercial waste by 2024/25 (Wales, United Kingdom)
- Recycle 70 % of municipal waste by 2024/25 (Wales, United Kingdom)
- - Recycle 90 % of construction and demolition waste by 2019/20 (Wales, United Kingdom)

Source: European Environmental Agency,

https://www.eea.europa.eu/publications/more-from-less

What can cities do?

Waste collection and recycling are two of the responsibilities most often associated with the local level. Improved waste collection can be the first step towards a circular economy but many cities and regions are taking further steps, for example related to extended producer responsibility or transformation of waste into secondary raw materials and separate collection of different types of waste.

When it comes to progress to circular economy from materials perspective some of the policy questions that cities need to consider are the following:

- Is waste increasingly recyclable?
- How far do the materials keep their value in the recycling process avoiding downscaling?
- How far is the recycling system optimised for environmental and economic sustainability?
- Are materials designed to be recycled avoiding pollution from recycling loops (link to eco-design)?

Attention therefore needs to be paid to extending the quality and value of recycled material, starting from the design of materials and products. More innovation and increased efficiency are also required at all stages of the recycling system: collection, pre-treatment and processing.

In France, there is an interesting example of an award targeted at different types of territories – Territoires Zéro Déchet Zéro Gaspillage (TZDZG)[8]. (Territories with Zero Waste and Zero Wasting) bringing together the waste issue with the territorial dimension.

[8] https://www.ecologique-solidaire.gouv.fr/territoires-zero-dechet-zero-gaspillage

6.2. Waste heat recovery

Waste heat recovery is the process of capturing heat from waste streams of existing industrial processes and using this heat directly. It is also possible to upgrade it to a more useful temperature, and/or converting it to electrical power or cooling. The energy generated from heat recovery, if not required by the process or industrial site can be exported to neighbouring facilities or to electrical or heat distribution networks. Waste heat recovery results in energy savings and greenhouse gas emission reductions. There is increasing interest in the development and application of heat recovery systems. Key drivers are the national regulatory requirements with regards to emissions and emission reduction targets, increased energy costs and energy security considerations. Technological improvements and innovations are essential for enabling European industries to benefit from these developments. Efforts should focus on improving the energy efficiency of heat recovery equipment and reducing installed costs.

Better use of waste heat represents a significant source of energy savings for industries. In a context of reducing greenhouse gas emissions and introducing the concept of circular economy in heat management in view of industrial process electrification, European industries have a clear interest in finding new ways to capture the heat produced by their process and to reuse it or to produce electricity.

A vast amount of waste heat is produced in urban areas from a range of local sources (e.g. from metros, large buildings, extensive ventilation systems) and from urban waste or waste-water systems. Thermal energy captured can be supplied through individual central heating and cooling systems or distributed through district heating and cooling networks to multiple buildings. In some cases, it might be needed to combine the recovery of waste heat with different technologies, (e.g., heat pumps) in order to bring the temperature level of the waste heat to those matching the existing heating and cooling applications addressed in the proposal.

In urban areas there is significant potential for waste heat and waste-water heat recovery, in services sector and transport system facilities and their connection and integration into the existing heating and cooling supply systems in buildings/facilities or district heating/cooling systems. To achieve this, there is a need to develop sustainable business models and organisational, managerial, and financial solutions for deployment of the proposed technological solutions in the EU, with due regard to the legislative framework. [v1]

Under Horizon 2020 Programme EU is supporting research activities related to waste heat recovery. One of these projects is I-ThERM which is aiming to investigate organisational, technoeconomic and socioeconomic barriers to the wide adoption of advanced heat recovery technologies and ways of overcoming them and identify streams of waste heat from industrial processes in the EU 28 and potential for energy recovery.

6.3. Upcycling

Value Recovery Models focus on maximising recovery and recycling of products and materials after use into new products or useful resources in order to reduce wastage and conserve resources. The development of reverse logistics, i.e. the return from point of consumption to the point of production, is essential for this model. It should be considered that for some materials, recycling

involves a loss of quality and for products also loss of design, and technical and energy inputs. Acknowledging this, difference can be made between downcycling, which results in lesser quality and reduced functionality, and upcycling. **Upcycling is a process of transforming by-products and waste into new materials or products of higher quality than the original one or better environmental value.**

Box 34 Producing newly designed furniture from waste and abandoned materials: experience of Api'Up Association (Nouvelle Aquitaine region, France)

The focus of the activity of the association is the production of a series of new furniture from waste and abandoned materials which are collected following an upcycling logic. In addition, the association aims to raise awareness of sustainable consumption and production. The material is collected in the local area, sorted and transformed to obtain wooden panels that are used to create a specifically designed collection of furniture, which adds value to the waste material used. Api'Up is also involved in social inclusion projects and advocates for the preservation of local skills and traditional know-how in carpentry and sewing.

