Co-funded by the European Union

Fostering Circular Cities

A Study on Urban Circularity Hotspot Frameworks for the Western Balkan Region

Jan Bitter-Krahe, Stefano Turrini, Henning Wilts
Wuppertal Institute for Climate, Environment and Energy

(210078-D07 – Urban circularity hotspot study framework)

In consortium with:

Imprint

This publication is a result of the research project "Circular Economy Beacons" (*KIC project: 210078 Balkan Circular and Climate Innovation Beacons; Deliverable: 210078-D07 – Urban circularity hotspot study framework)*

The research project that forms the basis of this publication was carried out on behalf of EIT Climate-KIC and Co-funded by the European Union. The content of this publication is the responsibility of the authors.

Project term: January 2021 – December 2021

Project coordination/Contact:
Dr. Henning Wilts
Wuppertal Institut für Klima, Umwelt, Energie gGmbH
Director Division Circular Economy
Döppersberg 19
42103 Wuppertal, Germany
Tel.: +49 202 2492-139, Fax: -250
E-Mail: henning.wilts@wupperinst.org

Publisher:
Wuppertal Institut für Klima, Umwelt, Energie gGmbH
Döppersberg 19
42103 Wuppertal, Germany
www.wupperinst.org

Date:
December 2021

TABLE OF CONTENTS

1. INTRODUCTION

A main goal of this study – which also functions as deliverable **210078-D07** of the Circular Economy Beacons (CEB) project – is to evaluate currently available frameworks that measure and operationalise **Circular Economy** (CE), with a particular focus on the **urban** context. The regional focus lies on the **Western Balkan region**, which is at the centre of the project. Such "**Urban Circularity Hotspot Frameworks**" (UCHF) aim at providing decision support for policy makers, companies, citizens etc. regarding the transition to CE within cities. Based on the analysis of different frameworks, suggestions are derived regarding UCHF suitable for the specific characteristics of Western Balkan municipalities, i.e. a **Circular Economy Beacons Urban Circularity Hotspot Framework (CEB-UCHF)** ready for short-term implementation.

Following this introduction regarding CE (cf. Section 1.1), urban circularity (cf. Section 1.2) as well as indicators and existing framework evaluations (cf. Section 1.3), several UCHF are evaluated based on an existing criteria set and focus criteria for the considered region (cf. Section 2.1) as well as additional evaluation criteria related to a short-term implementation in Western Balkan municipalities (cf. Section 2.2). In the next step, four particularly interesting frameworks are analysed in detail (cf. Section 2.3). In order to derive suggestions for the short-term adoption and application of UCHF in the Western Balkan region, the results of these analyses are consolidated and, based on this, one framework is selected as a promising CEB-UCHF (cf. Section 3.1). In order to foster a short-term implementation in selected Western Balkan municipalities and enable a monitoring of this process, respective criteria and actions are proposed (cf. Section 3.2). This study concludes with a summary and an outlook (cf. Section 4).

1.1. CIRCULAR ECONOMY

Up until today, the linear economy model adopted has brought enormous economic growth, yet hand-in-hand, pressure on our planet's resources mounts. Globally, material consumption has grown eightfold over the past 100 years and is expected to have tripled by 2050 (Prendeville et al., 2018). This has led to a need for the economic system to develop more environmentally and socially sustainable economic models. Among these is the **Circular Economy (CE)**, considered as an alternative model to the unsustainable linear 'take-make-waste' paradigm (Chizaryfard et al., 2021; Kravchenko et al., 2019; Kristensen & Mosgaard, 2020; Papageorgiou et al., 2021; Sánchez Levoso et al., 2020).

The CE model has rapidly gained ground among academics, the private sector and policy-makers, being considered an *"irreversible global megatrend"* by the European Commission (2019). It promotes the responsible and cyclical use of resources to maintain their value in the economy, minimising pressures on the environment and contributing to improved socio-economic well-being. In the circular model, all aspects of economic activity are covered, from the extraction of resources through production, distribution, consumption and ending with recycling and possibly limited waste incineration (cf. Figure 1.1) (Papageorgiou et al., 2021).

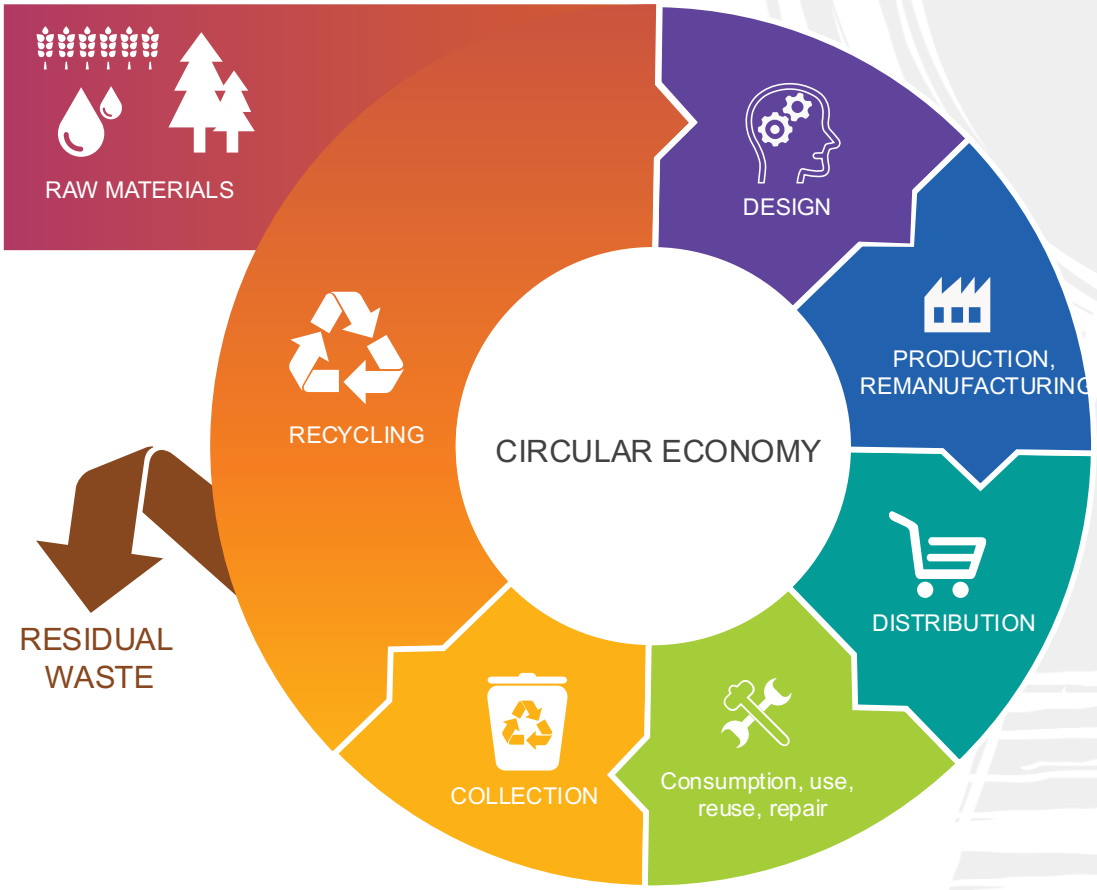

Figure 1.1: Circular Economy Framework (European Parliament, 2015)

In recent years, several attempts have been made to conceptualise CE as a phenomenon which has led to a great number of different definitions and concepts. Thus, a single universal definition of CE seems to be impossible, as the concept is dynamic and due to its interdisciplinary nature in continuous evolution. In fact, to date there are more than 100 definitions of the circular

economy (Kirchherr et al., 2017). However, in order to approach the goal of this report (cf. Section 1), it is essential to establish an operational definition of CE in the context of this work. Here, we adopt the definition of Kirchherr et al. (2017):

> *"A circular economy describes an economic system that is based on business models which replace the end-of-life concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations."*
> *(Kirchherr et al., 2017, pp. 224–225)*

This definition supports the thesis of a close relationship between the circular economy and sustainable development, defined by the United Nations as:

> *"The development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*
> *(Brundtland et al., 1987)*

Here, all three aspects of sustainability are included: economic, environmental and social. In the literature to date, the social dimension has been underrepresented compared to the other two aspects, even though it is particularly relevant for the transition to a truly sustainable economic system, i.e. one that is more value-based rather than profit-oriented (Mies & Gold, 2021). It is precisely this concept of **value** that is aimed at by adopting tools that allow different forms of "re-circulation" of materials and products at their end-of-life. These include the repair of goods, so that they can be used for longer; the reuse or redistribution of used goods or materials; refurbishing and remanufacturing, where a core of a used product is restored to be resold again (thus recovering added value) and recycling, where materials are recovered from products that have reached their end-of-life (Berg & Wilts, 2019). At the base of these tools there is the concept of "Eco-design", a process in which a product is conceived and engineered in order to be durable, upgradable and easy to repair, resulting in savings of valuable resources (Wilts et al., 2016).

Finally, in the transition process from the linear economy model to a circular one, a lot still has to be done to completely close the circle, since according to "The Circularity Gap Report 2021"

by Circle Economy the current economy is only 8.6 % circular, leaving a huge "*Circularity Gap*" of 91.4 % (Haigh et al., 2021).

The Concept of Prevention

The priorities of the Circular Economy are clearly represented by the Waste hierarchy elaborated by the European Commission (2021), where at the top of the pyramid is the principle of waste prevention (cf. Figure 1.2). The concept of **Prevention** is defined in the "Directive 2008/98/EC on Waste, Article 3" as a measures taken before a substance, material or product has become waste, reducing: the quantity of waste produced, the adverse impacts of the generated waste on the environment and human health, and the content of harmful substances in materials and products. The waste prevention requires the cooperation of various stakeholders at all stages of the value chain and it's not considered as the total elimination of materials, but rather as an **innovative and intelligent use** that ultimately leads to a reduced amount of waste (Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on Waste and Repealing Certain Directives, 2008; Wilts et al., 2020)

Figure 1.2: Waste hierarchy (European Commission, 2021)

There are several tools to support this principle, which is based on increasing material efficiency. They can be, for example, with the focus on the aspect of information flows or focuses on waste targets which would strengthen the link to resource efficiency (Wilts et al., 2016).

Waste management is a policy field that has always been mainly driven by framework conditions such as regulations for waste collection and treatment. In particular, targets play a crucial role for the emergence and diffusion of innovations. These are strong political signals needed to create long-term predictability for investments and to create the conditions for recycled materials, to re-enter in the economy as secondary raw materials at competitive prices.

In recent years a specific barrier to resource efficiency has been the fact that the concreteness and ambition of targets and political signals differ significantly along the waste hierarchy. On the one hand, recycling and disposal have been regulated by binding targets, while on the other hand, re-use and waste prevention have had no such specific targets. Possible minimum and quantified targets on waste prevention and management with well-defined minimum recycled content quotas for products, would increase the demand for high-quality secondary raw materials, providing important incentives for the reuse of waste. The underlying rationale is that secondary raw materials should gain higher market shares than virgin materials after an initial capital-intensive investment phase (Wilts et al., 2016).

Another instrument is **eco-design**. Designing goods to endure over time saves valuable resources. The instrument of mandatory eco-design standards for selected products aims to encourage manufacturers to consider future repair, reuse and refurbishment when designing products (Wilts et al., 2016). At this stage, these operations are preferred to recycling for several reasons. The first is that recycling operations are energy-intensive due to the transport, separation and processing of the material. Secondly, in many cases not all of the collected material is recycled for different reasons; both due to a lack of adequate infrastructure and available technology, and, as in the case of plastics, due to the presence of multiple bonded polymers, additives and dyes, which limit the effectiveness of recycling processes (Wilts et al., 2016).

The last instrument to be analysed is the **Extended Producer Responsibility (EPR)**. It is defined by the OECD as "an environmental policy approach in which the responsibility of the producer of a product is extended to the post-consumer phase of the product's life cycle" (OECD, 2001). In practice, EPR implies that producers take responsibility for collecting or taking back used goods and sorting and processing their eventual recycling, thus shifting the responsibility and costs of the negative environmental externalities of products from taxpayers to producers, in line with the "polluter-pays"-principle (Monier et al., 2014). The objectives of the EPR are to incentivise manufacturers to design more resource efficient and environmentally friendly products, waste reduction and increased recycling activities (Watkins et al., 2017).

