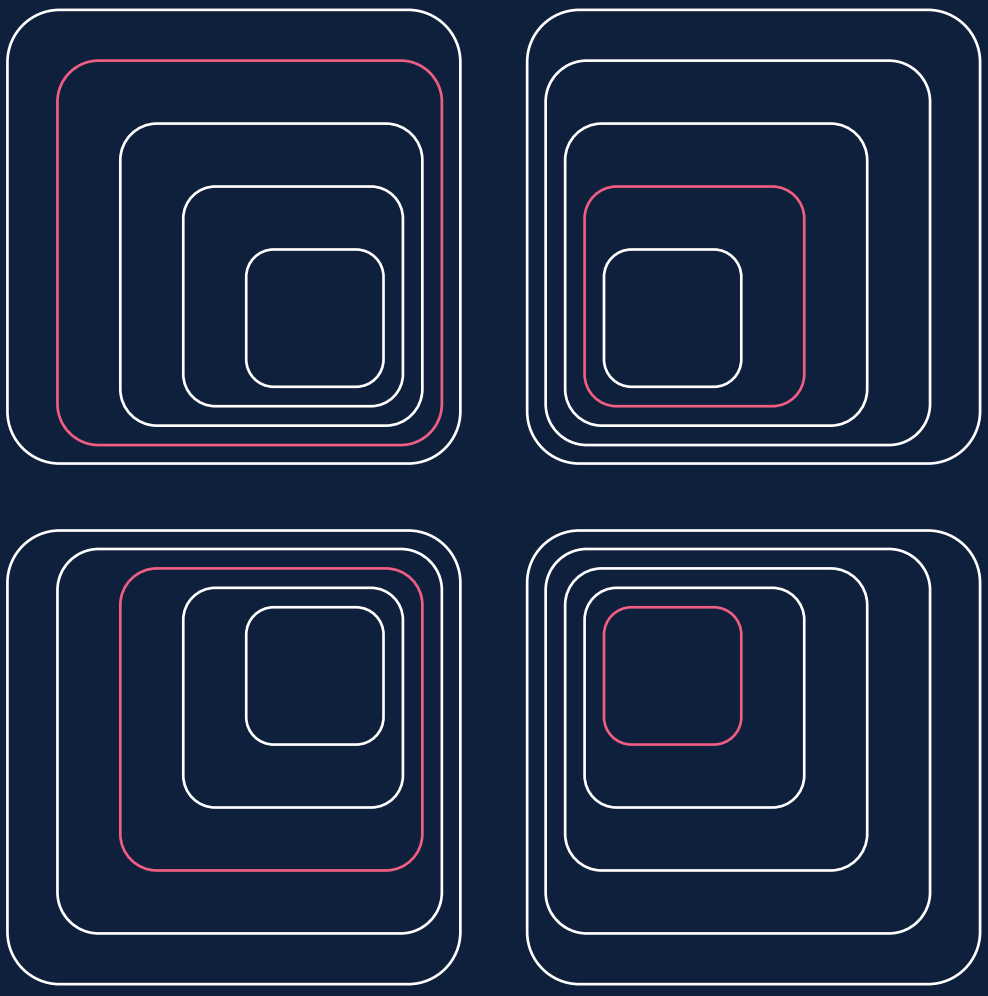
SYSTEMIC DESIGN FOR CIRCULAR CITY DIGITAL ASSESSMENT TOOLS



Proposal of an integrative framework for the evaluation of circularity within public utilities.

The case study of Circunet

DANIEL JARAMILLO RUEDA

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Abstract

Public infrastructure is still lacking a unified and complete methodology for assessing strategies and actions towards sustainability that take into consideration urban complexity. There is a need for tools and frameworks that facilitate the decision making and identification of strategies, for actions that fulfill sustainable supply and demand of public infrastructure systems, without losing sight of their uniqueness. One of the most relevant approaches towards sustainability of public infrastructure is the shift of its consumption models from linear to circular based. SisTer® proposes a tool called **Circunet for supporting and evaluating this shift.** This thesis work evaluates the efficacy of Circunet for achieving this intended matter; it demonstrates the **importance of a systemic design vision as a methodological tool for the evaluation and support of the transition of public infrastructure towards circular economy models.** As a result, this thesis proposes a new methodological framework for Circunet to evaluate and support this transition in a holistic manner, capable of understanding and taking advantage of urban complexity. The framework understands the uniqueness of each urban infrastructure and offers indicator pathways that support the identification of causes and consequences of circular practices, opening the doors for the creation of precise strategies and decision making for the shift towards circularity.

Keywords

Urban metabolisms **|** Public utilities **|** Circular Economy **|** Systemic Design **|** Complex systems **|** Indicators **|** Circunet **|** Urban infrastructure **|** Digital tools

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01

INTRODUCTION AND FRAMING OF THE THESIS

1. Introduction

This thesis work originates from the request for collaboration between the Department of Systemic Design at the Polytechnic of Turin and the Sis.Ter® consulting agency, for the evaluation and support for construction of a digital tool called Circunet. **The main objective of the tool is to support public administrators and network managers to have better control and decision making over local networks in accordance with the principles of the circular economy.** Helping so in the promotion and improvement of sustainable practices, and making easier the monitoring of the circular performance of actions and strategies carried out for the management of public networks.

Circunet arises from the perceived need by Sis.Ter® of a framework capable of evaluating the circular performance of urban services in a transversal way. Using environmental and socio-economic indicators, with the intention of an holistic understanding of the lifecycle of the network, from its creation to its end of life. At this state Circunet is an in development tool, currently in phase of a functional MVP. It has already been tested in some few contexts and it is intended to be applied as a fully functional tool in various European realities. This last point entails a complex and dynamic tool capable of understanding different complex contexts with a plurality of stakeholders and networks that influence the approach towards an accurate evaluation of the circular performance. In this sense it is relevant to **understand up to what extent Circunet is achieving its main objective while offering an unified approach capable of understanding complexity, adding value to its customers and to the territory.**

Specifically Sis.Ter® requested a research project capable of giving support to the existing tool with a critical evaluation through the lens of Systemic Design (SD). In this sense the present thesis starts by taking into consideration key **elements under the spotlight such as Circular economy (CE), urban networks and digital tools (digitalization for CE),** in order to create a research base for the evaluation of Circunet. These nodes should support an informed evaluation, capable of measuring the accuracy of the tool in contrast to its main goal, understanding elements, objectives and actions of the tool not only as an artifact but as a service.


AMSTERDAM
MADAME TUSSAUDS

1.1
Research Journey

Having in mind the main objective of the thesis and the three key domains previously mentioned: Circular economy (CE), urban networks (UNs) and digital platforms (DP), the first step for this project was to create a research framework through four domain questions.

For answering these questions it is relevant to have an in-depth understanding of the circular economy and apply this knowledge to cities' urban networks. Parallel to this it is crucial to have an understanding of how the circular economy is being applied in cities and how different indicators help the monitoring and measurement of these practices. On the other hand being urban infrastructures complex systems as well as cities it is important to understand how complex systems work and how these can be evaluated and intervened towards sustainable practices. Furthermore it is relevant for the matter of the thesis to co-construct an understanding of digital platforms and data analysis in comparison to the proposed solution, helping build good practices within the platform. By solving these inquiries it is intended to offer a framework for the monitoring of urban networks which helps the creation of a circular environment between public and private entities, supporting processes for circularity in a short and long term.

Parallel to the domain questions it is crucial to have an in-depth understanding of the current version of the proposed platform. This will be developed in detail in chapter 5, where every function, element and action proposed by the platform will be analyzed under the light of the research.

SD/ CE+UNs:

How can the circular economy, supported by a sistemic design approach, may help the transition of urban infrastructure into more sustainable and conscious networks?

CE+DP:

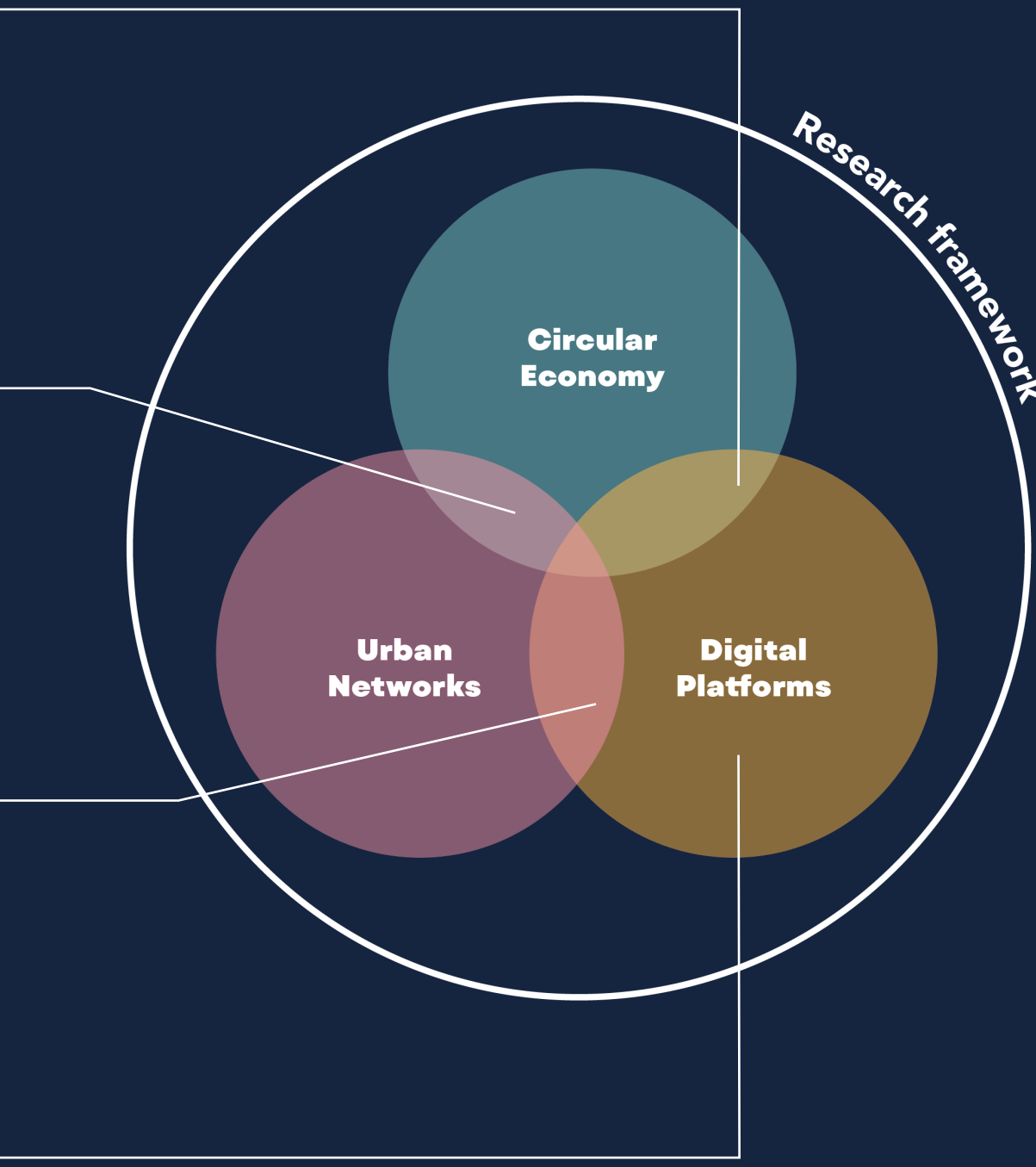
How can the circular economy be applied within digital platforms for public administration? What may differentiate Circunet from existing approaches?

DP+UNs:

How can managers benefit from digital platforms that offer indicators for the measurement and monitoring of networks?

SD/ DP:

How can SD help the construction of a business intelligence (BI) digital tool that delivers insights of the "circular performance" of cities' urban networks?


Research framework
Circular Economy
Urban Networks
Digital Platforms

1.2
Structure Of The Thesis

In order to achieve its objective this thesis was structured through four main sections.

01

The method and problematic framing

This first section defines the need from where this thesis project emerges. It defines the "why" it is important to do such research, establishing a **scenario analysis of why Circunet exists.** Parallel to this, it sets the methodological tools that were implemented for the research.

02

The literature review

The second section explores and creates a research framework that **supports a critical and informed process based on the literature review.** It explores and gives various insights of the 2 main topics treated by the tool which are circular economy and urban networks. These two topics are treated under the light of the systemic design and outcomes of how to relate these are highlighted. In this section there is an intention of neutrality and objectivity, it is descriptive and is not trying to highlight evident or undersurface problems with the logic of the platform, these will be treated further on.

03

The case study - Critical evaluation of the tool

This section has the objective of mapping and describing the functionalities of the tool. After a complete scan of the tool as a digital solution and as a service, a critical evaluation of the tool is made. This section **unveils cirticalilites within the platform and proposes opportunities of action over these critical points.** These takeouts are then analyzed under the light of a benchmark of different tools and frameworks and as a result of this analysis, different opportunities emerge as potential actions for alleviating the pain point of the tool.