The activities of the association started in 2012, when an interest in upcycling started to emerge. Nowadays the association works primarily with wood, but it is performing several tests to use textile and leather. Financial support was received from European funds, national funds, Region of Aquitaine Limousin Poitou-Charentes, Landes department, urban centers, Aquitaine Active and banks. The project resulted in the creation of new jobs. Half of the collected waste was treated towards a more environmentally responsible recycling and the other half was upcycled or reused.

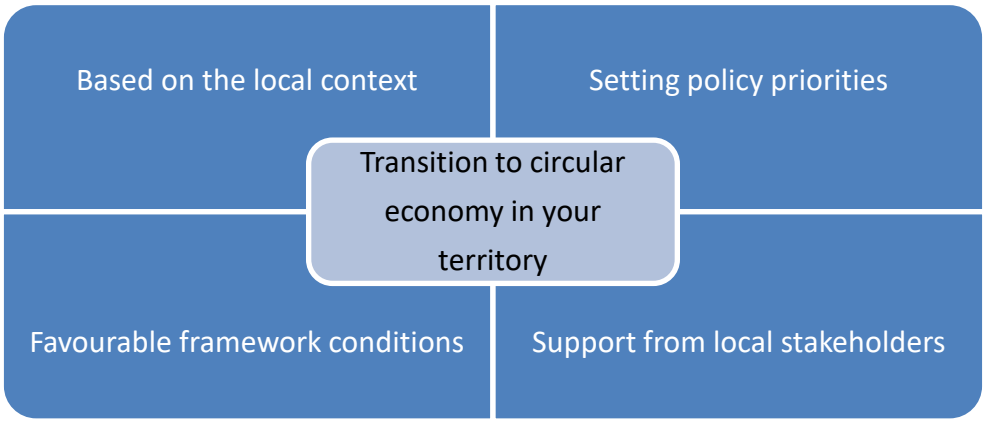
The experience of Api'Up is interesting for two aspects: one is related to the products created and the other to the philosophy behind it. Many other recycling and upcycling activities exist; however, they consist mainly in reaggregation of different pieces of furniture to create new ones. Api'Up instead transforms old pieces of furniture to obtain again wooden panels from which new furniture is created following a defined design style. In addition to this, the activities of Api'Up are closely connected to the local territory.

Sources: http://www.dudechetaudesign.com/, Interreg Europe RETRACE project

IV. Towards a Comprehensive CE strategy in your territory. Planning for circular economy.

The transition to a circular economy is place-specific. It depends on the structure of the regional and local economy, on the existing policy mix (national legislation and local incentives) as well as on cultural and behavioural factors. The transition to the circular economy is a complex process requiring multi-sector and multi-governance effort requiring the buy-in, the efforts and the backing of numerous stakeholders. The circular economy also requires changes in the current production and consumption system and as such it is conditioned by a number of policy interventions. This transition often has both winners and losers therefore when addressing the change on a local level different trade-offs are to be carefully explored and properly communicated.

Figure 15 Building blocks of the transition to a circular economy



The transition to the circular economy is often hampered by a number of lock-ins which should be addressed individually:

- Lack of systemic vision;
- Unfavourable policy framework;
- Vested interests;
- Risk-averse organisational models;
- Practices of producers and consumers

In the following sections we will present approaches and techniques for addressing the above lock-ins and obstacles.

1. Assessing local context and potential

The circular economy depends to a certain extent on the availability of natural assets. Before embarking on the road to transition to the circular economy, it is paramount to analyse the local potential, resources and capabilities. It is also important to have a very clear idea of potential obstacles and blockages.

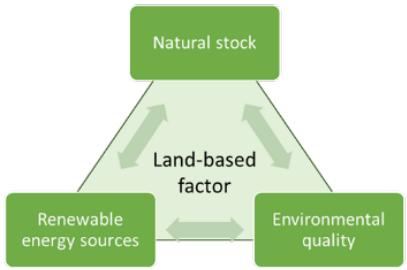
Box 35 Cities and their territorial capital

Cities and regions should make use of the territorial capital. They hold significant assets that are key building blocks on the road to a circular economy. This capital varies across territories (geographical location, natural resources, social capital and institutions, etc.), their economic role in the cities and regions, and how much they can be leveraged to

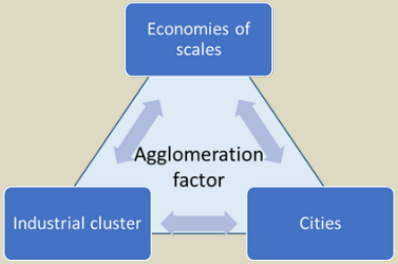
foster transition to the circular economy. Being able to realise the potential of the territorial capital depends on a number of factors including policy, institutions, political will and the financial context.