1.2. Urban Circularity

At the centre of the future economic system are cities and other urban settlements which today are hosting more than half the world's population and generate approximately 70 % of the world's GDP, even though they occupy only 2 % of the total land area (Paiho et al., 2020;

Papageorgiou et al., 2021). This concentration of human activity has considerably increased the consumption of resources and production of waste, converting cities from places of development into places vulnerable to environmental problems, such as air and water pollution, resource depletion and ecosystem degradation, and socioeconomic problems, such as increasing inequality and poverty (Bai, 2007; Ferrão & Fernández, 2013; OECD, 2018; Papageorgiou et al., 2021; Rockström et al., 2021; Satterthwaite, 2011). By adopting the CE model, cities will be able to decouple urban development from resource consumption, thus integrating socio-economic well-being priorities and reducing environmental pressures (Gravagnuolo et al., 2019; Marchesi & Tweed, 2021; Murray et al., 2017; Papageorgiou et al., 2021; Sánchez Levoso et al., 2020) (Papageorgiou et al., 2021). The literature provides several definitions of a circular city, the one by the European Circular Cities Declaration (2020) states:

> *"A circular city is one that promotes the transition from a linear to a circular economy in an integrated way across all its functions in collaboration with citizens, businesses and the research community. This means in practice fostering business models and economic behaviour which decouple resource use from economic activity by maintaining the value and utility of products, components, materials and nutrients for as long as possible in order to close material loops and minimise harmful resource use and waste generation. Through this transition, cities seek to improve human well-being, reduce emissions, protect and enhance biodiversity, and promote social justice, in line with the Sustainable Development Goals." (Circular Cities Declaration, 2020)*

1.3. Indicators and Previous Studies on Framework Evaluations

Cities represent real **accelerators** for the development of CE, where the planning of targeted strategies and the continuous measurement of progress through well-structured indicators, can create a more resilient and efficient environment, and thus, **urban circularity**. The design of circular strategies for cities and other urban settlements must include systematic control and monitoring measures with appropriate frameworks of indicators, to support policy makers and strategic planners from government, civil society and business. The starting point for a proper determination of these measurement frameworks is a clear understanding of the objectives and rationality of a circular economy, otherwise their development may overlook relevant trends and developments in the model (Wilts & Steger, 2019).

The term "**indicator**" refers to variables or functions of variables that provide information to support decision-making (Gallopín, 1996; Moraga et al., 2019). They can summarise, focus and condense complex information in a simplified and meaningful way and thus can serve as effective tools for measuring progress and performance and communicating complex information (Papageorgiou et al., 2021; Saidani et al., 2019; Singh et al., 2012; Tapia et al., 2021). Usually, an indicator is related to a reference value, such as an objective, target, standard or benchmark. This reference value gives meaning to the indicator and distinguishes it from raw data (Moldan et al., 2012; Papageorgiou et al., 2021; Waas et al., 2014). In the literature, there are several definitions of an indicator, in this study we adopt the one proposed by the OECD (2002). This definition clearly describes the main characteristics of indicators, i.e. their ability to measure results and performance, while at the same time giving the possibility, through the representation of changes, to take corrective action:

> *"Quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect changes connected to an intervention, or to help assess the performance of a development actor".*
> *(OECD, 2002, p. 13)*

In recent years, the implementation of indicator-based frameworks for assessment and CE-oriented decision support on city level (here: "Urban Circularity Hotspot Frameworks" – UCHF)[1] has been limited and very heterogeneous, showing a lack of standardisation, which would support comparisons. In addition to not being particularly widespread, several frameworks do not fully incorporate the concept and principles on which CE is based, especially regarding the principle of prevention. Also, a lack of data has led to the design of metrics based only on available data and not on the true specific needs of the CE (Papageorgiou et al., 2021).

Analysing these frameworks more closely and starting from the criteria used to assess them, it emerges that, as in the study by Corona et al. (2019), no currently available framework fulfils all the predefined evaluation criteria for a comprehensive UCHF. In Corona et al. (2019), the authors do not adopt any classification according to the three system levels (micro, meso, macro), but examine 16 frameworks and classify them into two groups according to the object of analysis

[1] While in the literature, different terms for these types of frameworks can be found, in this study, we use the term "Urban Circularity Hotspot Frameworks" (UCHF) according to this deliverable's title (210078-D07 – Urban circularity hotspot study framework).

(*products/services/organisations* or *sectors/regions/global economy*), assessing the validity of the indicators along eight predefined criteria[2].

Even in the recent study by Papageorgiou et al. (2021), in which 15 frameworks based on about 305 indicators at **macro level** (cities, regions, countries) are analysed, no framework meets all the predefined evaluation criteria for UCHF. The applied criteria set, consisting of eight attributes and their respective criteria (cf. Table 1.1), is defined prior to the analysis and confirmed by the researchers and professionals participating in the Urban Circularity Assessment Framework project.

Table 1.1: Criteria for the evaluation of selected frameworks (Papageorgiou et al., 2021)

No.	Attribute	Criterion
1	Transparency	Whether there is a transparent description of the methodology for the development and application of the framework.
2	Stakeholder engagement	Whether stakeholders have been engaged through participatory approaches in the development of the framework.
3	Effective communication	Whether appropriate techniques are applied to effectively communicate the results from the application of the framework.
4	Ability to track temporal changes	Whether the framework has been applied considering temporal changes.
5	Applicability	Whether the application of the framework is based on easily accessible and regularly updated data.
6	Alignment with specific CE principles	Whether the framework was developed based on specific CE principles.
7	Validity	To what extent the framework includes indicators that reflect CE aspects.
8	Relevance to sustainable development	To what extent the framework includes indicators that reflect aspects relevant to the four pillars of sustainable development (environmental, social, economic and governance).

For criteria 1-6, the assessment was carried out by evaluating whether a framework fulfilled (completely or partially) each criterion. Only one framework is found to fulfil all of these six criteria (Papageorgiou et al., 2021). Criterion 7 is used to assess the validity of the evaluated frameworks. Validity refers to the extent to which a metric measures what it aims to measure. In this case, the aim is to measure circularity at the **macro level**. Here, 12 validity requirements

[2] (1) Reducing resource inputs, (2) Reducing emission levels, (3) Reducing material losses/waste, (4) Increasing renewable and recycled resource inputs, (5) Maximising the utility and durability of products, (6) Creating local jobs at all skill levels, (7) Creating and distributing added value, (8) Increasing social welfare (Corona et al., 2019)

are chosen[3]. The first eight reflect specific CE objectives, i.e. they represent desirable outcomes related to environmental quality, economic prosperity and social equity, resulting from the implementation of CE strategies. The other four are intended to represent interventions aimed at enabling CE. Of these, the first two represent interventions related to design and training, which underline their important role to make the CE model operational. The second two relate to investment and governance to promote CE. Of the 15 frameworks analysed, nine meet at least half of the validity requirements. The most satisfied requirements are number 1 (*Reduced input of resources*) and 4 (*Increased input of renewable and recycled resources*) (Papageorgiou et al., 2021). Finally, criterion 8 aims to measure how well the frameworks respect the dimensions of sustainable development; environmental, social, economic and governance. In addition to the "classical" three sustainability dimensions, Papageorgiou et al. (2021) argue that governance should also be considered at macro level as an individual sustainability dimension (Papageorgiou et al., 2021).

2. ANALYSIS OF URBAN CIRCULARITY HOTSPOT FRAMEWORKS

One of the main goals of this study is to analyse currently available UCHF regarding, on the one hand, their overall suitability to measure and, subsequently foster, CE on a city level, i.e. urban circularity and, on the other hand, their specific suitability for the Western Balkan context. In this section, we first focus on an evaluation based on the criteria set proposed by Papageorgiou et al. (2021) (cf. Table 1.1), putting a special focus on criteria that are of particular relevance to the Western Balkan context. Secondly, we supplement the existing criteria set with additional criteria that represent even more the specific characteristics of the Wester Balkan region and relate to a short-term adoption and application of UCHF for our specific context. Building on this, we finally perform detail analyses of selected UCHF in order to select a framework suitable for a short-term implementation in the Western Balkan context including criteria and activities to enable its implementation in the course of the CEB project in 2022.

[3] (1) Reduced input of resources, (2) Reduced emission levels (pollutants and GHG emissions), (3) Reduced material losses and waste, (4) Increased input of renewable and recycled resources, (5) Maximized utility and durability of products, (6) Creating business and jobs at all levels of skills, (7) Value added creation and distribution, and other outcomes improving economic performance, (8) Increased social wellbeing, (9) Designing for circular economy, (10) Educating for circular economy, (11) Investing for circular economy, (12) Governance for circular economy (Papageorgiou et al., 2021)

2.1. Focus Criteria and Overall Evaluation of Frameworks

Building on the study by Papageorgiou et al. (2021), we consider a total of 20 different frameworks within our analysis. These include the 15 frameworks assessed within the previous study as well as five additional ones from further literature and online research. The 20 considered frameworks are:

- CCAF – The Circular City Analysis Framework (Cavaleiro de Ferreira & Fuso-Nerini, 2019)
- PCEI – Peterborough Circular Economy Indicators (Morley et al., 2018)
- UCDI – Urban Circular Development Index (Wang et al., 2018)
- UAF – Urban Agenda Framework (Urban Agenda for the EU, 2019)
- ACM – Amsterdam Circular Monitor (City of Amsterdam et al., 2020)
- LCI – London Circularity Indicators (Cambridge Econometrics, 2018)
- CEMF – Circular Economy Monitoring Framework (European Commission, 2018)
- MFEML – Monitoring Framework for Economy-wide Material Loop closing (Mayer et al., 2019)
- KIMCE – Key Indicators for Monitoring the Circular Economy (Magnier et al., 2017)
- CB – Circularity Baseline (Morlet et al., 2015)
- EISCED – Evaluation Index System of Circular Economy Development level (Guo-gang, 2011)
- CEEIS – Circular Economy Evaluation Indicator System (Geng et al., 2012)
- CEAIS – Circular Economy Assessment Index System (Qing et al., 2011)
- CES – Circular Economy Scoreboard (The European House – Ambrosetti & ENEL Foundation, 2020)
- EISCE – Evaluation Indicator System for Circular Economy (Avdiushchenko & Zając, 2019)
- CCST – Circle City Scan Tool (Circle Economy, 2021)
- MUCTP – Measuring urban circularity based on a territorial perspective (Wilts & Steger, 2019)
- MCC – Measuring the Circular City (City Loops, 2020)
- UCAF – Urban Circularity Assessment Framework (Stockholm Environment Institute, 2020)
- CECI – Circular Economy City Indicators (be circular – be.brussels, 2016)

In order to focus the evaluation on the most relevant frameworks, we follow a stepwise process to define the frameworks further evaluated within a detail analysis. As the first step, those frameworks are excluded for which only limited information could be found in our research, (a) due to insufficient documentation or (b) due to frameworks being subjects of ongoing research and development projects. Thus, UAF and CEEIS are excluded from further evaluation due to reason (a) and MCC, UCAF and CECI due to reason (b) (be circular – be.brussels, 2016; City

Loops, 2020; Geng et al., 2012; Papageorgiou et al., 2021; Stockholm Environment Institute, 2020; Urban Agenda for the EU, 2019).

As a second step, we define focus criteria which are especially relevant to the Western Balkan context. As many municipalities in this region, which are the main addressee of our study's results, have little to no awareness or experience regarding CE in general and on city level (European Commission, 2020; Kabashi et al., 2021), three of the proposed criteria are of special relevance here: **(1) Transparency**, **(3) Effective communication** and **(5) Applicability**. All of these directly relate to a short-term adoption and application of UCHF with low levels of CE development and background knowledge. It is, thus, crucial for a suitable UCHF for Western Balkan municipalities to provide a clear and transparent documentation of the development and application process of a framework. Also, results need to be effectively communicated in order to enable actual change in the cities of the region. Finally, the applicability mainly refers to the access to high quality and current data, which is necessary to enable sound decisions towards urban circularity. The focus criteria were proposed by the authors of this study and confirmed by the project partners of the CEB project[4] within a reflection workshop regarding the UCHF evaluation. Within the workshop, the partners furthermore suggested to include **(2) Stakeholder engagement** as an additional focus criterion. In order to enable systemic change towards CE in the Western Balkan municipalities, it is crucial to include relevant stakeholders, such as policy makers, companies and citizens.

To support the analysis of the remaining 15 frameworks, we create an evaluation matrix (cf. Figure 2.1). The matrix is based on "Harvey Balls", an effective graphical representation of the fulfilment of specific criteria. The Harvey Balls, on the one hand, are created by "translating" the results of Papageorgiou et al. (2021) into the graphical representation and, on the other hand, by evaluating the additional frameworks based on our own research (CCST and MUCT). By analysing the matrix, further nine frameworks are excluded from a more detailed evaluation. Each of the excluded frameworks does not fulfil at least one of the focus criteria described above (e.g. CCAF does not fulfil the Applicability criterion). One framework (EISCED) does not fulfil any

[4] CirEkon (Serbia), Cleantech Bulgaria, Chamber of Commerce and Industry of Serbia, Timis Chamber of Commerce, Industry and Agriculture (Romania), ATHENA Research and Innovation Center in Information, Communication and Knowledge Technologies (Greece), EIT Climate-KIC

of the focus criteria. The excluded frameworks are: CCAF, UCDI, MFEML, KIMCE, CB, EISCED, CEAIS, EISCE and MUCTP.