04

The proposal

Last but not least the fourth section transforms these opportunities into a potential proposal for the tool. It combines the literature review with different opportunities of action over critical points, and offers a solution based on the methodological tools. At the end **a solid and concise proposal is made for a new methodological structure of Circunet and its implementation within the digital tool.** After having a clear implementation of the proposed solution, the work opens a discussion of the advantages and limitations of the proposal. Concluding up to what grade the initial objectives of the thesis have been fulfilled and what could be future developments of the solution.

IN SUCCESSFUL ECONOMIES, CITIES ARE THE ENGINES OF GROWTH AND INFRASTRUCTURE PLAYS A SIGNIFICANT PART IN THE GENERATION OF ECONOMIC PROGRESS AND DEVELOPMENT.

SHAKUNIYA, PRASAD & BHUTE
2016

1.3
Introduction To Systemic Design (SD)

Systemic design is the center and the methodological lens for this research, due to this, it is important to define how to interpret it for this thesis purposes. The following definition and approach is the sum of various authors, however it is important to highlight the relevance of the approach and definition given by the research team of the Polytechnic of Turin.

The systemic design is a methodology and practice developed in line with the systems thinking. Systemic design's main scope is to analyze complexity within systems and offer **approaches to complexity by the creation of sustainable networks,** it projects the relationships between components that generate a system, enhancing local identity and resources, and produces development and well-being for the individual and the community. The methodology gives value to the network not as the sum of elements but as the quality and scope of the interactions between the network's elements; these should find a balance that generates value to the intended network and raise awareness and significance to the local resources. Furthermore by acting in an innovative way, constructive **behaviors may arise towards a "glocal culture",** added to this an economy defined as Blue Economy is created (Pauli, 2014), generating growth that occurs through autopoietic flows which catalyze sustainable development.

1.3.1
Applying Systemic Design

Systemic design can be used for understanding or analyzing situations where multiple clusters of stakeholders are involved no matter their nature, size or relevance. **One of the main queries of SD is the analysis of the flows between and within these clusters, understanding inputs and outputs as critical points for sustainable practices, aiming a quantitative and qualitative balance between both.** For example, the waste of an "A-company" may become input for a "B-company" inside the same territory, gaining value and giving prominence to the local productive realities. The result is the development of identity that is born from the awareness of one's own values and resources, taking into the realization of sustainable development on environmental, economic and social levels.

According to the systemic design research team of Polytechnic of Turin, SD is based on five principles. These introduce us to relevant questions for applying systemic design in the project. These 5 principles are:

Inputs -Outputs

Human Centered

Relations

Autopoiesis

Local action

Inputs-Outputs

Understand the outputs of a system or subsystem as the inputs of another. Creating a retrofitting flow of relationships that reduce waste products by the exchange of materials, energy, information or other types of supplies.

Human Centered

Human well being becomes the center of the project when considered its relation to the context and the network. This recognition ensures giving value to local know-how and culture.

Relations

The exchange of goods creates open relationships within the system. The more inclusive and open the stronger these relations and therefore the system becomes more sustainable.

Autopoiesis

The exchange of goods creates open relationships within the system. The more inclusive and open the stronger these relations and therefore the system becomes more sustainable..

Local action

Enhance the use of human, cultural and material capital of the territory by giving special focus to the local context.

1.3.2
The Relevance Of SD For Urban Infrastructures

Systemic design can be applied to any topic and urban infrastructures is no exception. The complexity of urban infrastructures and the **relevance of understanding the local context is of vital importance in order to acknowledge the dynamics of the constituent network of actors,** actions and relations that make them functional; this fact, added to the need of a shift of urban infrastructures into more sustainable networks (explained in detail in chapter 3), makes systemic design a highly beneficial vision for the creation of tools that support this leap, capable of grasping complexity and sustainability, while offering a unified vision for the network.

By applying the 5 principles to the topic we can define **5 guiding questions that will be solved along the thesis,** these will be:

Inputs-Outputs:

How can the resource flows of urban infrastructure be used in circular ways?

Relations:

How do flows of resources and information add value to the urban infrastructure networks?

Autopoiesis:

How retrofitting loops add strength and resiliency to the urban infrastructure networks?

Local Action:

How could local capital (human, cultural and material) define and add value to the urban infrastructure networks?

Human Centered:

How does human welfare may become key for the interactions between the network and the surrounding context?

THE OUTPUTS OF A SYSTEM BECOME THE INPUTS FOR ANOTHER PRODUCTION CHAIN.

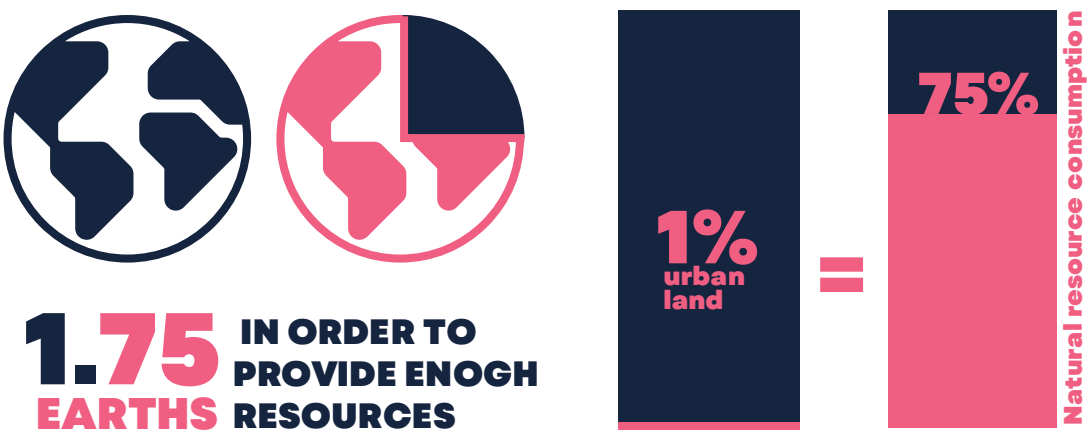
BISTAGNINO
2011

1.4
Introduction To The General Issue

According to the United Nations (UN), by the start of 2022 the world's population is expected to reach around 8 billion people, of which more than 56% are urban dwellers (UN, 2022), a percentage that in the past decades has been exponentially increasing and it is expected to reach 70% by 2050. This growth in urban population can be summarized as the sum of two main factors: The first one is the intrinsic growth of the urban areas (UAs), the second one is urbanization, a term defined by The Cambridge Dictionary as: "The process by which more and more people leave the countryside to live in cities." (Cambridge University press, 2021) This migration may occur for many reasons, however in the majority of cases it is a factor of convenience, a search for a better quality of life.

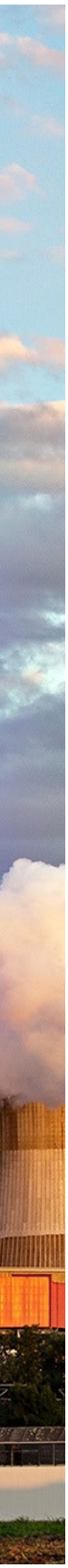
Together with the growth of population **there is a vast and dense growth in consumption and infrastructure,** meeting basic needs of modern civilization such as energy, clean water, transportation, telecommunications, among others. However, along history this growth has become an economical pattern dictated by unmeasurable consumption of resources, nominated by various authors as the myth of unlimited growth (Meadows, 1982). When talking about unlimited growth we refer to resource consumption with the illusion of an unlimited planet, a controversial vision for many. Organizations like the Global Footprint Network state that today, with the current increasing rate of consumption, **we need about 1.75 Earths in order to provide enough resources for human consumption and absorption of our own waste.** (Theworldcounts, 2022) declares that humanity is entering earlier each year into an "Ecological Overshoot" phase, where our yearly demand on nature exceeds its capacity of supply and regeneration.

As reported by UN-FAO only 1% of the habitable land is urban and build-up land (Ritchie & Rosner, 2013), nevertheless it represents 75% of natural source consumption, 50% of solid waste and accounts for approximately 70% of the GHG emissions (UNEP, 2018). **As existing urbanizations grow and new urban areas emerge, natural source consumption is predicted to grow even faster**, intensifying scarcity of resources and environmental problems. In this sense, **the hurdle is both clear and urgent: Urban areas must be reimagined.**



“We don’t think a sustainable society needs to be stagnant, boring, uniform, or rigid. It need not be, and probably could not be, centrally controlled or authoritarian. It could be a world that has the time, the resources, and the will to correct its mistakes, to innovate, to preserve the fertility of its planetary ecosystems. It could focus on mindfully increasing quality of life rather than on mindlessly expanding material consumption and the physical capital stock.”

MEADOWS, RANDERS & MEADOWS
1982



1.4.1 Sustainability And Urban Infrastructure

Reimagining urban areas involves many factors, all intertwined with each other making it impossible to define a magical action that will solve everything. Processes of urban and rural planning in Europe and around the world have been significantly changing along the past decades and have evolved with the understanding of sustainable resource consumption and management. **The adoption of sustainable practices and visions are turning into the core aim of many international policies, and a transition towards a more sustainable infrastructure has become one of the priorities for public administration.**

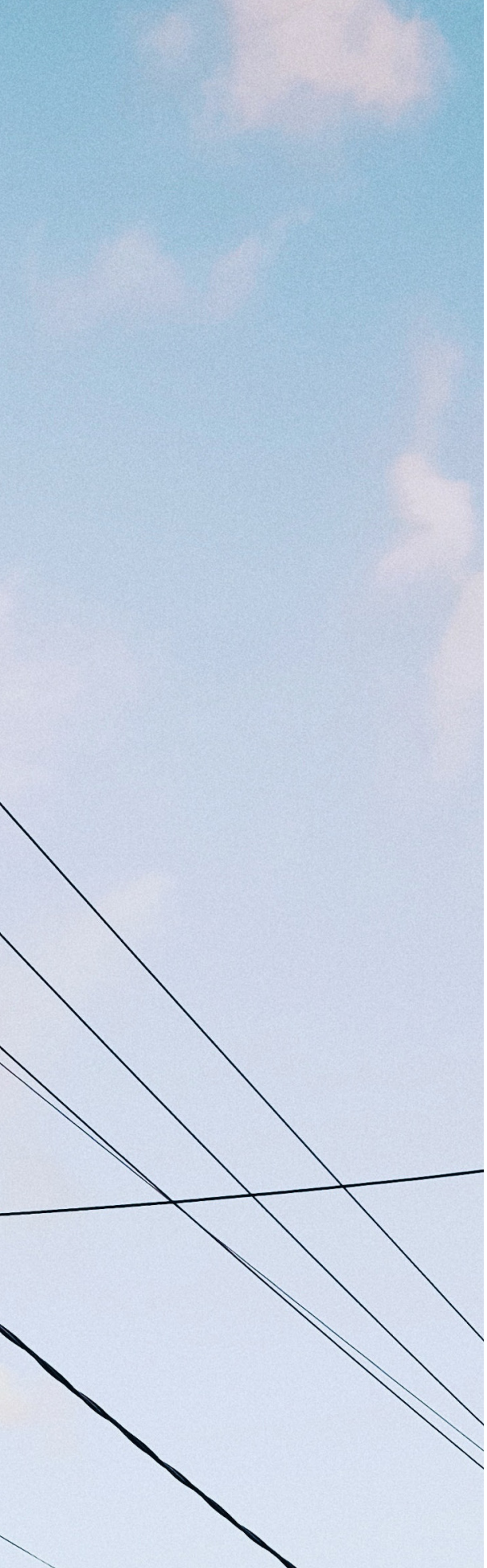
We can understand infrastructure as as the built environment and the service network around it (Burdett, 2018). Urban infrastructure is continuously evolving and expanding with urban areas, providing access to essential goods and services that catalyze human development and wellbeing. Nonetheless, although essential for contemporary society, infrastructure is also the source of many negative environmental impacts, caused both, **directly and indirectly by the planning, construction, use, maintenance and disposal of these.** Public administrations are targeting both direct and indirect impacts in order to mitigate and prevent more negative consequences.

This transition of infrastructure has many facets, all of them context dependent, meaning it is impossible to declare a unique action able to impact or be implemented with the same scale by every urban population. For example the level of development of a country varies its capability and approach to sustainable actions, and **each context may present economical, cultural, natural, political, educational, demographic, among others, limitations that create gaps in the development of more sustainable infrastructure**, making it impossible to declare a unique path towards sustainability, although the goal is always the same: Satisfy our generational consumption needs without jeopardizing resources for future generations.