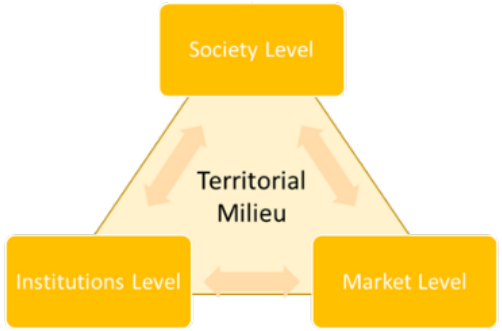
The analysis of the local context and potential could be guided by the below framework including assessment elements, guiding questions and presentation of the assessment. The framework starts with a number of guiding questions asked by categories of assets. For each category of questions, we introduce the types of indicators measuring the relevant territorial feature and also the potential use of the indicator. This framework will give the baseline of the territory which will represent its starting point and on which it will base prioritisation and future policies and actions.

Table 2 Methodological framework for analysing the local context in the context of a transition to circular economy

Assessment elements	Guiding questions	Presentation of the assessment	Potential use
A. Physical (land-based) endowment of the city	• What are the natural resources (land, water, timber, minerals, solar radiation, wind, biomass, etc.) on the territory of the city or in peri-urban areas? • What ecosystem/environmental services are available on your territory?	Indicators of material and energy resources and description of ecosystem services that support economic activities in your territory. 	Enabler for bio-based materials Type of renewable energy which could be produced Possibility for 'circular brown use' Baseline for monitoring and reporting
B. City performance	• What is the performance of the city in terms of resource productivity/ efficiency? • How dependant is it on the import of resources (raw materials, energy resources, etc.)?	Indicators on resource/water/energy productivity (GDP/domestic material consumption, GDP/ water consumption, GDP/gross energy consumption).	Baseline for monitoring and reporting
C. Business capabilities	• What are the capabilities and competitive advantages of local industries and SMEs in areas related to the circular economy and sustainability? • How dynamic is the local entrepreneurial environment in relation to developing circular businesses? Are there any new	Based on expert analysis and consultation with stakeholders, define and describe whether local industries and SMEs have the necessary knowledge and expertise to start CE activities, and whether there are CE technology providers Describe if there are any start-ups focusing on CE innovations. Present the opinion of local experts and	Baseline for monitoring and reporting Potential for disseminating good practices and inspiring others

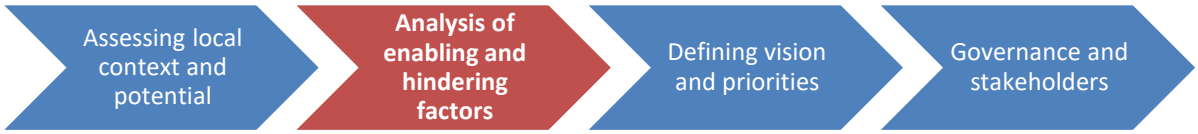
	businesses, start-ups, business models? • Number of companies with eco-innovations — • How many companies are EMAS-certified? • How many eco-labels are there on the territory of the city?	stakeholders on innovation and entrepreneurship environment in the region/city.	
D. Capabilities of knowledge organisations	• What is the existing expertise and knowledge in the city, including research and innovation (R&I) capacities such as those within universities, which relate to circular economy, eco-innovation and sustainability? • Are there any skills in the city related to the circular economy?	Describe if local academic organisations have been dealing with CE-related R&I activities, and if they have any projects, publications, patents.	
E. Industrial potential	• What are the potential for circular economy activities in the different economic sectors?	Based on the expert analysis and consultation with stakeholders, define and describe whether any CE activities (R0- R9) are appropriate in the local industries. Start with the most problematic ones or the ones with the highest potential If available, present indicators on waste streams from each industry	Develop specific sectoral approaches
F. Agglomeration-related potentials	• Is there a 'critical mass' for circular activities to benefit? E.g. are there compact cluster of industries that can potentially	Complement analysis on industries (above) with the qualitative review based on expert analysis and consultation with stakeholders	To be used for prioritisation

	benefit from resource sharing, exchange, efficiencies, symbiosis? • Can the existing agglomerations/proximities (urban, industrial, etc.) potentially offer "closing material loop on the territory" and enable economies of scale?	Identify the industrial clusters in the territory, collect and present their views on potential resource sharing, exchange, collaboration. 	
G. Accessibility	• Is the city well connected internally and with other locations with which resource and side stream exchange can be set up? • Is the existing transportation and logistics infrastructure sufficient for potential CE activities and projects?	Accessibility and logistics infrastructure review can be done as part of the industry analysis. Additional consultation with stakeholders will help to map all logistics infrastructure connecting the region/cities internally and with other territories and industrial/economic zones.	
H. Explore trade-offs and define winners and losers	• Who are the winners and the losers from the transition to the circular economy? • Would the loss of a specific source of revenue be replaced by another potential gain? • What does it take to make CE champions out of winners?	Based on analysis	Engage the winners as champions of CE Manage the losers