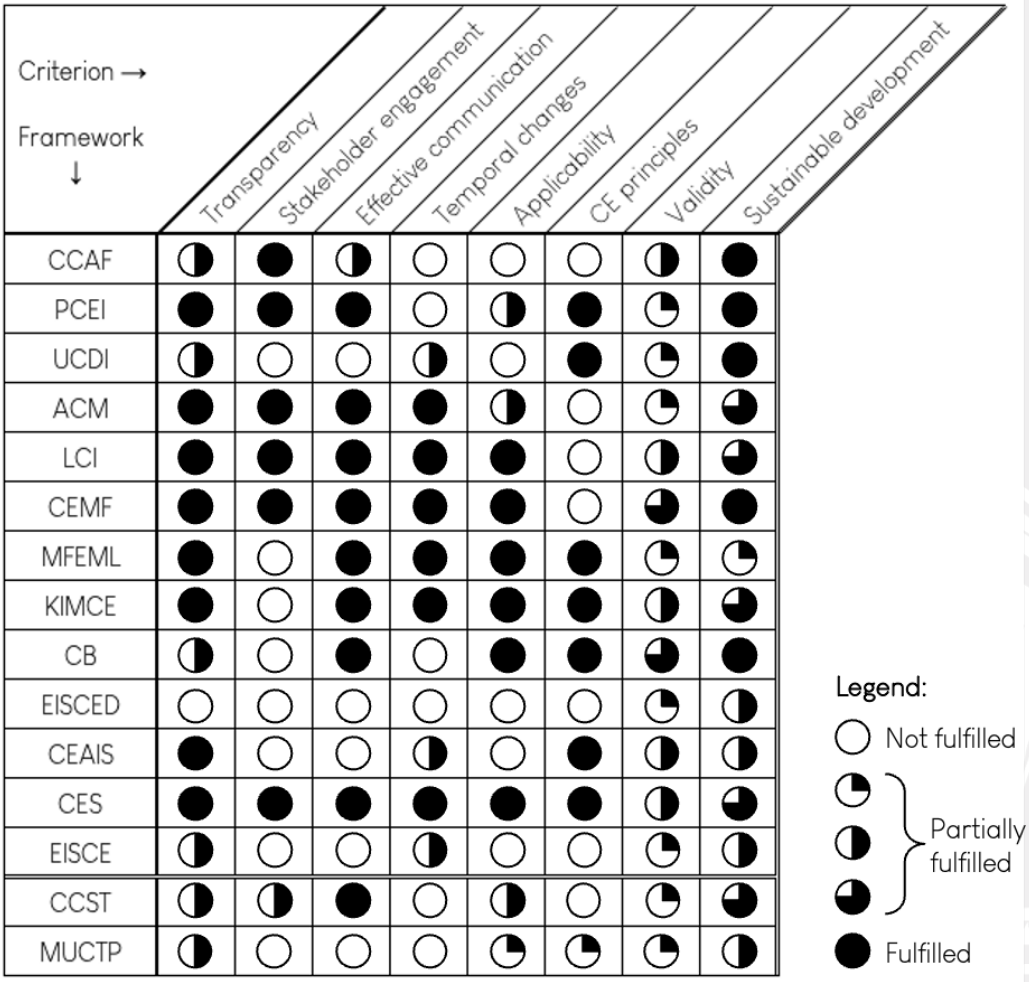

Figure 2.1: Evaluation matrix for UCHF
(Own illustration partially derived from Papageorgiou et al., 2021)

This leaves a total of six frameworks that for further evaluation: PCEI, ACM, LCI, CEMF, CES, CCST. In order to further narrow down the relevant frameworks for the Western Balkan context and to increase the focus on the region's municipalities' specific needs, in the next step, we develop additional evaluation criteria based on the characteristics of the region.

2.2. The Case of the Balkan Region and Additional Evaluation Criteria

In recent years, CE has been recognized as a new concept to be implemented throughout the Western Balkan region. However, as the concept is still in its formative years, citizens, companies, politicians and media of the region have only a partial understanding of what CE fully entails. Research suggests that communities in the region are not fully aware of the core concept of the CE model, the path towards its development and the benefits of its adoption. Even though there is a common will towards protecting the environment, there is a lack of understanding of how companies' and individuals' actions can contribute towards a progressively healthy existence through CE. Another deep-rooted misconception shared by consumers within the region is that the materials extracted from nature for a linear model of "take-make-waste" are inexhaustible. These factors combined with the lack of available data to track the development status of CE in the region, have generated a fracture between international standards concerning CE and the current in-country situations of all the Western Balkan states (Kabashi et al., 2021).

In the Western Balkan region, one of the main problems is poor waste management. The production of waste has increased steadily in recent years due to economic development and increased consumption, and currently stands at around 1,000 kg per capita. Although this is still lower than the EU average of 1,700 kg per capita, recycling rates are very low (below 3 %, compared to the EU average of 44 %), resulting in a higher amount of non-recycled waste per capita (European Commission, 2020). Landfilling remains the most popular method of waste disposal, although according to the waste management hierarchy (cf. Figure 1.2) this is the least desired option. Despite efforts to get rid of illegal landfills, they continue to thrive and pose a serious risk to public health, particularly due to hazardous waste and groundwater contamination (Kabashi et al., 2021).

In addition to the difficulties related to waste management, Western Balkan countries encounter the chronic dilemma of primarily generating energy via coal or other fossil fuels. Emissions from existing coal power plants, responsible for generating around 70 % of the electricity produced in the region (European Commission, 2020), act as one of the primary concerns for the wellbeing and health of citizens in the region. This needs structural reform to align with the demands of a structure based on CE. By increasing decarbonization efforts, aiming to completely eliminate non-renewable sources and coal-based energy, and implementing clean and renewable energy infrastructures, the region will be closer to reaching climate neutrality and sustainability.

However, when it comes to shifting toward CE, it is evident that the region is presented with a wide range of challenges (Kabashi et al., 2021).

In order to address these challenges and try to reach the levels of circular development of European countries as soon as possible, it is urgent that the Western Balkan countries and cities adopt some methods to measure, assess and foster the development of CE at an urban level in the short term, i.e. to adopt and apply suitable UCHF. In order to find the most suitable and ideally readily available framework to use for municipalities in the Western Balkan region, we propose to supplement the criteria proposed by Papageoreorgiou et al. (2021) (cf. Sections 1.3 and 2.1) with three additional evaluation criteria:

- Awareness and level of development of CE
- Approach type
    - Top down
    - Bottom up
- Quantity and quality of data required

All three criteria are derived from the specific characteristics of the Western Balkan region. They were also proposed by the authors of this study and confirmed by the project partners of the CEB project within a specific reflection workshop, similar to the focus criteria (cf. Section 2.1). The first additional criterion builds on the fact that awareness and development regarding CE is generally rather low in the Western Balkan region. Therefore, a suitable UCHF needs to be applicable in municipalities with low awareness and development levels and still deliver valuable insights regarding CE levels, hotspots and potentials for improvement. The second additional relates to the fact, that policy making in the Western Balkan region mainly functions top down, thus a framework is required that enables such an approach. On the other hand, a suitable framework also needs to provide bottom-up functionalities in order to involve all relevant stakeholders and their experiences to foster circular change in the region's cities. The third additional criterion is based on the situation that in many Western Balkan countries and especially cities, data quantity and quality is relatively limited. A suitable UCHF for the region needs to still work with low quantity and quality data and still provide – at least – some decision basis for fostering urban circularity.

To, on the one hand, include the additional criteria and, on the other hand, focus the further analysis on only relevant frameworks, the evaluation matrix (cf. Figure 2.1) is updated by adding the new criteria and excluding the irrelevant frameworks (cf. Figure 2.2).

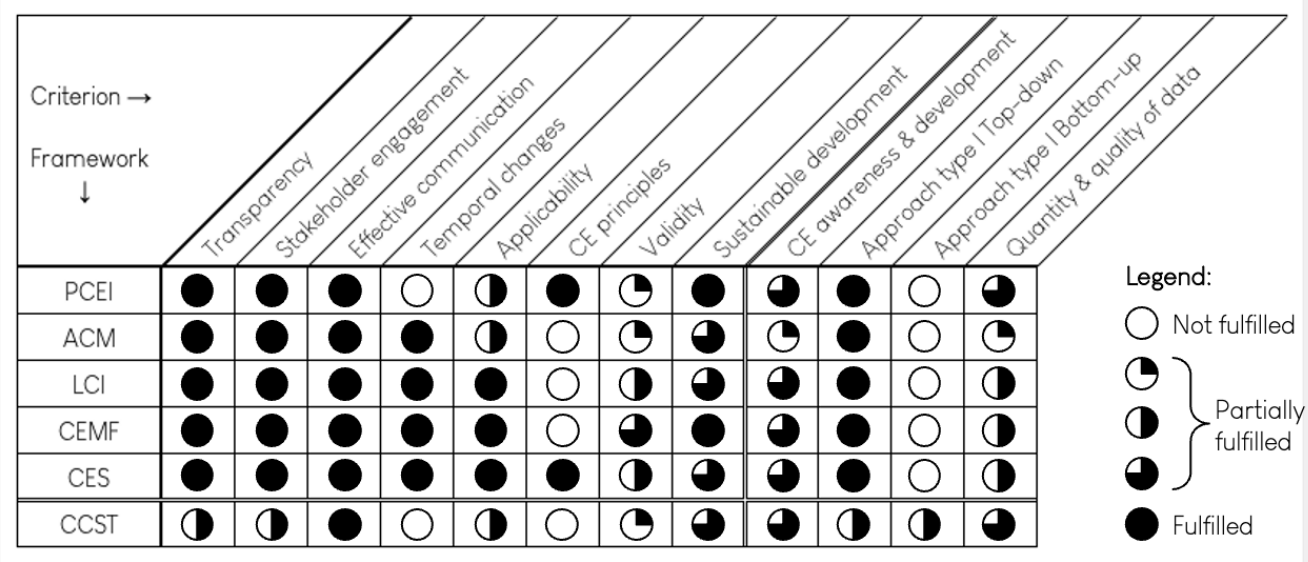

Figure 2.2: Updated evaluation matrix for UCHF for the Western Balkan region (Own illustration partially derived from Papageorgiou et al., 2021)

Based on the evaluation matrix (cf. Figure 2.2), it becomes clear that all six frameworks have their individual potentials and shortcomings. None of the framework fulfils all evaluation criteria. The framework that, at least partially, fulfils most criteria is CES. Here, only the *Bottom-up approach type* criterion is not fulfilled. CEMF and LCI both show weaknesses regarding *CE principles* and the *Bottom-up approach type* criterion. However, both frameworks score relatively high in all other criteria, especially the four focus criteria as described in Section 2.1. ACM shows similar weaknesses and also has lower scores regarding several other criteria, e.g. *Applicability*, *Validity*, *CE awareness & development* and *Quantity & quality of data*. Similar to all previously mentioned frameworks, PCEI does not fulfil the *Bottom-up approach type* criterion. While this framework scores highly regarding CE principles, it does not enable a tracking of Temporal changes and, in addition, shows lower levels of *Applicability* and *Validity*. Finally, CCST has the lowest overall scores of all six frameworks considered here. However, it is the only framework that, at least partially, fulfils all additional evaluation criteria that aim at a short-term implementation in Western Balkan municipalities.

Based on the presented potentials and shortcomings, for frameworks are selected for the following detail analyses. These are **CES, CEMF, LCI** and **CCST**. Despite their lack of Bottom-up characteristics, the first three are selected due to their good performance regarding the evaluation criteria proposed by Papageorgiou et al. (2021), especially concerning our four focus criteria (cf. Section 2.1). This generally good performance indicates a high potential for fostering CE on macro level. However, their immediate potential for short-term implementation in Western Balkan municipalities, thus for fostering urban circularity in the region, needs to be further analysed. Despite its worse performance regarding the basic evaluation criteria, the CCST is also selected for detail analysis due to its good performance regarding all additional evaluation criteria (see above), thus indicating the potential for a short-term implementation. In the following, all four frameworks are analysed in detail.