Although there are no unique actions, international standards have been explored and developed as guides for responsible growth and consumption. Today a clear example of these guidelines are the UN Sustainable Development Goals (SDGs) which were set up in the general assembly of the United Nations in 2015. These guidelines provide a global sustainable development framework across 17 goals and 169 targets, highlighting social and environmental challenges for our global community. Among these 17 goals these are specific goals pointing to the development of more sustainable cities and infrastructure:

Although important, SDGs are not the only framework with a strong presence in the international community for urban and infrastructure development. Frameworks and studies about sustainable growth have been around for decades, a clear example could be the “Circular Economy” (CE), a model of production and consumption based on the regeneration of the life cycle for consumed goods (EPA, 2021). **Although “circular actions” have been around for ages, seeing these actions as a framework for sustainability is a much more recent idea** and can be dated to 1966 with the work of Kenneth


TRAEL



E. Boulding, who presented the concept of a "cyclical system of production". Later on the term "circular economy" became popular in 1988 (Kneese, 1988), describing a system where waste is diverted into inputs. Nowadays CE is a much more complex concept that integrates all the stages of consumption of goods from the conception and design to the repurposing and disposal.

It is important to see these frameworks as guidelines that unify local action for a global impact. As previously declared, there is no unique path towards sustainability but there is an unifying target and as proposed by the Ellen Macarthur Foundation (E.M. Foundation, 2015) **CE is a vision capable of unifying how we understand consumption and turn it into a more sustainable practice; becoming an ideal framework for urban and infrastructure development which requires vast amounts of resource consumption and has such a big impact in the ecosystem and society.**

In this context many public administrations have identified CE as a guiding tool for their responsible consumption needs. Not only governments but also public service providers are adopting practices that intend to reduce the negative ecosystem impacts without jeopardizing the contemporary standards of quality of life. However, as stated by Maranghi and colleagues, due to the rise in urbanization, **it is of high importance to innovate in methods for management of urban systems and to establish standard methods for assessing the environmental performance of cities and their infrastructures.** (Maranghi et al., 2020) The authors state we are still lacking a unified and complete methodology for assessing policies and actions for urban sustainability that take into consideration urban complexity. **There is a need for tools and frameworks that facilitate the identification and decision making, of actions that fulfill sustainable supply and demand systems.**

02

CIRCULAR ECONOMY

If we could build an economy that would use things rather than use them up, we could build a future.

Ellen Macarthur
Founder of the Ellen Macarthur Foundation

Being one of the research domains, as mentioned in the first chapter, CE is a fundamental axis for the entire thesis. This first phase of the research intends to identify elements for the understanding of the concept of circular economy and how this can be applied to urban infrastructures. The given definitions and approaches are interpreted from the sum of various authors.

2.2 Definition

The definition of CE is in constant evolution and what characterizes something from belonging or not belonging under the term "Circular Economy" remains vague. Different backgrounds, visions and ambitions make it hard to give a unified definition. Therefore, although the main fundamental concepts are widely recognized (reuse, reduce, recycle) different objectives and approaches are expressed in multiple facets of the term. The concept of circular economy is rooted in the study of nonlinear systems, especially living systems, which are self-generated, optimized and make maximum use of available resources without generating waste. In general, the circular economy is an economic model where products and services are traded in closed flows or cycles. Optimizing the entire system and not individual components is a guiding light for CE, that means considering the elements of a system as parts of an interconnected whole. **Similar to SD, CE leads to a focus on the relationships between the parts and a careful analysis of the material flows within.** Therefore, the Circular Economy is a model of economic development based on a closed circuit that brings benefits to entities, society and the environment, a model intentionally restorative, standing in contrast to what is dictated by a linear economy ('take-make-waste model of consumption). We can better illustrate this definition by bringing some existing definitions.

"A circular economy is a systemic approach to economic development designed to benefit businesses, society, and the environment. In contrast to the 'take-make-waste' linear model, a circular economy is regenerative by design and aims to gradually decouple growth from the consumption of finite resources."

Ellen Macarthur Foundation
2019

"Where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimized."

European Commision
2020

"'Circular economy is an approach that would transform the function of resources in the economy. Waste from factories would become a valuable input to another process [...] It entails redesigning products to be more durable, reusable, repairable, and recyclable, and therefore kept in circulation for as long as possible. Beyond product design innovations, it also means changing the way we consume and use goods and services, and rethinking consumerism as a society."

Catham House Organization
2021

"[...] In reality, the concept aims to reduce the use of the earth's natural resources (energy expenditure, water resources, raw materials) when the good or service is created. Also, at the time of production, the resources used are optimized for prolonged use. Likewise, the good produced is in such a way that it can be reassigned to other uses as soon as it is out of use."

Wesby Energies,
2021

"In a circular economy, economic activity builds and rebuilds overall system health. It doesn't only entail reducing the negative effects of a linear economy, but it represents a systemic shift that builds long-term resilience, generates business and economic opportunities, and provides environmental and societal benefits".

Earth.org
2021

"A circular economy model aims to close the gap between the production and the natural ecosystems' cycles [...] eliminating waste – composting biodegradable waste or, if it's a transformed and non-biodegradable waste, reusing, remanufacturing and finally recycling it. On the other hand, it also means cutting off the use of chemical substances (a way to help regenerate natural systems) and betting on renewable energy."

You Matter
2020

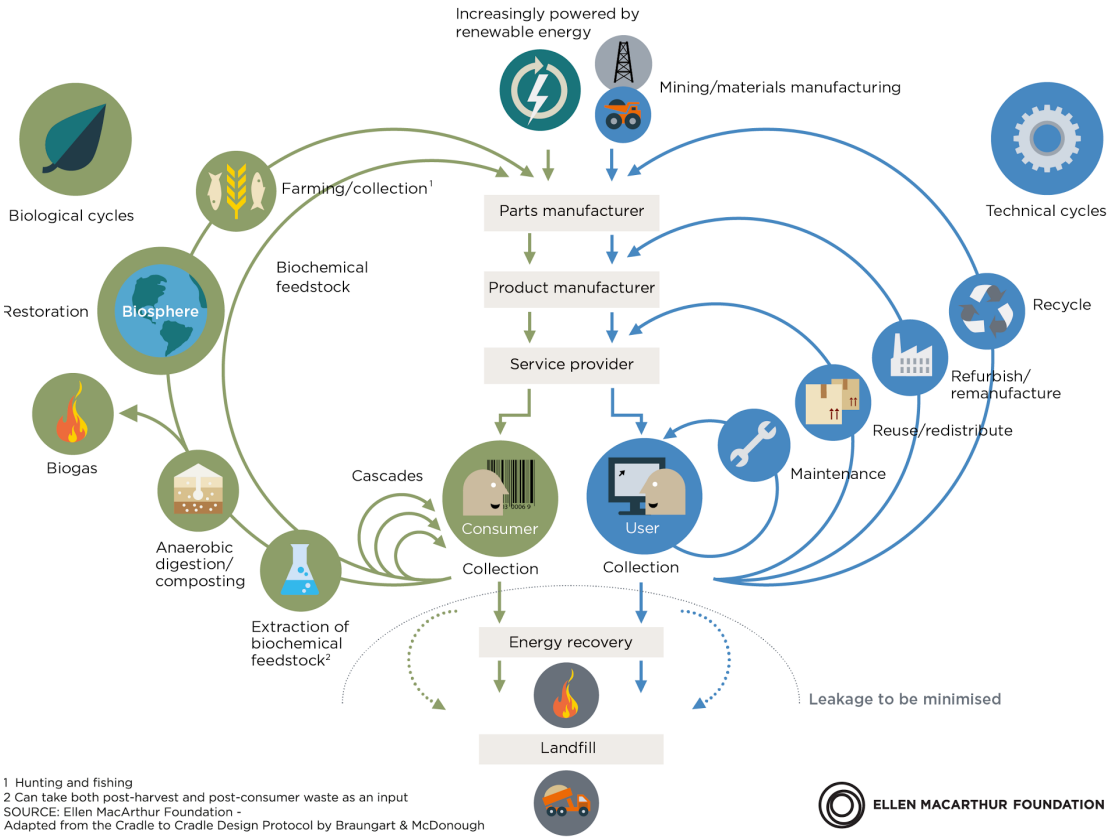
2.3 Principles Of Circular Economy (CE)

According to various authors CE is developed over fundamental principles, which can be interpreted as the guiding actions when putting the theory into practice. These principles are: The core principles (Ellen Macarthur Foundation, 2022) and the enabling principles (Circle Economy, 2021.).

2.3.1 Core Principles

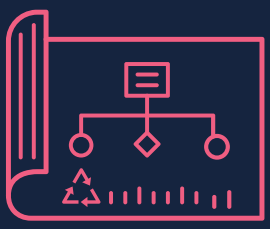
These relate to direct handling of material and energy flows—for example closing loops, extending product lifecycles and increasing usage intensity. According to EMF, these principles can be categorized as:

CIRCULAR ECONOMY - *an industrial system that is restorative by design*



1 Hunting and fishing
2 Can take both post-harvest and post-consumer waste as an input
SOURCE: Ellen MacArthur Foundation -
Adapted from the Cradle to Cradle Design Protocol by Braungart & McDonough

ELLEN MACARTHUR FOUNDATION

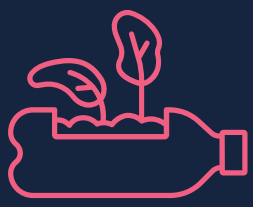


Design out waste and pollution

This principle recognizes the **design and planning phase as a big part of the waste problem** and aims to reduce the waste even before the creation of the products and services, by the other hand it incentivises the use of adequate renewable sources, by understanding their beginning and end of life.

Regenerate natural systems

Other than reducing the consumption of resources this principle aims for the **active regeneration of these resources,** it is about returning good things to the environment and not just having a passive view towards its restoration.



Keep products and materials in use

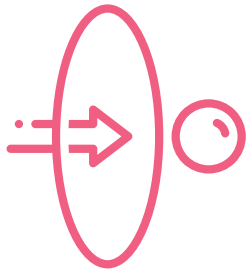
This principle involves the designing and use phase, it suggests **extending the life of materials as long as possible.** Initially as designing for durability, for example with the selection of adequate materials, or by the other hand by actively reusing, repairing and remanufacturing products out of these materials, and when possible upgrading them, for example with take-back strategies.

2.3.2
Enabling Principles

Complementary to the core principles, the enabling principles remove obstacles for core actions. This is because although there is an increased interest and efforts towards executing the core principles, there are persistent obstacles to their implementation.

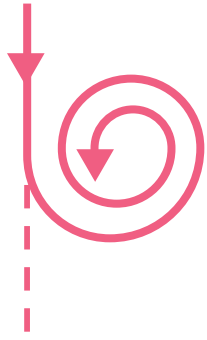
Design for the future

In line with the first core principle, the design phase becomes crucial for unlocking other circular actions. It is about applying design that accounts for a systemic perspective, going beyond the product itself, referring to the business, value-supply chain and policy environment in which the product must operate.



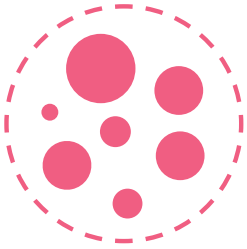
Rethink business and legislative models

When applying CE to an entity, it creates greater value when it influences the core of the organization. It becomes a guiding light, a fundamental value for development and growth as an organization building on the interaction between products and services. For example a transitioning from a linear to a circular model may shift the core focus from selling material goods, to granting access to its functionality, turning itself into a service based model (Lieder & Rashid. 2016).



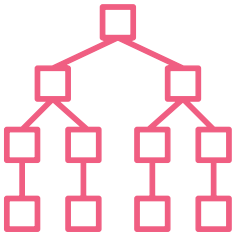
Incorporate digital technology

Digital tools provide efficient communication bringing insights that help track and optimize resource use and enable the implementation of circular models, strengthening connections between the network actors. These facilitate the long-term and big-scale diffusion of CE and support data collection and processing which according to Andrews & Whitehead (2019); is necessary for keeping track of resources and capital and identifying and solving inefficiencies in developed processes.



Team up to create joint value

Working together throughout the network not only aligns strategies and actions towards a common good but also alleviates barriers such as the lack of capital, know-how, transparency and tools. It creates a pooling structure of resources which motivates new emerging sharing markets (de Mattos & de Albuquerque 2018; Mishra et al., 2019; Ngan et al. 2019).



Strengthen and advance knowledge

By Developing research and structure knowledge, it is possible to encourage conscious innovation networks able to understand findings and act with ease towards sustainable practices.

2.4
Circularity At A City Scale

When talking about the application of circular practices, the nature of the CE principles vary according to the context and scale of application. For example when talking about a company CE is usually applied to fixed input and output flows that involve clear structured networks with few variations in the interactions within these. This is not the case when applying CE to much more complex systems like cities and its networks. For these, **the application of CE should comprehend much more organic structures with less defined roles and ever changing and evolving interactions.** (Fernandez at. all, 2017) By another hand, the limits of a city are much less defined, these are open systems that constantly dance between virtual and physical boundaries, alternating the flows that compose the system. [See focus 1: Complex systems] In this sense it is pertinent for this research to understand how CE is being applied within cities and urban structures.