I. **Territorial milieus**	• Are there interactions happening over time between companies and residents living in the immediacies?	Based on expert analysis and interviews with companies 	Build upon the momentum created by such interactions
J. **Technological lock-ins**	• Are there any technological lock-ins in your city such as waste-to-energy facilities?	Based on local knowledge, analysis and meetings	Design strategies for overcoming technological lock-ins

Source: Inspired by ESPON CIRCTER Policy Guide

2. Analysis of enabling and hindering factors



In addition to knowing the contextual situation in the territory it is also important to understand what can hinder or intensify the circular economy transition in order to efficiently address the barriers and build on existing drivers in the envisaged strategy and actions.

The widely applied framework for analysis of barriers and drivers differentiates factors of economic, regulatory, socio-cultural/behavioural and technological/knowledge origin. In the second column of the table we have singled out a non-exhaustive sample list of drivers/barriers. We have not separated drivers and barriers in two column as in the majority of the cases the (non-)availability of a policy or an incentive may be a driver while the opposite represents a barrier. In the right-hand column of the table there are examples of policies which address the corresponding driver/barrier.

While we are not in the position to list all possible drivers and barriers for the sectors presented in this guide what is important is the methodology of analysis. Drivers and barriers will be context-specific and should be developed (as well as the solutions) in the process of a dialogue with local stakeholders.

It has to be noted that often the solution to a problem is only in the hands of the national authorities and in such a caser the only useful initiative of the local authority would be to draw the attention to the issue and eventually trigger action from the national authority.

An alternative methodology to analysing drivers and barriers could be the SWOT analysis whereby drivers should be come strengths and barriers should become weaknesses. Opportunities lie in acting on and amplifying the drivers and addressing the barriers through policies, initiatives and dialogues. Threats lie in obstacles deepening because they have not been addressed.

Table 3 Framework of analysis of drivers for and barriers to the transition to the circular economy at local level and corresponding city-level policies

Types of barriers and drivers	Examples of CE drivers and barriers	What can cities do about that?
Economic	*Drivers:* • Economic savings • Profit increase • Funding/investment sources for CE businesses or initiatives • new market/business opportunities • attractive prices for circular products and services *Barriers:* • no or limited returns from investment • limited market for recycled products • high prices for imported or raw materials	• City-level programmes could keep educating companies in a multitude of ways and should keep demonstrating to other companies and society the benefits of the transition to the CE • Work with financial institutions and EU programmes to channel more funding into circular economy initiatives • Cities can do little or nothing about it
Regulatory	*Drivers:* • High charges for waste/high landfill taxes • Tax benefits for green activities • charges, taxes on unsustainable/harmful activities *Barriers:* • subsidies for traditional polluting/inefficient activities (e.g. for coal, water and energy costs) • no ban of specific products (e.g. single use plastic) • Rigid 'end of waste' criteria preventing repurposing waste streams for recycling, reuse, remanufacturing, etc.	• Cities could gradually increase waste landfill charges to steer waste away from the landfill at the same time ensuring predictability for businesses and households and tightening enforcement • Green activities could be exempted from local taxes
Behavioural/ socio-cultural	• CSR culture and leadership in companies • Awareness of consumers	• Development of CSR support programmes: integrate CSR in relevant city policies; ensure political support and buy-in for CSR; enhance CSR partnership and network; development of a sectoral CSR pilot project; use ESIF funds

	• Level of entrepreneurial culture	for CSR and circular economy activities; develop CSR support tools. • Develop awareness programmes for citizens and households on transition to CE, CE business models, etc. • De-risk certain circular economy endeavours by providing financial and in-kind support
Technological/ knowledge	• Qualified staff, local experts • R&I capabilities in companies and universities • Research, testing, piloting infrastructure	• Develop educational programmes for managers and employees in different high-priority sectors • Establish partnerships with (local) universities and provide a platform for linking science and business

3. Defining vision and priorities

The analysis of the local strengths allows the identification of the areas with the highest potential for development. This analysis is enriched by the review of drivers and barriers. The two together would lead to the formulation of a vision for the territory and also a set of policies and initiatives to be undertaken in order to move in the direction of the vision.

Prioritisation need to take place both in terms of sectors of the national economy (NACE) and also in terms of business models to focus on. For example, while industrial symbiosis is a new business model it is not a sector itself and is relevant to different sectors of the economy.