2.3. Detail Analysis of Selected Frameworks

2.3.1. Circular Economy Scoreboard (CES), (The European House – Ambrosetti & ENEL Foundation, 2020)

The CES was found to be the framework most in line with the criteria adopted during the analysis. It is based on a multi-level methodology aimed at providing a comprehensive picture of the circularity level of a **country**. Therefore, the choice of both, the pillars and of the variables included in the scoreboard, is driven by the desire to represent CE as comprehensively as possible. The CES is developed across 4 pillars and 23 Key performance Indicators (KPIs), which cover all the macro-dimensions of the CE (The European House – Ambrosetti & ENEL Foundation, 2020). The four pillars, represented in Figure 2.3, are:

- **Sustainable inputs**, which capture the use of renewable energy and of recyclable, recycled and biodegradable materials to manufacture goods and provide value in consecutive life cycles
- **End-of-life**, which describes ways of recovering end-of-life value of asset, products and materials through reuse, remanufacturing and recycling
- **Extension of useful life**, which reflects the capability of increasing the duration of the useful life, with respect to the usual end-of-life of a product or its components
- **Increase of the intensity of use**, which rates the increase of the load factor of a single item (for example with product as a service or sharing services models). It measures the increase of the benefit obtainable with each unit of input (material and energy) used

The four pillars are logically and practically connected by the "**circular-by-design**" approach, since the moment a product or a service is conceived. Moreover, these pillars are chosen to be representative of the overall life cycle of products and services, capturing the production patterns in the first two pillars (Sustainable inputs and End-of-life) and the consumption and usage patterns in the last two pillars (Extension of useful life and Increase of the intensity of use) In addition, to assess in more detail the CE development level of a country along the four pillars, 23 Key Performance Indicators (KPIs) have been defined within the framework (cf. Table 2.1) (The European House – Ambrosetti & ENEL Foundation, 2020).

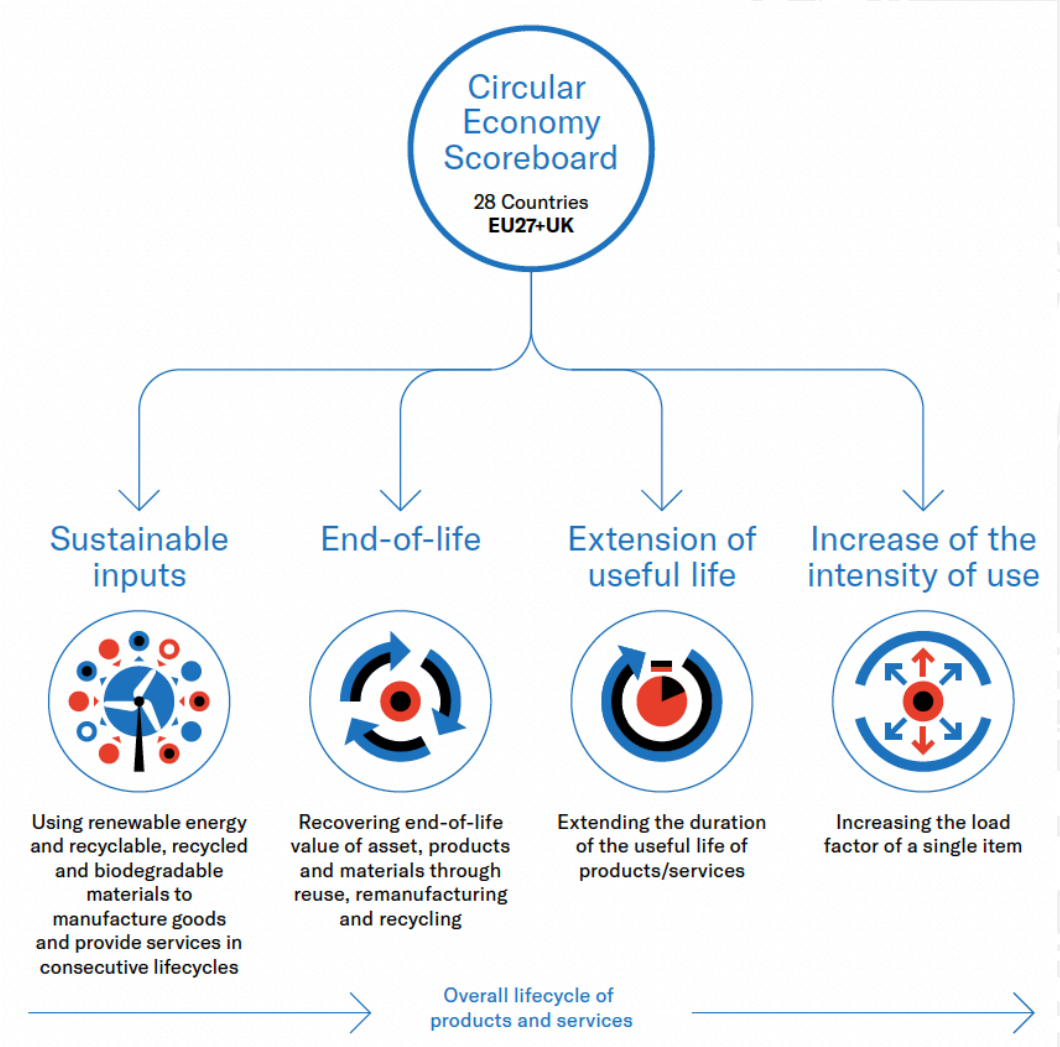

Figure 2.3: Circular Economy Scoreboard (CES) thematic areas (The European House – Ambrosetti & ENEL Foundation, 2020)

Table 2.1: Key Performance Indicators of the Circular Economy Scoreboard (The European House – Ambrosetti & ENEL Foundation, 2020)

Sustainable inputs	**Circular material use rate**	%	Eurostat
	Resource productivity	€ per tonne of material consumption	Eurostat
	Share of total organic area in total utilized agricultural area	%	Eurostat
	Water productivity	€/m³ of water	EEA
	Energy intensity	TOE per thousand Euros	Eurostat
	Share of energy from RES	% of final energy consumption	Eurostat
	Final energy consumption by RES in transport	% of final energy consumption	Eurostat
	Final energy consumption by electricity in manufacturing sector	% of final energy consumption	Eurostat
	Final energy consumption by electricity by households	% of final energy consumption	Eurostat
End-of-life	Packaging waste recycled	%	Eurostat
	Total generation of waste per GDP unit	kg per million Euros	Eurostat
	Industrial waste treated by recycling	% on total industrial waste generated	Eurostat
	Municipal waste treated by recycling	% on total municipal waste generated	Eurostat
	Patents related to recycling and secondary raw material per employees in Circular Economy sectors	patent per employees	Eurostat
	Sewage sludge treated and disposed in agriculture or as compost	% of sewage sludge produced	Eurostat
Extension of useful life	End-of-life vehicles recovered and reused	% of end of vehicles scrapped	Eurostat
	Load factor	tonne-km / vehicle-km	Eurostat
	Value added of retail sale of second-hand goods	Euro per capita	Eurostat
	Employment in repair and reuse sectors	% of total employment	Eurostat
Increase of the intensity of use	**Individuals using any website or app to arrange an accommodation from another individual**	%	Eurostat
	Individuals using dedicated websites or apps to arrange a transport service from another individual	%	Eurostat
	Collective transport on total passenger transport	% of total inland passenger-km	Eurostat
	Individuals using the internet	% of individuals aged 16 to 74 in the last 12 months	Eurostat

Limitations: While the CES scores highly across all evaluation criteria, it also exhibits a crucial shortcoming, as it is specifically designed to assess CE at a national and regional rather than urban/city level. While some of the indicators, i.e. KPIs, used could also be applied at city level, the related data would either have to be collected from different sources or scaled to provide insights on city level. It also completely focuses on a top-down approach and does not enable bottom-up participation or interaction. It, thus, leaves out a crucial success factor for urban circularity: including diverse stakeholders in the CE assessment and strategy development process in order to raise awareness foster acceptance for a circular transition.

Summary

According to Papageorgiou et al. (2021) the CES framework, which is suitable for measuring the development of CE at **national** and **regional** level, is the one that most satisfies the proposed criteria set. It also completely fulfils all four focus criteria (cf. Figure 2.1), thus making it a generally interesting candidate for implementation. The framework is mainly connected by the "circular-by-design" approach and is composed of four thematic areas, which represent the overall life cycle of products and services. The first two pillars (Sustainable inputs and End-of-life) capture the production patterns and the last two pillars (Extension of useful life and Increase of the intensity of use) capture the consumption and usage patterns. Due to its focus on a national and regional level as well as its lack of bottom-up engagement, however, its **potential for short-term adoption and application in Western Balkan municipalities is limited**.

2.3.2. Circular Economy Monitoring Framework (CEMF), (European Commission, 2018)

The CEMF, developed by the European Commission (2018), was originally designed for the policy making of the European Union. It is designed for an application at **national and regional** level. It aims to measure progress towards a circular economy in a way that encompasses its various dimensions at all stages of the life cycle of resources, products and services. The framework consists of four thematic areas (Production and consumption, Waste management, Secondary raw materials, Competitiveness and innovation), ten indicators and several sub-indicators (cf. Figure 2.4). Table 2.2 shows all the sub-indicators that help provide a broad picture of the key leverage points for increasing circularity in the EU's economy (European Commission, 2018).

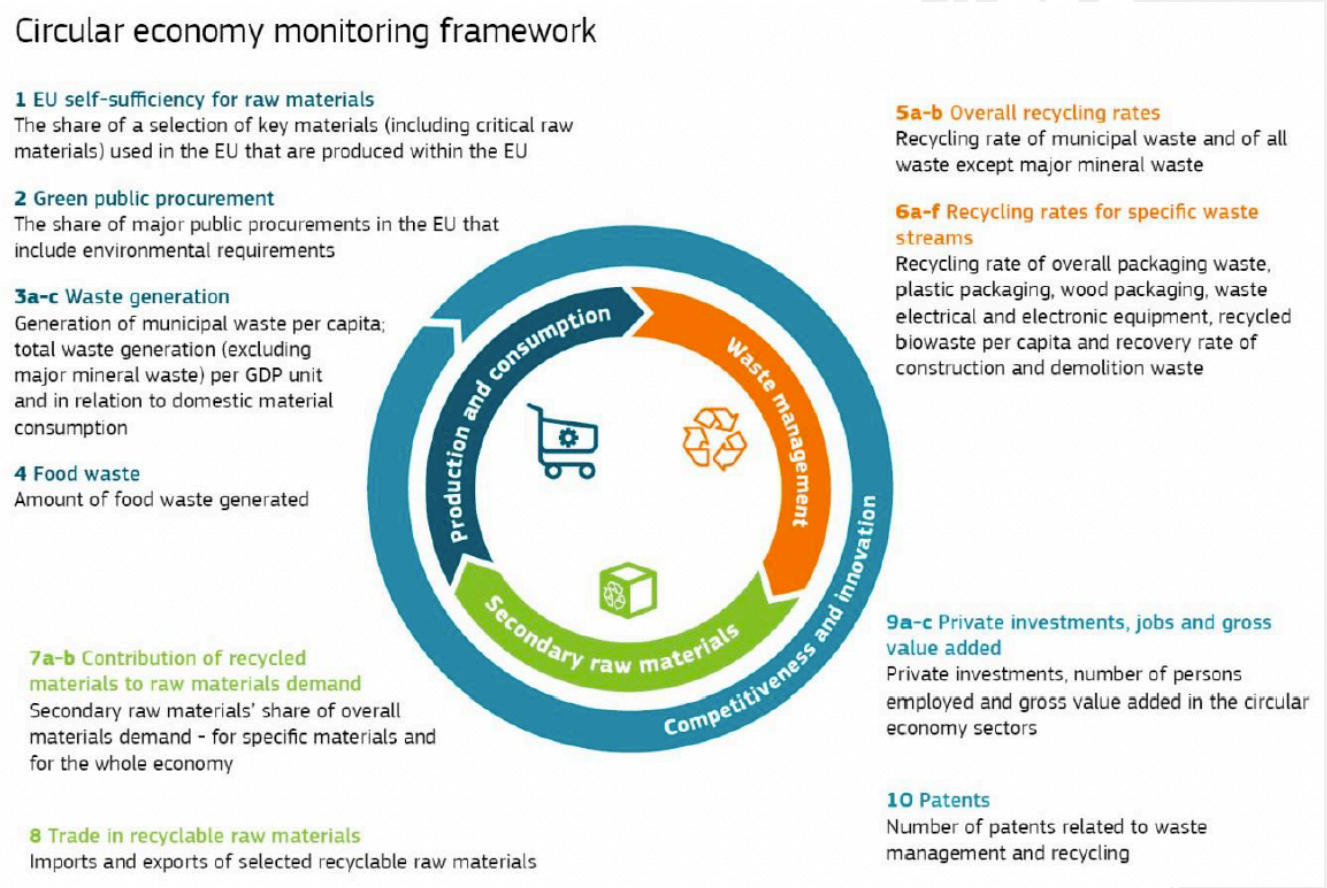

Figure 2.4: Circular Economy Monitoring Framework (European Commission, 2018)

The first thematic area is **Production and consumption**. Here, monitoring these phases is essential to understand progress towards CE. In the long term, this transition can contribute to increasing the EU's self-sufficiency in selected raw materials for production in the EU. A key aspect is **waste prevention.** Here, households and especially economic activities are required to reduce the amount of waste that they generate. In this regard, there are three sub-indicators to calculate the waste generation indicator: municipal waste generated per capita, waste generation excluding major mineral waste divided by GDP and waste generation excluding major mineral waste divided by domestic material consumption. Also, the food waste generation indicator is relevant because it measures an important waste stream with a significant environmental impact. Finally, the share of green public procurement in the economy provides a useful indication of how much public funds contribute to CE.