Before understanding how to apply circularity in cities, we first need to understand what a city is and intends. It is well known that cities are delimited urban areas (Large human settlements) composed of a series of criteria, however these delimitations and criteria vary according to the place these are located in the world and the culture of reference. Factors like population, dimension, infrastructure and independence, will determine in a subjective way whether it is a city or not. For example countries like Canada consider settlements of over 1000 residents a city while countries like Japan start the counting from 50,000 residents (Rosenberg, 2020) Another factor that can define the nominative of a city is the presence of public services and infrastructure such as public transport, hospitals, electricity, water and gas pipelines, among others. However these are all technical definitions of a city, and the mentioned factors are constantly changing. By the other hand **cities could also be interpreted as unique phenomena based on unpredictable nonlinear dynamics** (Fernandez, 2017). **These are multi dimensional flows of capital [See focus 2: 6 capitals], that emerge from intricate structures of actors and interactions.**(UN Habitat, 2020) We will take this last definition as the guiding definition for the thesis. In this sense when applying CE practices to such structures **there should be a comprehension far beyond the single elements that compose the system.**

FOCUS 1

COMPLEX SYSTEMS

Cities are not just the sum of its parts and should be approached as complex systems.

Large amount of elements:

They are composed by subsystems rich in interaction and information.
People, infrastructure, policies, nat. resources.

Non-Linear:

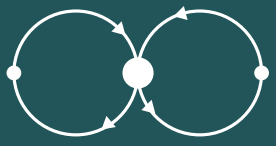
Multi-Dimensional dynamic interactions between parts and levels of hierarchy with no cause-effect nature.
Economic fluctuations / People flows / Legislation

Open nature:

Able to exchange flows with their environment. They work within physical and virtual boundaries.
Imports/Exports, tourism, waste, knowledge.

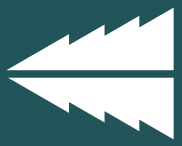
Inter and intra dependent trade offs:

Parts do impact on another, their actions compromise flows and behaviors within the system.
Budget for environmental policies.



Direct and indirect feedback loops:

Are able to retrofit, self-organize and adapt without external intervention.
Energy consumption in day time. (Meteo-source-use)



Relate to time:

They are ever-evolving networks and are conditioned by their own history.
Growth rates (Population, technology, infrastructure)

FOCUS 2

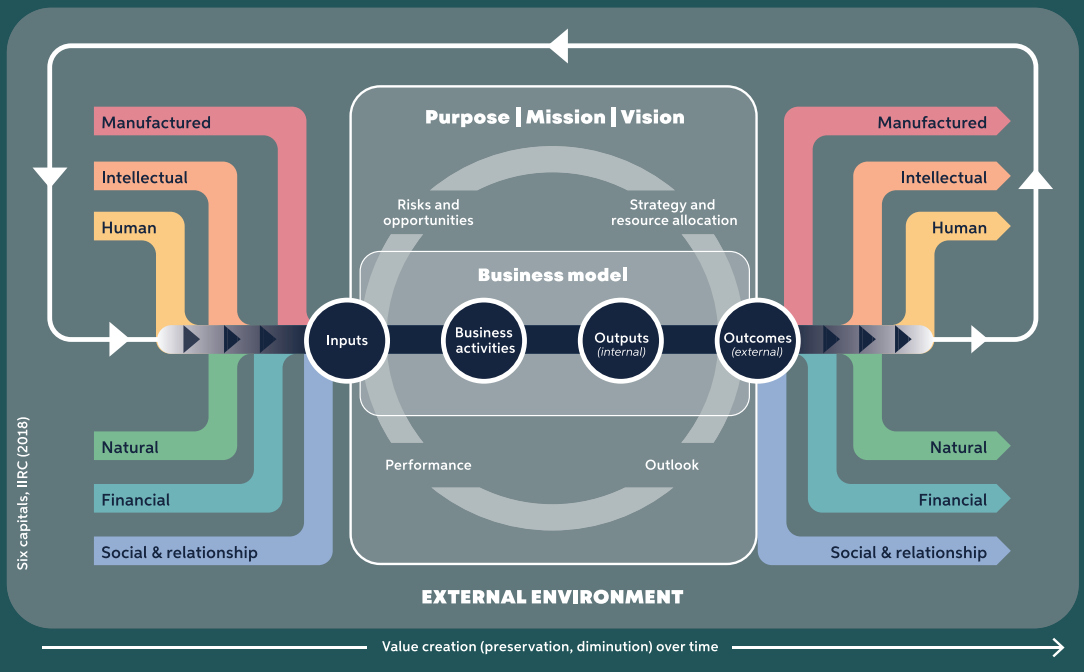
CAPITALS

The multiple capitals concept defines 6 different types of capitals: Financial capital; manufacturing capital; human capital; social and relationship capital; intellectual capital and, natural capital.

This concept is just a clearer, "newer"definition of the economic system we already live and thrive in, plus a recipe for sustainable growth. Cities impact and depend on these capitals: increasing, decreasing, or transforming them.

In order to understand whether a city is acting responsibly and with integrity, its actions must consider all of the impacts and dependecies between capitals. (KPMG, 2017) It must surpass a traditional and quantifiable qualification and bring people as the center of any action.

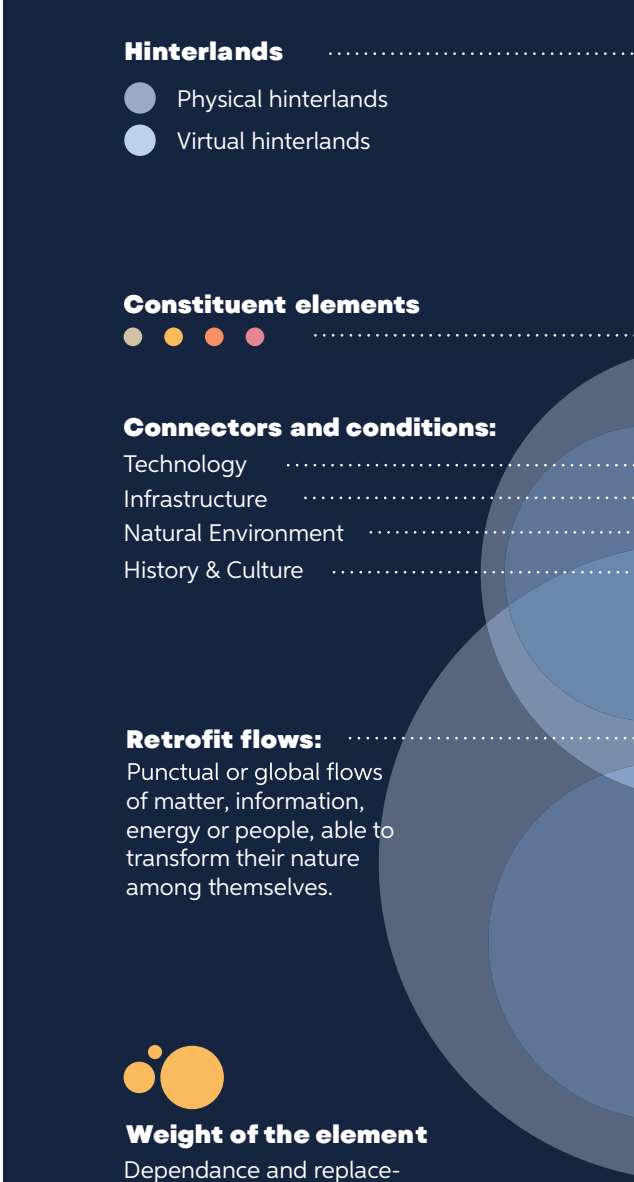
These "softer" capitals, often thought of together as 'sustaining sustainability,' are not owned by the city using or influencing them. But their availability, quality, and price can influence a citiy's ability to create value over time.

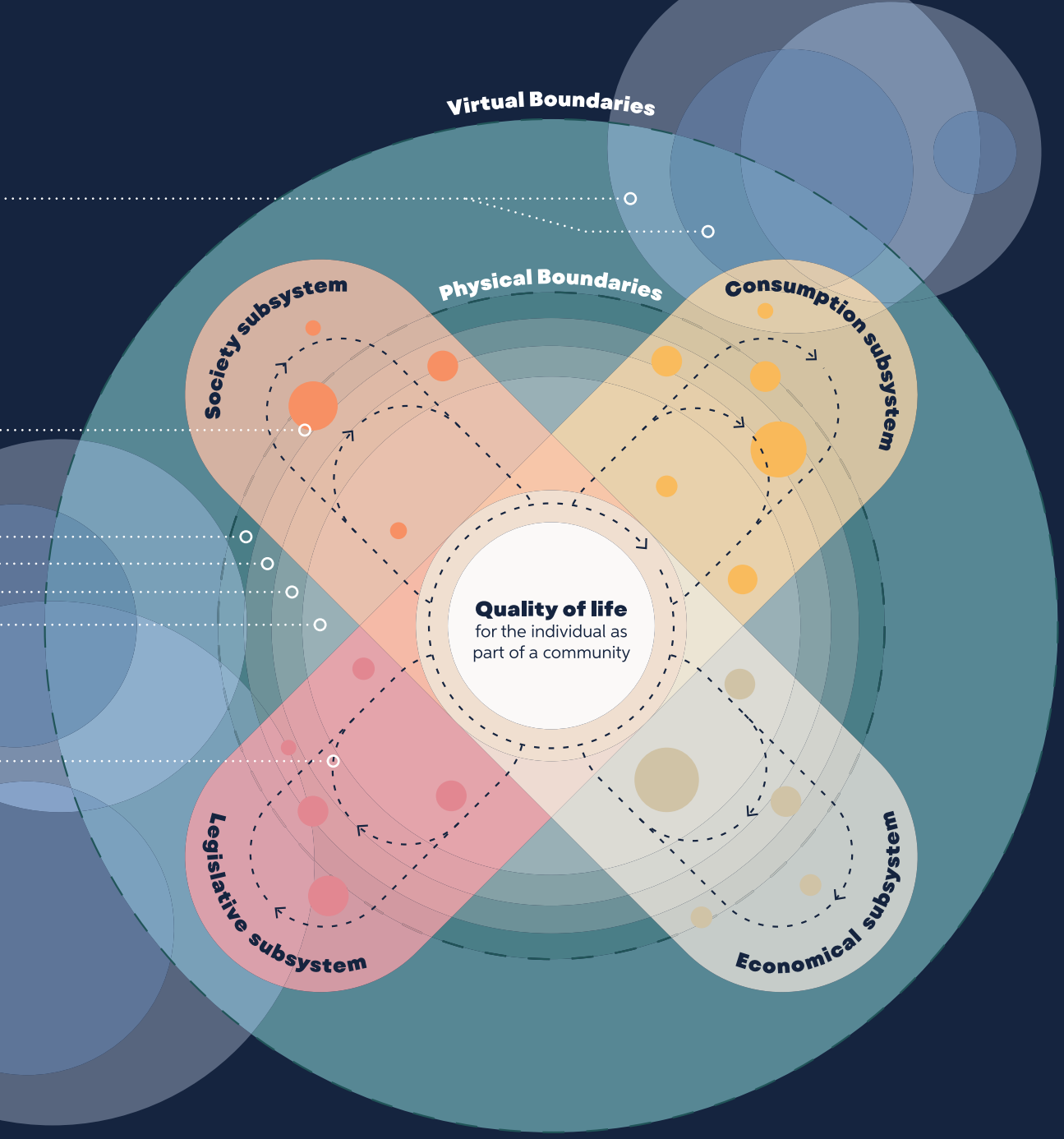


2.4.1

APPLYING CIRCULARITY IN CITIES

In order to comprehend the elements that make part of the systems and their flows it is necessary to see the city through a systemic approach. Thus, **the city should be regarded as a complex ecosystem of connected elements with a common purpose, the citizens' well-being.** A city becomes a construction of initiatives taken through time by a great number of players who are tightly interconnected among themselves and historical, spatial or structural alterations to one of the elements may modify other parts of the system. **Cities should be addressed and governed with complexity** (Maranghi et al., 2020) ; **this approach to cities can facilitate a more informed vision of themselves and their circularity,** providing information about urban sectors and their context in a holistic way, capturing direct and indirect interactions and relations. These relations and interactions can be mapped by defining clusters of actors, entities, actions, processes, etc. that define what we can call, the city's subsystems. These subsystems exist in multiplicities of scales and importance, however we can identify **four main subsystems that rule the majority of the dynamics of a city: The legislative, social, economical and consumption subsystems.** Taking this into consideration we can project a framework that comprehends in an schematic way the macro relations of the of the city as shown in the following scheme:





This framework understands the city as a network of actors and actions able to adapt, with emergent properties and flows that interact with the context. It sees the city as a system composed by the **four main subsystems that coexist within physical and virtual boundaries.** Within these subsystems there are flows that build dynamics between different elements and that at the same time interact with other subsystems and create codependent links. These **interactions are those that constitute the city and create retrofitting loops around the basic objective of the city,** the well-being and quality of life of the individual as part of the community. Extend explanation (physical and virtual boundaries and levels)

HOW TO APPLY A CIRCULAR MODEL WITHIN THESE DYNAMICS OF COMPLEX CITIES?