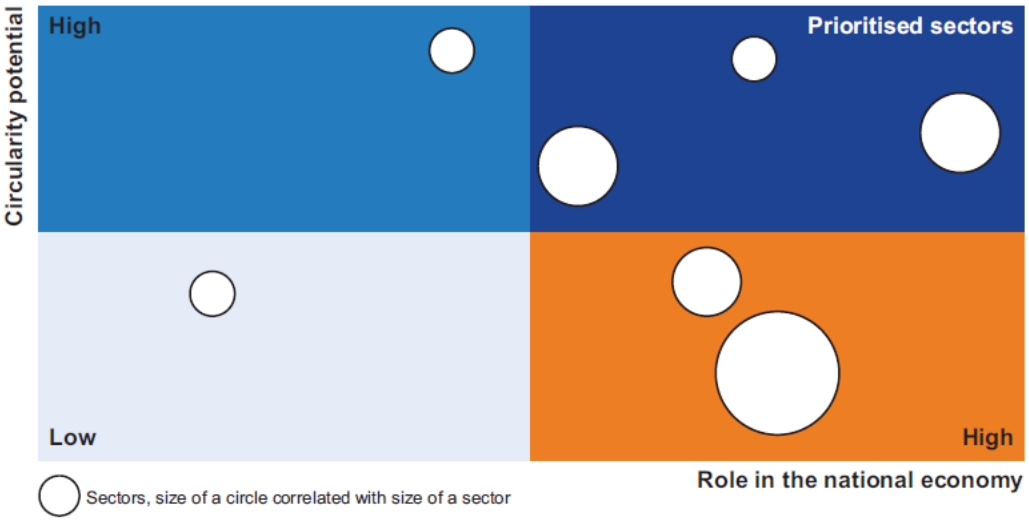
While defining the sectors to concentrate on during the transition to the circular economy it would be worthwhile to start with the Regional Innovation Strategy for Smart Specialisation (RIS3). Usually, the sectors in the strategy have been defined based on a detailed economic analysis and stakeholder consultation. The integration of the transition to the circular economy and RIS3 will be very important in the context of European Structural and Investment Funds (ESIF) for the period 2021-2027. Local authorities are encouraged to analyse and integrate priority sectors for circular economy with other sectoral strategies (i.e. National/regional/local Waste Management Plan for waste; bioeconomy strategy for bio-regenerative sources; water management strategy or water catchment plans for water reuse, etc.).

There are also other factors and criteria to be taken into consideration when defining the priorities:

- Existing environmental problems. Logically, if there is a serious environmental problem (i.e. droughts and lack of water) a given sector (water reuse) can be prioritised even if drivers (water reuse regulation) are missing.
- Availability of data: this is not a criteria which would be sufficient per se for the selection of a certain sector as a priority one. However, it would be much easier to define the baseline if data are available.

The below figure introduces a visual approach to sector prioritisation.

Figure 16 Framework for sector prioritisation



Source: Ellen MacArthur Foundation, 2016, Toolkit for policy makers

The above analysis, combined with extensive stakeholder consultation should lead to the formulation of vision for the city as well as quantitative and qualitative targets that go with it.

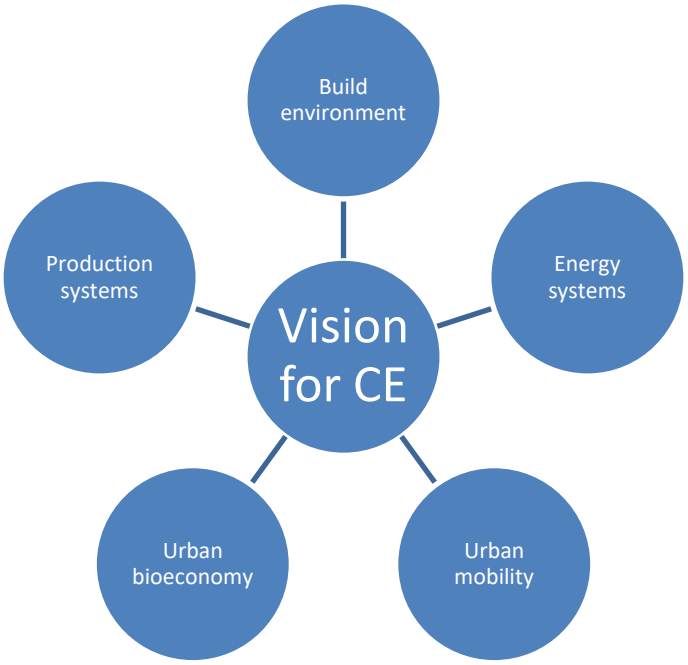
Below we will present several examples of visions, not necessarily city-level ones.