The second thematic area concerns **Waste management**. This area focuses on the share of waste that is recycled, as this is the treatment through which waste materials are effectively returned to the economic cycle and can continue to create value. Two main indicators monitor general progress in waste recycling and recycling in specific waste streams. The most appropriate indicators to track the overall targets are recycling of all waste excluding major mineral wastes and recycling of municipal waste. The focus with regard to specific waste streams is on those that currently represent a significant challenge for the economy and the environment, such as packaging waste, including plastic and wood waste, bio-waste, electrical and electronic waste, as well as construction and demolition waste.

The third thematic area concerns **Secondary raw materials**. This is because to close the cycles of CE, materials and products must eventually be reintegrated into the economy. The most important indicator represents how much recycled materials contribute to the raw materials demand. This indicator contains two sub-indicators; one related to the circular material use rate and the second to the end-of-life recycling input rate (ratio of secondary raw materials obtained through recycling divided by the overall quantity of raw materials fed into the economy). Another relevant indicator is related to the trade of recyclable raw materials between the EU Member States and the rest of the world.

The last thematic area concerns **Competitiveness and innovation**. A more circular economy will increase the lifespan of products by improving design for circularity and increasing reuse, repairability, durability and upgradability. On the one hand, this is achieved through the promotion of innovative industrial processes such as industrial symbiosis, and on the other hand, by supporting innovative forms of consumption, such as the collaborative economy. Two indicators are included to monitor developments in this thematic area: one on the economy of circular economy sectors (recycling, repair and reuse) in terms of jobs, investment and gross value added, and another one on patents related to recycling and secondary raw materials, as a proxy for innovation (European Commission, 2018).

Table 2.2: Indicators of the CEMF (European Commission, 2018)

No.	Name	Relevance	EU levers (examples)
*Production and consumption (*Indicators under development)*			
1	EU self-sufficiency for raw materials	The circular economy should help to address the supply risks for raw materials, in particular critical raw materials.	Raw Materials Initiative; Resource Efficiency Roadmap
2	Green public procurement*	Public procurement accounts for a large share of consumption and can drive the circular economy.	Public Procurement Strategy; EU support schemes and voluntary criteria for green public procurement
3a-c	Waste generation	In a circular economy waste generation is minimised.	Waste Framework Directive; directives on specific waste streams; Strategy for Plastics
4	Food waste*	Discarding food has negative environmental, climate and economic impacts.	General Food Law Regulation; Waste Framework Directive; various initiatives (e.g. Platform on Food Losses and Food Waste)
Waste Management			
5a-b	Overall recycling rates	Increasing recycling is part of the transition to a circular economy.	Waste Framework Directive
6a-f	Recycling rates for specific waste streams	This reflects the progress in recycling key waste streams.	Waste Framework Directive; Landfill Directive; directives on specific waste streams
Secondary raw materials			
7a-b	Contribution of recycled materials to raw materials demand	In a circular economy, secondary raw materials are commonly used to make new products.	Waste Framework Directive; Eco-design Directive; EU Ecolabel; REACH; initiative on the interface between chemicals, products and waste policies; Strategy for Plastics; quality standards for secondary raw materials
8	Trade in recyclable raw materials	Trade in recyclables reflects the importance of the internal market and global participation in the circular economy.	Internal Market policy; Waste Shipment Regulation; Trade policy
Competitiveness and innovation			
9a-c	Private investments, jobs and gross value added	This reflects the contribution of the circular economy to the creation of jobs and growth.	Investment Plan for Europe; Structural and Investment Funds; InnovFin; Circular Economy Finance Support Platform; Sustainable Finance Strategy; Green Employment Initiative; New Skills Agenda for Europe; Internal Market policy
10	Patents	Innovative technologies related to the circular economy boost the EU's global competitiveness.	Horizon 2020

Limitations: In the CEMF, designed primarily for application at the national and regional level, many indicators cannot directly be applied at the urban/city level. In addition, during the design of the framework, importance was given to data that were already available, rather than data that better reflect the principles of CE and should have been collected and measured for the first time. The framework focuses on recycling indicators, but not on operations such as re-use, which are preferred in a CE model. In addition, it focuses on down-cycling rather than up-cycling. There are also important shortcomings regarding the consideration of eco-design and the collaborative economy on the one hand, and environmental impact assessments on the other hand. Finally, and similar to CES, the CEMF does not enable any bottom-up engagement, thus leading to shortcoming regarding the creation of awareness and acceptance for actions towards increasing urban circularity.

Summary

This framework developed by the European Commission (2018) is mainly suitable for application at **national** or **regional** level, rather than urban/city level. However, considering the evaluation criteria, it is among those with the highest scores across all criteria. It also completely fulfils all four focus criteria (cf. Figure 2.1), thus making it a generally interesting candidate for implementation. The framework consists of four thematic areas (Production and consumption, Waste management, Secondary raw materials, Competitiveness and innovation), ten indicators and several sub-indicators. At the level of production and consumption, emphasis is placed on the principle of **prevention** by measuring the generation of waste by households and businesses over time. On the contrary, in the section on waste management, the framework focuses on products that have already reached their end-of-life, measuring both general and specific material recycling values. In the secondary raw material section, the measure of the contribution of recycled materials to the raw materials demand is assessed, while the fourth section offers information about the dimensions of the economic model, through the collection of data such as the number of employees, gross value added and the number of patents. Due to its focus on a national and regional level, further shortcoming related to CE principles as well as the lack of bottom-up engagement, **the potential of the CEMF for short-term adoption and application in Western Balkan municipalities is limited**.

2.3.3. London Circularity Indicators (LCI), (Cambridge Econometrics, 2018)

The LCI framework by Cambridge Econometrics (2018) was designed to measure the future progress of the city of London towards urban circularity. Considering the evaluation criteria, it is the one with the highest score at **city level**. Similar to CES and CEMF, it completely fulfils all four focus criteria (cf. Figure 2.1). The LCI framework consists of three thematic areas: Resource productivity and consumption, Waste production and Recycling, and size and value of the circular economy (cf. Figure 2.5). In the following, the different thematic areas, related indicators as well as their potential limitations are presented.

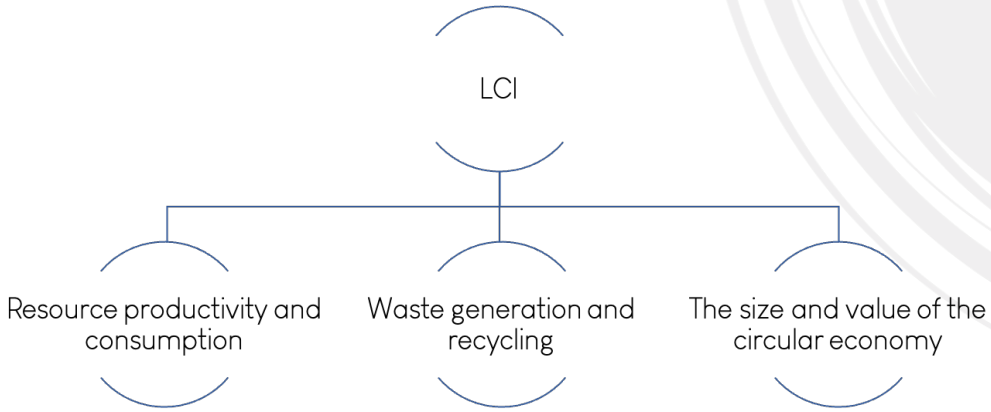

Figure 2.5: London Circularity Indicators (LCI) thematic ares (Own illustration based on Cambridge Econometrics, 2018)

<u>Resource Productivity and Consumption:</u> In this thematic area three indicators were developed: circularity of consumption, material productivity and scope 3 emissions.

Circularity of consumption: In this first indicator, a proxy for circularity has been developed using existing consumption data. The consumption of goods and raw materials (as a proxy for the linear economy) is compared to the consumption of services, technology and recycled materials (as a proxy for the circular sectors). The circularity of consumption indicators are presented as a percentage change from baseline levels (2010). One method of measure is to categorise consumption from households and industries. For households, the implications of increased circularity could be reflected in waste and recycling statistics, as households recycle larger shares of their generated waste. For industries, the growth in circularity could be represented by an increase in the share of inputs from recycled materials, leading to decreases in waste generation.

Limitations: This indicator can only be considered as a proxy for circularity, because the results depend heavily on assumptions about what is defined as circular or linear consumption.

Material productivity: The material productivity indicator captures the total material intensity per unit of Gross Value Added (GVA). As the circulation of materials increases, it is anticipated that the material inputs per million pounds of GVA generated would decrease. Indeed, in a more circular economy, the higher the levels of recycled material introduced into the economic system, the more the material intensity of production decreases. However, such a decrease would be more pronounced if economic activity shifted from sectors that are material-intensive (e.g. construction) to those that are less so (e.g. services). Thus, this trend marks the importance of the role that services play in the future economy of cities.

Limitations: Data on total material consumption are not always available at the city level, so it may be the case that these values are calculated at the country level and scaled to reflect the sectoral composition of the economy of the city in question.

Scope 3 Emissions: Scope 3 emissions are the emissions (measured in tonnes of CO_2-equivalent) that help to measure the circularity of a city's economy, because they capture changes in consumption activities. If industries, businesses and consumers adopt more circular practices, such as those aimed at waste prevention and increased use of recycled products, emissions are likely to be reduced.

Limitations: When checking total emissions there are certain factors that have to be taken into account, in order to get a correct view of the whole. Indeed, in the case of an increase in total emissions, this can be justified simply by an increase in the number of consumers. Conversely, a decrease in emissions may be the consequence of a recession and is not necessarily the result of an improvement in the material or carbon intensity of consumer goods and services. The second limitation is found in the methodology used to derive this indicator: it includes the embedded emissions from the goods and services a city consumes, but does not measure the embedded emissions from the goods and services it produces. Any goods produced locally but consumed elsewhere are not included in this metric.

Waste generation and recycling: Three indicators have been developed in the thematic area of waste generation and recycling. These indicators are: waste management, waste intensity of households and industry waste.

Waste management: This indicator provides information on waste management, offering an overview of the destination of products that have reached their end-of-life. When a product becomes waste, recycling is the preferred solution, followed by incineration and only finally landfill.

Limitations: It is important to always compare what the increase or decrease of one solution means for the other alternatives. For example, a reduction in waste going to landfill is not always seen as a success. In fact, this is positive if it leads to an increase in the proportion of waste actually recycled or better still if there is a decrease in waste generated. On the other hand, this is negative if this is compensated by a higher share of waste dispersed into the environment.

Waste intensity of households: This indicator estimates the tonnes of waste generated per household. This measure can determine whether there is prevention in the creation of waste.

Limitations: When the amount of waste generated decreases, recycling rates may be affected. The recovery of materials from generated waste may become more difficult, for example, due to changes in the composition of household waste and the types of materials disposed of. For this reason, it is important to review the two indicators at the same time. Another example is when the total amount of waste generated increases due to population growth, and the level and relative intensity of waste per household decreases. One of the possible reasons for this reduction in household waste intensity can be attributed to an increased circulation of materials.

Industry waste: This indicator represents the waste generated by sector and material type. It is calculated using estimates for waste intensity by industrial sector combined with data on activity by industrial sector for the city in question.

Limitations: A number of factors need to be taken into account when analysing this indicator. The first is the added value of the sector in question, because an increase in waste generated does not always mean that the sector has adopted less circular practices, but additional waste may have been generated due to increased activity and production in the sector. Therefore, a more accurate measure is to quantify how much waste has been generated for a given level of production, as was done previously with the indicator on the intensity of waste generated by households.

The size and value of the circular economy: In this thematic area, the size and value of the circular economy is measured. This is done through two indicators. The first relates to the

measurement of the number of employees and the second measures the total added value produced by the circular economic model.