Now the question that merges, is how to apply a circular model within these dynamics of complex cities? A transition of a linear model to a circular model needs systems thinking (Urbinati et al., 2017) and in such contexts its adoption can occur spontaneously, planned or in a mixed way. In order to sustain this transition it is relevant to create a city-level culture (Top-down and bottom-up) actively supported and managed by a CE mindset. The non-linearity of the transition implies that while it cannot be controlled, (Kemp & Loorbach, 2003) **its scope and trajectory can be influenced by combining long-term thinking with short-term and linking stakeholders and actions in multi-leveled aspects.** (Rotmans et al., 2001)

Furthermore, the application of CE practices may vary between 2 main visions:

The long range vision and the contingency vision.

The long range vision is characterized by its ability of foreseeing the future and projecting the actions taken in line with that vision, we can see it as a preventive action with a high level of resilience, however the highly complex and dynamic nature of contemporary cities makes it challenging to give precise and reliable foresight of events. By the other hand the contingency vision surrenders to unexpected changes in the urban context, it is more of an adaptive vision with no projective nature, weak for facing future challenges. (Klosterman, 2013). Therefore **cities should be in grade of managing uncertainty by being able to prepare for the future and shaping it actively with short-term actions.** Taking this into consideration and for purposes of the thesis we can map how the projection of urban practices work at a city level, as shown in the following diagram,when applying circular practices in cites we have to understand them as actions that have a before and after. These can be born as a top-down initiative or as a bottom-up initiative however in order to turn itself into an action it usually requires agreed strategies that align the involved stakeholders. All appli-

cations and actions of CE in cities come from a perceived need for a “Know how, what or why” that enables the first action, for example if some actor in the chain of command wants to reduce its carbon footprint and has no clue of how to do it, there is a need of instruction (know-how) that riggers the “know-what” to do and the passage of **information between stakeholders should always include a “Know-why” otherwise there is a lack commitment and alignment of actions and objectives** that this actions wants to reach. This know-why can be the cause or the consequence of the action, this because CE actions could decrease the impacts or reduce the causes of a linear-productive model. The applied practice should be context dependent, and aim for the conditioning of assets or products within the local territory.

Today, implementing both adaptation and mitigation is essential in cities to avoid hazardous effects of climate change. Therefore, **understanding the relations between adaptive and mitigative measures is crucial and can be done by centering on the drivers of mutualism, trade-offs or conflicts.** These three should comprehend multi-scale and multi-level cooperation.

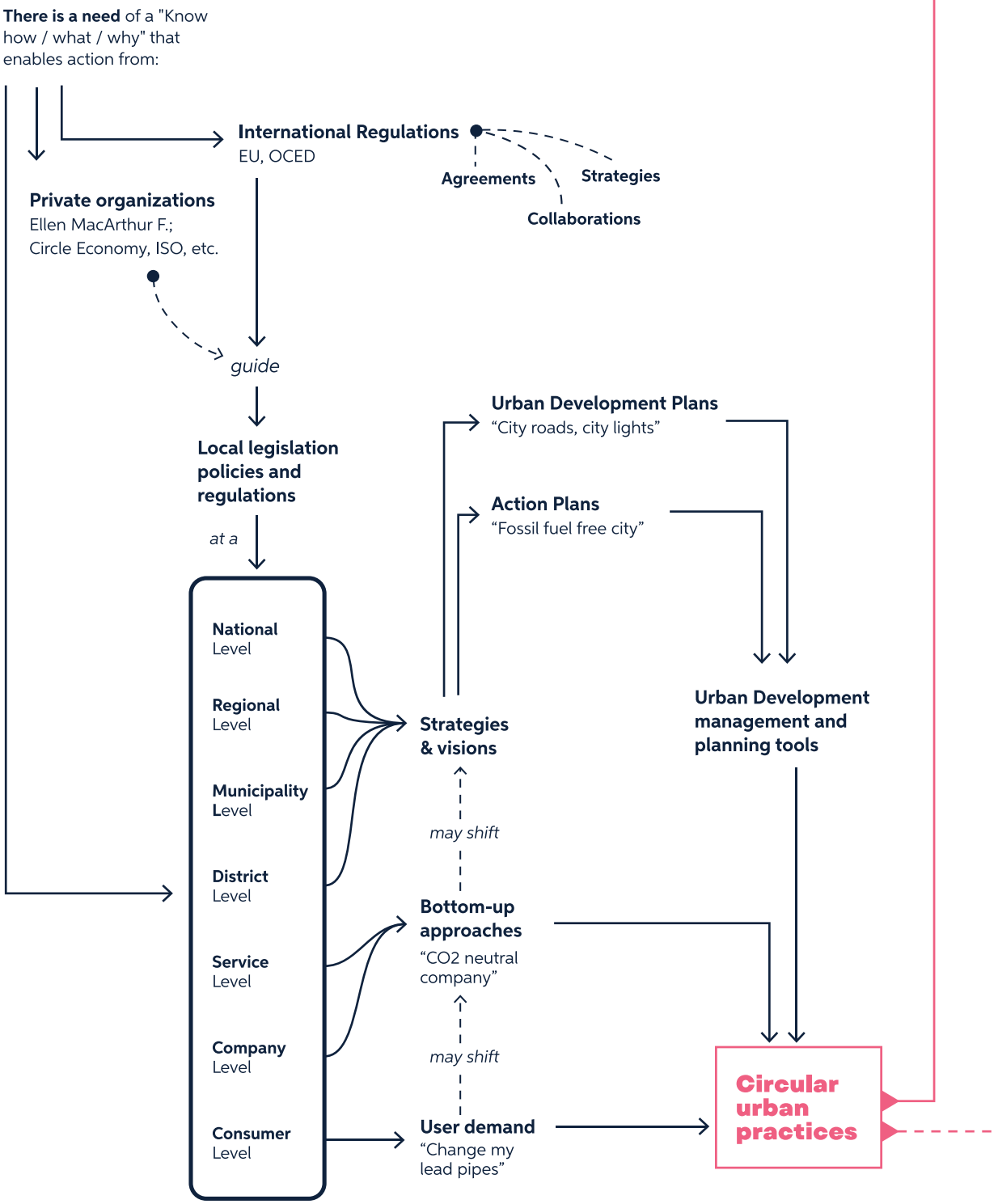
Added to this, in order to avoid unfavorable relations or to catalyze positive ones, it is required to have strategic plans and a structured system of interventions.

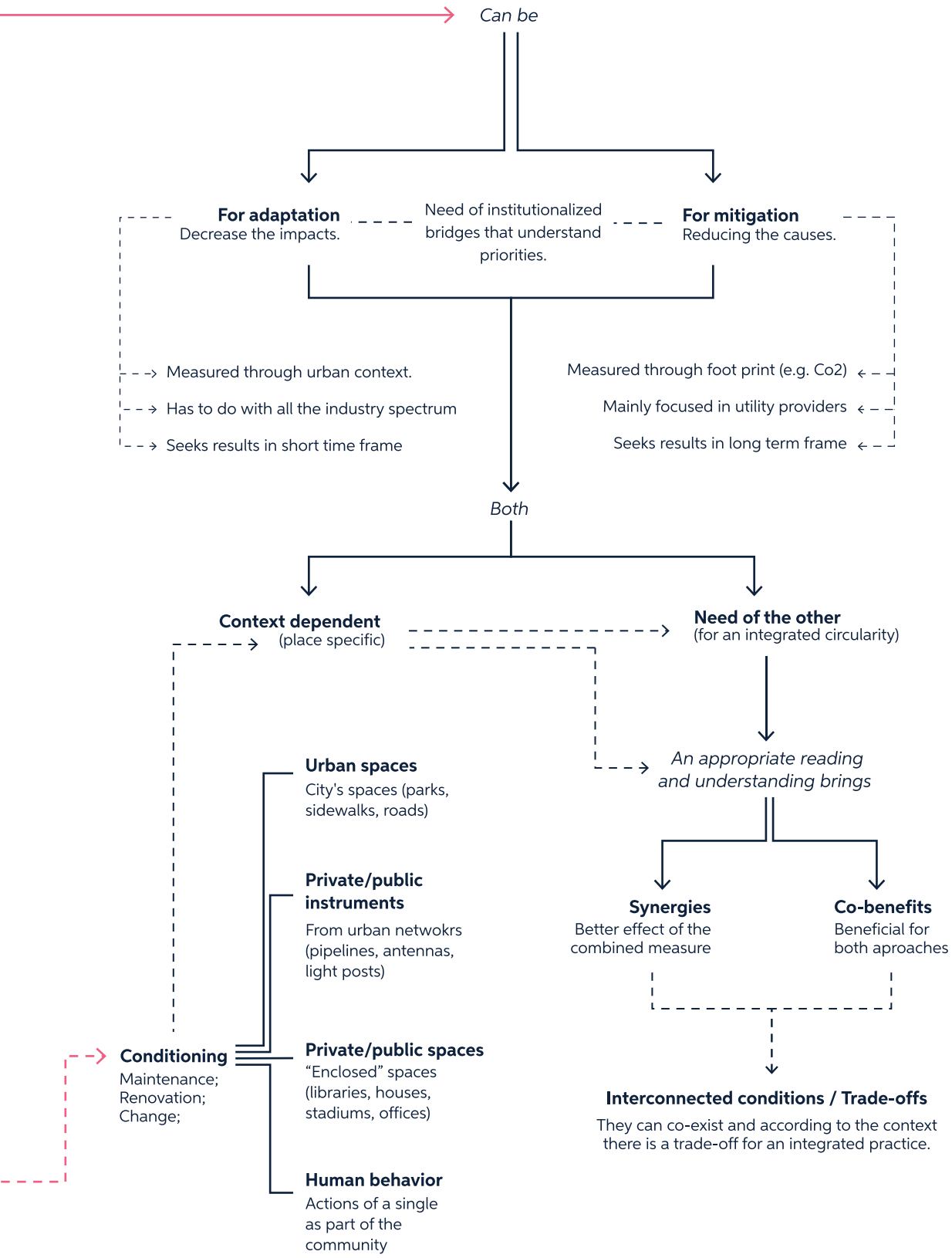
Only by applying these intertwined features urban planning can apply accurate assessment of successes and gaps in the ongoing processes towards CE within cities. (Codemo, Favargiotti, & Albatici, 2021)

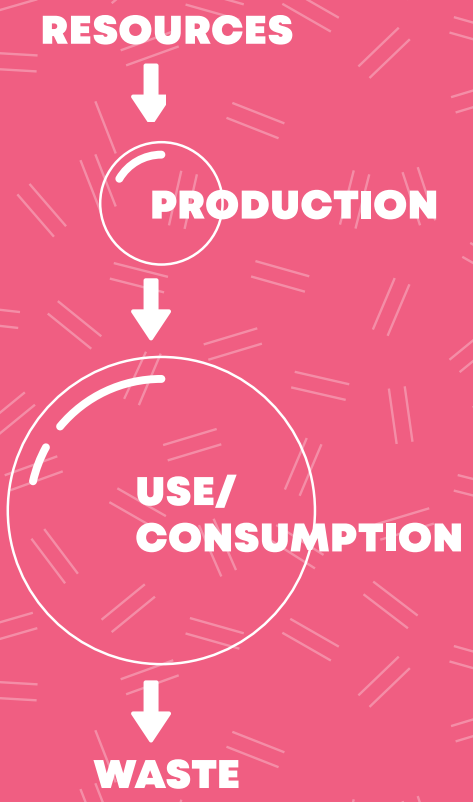
Maintenance of urban infrastructure can be both a contingency or a long range vision. It all depends on what caused the action.