Box 36 WRAPs vision for UK circular economy till 2020

Goal	Target
Lean production	30 Mt fewer material inputs
Reducing waste	20% less waste produced (20 Mt less)
Reducing the amount of working products thrown away	20 Mt more materials recycled
Goods to services	NA

Source: http://www.wrap.org.uk/content/wraps-vision-uk-circular-economy-2020

Figure 17 Example of a possible combination of sectors for the transition to the circular economy



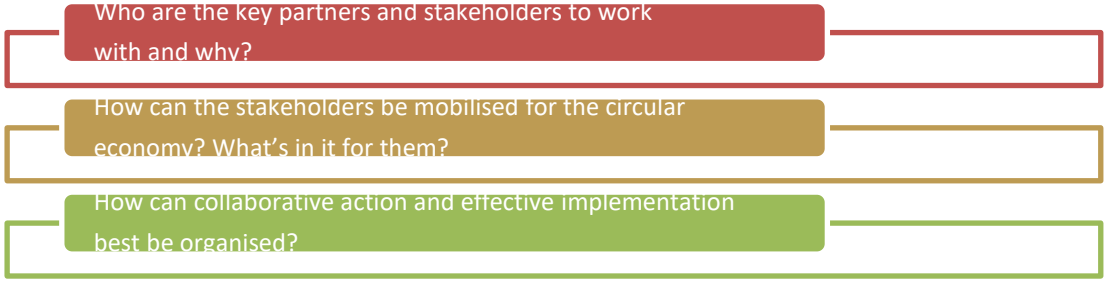
Source: Ellen MacArthur, Cities in the Circular Economy: an Initial Exploration

Naturally, when defining the city vision the policy makers will aim at high-level objectives and impacts related to the environmental problems and pressures mapped during the initial stages of the process.

4. Governance and stakeholders

Defining the governance of the transition to the circular economy is key to its success. There are three phases to governance definition.

Figure 18 Stages in good governance in the transition to the circular economy



Key partners and stakeholders

Partners include specific flagship projects and actors from sectors with significant potential for improvement in terms of circular economy and resource efficiency. The **private sector** is a fundamental partner and stakeholder as provider of goods and services. They are the among the first to take actions and subsequently benefit. The circular economy is also an excellent opportunity to create an **entrepreneurial ecosystem** around it including green start-ups, cleantech incubators and universities for example.

Governments are important stakeholders in the transition to the circular economy. They partly create the local policy mix and are an important enabler of the transition in many different ways.

In the figure below we have listed different types of stakeholders and their respective roles in the transition to the circular economy on urban level.

Figure 19 Stakeholders' role in the circular economy

STAKEHOLDERS	ROLE IN CIRCULAR ECONOMY
Local champions	Goodwill ambassadors Community mobilisers
Public sector allies	Key implementation partners Improve framework conditions
Sectoral representatives	High impact on economy and environment Target sectors for transformation
Eco-industries	Capitalise on their infrastructure Strengthened roles in promoting CE
Entrepreneurs	Direct beneficiaries of the strategy Can be activated for the circular economy
Business support structures	Key allies for circular economy promotion Service providers to local entrepreneurs and
Academia and knowledge providers	Knowledge generation on local CE features Assessments and advice
Educators	Teach the circular economy principles Mobilise the young and lifelong learners
Investors	Mobilise finance for CE Develop new financing models
Grassroots	Demonstrate benefits to citizens Reach out to all citizens

Source: CIRCTER Policy Guide

Local CE champions – could serve as an example and inspiration for others

Public sector allies – economic or environmental departments in city administrations

Sector representatives – from industries which are either transition leaders or have the highest

untapped potential to shift to new ways of working

Eco industries – representatives of industries which are dealing with sectors such as waste management, water supply and sanitation, etc.

Entrepreneurs – open minded companies and individuals who can take up circular economy principles early on in their activities

Business intermediaries – such as Chambers of Commerce who have a large member base and who can incorporate circular transition in their training programme for example. Local industrial zones are also a good possible partner

Universities – especially the ones with relevant departments such as environmental studies, technology, innovation, etc.

Investors and funding sources – Banking institutions are yet to get to grips with the concept of circularity, the business models associated with it and their financial flows. Relevant national and/or regional Managing Authorities of European Structural and Investment Funds (ESIF) are a good potential source for funding aspects of the CE transition

Box 37 Good practice example of Maribor Circular Economy strategy development

The Maribor Strategy was initially inspired by one major challenge: re-using the waste, surplus energy and wastewater generated by one sector as a resource commodity for another sector (following re-processing). Solving this issue required the integration of concerted waste management processes into the city's energy and water supply systems. A significant lever for strategy implementation was the mobilisation and federation of public utility companies within a city-level circular waste management strategy. All in all, the strategy was implemented along six selected sectors (pillars). This association of interests was then embodied by the establishment of a new institution: the Wcycle Institute Maribor (IWM).

The Municipality, the public utility companies and newly-established IWM, together with the business sector, identified 20 joint collaboration projects for the coming years. The Wcycle Institute is the main piece of the multi-stakeholder CE approach as a platform where the utility companies can speak about general strategy and the projects. There are monthly discussion and exchanges of documents. Thanks to the Institute, every company is aware of what the others are doing.