Number of jobs: The number of jobs in CE is a key indicator of the contribution of CE to economic activity. However, there are a number of ways that CE jobs can be measured, including direct jobs (i.e. those engaged solely in CE), indirect jobs (i.e. those dependent upon CE) or the CE content of employment (i.e. assigning 'portions' of jobs that involve CE aspects but are not solely committed to CE activities). Measuring each of these comes with its own challenges. A first approach to measuring CE jobs is sectoral, and is based on 5-digit SIC (Standard Industrial Classifications) codes (i.e. repair, recycling, rental and leasing jobs) (cf. Table 2.3). A second approach uses an input-output model to derive the percentage of jobs that are dependent on CE. The input-output approach calculates, at the sectoral level, the share of intermediate demand for inputs from the circular sectors identified by 5-digit SIC codes.

Table 2.3: Sector activities directly related to CE (based on 5-digit SIC codes) (Cambridge Econometrics, 2018)

Sector activities which are considered directly part of the circular economy (based on 5-digit SIC codes)
Repair of Machinery and Equipment
Repair of fabricated metal products
Repair of machinery
Repair of electronic and optical equipment
Repair of electrical equipment
Repair and maintenance of ships and boats
Repair and maintenance of aircraft and spacecraft
Repair and maintenance of other transport equipment
Repair of other equipment
Recovered materials
Recovery of sorted materials
Wholesale of waste and scarp
Retail sale of second-hand goods
Rental and leasing
Renting and leasing of cars and light motor vehicles
Renting and leasing of trucks

Renting and leasing of recreational sports goods
Renting of video tapes and disks
Renting and leasing of media entertainment equipment
Renting and leasing of other personal and household goods
Renting and leasing of agricultural machinery and equipment
Renting and leasing of construction and civil engineering machinery and equipment
Renting and leasing office machinery and equipment (including computers)
Renting and leasing of passenger water transport equipment
Renting and leasing of freight water transport equipment
Renting and leasing of passenger air transport equipment
Renting and leasing of freight air transport equipment
Renting and leasing of other machinery, equipment, and tangible goods
Repair of computers, electronics and household goods
Repair of computers and peripheral equipment
Repair of communication equipment
Repair of consumer electronics
Repair of household appliances and home and garden equipment
Repair of footwear and leather goods
Repair of furniture and home furnishings
Repair of watches, clocks and jewelry
Repair of other personal and household goods

Limitations: Both methodologies use a sectoral approach, which is limited by the sectors that are represented in the SIC. In fact, to date there are many jobs that are directly enabling or supporting employment in CE, but do not have their own SIC code. The sectors that are included and summarised in the table above are probably representative of a small component of the overall CE and, for example, exclude CE-enabling employment in technology, research, government and education. Therefore, this leads to an underestimation of total circular jobs. The employment indicator also presents other critical issues to be considered. On the one hand, possible increases in recycling rates do not always translate into direct increases in employment of the same sector. This is due to possible changes in labour productivity or in the development of efficient mechanical procedures for the recovery of resources. On the other hand, a possible increase in employment in the waste sector could be linked to an increase in total waste

generation or to improvements in waste management practices, although these two effects reflect very different outcomes for the circular economy.

Gross Value Added (GVA) of the CE output: The measure of GVA of the CE output is calculated using data on direct employment in CE and the sector's estimate of productivity. The metric only takes into account jobs with 5-digit SIC codes. In a more circular economy, the GVA indicator would experience gains and encourage improvements in resource efficiency.

Limitations: The metric only takes into account the components of CE identifiable by 5-digit SIC codes, showing a clear underestimation of the economic value of CE sectors. Moreover, as the GVA indicator is based on the labour productivity across sectors, the estimates do not take into account improvements due to technological and supply chain innovations, which improve the resource efficiency of individual firms. However, these are widely considered to be key aspects of the circular economy (Cambridge Econometrics, 2018).

Summary

The LCI framework adopted by the City of London and developed by Cambridge Econometrics (2018) is one of the most comprehensive frameworks for measuring the level of development of CE at **urban/city level**. It consists of three thematic areas, the first one being Resource productivity and consumption. Here, on the one hand, the level of consumption considered circular is measured, and on the other hand, the productivity of materials through energy intensity. In addition, emissions, measured in tonnes of CO_2-equivalent, also help to capture changes in consumption activities. Finally, further measures should be taken into account when analysing these indicators. For example, a possible increase in emissions does not always represent a decrease in the level of circularity.

The second thematic area concerns waste generation and recycling. In addition to providing information on where end-of-life products end up, it offers specific information on waste generation per household, thus enabling an analysis of the basic principle of CE, **prevention**. Also in this section, an important indicator is represented by the waste generated by sector, which is calculated using estimates for waste intensity by industrial sector, combined with data on activity by industrial sector for the city in question. In this case, an increase in waste generated does not always mean that the sector has adopted less circular practices, because additional waste may have been generated due to increased activity and production in the sector.

The last thematic area measures the size and value of CE through two indicators. The first relates to the measurement of the number of employees and the second measures the total added value produced by the CE model. In both of these indicators the major limitation is that the metric only takes into account the components of CE identifiable by 5-digit SIC codes. This shows a clear underestimation, on the one hand, of the economic value of CE sectors and, on the other hand, in the quantity of total circular jobs.

Overall, the LCI, being the highest scoring framework among those at city level, shows some potential for the implementation in Western Balkan municipalities. However, some shortcomings exist regarding the indicators used. Furthermore, similar to CES and CEMF, the LCI lacks the ability to enable bottom-up engagement and, thus, shows limited potential for raising awareness and acceptance for a circular transition on city level. Keeping these shortcomings in mind, it could be possible to adapt the framework to a Western Balkan context, given that the relevant data is available and uncertainties regarding the indicators are made transparent and are processed proactively. **However, an elaborate adoption process could hinder the short-term implementation of the LCI in Western Balkan municipalities, thus limiting its overall potential for our case**.

2.3.4. Circle City Scan Tool (CCST), (Circle Economy, 2021)

The CCST, designed by the non-profit organization Circle Economy (2021), aims to promote practical and scalable solutions for the transition to CE in cities. The CCST is a promising digital tool to support various stakeholders including policy makers, to find out what CE opportunities are available to them by identifying specific areas of interest. The tool currently uses around 4.4 million data points from some 6,000 cities to analyse the best circular solutions at an **urban level**. It is based on 75 CE strategies and 3,124 CE case studies. In the future, more data shall be included to make the tool more efficient (Circle Economy, 2021).

The current prototype of the CCST is available online and was developed in collaboration with a wide range of organizations, partners and cities, such as Metabolic, ICLEI (Local Governments for Sustainability), Ellen MacArthur Foundation, geoFluxus and Metabolism of Cities (Circle Economy, 2021). The easy-to-use and readily available digital tool is designed to guide and support the user step-by-step towards more circular actions. On a practical level, the user first gets an overview of each sector with values for socio-economic factors such as jobs, emissions and added value. Here, there are both detailed definitions for each sector and possible circular

initiatives within the sector. The second step is to determine the desired focus by defining the sector, the material within the sector and the impact area of interest.

In the next step, a radial diagram (cf. Figure 2.6) shows which opportunities are suitable for the specific research undertaken. The closer these are to the centre of the diagram, the higher their score. The opportunities come from eight key elements which are:

- Strengthen and advance knowledge
- Rethink the business model
- Design for the future
- Incorporate digital technology
- Team up to create joint value
- Prioritize regenerative resources
- Stretch the lifetime
- Use waste as resources

At this point, by clicking on the suggested option, the user can gain a greater understanding of the proposed strategy, see similar examples in other cities and connect directly with possible solution providers. The last step of the tool is a visual report summarizing the specific case. Finally, to increase the effectiveness of the tool, the option to create a specific action plan shall be implemented in the future (Circle Economy, 2021).

In conclusion, this tool, thanks to the numerous case studies and good practices already available, shows enormous potential; in general and especially for the Western Balkan countries and municipalities that are still lagging behind in the development of CE at an urban level (Circle Economy, 2021).

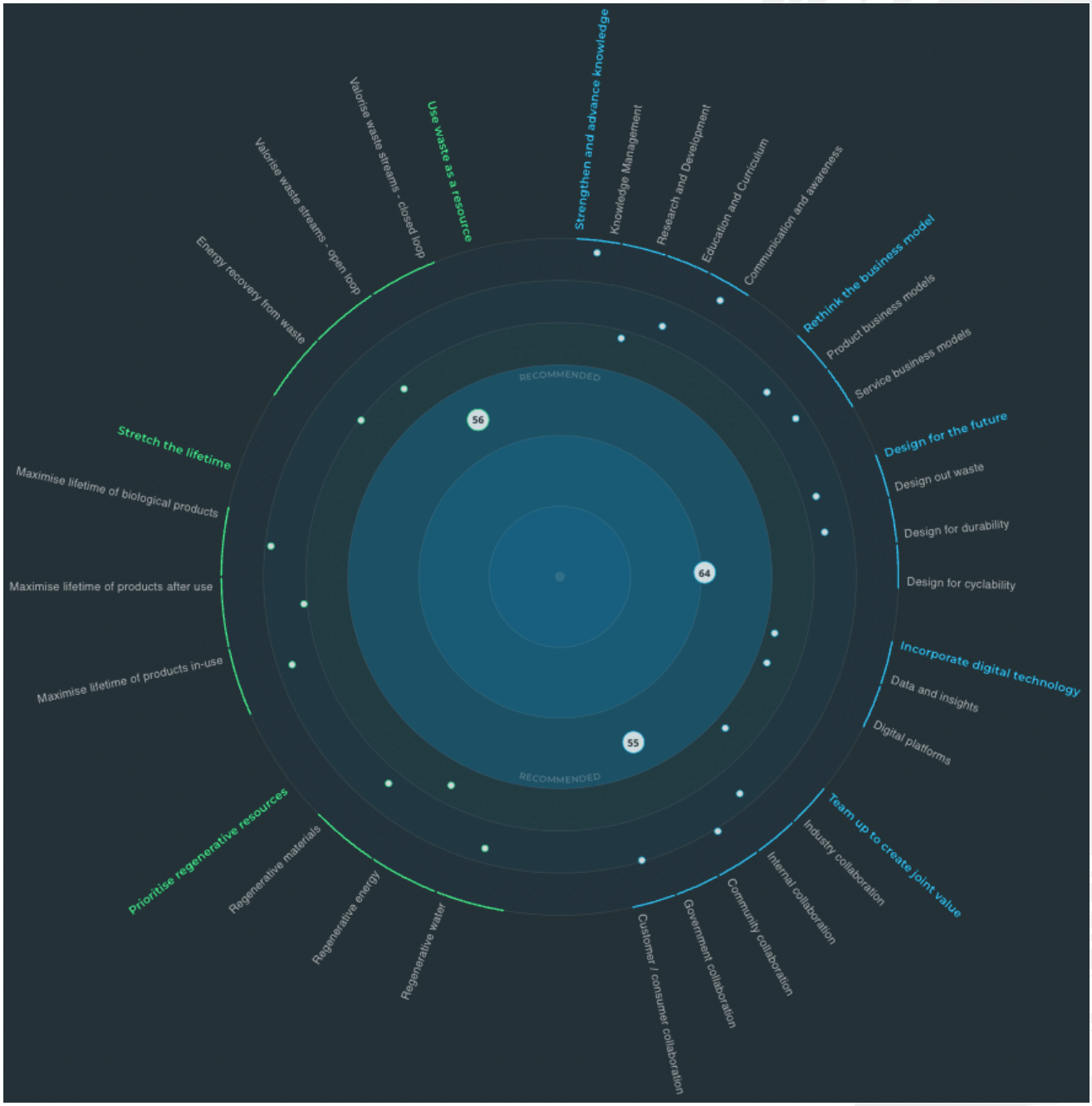

Figure 2.6: Circle City Scan Tool (CCST) radial diagram (Circle Economy, 2021)

Limitations: The main limitation of this tool is that it is based on data that the organization providing the platform, i.e. Circle Economy, collects in cooperation with its partners. Currently, there are only few cities in the Western Balkan countries in the CCST database. Therefore, the

big challenge will be to combine and converge the large volumes of resource and other relevant data regarding the region's cities into the platform. Finally, a further small limitation is that users, in order to get useful results, have to know relatively detailed which sectors and materials could be interesting to investigate. These have to be defined at the beginning of the analysis, thus limiting more exploratory applications that aim at openly finding any hotspots or potentials for improvement. Overall, the CCST has the lowest scores of the four frameworks analysed in detail. This implies potential for improvements regarding several evaluation criteria, e.g. *Temporal changes*, *CE principles* or *Validity*. However, as the tool is still under development and currently available as a prototype, these improvements could be included within future updates/releases of the CCST.