CIRCULAR URBAN PRACTICES

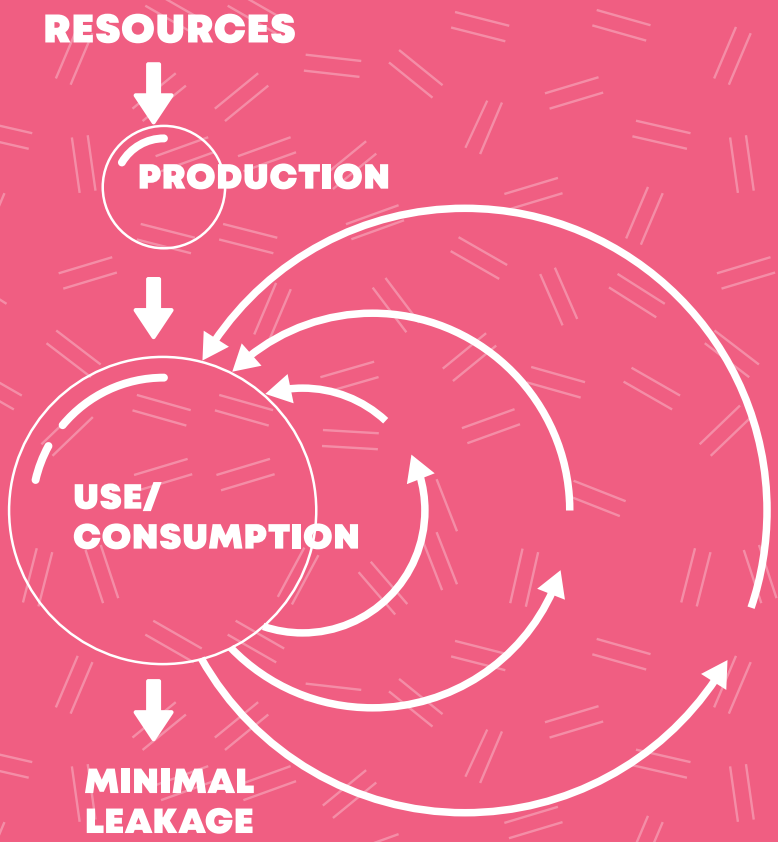
What creates a circular urban practice




Can be
For adaptation
Decrease the impacts.
Need of institutionalized bridges that understand priorities.
For mitigation
Reducing the causes.
Measured through urban context.
Has to do with all the industry spectrum
Seeks results in short time frame
Measured through foot print (e.g. Co2)
Mainly focused in utility providers
Seeks results in long term frame
Both
Context dependent
(place specific)
Need of the other
(for an integrated circularity)
An appropriate reading and understanding brings
Synergies
Better effect of the combined measure
Co-benefits
Beneficial for both aproaches
Interconnected conditions / Trade-offs
They can co-exist and according to the context there is a trade-off for an integrated practice.
Conditioning
Maintenance;
Renovation;
Change;
Urban spaces
City's spaces (parks, sidewalks, roads)
Private/public instruments
From urban netwokrs (pipelines, antennas, light posts)
Private/public spaces
“Enclosed” spaces (libraries, houses, stadiums, offices)
Human behavior
Actions of a single as part of the community



FROM ~~LINEAR~~ MODELS TO CIRCULAR



2.5
Circular Cities

Conceptions towards more sustainable cities have been present for years. Since the first half of the nineteenth century concepts like Garden Cities, presented by Ebenezer Howard, or urbanistic projections, presented by Le Corbusier, among many others, have been expanding and laying a solid base for contemporary urbanistics. It wasn't until 1987 with the publication of the **Brundtland Report by the UN**, that these visions of a more sustainable city gained real importance. This publication successfully established sustainability as a critical part of economic models for countries and cites. The report **increased the awareness of the importance of the relation among economies and their dependence on natural resource ecosystems,** it raised a sense of care and responsibility for the future and the environment. (Drolet, 2015)

This push towards the search of more sustainable practices have challenged city authorities to reduce their ecological footprint by redesigning cities and turning these into eco-cities and smart cities cities that reinterpret urban landscapes, flows and industries with an eco-environmental and biomimicry mindset. In this sense, **'circular cities', is the newest iteration of urban sustainability initiatives (**Milios, 2018). There are various interpretations to what a circular city means or does, however all these interpretations do agree on one thing, and is the analogy of **understanding the city as a living system due to its ability of self-organization under continuous change thanks to selective and decentralized flows of matter, energy and information.** (Zellner & Campbell, 2015). In circular cities these flows are guided by the CE-principles and aim at the creation of sustainable networks that allow optimal use of city assets and products.

The function and nature of these flows is what dictates whether a city is circular or not, cyclical and regenerative flows will incline towards a more circular city. It is important to clarify that circularity within a city context is not a white or black situation, and we should talk about degrees of circularity. This is because cities around the world that are transitioning towards circularity have different strategies, scales of implementation and overall objectives, and for the present moment we can't talk of "fully-circular cities", hence **there is no path nor limit to what can be or should be done.** Accordingly there is no international agreement for how to apply circular practices, and just recently international approaches have emerged, such as the European Green Deal, varying in scale, scope, impact or focus.

Although there is no consensus of what a circular city should be or do, ideally **circular cities should be able to map different elements within them that comprehend all 8 CE principles previously mentioned.** The "Guide to circular cities" led by Mr Okan Geray, published in 2020 by a coalition of UN organizations and others, mentions the mapping and relation of four key components that should be taken into consideration when referring to a circular city; **these can be interpreted as a guide for outlining the CE degree in the territory**. The mentioned components by the guide are:

City assets and products

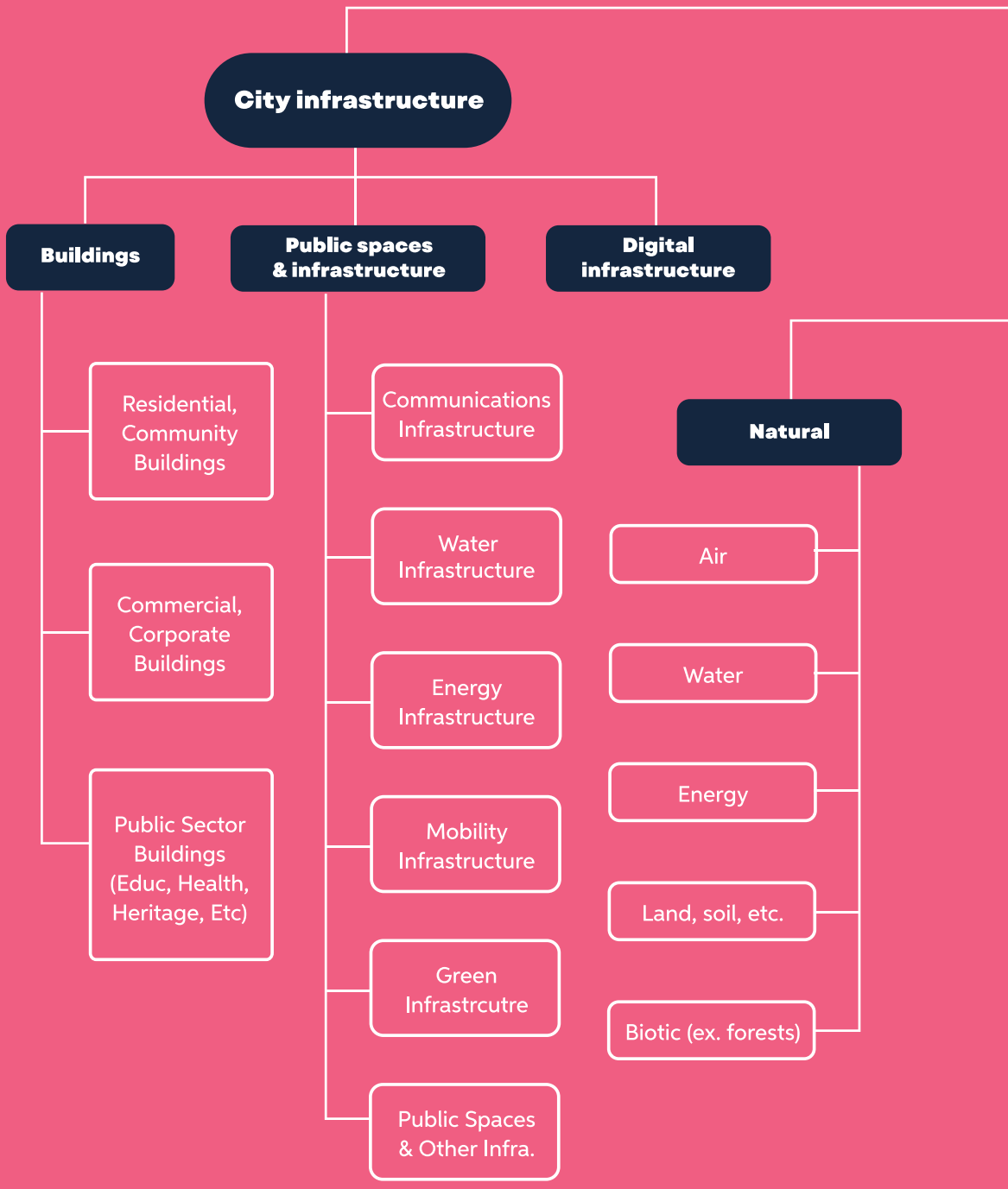
Circular actions

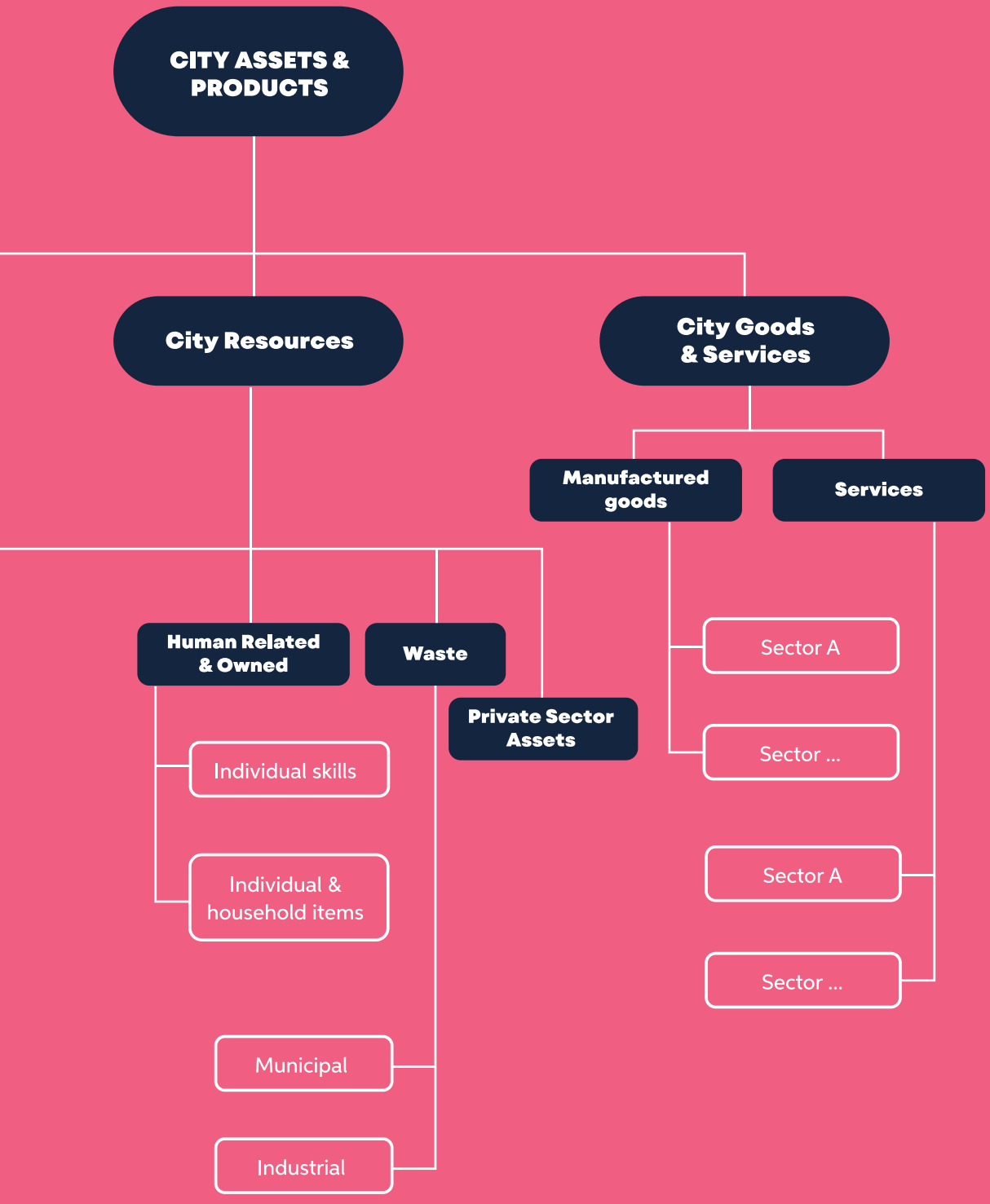
Circular city output

Circular city enablers

CITY ASSETS AND PRODUCTS

This refers to a mapping of the city infrastructures, resources, goods and services available for use/consumption in the city. Here it is important to add the fact that cites are composed not only by the structures inside the physical boundaries of the territory (Chavez et al., 2018).




CITY ASSETS & PRODUCTS
City Resources
City Goods & Services
Manufactured goods
Services
Human Related & Owned
Waste
Private Sector Assets
Sector A
Sector ...
Individual skills
Individual & household items
Sector A
Sector ...
Municipal
Industrial

CIRCULAR ACTIONS

These are outcome-oriented actions that can be or are being applied to improve assets and products utilization and lifespan. In this case the Geray's proposed actions with EMF proposed actions for CE, can be seen as potential circular actions for cities.

Refurbishing

Is about **restoring an old city asset or product** for bringing it to a functional or higher condition. It can be applied to extend the lifespan of city assets and products without changing their core functionality.

Reusing

Using a city asset or product again, with scare or non modifications, destined to the same function or a new one.