The Maribor approach has been considered truly innovative as a bottom-up, cross-sectoral solution for re-using material, energy and aquatic waste. It represents a crucial mind-shift with regard to the management of public utility companies.

Source: CIRCTER case study on Circular Economy Strategy in the Maribor Region, Slovenia

The Scottish Circular Economy Business Network (SCEBN) has been established as a follow-up of the Scotland's Circular Economy strategy. Its goal is to support and 'develop business-led initiatives topromote the opportunities of a more circular approach' by providing a platform for engaged and innovative business leaders to help build responsive and networked supply chains in Scotland.

The founding members of the network include public-sector and nongovernmental organisations, such as Scottish Enterprise (SE), Highlands and Islands Enterprise (HIE) and Scottish Environment Protection Agency (SEPA), and Zero Waste Scotland.

Source: CIRCTER case study on Scotland's Circular Economy Strategy

Stakeholder mobilisation

The governance structure of the circular economy transition varies from case to case. The example from the Brussels Region is just one example of a government structure based on a steering committee and a coordination committee.

Box 38 Governance of the Brussels' Regional Plan for a Circular Economy (RPCE)

For example, Brussels' Regional Plan for a Circular Economy (RPCE), adopted in 2016 as part of the Brussels regional Strategy 2025, is a flagship CE initiative in Belgium's capital. It established an innovative governance structure for stakeholder engagement, which enabled both top-down and bottom-up involvement in defining the plan and implementing it.

The governance of the RPCE is structured around the following elements: The steering committee is composed of representatives from the three ministries in charge of the RPCE, the region presidency, regional ministries associated with the initiative, and the 11-chapter coordinators within the respective administration of the RBC (e.g. Bruxelles Environnement,

Impulse.brussels, Brussels Economy Employment, Actiris, Bruxelles Formation, VDAB Brussel, Innoviris, Citydev, Finance.Brussels, Agence Bruxelles - Propreté, the Brussels Office of Planning, the Port of Brussels, Atrium, Bruxelles Mobilité, the CIRB, as well as the Economic and Social Council). The PREC Coordination Committee is the daily management unit at Bruxelles Environnement that organises the concrete implementation of the PREC.

Source: CIRCTER case study

V. Overall recommendations for city-level policy makers

- The transition to the circular economy is complex and requires the **introduction and enforcement of complex policy landscapes** on all governance levels ranging from the strategic to the operational. Policies should address all stages of the product from material sourcing to disposal and secondary material treatment. Similar types of policies should be adapted to different sectors of the economy and their specific value chains.
- With regards to territories policies need to be analysed from a point of view of policy design but also **policy implementation**. Policies differ in their contribution to the transition to the circular economy, their capacities to trigger radical changes of behavioural models for companies and citizens.
- Rural regions are more suitable to hosting bioeconomy policies and business models, changes in food production, urban regions are more apt to deploy different collaborative methods, municipal waste management, new business models for repair and reuse, etc. This recommendation is mainly targeted at national level and is in fact only a recognition that not all sectors are equally relevant to different types of territories.
- **Policies should take into consideration different factors** such as the agglomeration economies; the land-based resources of the territory; its accessibility conditions; knowledge- and technology-based enablers; available technology; as well as governance and institutional drivers.
- The development of **regional development strategies and local circular economy strategies and action plans** is also gaining speed in the European Union and should be further stimulated. They allow focusing on the regional economies and value chains, sectors of specialisation, regional and local knowledge and other intangible assets, etc.
- **Cities and regions hold significant assets that are key building blocks on the road to circular economy.** This territorial capital varies across territories (geographical location, natural resources, social capital and institutions, etc.), their economic role in the cities and regions, and how much they can be leveraged to foster transition to the circular economy. The realisation of the potential of the territorial capital depends on a number of factors including policy, institutions, political will and financial context. This recommendation is targeted both at regional and city level.
- **Regions and cities as main actors in waste management.** Regions and cities have a significant leverage in waste management in a number of countries. In most cases individual municipalities are responsible for waste management. Also, regions are a suitable geographical level for coordinating the efforts of individual municipalities and setting up systems for integrated waste management. Therefore, the role of cities and regions for enhancing the circular economy dimensions of waste management should be actively promoted and supported. Regions can also elevate the level of their ambitions and strive to become zero waste territories.
- **Regional/city vision for better waste management.** Meeting the increased targets can happen through setting action plans for the prevention and reduction of different waste streams as a part of their long-term visions and strategies for waste prevention and development of circular economy. Additionally, regional and local authorities can take action to raise consumer awareness on waste by establishing focused educational

programmes and providing practical tips to consumers on how to prevent waste. The effectiveness of such campaigns can be increased by using new media and technologies to reach out to consumers. This recommendation is targeted both at regional and city level.