Summary

The CCST is a digital tool designed by the non-profit organisation Circle Economy (2021) which aims to promote practical and scalable solutions for the transition to CE on an **urban/city level**, i.e. urban circularity. Unlike the other frameworks analysed in this study, this one includes an online platform already available and **ready to use**. On a practical level, users, after expressing the focus of their research by specifying the sector, the type of material and which impact they wish to counteract, are guided towards the specific available opportunities offered by CE. While exhibiting several shortcomings related to the tool being still under development, it is the only one of the four frameworks analysed that enables both, **top-down and bottom-up engagement**. It, thus, shows potentials for raising awareness and acceptance for CE-oriented strategies and actions on city level. **Limitations** arise due to the **availability of data for the Western Balkan region** as well as a certain experience level regarding CE required. In conclusion, the CCST – despite some drawbacks – seems to be a promising framework for a short-term implementation in Western Balkan municipalities, given that relevant data from the municipalities is included in the CCST database.

3. URBAN CIRCULARITY HOTSPOT FRAMEWORK FOR WESTERN BALKAN MUNICIPALITIES

The main aim of our analysis is to derive a suitable UCHF for a short-term implementation in Western Balkan municipalities as well as criteria and actions towards its implementation within the CEB project in 2022. Therefore, in this section, we first summarize the findings of our analysis

in order to propose one of the considered frameworks as the Circular Economy Beacons Urban Circularity Hotspot Framework (CEB-UCHF). In a second step, we propose criteria and actions for a short-term implementation of the CEB-UCHF in 2022.

3.1. Definition of a Circular Economy Beacons Urban Circularity Hotspot Framework

Based on the overall (cf. Section 2.1) and case specific evaluations (cf. Section 2.2) along four general, four focus and three additional evaluation criteria as well as detail analyses of the four most promising frameworks (CES, CEMF, LCI and CCST; cf. Section 2.3) it becomes clear that – as of yet – there is no UCHF available without any shortcomings. The main shortcomings of the first two (cf. Sections 2.3.1 and 2.3.2) is their focus on a national/regional level, rather than urban/city level, thus leading to limited applicability and significance for cites in general and Western Balkan municipalities specifically – even though, both frameworks are highly comprehensive and provide valuable insights into multiple CE aspects required for decision making. The LCI, which is designed to assess CE aspects at city level, could be a promising alternative. However, several of the indicators used show shortcomings regarding validity and reliability. Also, the region-specific adaption of the framework to the Western Balkan context could prove elaborate, thus hindering a short-term implementation as a UCHF for Western Balkan municipalities.

Finally, the CCST – while being the only considered framework implemented within a ready-to-use online tool (prototype) – has shortcomings related to its ongoing development, including a lack of data on Western Balkan municipalities. While this impedes a direct implementation within these municipalities, the collection of relevant data and inclusion in the CCST database could prove less time and resource consuming than adapting an entire framework to the case at hand (as would be necessary for the LCI). Therefore, considering the shortcomings and potentials of the four presented frameworks, we propose to select the **Circular City Scan Tool (CCST)** by **Circle Economy (2021)** for a **short-term implementation in Western Balkan municipalities within the CEB project in 2022**, i.e. as a CEB-UCHF.

3.2. Criteria and Actions for a Short-Term Implementation and Monitoring

In order to enable a short-term implementation of a CEB-UCHF in 2022, specific success criteria need to be considered and monitored during implementation. Building on the analyses above, the characteristics of the Western Balkan municipalities and the benefits and shortcomings of the selected CEB-UCHF, i.e. the CCST, we propose five success criteria to be considered and monitored in the next phase of the CEB project:

1) Data availability for Western Balkan municipalities: In order for the tool to produce useful and reliable results, relevant data for Western Balkan municipalities needs to be collected and included into the CCST database. This includes data for different sectors that might already be available on urban/city level (e.g. Gross Value Added, emissions, jobs) or that might still need to be collected (e.g. material inputs, CE best practices).

2) Awareness and acceptance of CE-related challenges and opportunities: In order for a systemic transition towards CE on city level, relevant stakeholders need to be made aware of specific CE-related challenges and opportunities for their respective municipality and how to overcome the former and utilize the latter. This entails CE-related capacity building and the inclusion of stakeholders along the assessment and strategy development process (data collection, focus definition, impact assessment, review of opportunities, action planning).

3) Insights on urban circularity hotspots and levers for change: In order to enable positive effects for citizens and businesses, local governments/administrations need a clear picture of the most important and pressing issues related to CE as well as the greatest opportunities for systemic and sustainable progress. The CCST can provide first indications for such hotspots and short-term potentials for transformation but policy makers need to prioritize and set focus areas for urban circularity in order to generate positive effects.

4) Transformative strategies and actions for urban circularity: In order to foster an active CE-oriented transition within Western Balkan municipalities, ambitious and feasible strategies and actions need to be defined based on the assessment of the status quo and the evaluation of challenges and opportunities. This can be related to the eight key elements of the CCST radial diagram (cf. Figure 2.6) and further relevant aspects from a specific municipality's perspective.

5) Traceable progress towards CE: In order to monitor the transition towards urban circularity within the Western Balkan municipalities and ensure a positive change, specific

indicators/aspects related to CE on urban/city level need to be defined and periodically measured and assessed. This relates to the indicators included in the CCST and potentially to further indicators representing aspects specifically relevant for each respective municipality.

Building on these success criteria, we propose a number of actions as follow-up activities for the CEB project in 2022. These aim at enabling a short-term implementation of the CEB-UCHF within selected Western Balkan municipalities in order to foster urban circularity in the respective cities and the region overall. The four key actions for CEB 2022 are:

A) Define one or two selected Western Balkan municipalities for implementation of the CEB-UCHF and monitoring: These municipalities should be willing and able to collect and provide relevant data, engage with stakeholders within the implementations process and develop ambitious CE strategies and actions with a positive effect for citizens and businesses.

B) Collect and include relevant data from selected municipalities in CCST database: The tool requires data on, e.g., Gross Value Added, emissions, jobs and material inputs for different sectors as well as local CE best practices. The municipalities should either have data available or collect it for using the tool. While the online tool enables a direct input of data, contact with the developers of the tool (Circle Economy) and relevant partners (e.g. ICLEI) should be made to collaborate on collecting and integrating all necessary data.

C) Monitor implementation within selected municipalities: The selected Western Balkan municipalities most likely have a low awareness and development level of CE on urban/city level. Therefore, the implementation process needs to be supported along all steps (collecting data, setting focus areas, assessing opportunities, deriving strategies and actions). This can be done by engaging with the municipalities within workshops including relevant stakeholders which would also increase awareness and acceptance of a transition towards urban circularity. The monitoring also includes a periodically repeated assessment to provide measurable insights on the cities' progress towards CE.

D) Derive further steps towards urban circularity in the Western Balkan region: Along the implementation and monitoring process, continuous reflection and evaluation is necessary to further drive CE on urban/city level in the region – not only the selected municipalities. This can also include re-evaluating frameworks focusing in country/regional level, e.g. CEMF or CES.

4. CONCLUSION

In this study, we have analysed some of the most interesting currently available UCHF relevant for adoption and application in Western Balkan municipalities. The frameworks aim at collecting, measuring and assessing data to monitor the development of CE as well as provide decision support to foster urban circularity. Through the consideration of specific criteria, we analysed their potential regarding CE-oriented decisions on urban/city level in general and in the Western Balkan context specifically. Some of the most comprehensive frameworks are mainly applicable at national and regional level, e.g. CEMF – Circular Economy Monitoring Framework (European Commission, 2018) and CES – Circular Economy Scoreboard (The European House - Ambrosetti & ENEL Foundation, 2020). Other frameworks, e.g. PCEI – Peterborough Circular Economy Indicators (Morley et al., 2018), ACM – Amsterdam Circular Monitor (City of Amsterdam et al., 2020), LCI – London Circularity Indicators (Cambridge Econometrics, 2018) and CCST – Circle City Scan Tool (Circle Economy, 2021), are directly aimed at the urban/city level. However, only one, the CCST, is not specifically tailored to one city but aims at an application in any city – given, this city is included in the database. Most of the frameworks analysed appear to be structured in a complex way, requiring a considerable level of development and awareness of CE on the one hand, and availability of large quantities of very specific and high-quality data to monitor progress on the other hand.

In the case of the Western Balkan countries in particular, their specific characteristics need to be taken into account when measuring CE levels and developing strategies to foster urban circularity. Most of the frameworks analysed in this report are difficult to apply to these contexts for several reasons. Firstly, because they are mostly applicable at the national and regional level; secondly, because there is a lack of knowledge and development of CE, and consequently a lack of data available to carry out the measurements. These factors make it difficult to implement most of frameworks in the short term.

Therefore, our recommendations, given these particular characteristics, are first of all related to the **implementation** of a specific **Circular Economy Beacons Urban Circularity Hotspot Framework (CEB-UCHF)** in selected Western Balkan municipalities in 2022 and the **monitoring** of this process. Here, the recommended tool is the **CCST**, for which an online prototype is readily available. While the tool is not without its shortcomings, e.g. that not many Western Balkan cities are included in its database (yet), it promises a quick and relatively easy implementation in

selected Western Balkan municipalities – given that several success criteria are considered and monitored. These relate to data availability for Western Balkan municipalities, awareness and acceptance of CE-related challenges and opportunities, insights on urban circularity hotspots and levers for change, transformative strategies and actions for urban circularity and traceable progress towards CE. In order to enable and monitor a short-term implementation of the CEB-UCHF along these success criteria, we consider four actions as follow-up activities for CEB 2022:

- Defining one or two selected Western Balkan municipalities for implementation of the CEB-UCHF and monitoring,
- Collecting and including relevant data from selected municipalities in the CCST database,
- Monitoring implementation within selected municipalities and
- Deriving further steps towards urban circularity in the Western Balkan region.

In the future, further work related to UCHF in general and a CEB-UCHF specifically could be required. Thus, as a potential outlook, in the forthcoming analyses, it could be necessary to compare and interpret the first data collected with respect to different time periods. In addition, any good practices resulting from the implementation of tools such as the CCST should be shared among the various stakeholders, in order to accelerate the development of the CE model. Collaboration and engagement between stakeholders at urban/city, regional, national and international level is crucial to raise awareness of the benefits of implementing CE. In addition, a further analysis similar to the one presented within this study could be carried out in the coming years with respect to possible new frameworks. This would support the integration and adaption of current urban circularity strategies into more efficient frameworks. Also, any relevant changes in the specific characteristics of the Western Balkan countries should be monitored and updated with respect to the adopted strategy in a timely and accurate manner.

5. BIBLIOGRAPHY

Avdiushchenko, A., & Zając, P. (2019). Circular Economy Indicators as a Supporting Tool for European Regional Development Policies. Sustainability, 11(11), 3025. https://doi.org/10.3390/su11113025

Bai, X. (2007). Industrial Ecology and the Global Impacts of Cities. Journal of Industrial Ecology, 11(2), 1–6. https://doi.org/10.1162/jie.2007.1296

be circular – be.brussels. (2016). Programme régional en économie circulaire.

Berg, H., & Wilts, H. (2019). Digital platforms as market places for the circular economy—Requirements and challenges. NachhaltigkeitsManagementForum | Sustainability Management Forum, 27. https://doi.org/10.1007/s00550-018-0468-9

Brundtland, G. H., Khalid, M., Agnelli, S., Al-Athel, S. A., Chidzero, B., Fadika, L. M., Hauff, V., Lang, I., Shijun, M., Marino de Botero, M., Singh, N., Nogueira-Neto, P., Okita, S., Ramphal, S. S., Ruckelshaus, W. D., Sahnoun, M., Salim, E., Shaib, B., Sokolov, V., … Strong, M. (1987). Our common future (World Commission on Environment and Development, Ed.; 1st ed.). Oxford University Press.

Cambridge Econometrics. (2018). Measuring London's progress towards becoming a more circular city (p. 44). London Waste and Recycling Board.

Cavaleiro de Ferreira, A., & Fuso-Nerini, F. (2019). A Framework for Implementing and Tracking Circular Economy in Cities: The Case of Porto. Sustainability, 11(6), 1813. https://doi.org/10.3390/su11061813

Chizaryfard, A., Trucco, P., & Nuur, C. (2021). The transformation to a circular economy: Framing an evolutionary view. Journal of Evolutionary Economics, 31(2), 475–504. https://doi.org/10.1007/s00191-020-00709-0

Circle Economy. (2021). Circle City Scan Tool—Digital—Circle Economy. Cities.Circle-Lab.Com. https://www.circle-economy.com/digital/circle-city-scan-tool

Circular Cities Declaration. (2020). CC Declaration | What is a Circular City? Circularcitiesdeclaration.Eu. https://circularcitiesdeclaration.eu/cities-and-the-circular-economy/what-is-a-circular-city

City Loops. (2020). City Loops | Measuring City Circularity. Cityloops.Eu. https://cityloops.eu/measuring-city-circularity

City of Amsterdam, TNO, & TU Delft. (2020). Amsterdam Circular Monitor. City of Amsterdam.