Digitizing for information

Taking analogue information and processes and encoding these so that computers may **store, analyze, and transmit such information, in faster and less expensive** ways that have the potential of reducing environmental impacts.

Digitizing for dematerialization

Dematerialize products by **providing services** and taking advantage of digital technologies.

Replacing

Providing a substitute for a city asset, product. The change of the entire asset or their components may enhance their circularity potential by extending their life span and utilization. It can be done either as a preventive action, an upgrade(towards circularity) or as a response to an immediate need.

Strategic design

Design products and services that foment the other actions and offer modularity to solution, making products accessible and easy to disassemble.

Recycling

Transforming city assets and products at their **end of life into new materials and objects** so these can be consumable or usable again. Today a big part of the untreated waste has the potential of being useful again through recycling, being an alternative to 'conventional' waste disposal (i.e. incineration and landfilling), save materials and help negative ecosystem footprints like greenhouse gas emissions. Moreover, it potentially reduces resource consumption of materials, energy, water, among others.

Sharing

Sharing is the use of city assets and products as a **communal element.**

CIRCULAR CITY OUTPUT

Ideally, the application of these circular actions result in specific outcomes that come as **direct or indirect results.** These results may come in multiple forms, from the creation of **new city structures and products** in line with CE to the **emergence of cultural, economical or political circular actions,** or even the reduction of green-house gasses produced. These are just a few examples, but there are many combinations to what can be produced as a result.

CIRCULAR CITY ENABLERS

As important as city assets and products, **enablers are supplementary and complementary items such as entities, activities, or initiatives that catalyze and support circular city outputs.** There are multiple enablers varying in scale and importance, some of these enablers are mentioned in the following page.

Enablers can also be assets or products that support specific processes or services. In this sense having access to high level technology, or specific environment could be considered as enablers for circular actions. These four main components are **ideal for formulating circular city strategies and help for the transition of circular models.**

By the other hand, cities as well as companies do need to have a control and management of these actions and should be able to measure the success and performance of these actions towards CE objectives. In this sense **it is not only about acting or mapping the actions but also it is crucial to have a strategic application and follow-up of these initiatives,** ideally guided by frameworks and metrics.

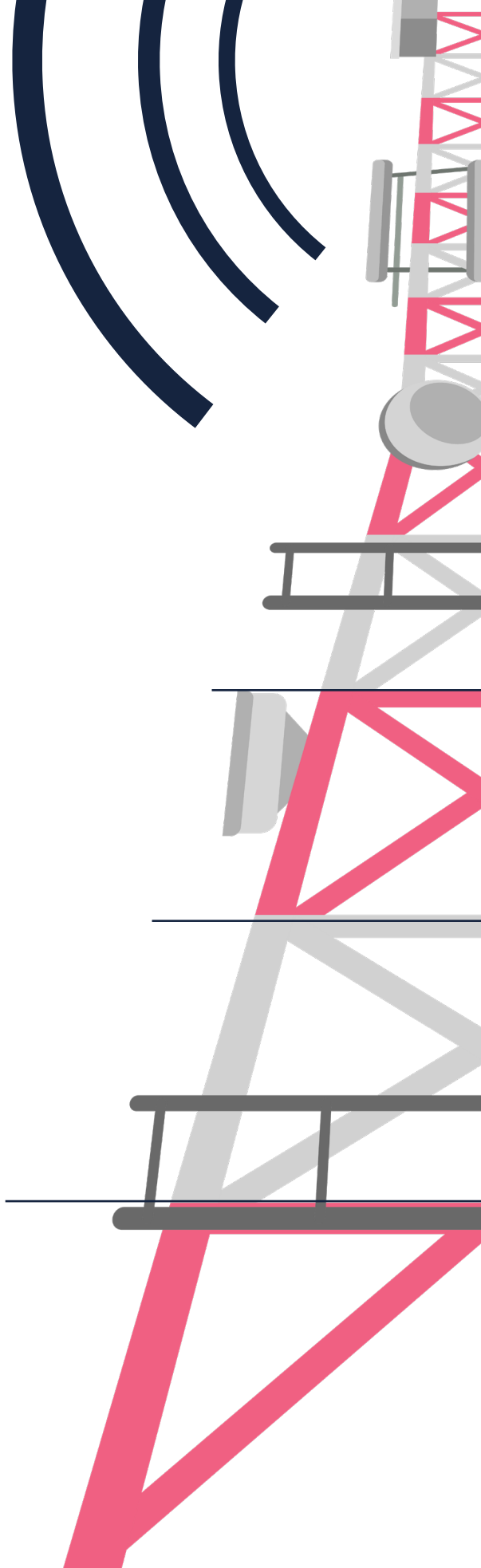
CIRCULAR CITY ENABLERS

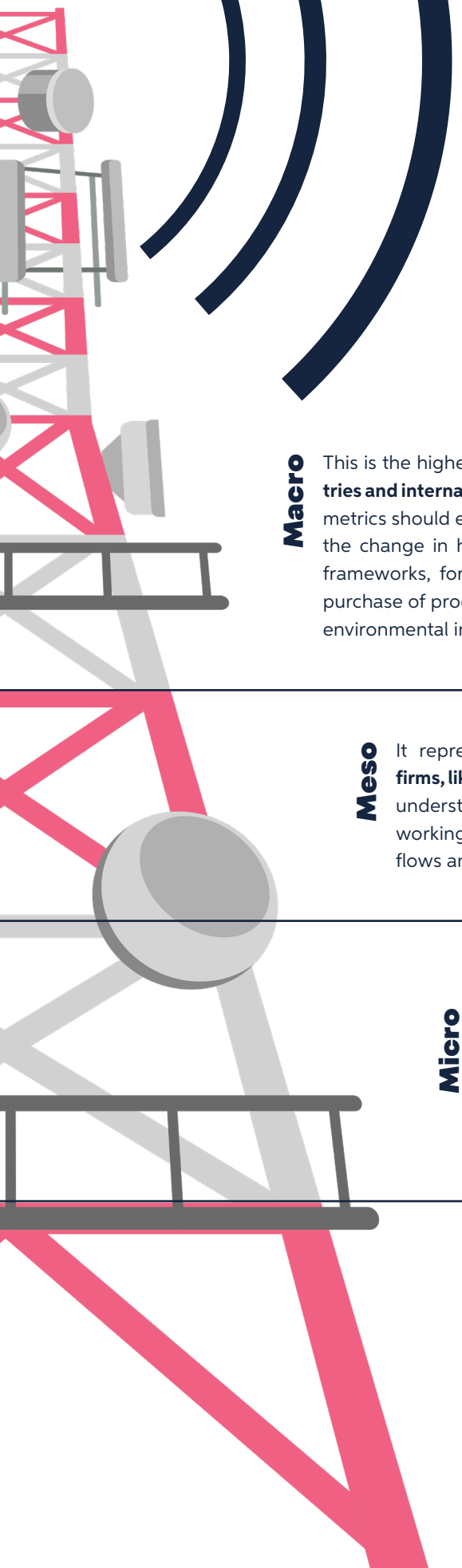
- Public-private partnerships for circularity
- R&D programs for circularity
- Circularity regulations
- National laws and directives
- Circular KPIs and their benchmarks and targets
- Awareness raising on circular city initiatives and actions
- Circularity training and skills enhancement
- Measures to promote confidence in circular activities
- Urban industrial symbiosis
- Strategic planning and development of circularity-related policies
- Use of public procurement as a lever for circularity
- Financial incentives to boost circularity
- Certifications for circularity
- Engaging and ensuring stakeholder participation.
- City innovation ecosystem related to circularity
- Integrated urban service

2.6
Metrics For Circular Cities

The private sector is not the only actor interested in measuring its progress featuring a circular economy. Public administrations are adopting CE roadmaps, frameworks and action plans with various indicators and metrics. Some of these come as a readaption of existing practices in the private sector and others through trial and error. Parallel to this non-governmental global and local organizations have built their own metrics and schemes related to circularity. (UN Global & KPMG, 2017). Other than organizations, the academic community has numerous studies and proposals on how to measure circularity in cites. However **none of these approaches present consistent linearity with one another and overlap in inconsistent ways.** These varieties of approaches work more as complementary tools to one another, however this means an **extra effort from public administrators for evaluating every possible aspect of the city.** In order to understand how Circunet may approach a more holistic view that brings a more cohesive approach to circularity we first need to understand how these frameworks are being projected.

It is important to highlight the fact that **CE in cities is a broad concept and its application opens a multiplicity of stakeholders with different roles in the economy and society, hence different objectives should be aligned.** The fact that they have different objectives will eventually result in a variety of indicators suited for each goal and action plan accordingly to each stakeholder. In this sense it is important to have in mind that these **metrics should work on various scales.** As proposed by Wbcsd & EIT Climate-kic.(2018). these scales could be divided as follow:





Macro This is the highest level where **cities, countries and international agencies** reside. Here metrics should evaluate actions that pursue the change in habits, laws, programs and frameworks, for example incentivizing the purchase of products and services with low environmental impact.

Meso It represents **networks of industries and firms, like cooperatives.** Here metrics should understand how industrial symbiosis is working and how companies exchange flows and mutualize needs.

Micro This is the level where **companies and consumers stand.** In this case metrics should look for rates of green consumption and production.

Nano Although the lowest possible level of analysis, it is **directly intertwined with all levels, here products and components stand** and metrics should cover a consumption phase, evaluating the increase in life expectancy of these goods through different circular actions.

DIFFICULTY IN CIRCULAR PRACTICE ADOPTION

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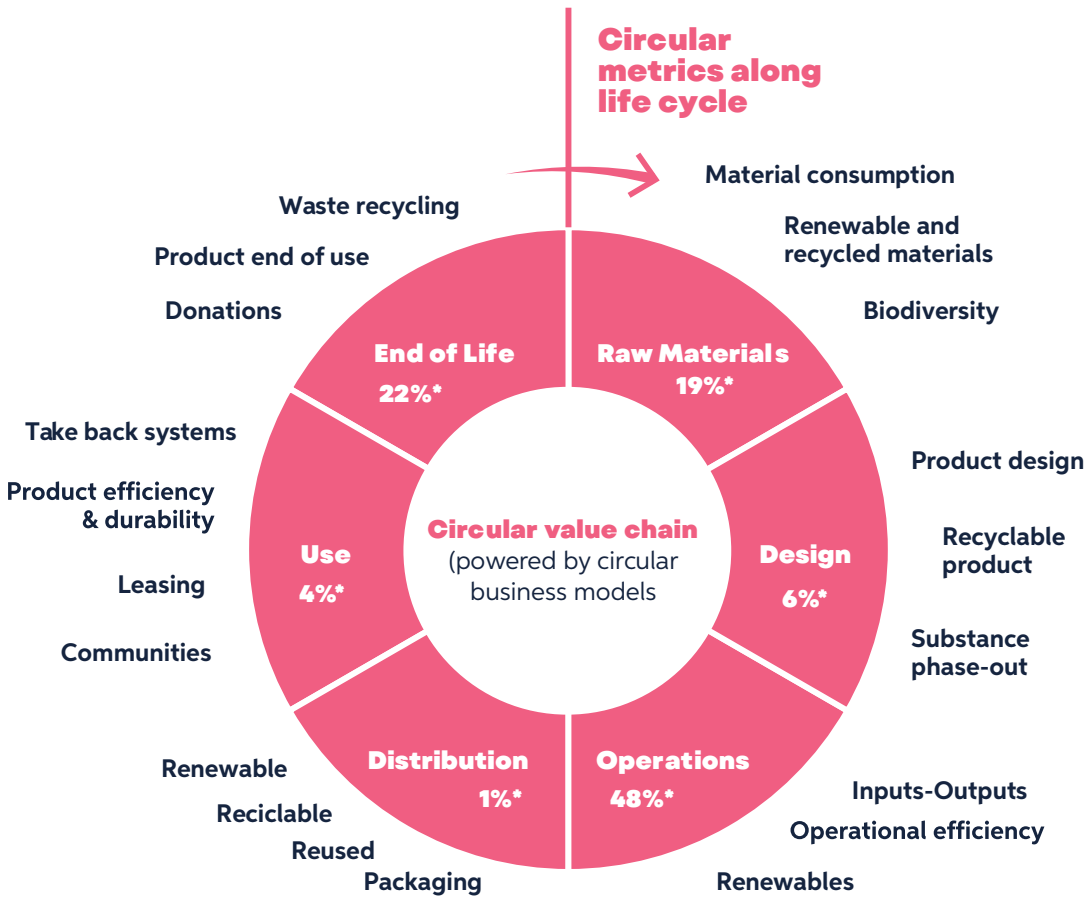
These scales are not exclusive and in an ideal measurement of CE performance these should interact in order to have a much more holistic vision of the impact of the actions and the scale of the barriers. Talking about barriers, these should be also considered when metering circular performance. Barriers for CE can be classified in two major groups, these are the **hard barriers and the soft barriers** (Campbell-Johnston Et al., 2019). The hard barriers are those that are **physical infrastructure dependent**, meaning the lack of technologies for an implementation or lack of physical structures like buildings or accessible materials. The soft barriers are those **societal conditions that govern over the particular actions,** for example an specific law for construction or transport , the historical value of a structure or even just the ideology of a CEO.