- **Multi-stakeholder cooperation for waste management.** In stimulating innovation with regards to addressing food waste policy-makers need to focus on development of cooperation mechanisms with universities, other cities and regions, entrepreneurs and civil society organizations. This recommendation is targeted mainly at regional level.
- **Better awareness for better plastics management.** Cities and regions have an important role for the improvement of knowledge in the whole value chain and increase awareness of citizens; improve waste collection systems and better separate collection: in cooperation with waste management operators; increase plastics recycling capacity; extend EPR models and provide economic incentives such as introducing obligatory price for plastic bags. They can also use public procurement as an instrument to stimulate change of models, better plastics and better recyclability. . Citizens and NGOs should also exert pressure on businesses to sort out the plastic they use through substitution or other innovative ways and also change habits: use less plastics for single use; and sensibilise the citizens on the problem of microplastics. This recommendation is targeted both at regional and city level.
- **Stimulate companies to adopt new business models.** Regions and cities should also stimulate companies to adopt new business models such as reverse logistics for (plastic) packaging and alternatives for disposable plastics. Policy makers and mainly business associations and NGOs could also have a role here and the main action should be awareness raising and demonstrating successful models. This recommendation is targeted both at regional and city level.

Industrial symbiosis

- **Application of economic and regulatory instruments.** Several economic and regulatory instruments introduced by regional and local authorities can drive industrial symbiosis indirectly, through favouring higher and penalising lower waste hierarchy options. Examples include relatively high landfill and incineration taxes, pay-as-you-throw schemes, local landfill bans of various waste streams (e.g. on organic waste), targeted economic incentives. In addition, actions such as promoting Green public procurement (GPP) or supply chain approaches that provide collective solutions to logistical difficulties in IS (e.g. treatment and recovery facilities shared by a number of companies or a circular supply chains voluntary protocol) can also be helpful. This recommendation is targeted both at regional and city level.

- **Development of cooperation platforms for industrial symbiosis.** The establishment of cooperation platforms can bridge the co-operation and coordination deficit between the suppliers of the production residuals, the potential clients of these residuals and the providers of know- how and technology. Such platforms may help provide potential markets with minimum required scale and scope of industrial symbiosis arrangements, as well as knowledge. The services provided by cooperation platforms can include offering support in

'material scans' and matchmaking for SMEs; providing industrial symbiosis-related technical trainings on the valorisation of material streams; and providing support in securing funding mechanisms.

- **Assessing opportunities for industrials symbiosis at urban, rural or regional level.** Local or regional authorities can get involved in understanding the potential for optimising material flows at the level of their region, city or village or in inter-regional exchanges, by undertaking material flow analyses especially in the case of public services or public works. Many opportunities can be found in optimising the management of construction and demolition waste, food waste or waste water. Involving local private or non-governmental partners in understanding their potential contribution can be beneficial for initiating industrial symbiosis.

- **Strengthening local re-use and repair ecosystem.** Regions and cities should work on strengthening their local reuse and repair ecosystem, by supporting the local organisations involved, and informing citizens of services' availability. Future Cohesion funds should continue to support this sector. One possible way of doing this is through the introduction of tax incentives for the development of repair services and jobs in Member States. Other efforts should be targeted at setting up and capacity building of repair and reuse centres. This recommendation is mainly targeted at local level.
- **Predominantly rural areas** are likely to face more difficulty in opening or strengthening a network or reuse and repair centres since their efficiency and capacity to provide the service for a wide range of products is likely to depend on the size that they can reach. Adequate choice of location and products covered, as well as the set-up of exchanges within a network of centres within a region are instrumental in making these services sustainable. This recommendation is mainly targeted at local level.
- **Predominantly urban areas** benefit from the critical mass to set up not only repair and reuse centres, but also, if governance structures allow, other initiatives such as tax incentives. In countries where these policies are still underdeveloped, they can provide the right environment to set up pilots to test new policies. This can be done at the level of a city or of a region depending on the institutional setting.
- **Repair and reuse services** usually include social employment, and it can represent an opportunity, to boost local recruitment, in particular for industrial regions that are losing importance (although this is applicable in any region). This recommendation is mainly targeted at regional level.

Bioeconomy

- For the bioeconomy, the territorial perspective is important: indeed, it is linked to the distribution of terrestrial, marine and maritime biological resources. Furthermore, the bioeconomy has the potential to foster the economic development of rural areas, by opening up new opportunities for the agricultural and forestry sectors (e.g. food processing, bio-based industries, bioenergy). The development of local strategies can contribute to identifying priority resources for the territories, settle conflict of usage (e.g. competition between food crops and energy crops) and promote the development of new

economic activities by sustaining the transition towards sustainable agriculture and forestry. A local strategy can create the enabling conditions for the development of the territory and can further assist in identifying the public and private resources than could encourage research and development. This recommendation is more suitable for predominantly rural and intermediate regions, as predominantly urban regions can further rely on public transport.

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