Corona, B., Shen, L., Reike, D., Rosales Carreón, J., & Worrell, E. (2019). Towards sustainable development through the circular economy: A review and critical assessment on current circularity metrics. Resources, Conservation and Recycling, 151, 104498. https://doi.org/10.1016/j.resconrec.2019.104498

European Commission. (2018). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on a monitoring framework for the circular economy (COM(2018) 29 final). European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018DC0029&tnqh_x0026;from=EN

European Commission. (2019). Report from the commission to the European parliament, the council, the european economic and social committee and the committee of the regions on the on the implementation of the circular economy action plan (COM(2019) 190 final). European Commission. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52019DC0190

European Commission. (2020). Guidelines for the Implementation of the Green Agenda for the Western Balkans—Accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions—An Economic and Investment Plan for the Western Balkans (Commission Staff Working Document SWD(2020) 223 final, COM(2020) 641 final). European Commission. https://ec.europa.eu/neighbourhood-enlargement/system/files/2020-10/green_agenda_for_the_western_balkans_en.pdf

European Commission. (2021). Waste prevention and management—Environment—European Commission. https://ec.europa.eu/environment/green-growth/waste-prevention-and-management/index_en.htm

European Parliament. (2015, July 3). Circular economy: The importance of re-using products and materials | News | European Parliament. https://www.europarl.europa.eu/news/en/headlines/economy/20150701STO72956/circular-economy-the-importance-of-re-using-products-and-materials

Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, 32008L0098, EP, CONSIL, OJ L 312 (2008). http://data.europa.eu/eli/dir/2008/98/oj/eng

Ferrão, P., & Fernández, J. E. (2013). Sustainable Urban Metabolism. MIT Press.

Gallopín, G. C. (1996). Environmental and sustainability indicators and the concept of situational indicators. A systems approach. Environmental Modeling & Assessment, 1(3), 101–117. https://doi.org/10.1007/BF01874899

Geng, Y., Fu, J., Sarkis, J., & Xue, B. (2012). Towards a national circular economy indicator system in China: An evaluation and critical analysis. Journal of Cleaner Production, 23(1), 216–224. https://doi.org/10.1016/j.jclepro.2011.07.005

Gravagnuolo, A., Angrisano, M., & Fusco Girard, L. (2019). Circular Economy Strategies in Eight Historic Port Cities: Criteria and Indicators Towards a Circular City Assessment Framework. Sustainability, 11(13), 3512. https://doi.org/10.3390/su11133512

Guo-gang, J. (2011). Empirical Analysis of Regional Circular Economy Development—Study Based on Jiangsu, Heilongjiang, Qinghai Province. Energy Procedia, 5, 125–129. https://doi.org/10.1016/j.egypro.2011.03.023

Haigh, L., de Wit, M., von Daniels, C., Colloricchio, A., & Hoogzaad, J. (2021). The Circularity Gap Report. Circle Economy.

Kabashi, F., Striffler, J., & Beharić, S. (2021). Circular Economy in the Western Balkans region: Waste Management as a Challenge. The Balkan Forum. https://thebalkanforum.org/file/repository/Circular_Economy_in_the_Western_Balkans_region.pdf

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005

Kravchenko, M., Pigosso, D. CA., & McAloone, T. C. (2019). Towards the ex-ante sustainability screening of circular economy initiatives in manufacturing companies: Consolidation of leading sustainability-related performance indicators. Journal of Cleaner Production, 241, 118318. https://doi.org/10.1016/j.jclepro.2019.118318

Kristensen, H. S., & Mosgaard, M. A. (2020). A review of micro level indicators for a circular economy – moving away from the three dimensions of sustainability? Journal of Cleaner Production, 243, 118531. https://doi.org/10.1016/j.jclepro.2019.118531

Magnier, C., Auzanneau, M., Calatayud, P., Gauche, M., Ghewy, X., Granger, M., Margontier, S., & Pautard, E. (2017). 10 Key Indicators for Monitoring the Circular Economy—2017 Edition. Ministry of the Environment, Energy and Marine Affairs, in Charge of International Relations on Climate Change. http://temis.documentation.developpement-durable.gouv.fr/docs/Temis/0086/Temis-0086452/22978_2017_ENG.pdf

Marchesi, M., & Tweed, C. (2021). Social innovation for a circular economy in social housing. Sustainable Cities and Society, 71, 102925. https://doi.org/10.1016/j.scs.2021.102925

Mayer, A., Haas, W., Wiedenhofer, D., Krausmann, F., Nuss, P., & Blengini, G. A. (2019). Measuring Progress towards a Circular Economy: A Monitoring Framework for Economy-wide Material Loop Closing in the EU28. Journal of Industrial Ecology, 23(1), 62–76. https://doi.org/10.1111/jiec.12809

Mies, A., & Gold, S. (2021). Mapping the social dimension of the circular economy. Journal of Cleaner Production. https://doi.org/10.1016/j.jclepro.2021.128960

Moldan, B., Janoušková, S., & Hák, T. (2012). How to understand and measure environmental sustainability: Indicators and targets. Ecological Indicators, 17, 4–13. https://doi.org/10.1016/j.ecolind.2011.04.033

Monier, V., Hestin, M., Cavé, J., Laureysens, I., Watkins, E., & Reisinger, H. (2014). Development of Guidance on Extended Producer Responsibility (EPR) [Report]. https://www.ecologic.eu/15139

Moraga, G., Huysveld, S., Mathieux, F., Blengini, G. A., Alaerts, L., Van Acker, K., de Meester, S., & Dewulf, J. (2019). Circular economy indicators: What do they measure? Resources, Conservation and Recycling, 146, 452–461. https://doi.org/10.1016/j.resconrec.2019.03.045

Morlet, A., Blériot, J., Hubold, S., Opsomer, R., Linder, M., & Banks, I. (2015). Delivering the Circular Economy: A Toolit for Policymakers. Ellen MacArthur Foundation.

Morley, A., Looi, E., & Zhao Chenxiao. (2018). Measuring the Circular Economy: Developing an indicator set for Opportunity Peterborough. Opportunity Peterborough; UCL. http://www.futurepeterborough.com/wp-content/uploads/2018/08/Final-Report-Measuring-the-Circular-Economy-of-Peterborough-2-1.pdf

Murray, A., Skene, K., & Haynes, K. (2017). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. Journal of Business Ethics, 140(3), 369–380. https://doi.org/10.1007/s10551-015-2693-2

OECD. (2001). Extended Producer Responsibility: A Guidance Manual for Governments. Organisation for Economic Co-operation and Development. https://www.oecd-ilibrary.org/environment/extended-producer-responsibility_9789264189867-en

OECD. (2002). Evaluation and Aid Effectiveness No. 6—Glossary of Key Terms in Evaluation and Results Based Management (in English, French and Spanish). Organisation for Economic Co-operation and Development. https://www.oecd-ilibrary.org/development/evaluation-and-aid-effectiveness-no-6-glossary-of-key-terms-in-evaluation-and-results-based-management-in-english-french-and-spanish_9789264034921-en-fr

OECD. (2018). Divided Cities: Understanding Intra-urban Inequalities. Organisation for Economic Co-operation and Development. https://www.oecd-ilibrary.org/urban-rural-and-regional-development/divided-cities_9789264300385-en

Paiho, S., Mäki, E., Wessberg, N., Paavola, M., Tuominen, P., Antikainen, M., Heikkilä, J., Rozado, C. A., & Jung, N. (2020). Towards circular cities—Conceptualizing core aspects. Sustainable Cities and Society, 59, 102143. https://doi.org/10.1016/j.scs.2020.102143

Papageorgiou, A., Henrysson, M., Nuur, C., Sinha, R., Sundberg, C., & Vanhuyse, F. (2021). Mapping and assessing indicator-based frameworks for monitoring circular economy development at the city-level. Sustainable Cities and Society, 75, 103378. https://doi.org/10.1016/j.scs.2021.103378

Prendeville, S., Cherim, E., & Bocken, N. (2018). Circular Cities: Mapping Six Cities in Transition. Environmental Innovation and Societal Transitions, 26, 171–194. https://doi.org/10.1016/j.eist.2017.03.002

Qing, Y., Qiongqiong, G., & Mingyue, C. (2011). Study and Integrative Evaluation on the development of Circular Economy of Shaanxi Province. Energy Procedia, 5, 1568–1578. https://doi.org/10.1016/j.egypro.2011.03.268

Rockström, J., Gupta, J., Lenton, T. M., Qin, D., Lade, S. J., Abrams, J. F., Jacobson, L., Rocha, J. C., Zimm, C., Bai, X., Bala, G., Bringezu, S., Broadgate, W., Bunn, S. E., DeClerck, F., Ebi, K. L., Gong, P., Gordon, C., Kanie, N., … Winkelmann, R. (2021). Identifying a Safe and Just Corridor for People and the Planet. Earth's Future, 9(4), e2020EF001866. https://doi.org/10.1029/2020EF001866

Saidani, M., Yannou, B., Leroy, Y., Cluzel, F., & Kendall, A. (2019). A taxonomy of circular economy indicators. Journal of Cleaner Production, 207, 542–559. https://doi.org/10.1016/j.jclepro.2018.10.014

Sánchez Levoso, A., Gasol, C. M., Martínez-Blanco, J., Durany, X. G., Lehmann, M., & Gaya, R. F. (2020). Methodological framework for the implementation of circular economy in urban systems. Journal of Cleaner Production, 248, 119227. https://doi.org/10.1016/j.jclepro.2019.119227

Satterthwaite, D. (2011). How urban societies can adapt to resource shortage and climate change. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 369(1942), 1762–1783. https://doi.org/10.1098/rsta.2010.0350

Singh, R. K., Murty, H. R., Gupta, S. K., & Dikshit, A. K. (2012). An overview of sustainability assessment methodologies. Ecological Indicators, 15(1), 281–299. https://doi.org/10.1016/j.ecolind.2011.01.007

Stockholm Environment Institute. (2020). Urban Circularity Assessment Framework. Sei.Org. https://www.sei.org/projects-and-tools/projects/urban-circularity-assessment-framework/

Tapia, C., Randall, L., Wang, S., & Aguiar Borges, L. (2021). Monitoring the contribution of urban agriculture to urban sustainability: An indicator-based framework. Sustainable Cities and Society, 74, 103130. https://doi.org/10.1016/j.scs.2021.103130

The European House - Ambrosetti, & ENEL Foundation. (2020). Circular Europe: How to successfully manage the transition from a linear to a circular world. https://circulareconomy.europa.eu/platform/sites/default/files/research-study-circular-europe.pdf

Urban Agenda for the EU. (2019). Indicators for circular economy (CE) transition in cities—Issues and mapping paper. https://ec.europa.eu/futurium/en/system/files/ged/urban_agenda_partnership_on_circular_economy_-_indicators_for_ce_transition_-_issupaper_0.pdf

Waas, T., Hugé, J., Block, T., Wright, T., Benitez-Capistros, F., & Verbruggen, A. (2014). Sustainability Assessment and Indicators: Tools in a Decision-Making Strategy for Sustainable Development. Sustainability, 6(9), 5512–5534. https://doi.org/10.3390/su6095512

Wang, N., Lee, J. C. K., Zhang, J., Chen, H., & Li, H. (2018). Evaluation of Urban circular economy development: An empirical research of 40 cities in China. Journal of Cleaner Production, 180, 876–887. https://doi.org/10.1016/j.jclepro.2018.01.089

Watkins, E., Gionfra, S., Schweitzer, J.-P., Pantzar, M., Janssens, C., & ten Brink, P. (2017). EPR in the EU Plastics Strategy and the Circular Economy: A focus on plastic packaging. Institute for European Environmental Policy (IEEP).

Wilts, H., Schinkel, J., & Feder, L. (2020). Prevention of plastic waste in production and consumption by multi-actor partnerships (PREVENT). Wuppertal Institut für Klima, Umwelt, Energie; PREVENT Waste Alliance c/o Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. https://prevent-waste.net/wp-content/uploads/2020/05/Prevention_of_plastic_waste_in_production_and_consumption_Singlepages.pdf

Wilts, H., & Steger, S. (2019). Measuring urban circularity based on a territorial perspective (Final Report Annex 10; CIRCTER – Circular Economy and Territorial Consequences). Wuppertal Institut für Klima, Umwelt, Energie. https://www.espon.eu/sites/default/files/attachments/CIRCTER%20FR%20Annex%2010%20Measuring%20urban%20circularity_0.pdf#viewer.action=download

Wilts, H., Von Gries, N., & Bahn-Walkowiak, B. (2016). From Waste Management to Resource Efficiency—The Need for Policy Mixes. Sustainability, 8, 622. https://doi.org/10.3390/su8070622