Moreover, it is important for CE metrics to have the capacity of **understanding the stage and conditions in which cities' flows, assets and products are present;** in this sense we can talk about metrics for 6 stages: Raw materials, design, operations, distribution, use and end of life. (Wbcsd & EIT Climate-kic, 2018). Applying different metrics to different stages makes these acquire different relevance for each stakeholder, these last will have different drivers for the application of metrics in various scales and phases.



*** Use of indicators by other tools for life cycle stage**
WBCSD (2018)

It is possible to extrapolate main drivers from various articles and CE applications in real life, these help us define what to expect from CE metrics at a city scale, these drivers are:

Mapping the actual situation of the territory, creating a baseline for CE.

Identify and manage risks associated with the existing linear models.

Determining the potential for a future CE environment and prioritizing circularity actions.

Drive city strategies towards an integrated circularity mindset

Justify achievement internally and externally.

Understand and project the impact of circular actions.

Assess and catalyze initiatives towards CE.

2.6.1 Frameworks And Indicators For Circular Performance

Being CE such a recent application concept for cities and urban infrastructures, the need of guiding frameworks is vital for the alignment of actions towards specific objectives.

Different cities and organizations do offer or apply frameworks that intend to help in the leading, creation, monitoring and evaluation of sustainable practices guided by the CE principles. In line with the key components described in chapter 2.5, **there are multiple frameworks and indicators that may support the management of circular practices** and can be used by any stakeholders to measure the circular performance of their projects or networks. **The following is a list of tools/frameworks/indicators for the measurement of CE performance,** which will be further analyzed in chapter 5 and 6. It is important to take into consideration that some of the following examples have been projected for the private sector, however they can be considered relevant as a recollection of good practices for the public sector. (Wbcsd & EIT Climate-kic, 2018)

BENCHMARK OTHER PLATFORMS

These are outcome-oriented actions that can be or are being applied to improve assets and products utilization and lifespan. In this case the Geray's proposed actions with EMF proposed actions for CE, can be seen as potential circular actions for cities.

NAME OF TOOL	EXPLANATION	CATEGORY
"QUICK SCAN CIRCULAR PURCHASE"	How do you choose an ideal circular purchase project? This quick scan helps you to estimate the success rate of your concrete circular purchase project.	Circular procurment
PROREMAT	Listed building systems and products that can be used in circular projects. The focus is mainly on building materials with recycled content.	Database
CIRCUBUILD	Circubuild maintains a database for circular construction products or services.	Database
RE-TRACE	tracks material flows. The platform maps your building materials and organizes your waste streams in order to draw up a Re-use & Re-cycle plan	Dealing with residual flows / Matchmaking / Sharing / Renting
PLATFORMU	helps to map your use of materials (wood, water, steel, oil, paper...), waste, unused space (storage space, meeting rooms, showrooms...) and even the need for human skills and capacity (graphic design, engineers, waste management...)	Dealing with residual flows / Matchmaking / Sharing / Renting
OPALIS	Facilitate the use of reuse materials in construction and renovation projects	Dealing with residual flows / Matchmaking / Sharing / Renting
SMART SYMBBIOSIS	a material flow from one company to another company. On the symbiosis platform, applicants and providers of valuable materials meet each other.	Dealing with residual flows / Matchmaking / Sharing / Renting
CIRCLETIPS	find hundreds of tips that contribute to a cleaner environment and a lower waste bill. More than 25 partner organisations provide tips, such as waste collectors, sector federations, management bodies and knowledge centres, each from their own expertise.	Dealing with residual flows / Measuring
THE ONLINE MATERIAL FLOW ANALYSIS TOOL (OMAT)	helping researchers build their dataset according to standards; facilitate and centralize the collection, updating and commenting of data; enable simultaneous collaboration on the same datasets; make datasets one-fold shareable with other researchers or the pubic.	Dealing with residual flows / Measuring / Evaluating

WERFWATER	Suppliers of excess water and local customers into contact with each other in a simple way.	Dealing with residual flows / Measuring / Evaluating
OOGSTKAART	provides insight into the stock of used and/or circular materials and raw materials in the construction and real estate sector, for both purchase and sale. In other words: the platform maps the urban mining potential of the Netherlands.	Dealing with residual flows / Measuring / Evaluating
ECOLIZER	is an ecodesign design tool and is aimed at all designers and companies who want to know and tackle the environmental impact of their products.	Design
EHO KIT	ffers concrete guidance to lecturers, professors, programme coordinators and training councils to integrate ecodesign into higher education programmes.	Design
CIRCULARITY CALCULATOR	The tool calculates and visualizes material flows and the financial added value of closing cycles. The results are captured in scores for general circularity,	Design / Measuring / Evaluating
C-CALC	allows the circularity of buildings to be evaluated according to multiple criteria. The tool gives the buildings a label, which shows the integration of the concepts of circular economy in the project.	Design / Measuring / Evaluating
MATERIAL CIRCULARITY INDICATORS (MCI)	it calculates the quantity and intensity of circulation at product and/or company levels (circular and restorative flows). The tool also allows to compare your performance with your industry's average	Design / Measuring / Evaluating
CYCLE-UP	marketplace with extra service for the reuse of building materials.	Matchmaking / Sharing / Renting
DIAG - IT	resource diagnostics	Matchmaking / Sharing / Renting
BACKACIA	marketplace for the reuse of building materials.	Matchmaking / Sharing / Renting
SMARTYARD	Connects supply and demand and unburdens its users during the entire (re)rental process.	Matchmaking / Sharing / Renting
WORKING TOGEATHER	Samenwerk is the first online platform where you can find temporary workplaces together everywhere in Flanders.	Matchmaking / Sharing / Renting
I.REVITALISE	sharing B2B capacity that focuses on high-tech and high-quality material and competencies in the industry.	Matchmaking / Sharing / Renting
WERFLINK	haring platform on which companies active in the construction sector can share, exchange, (re)rent and (re) sell equipment, equipment, material surpluses, freight and storage space.	Matchmaking / Sharing / Renting

INSERT MARKETPLACE	you can offer or find reusable (construction) materials and raw materials.	Matchmaking / Sharing / Renting
CIRCLEAID	you can ask questions to experts with experience with circular business models. They will give you advice, or draw up a guidance process in which they share their knowledge with you in the process.	Matchmaking / Sharing / Renting
GABI CIRCULARITY TOOLKIT	(paying) software that helps you calculate the Material Circularity Indicator (MCI) developed by The Ellen MacArthur Foundation for your products.	Measuring / Evaluating
CIRCULAR TRANSITION INDICATORS (CTI)	Central to the CTI is a self-assessment that determines the circular performance of a company. It focuses primarily on the circular and linear material flows that go through the company.	Measuring / Evaluating
CIRCULYTICS	holistic assessment tool that supports companies in their transition to a circular economy.	Measuring / Evaluating
IMPACT WIZARD	e guide to evaluate and increase your impact. This toolbox helps you find indicators and measuring instruments that fit your organization or project.	Measuring / Evaluating
TOTEM	[Tool to Optimise the Total Environmental impact of Materials] helps the Belgian construction sector to objectify and reduce the environmental impact of buildings.	Measuring / Evaluating
PARTNESHIP METHODOLOGY AND TOOLKIT	Step-by-step plan from A to Z to achieve solid partnerships.	Orientation in general
RESCOM CIRCULAR PATHFINDER	Starting tool for CE. Will point you to promising circular trajectories for your specific situation.	Orientation in general / Design
CLOSING THE LOOP BY DESIGN	Guidelines for product developers to make products more circular.	Orientation in general / Design
SVID SUSTAINABILITY GUIDE	The guide offers companies, designers and higher education inspiration and tools to get started sustainably. This is done with an overview of circular business models, principles of ecodesign and cases of forerunners in the circular economy.	Orientation in general / Design
USE2USE	is a set of tools that you can use to design for circular consumption. The unique thing about this toolkit is the focus on the end user: it is not so much about your business model, but about how a user experiences circularity.	Orientation in general / Design
CFDA GUIDE TO SUSTAINABLE STRATEGIES	provide an insight and overview of how to bring sustainability to the fashion industry. The guide captures the complex concept of 'sustainability' and simplifies it into clear, digestible sources and actions.	Orientation in general / Design
CE COMPASS	checklist that indicates which accents of circular economy you can put in a circular project	Orientation in general / Design

CIRCULATOR	shaping your own circular business model consult the most common circular business models view cases of organizations	Orientation in general / Design
AMBITION MAP CIRCULAR PURCHASES	The ambition map gives you an overview of possible circular objectives and purchasing strategies. A useful starting point to get started: what actions does your organization take? Which ones are feasible in the short term? Which ones require a long-term ambition?	Orientation in general / Design
SUSTATOOL	smaller organization can work on a sustainability policy. This tool offers you a systematic and practical no-nonsense approach.	Orientation in general / Design
THE CIRCULAR DESIGN GUIDE	is a guide from IDEO and the Ellen MacArthur Foundation that wants innovators, entrepreneurs and intrapreneurs to ask new questions about value creation and sustainable business models, and to encourage them to apply circular principles in their own work.	Orientation in general / Design
OVAM SIS TOOLKIT	The OVAM SIS Toolkit is a comprehensive design tool to integrate sustainability principles into innovation and design processes, in order to increase your value creation. SIS stands for 'Sustainable Innovation System'.	Orientation in general / Design
CLOSE THE LOOP	offers five strategies that you can implement to work on a circular fashion industry. Based on the reasoning that it is impossible to apply all strategies to all links in the chain,	Orientation in general / Design / Dealing with residual flows / Measuring / Evaluating
CIRCLE - CITY SCAN	It marks the first public presentation of the holistic approach to 'downscaling the Doughnut', combining local aspiration with global responsibility. How can our city be a thriving home to thriving people, while respecting the planetary boundaries?	Measuring / Evaluating
KNOWLEDGE HUB	Discover and contribute practical examples of the circular economy	Orientation in general / Design
CIRCULARITY INDICATROS	The C-Indicators Advisor is flexible in the way the databank is not frozen and can be easily updated. As such, it is possible for you to contribute in the tool development, enrichment, or consolidation.	Measuring / Evaluating
DIGICIRC DATA HUB	DigiCirc aims to empower SMEs to leverage digital technology as a key enabler for innovative circular services, processes and business models.	Orientation in general / Design
EU MONITORING FRAMEWORK FOR THE CIRCULAR ECONOMY.	Sankey diagram of material flows in the European Union (EU); and 2) the circular material use rate or circularity rate, i.e. the share of material recovered and fed back into the economy.	Measuring / Evaluating
REBURG	Reburg is a fictional city in a circular future. With the city we show what life in a circular economy could look like.	Orientation in general / Design

Scan for links of all the tools

In summary, there are many experiences related to tools for measuring the degree of circularity, some come close to being recognized as indicators, others are just the beginning of a path that will ensure real applications to public or private realities. The limitation of all these systems, even the most accurate, is that they are not based on a single focus and run the risk of being for everyone and for no one at the same time. **To date, the existing frameworks do not allow for a complete analysis of cities** since they leave open the interpretation of the context, including all possible realities in one, mixing non comparable characteristics, which as a result leads to a **loss of effectiveness in the analysis phase,** the phase following the measurement of the degree of circularity, **which could be seen as the most relevant point at the time of making such an assessment** since through this one creates possible paths to implement in environmental, economic and social matters.

2.6.2 Insights For Evaluating CE Performance In Cities

Through a qualitative evaluation of the previously mentioned frameworks added and taking into consideration the bases for circular economy practices we can derive various insights that could help the critical evaluation of Circunet (Chapter 5).

As a premise, metrics should understand the temporality of the flows, comprehending flows, assets or products with a lifecycle mindset. In other words, when measuring circular performance, this last should be interpreted differently according to the stage of life in which the measured element is present. (see chart chapter 2.6) For example, if an indicator is “Carbon footprint” we shouldn’t compare the amount of Co2 released to the atmosphere in the production vs. the CO2 released in the distribution, this is simply because no matter if their quantities are similar, the actions in practice will vary. Taking this into consideration we can expose the following series of insights:


TO DO
NOTES
DATE

INSIGHTS FOR CE MEASURE

Metrics in silos:

Some tools show a tendency for understanding **AFP's (**assets, flows or products) **as isolated phenomena** from the rest. Metrics do relate only between specific lines of supply, ignoring complex structures of relations between stakeholders, losing sight of multilayered and leveled networks that are constantly influencing each other.

The black-box phenomena:

When analyzing the AFPs of a city, many times these are just considered as inputs and outputs, there is **no comprehension of what happens to the retained capital.** By not understanding this transition from inputs to outputs, different hints of the context conditions could be misinterpreted.

Standardization not uniforming:

There is an evident need for standardization, different types of tools do help the integration of more visions and approaches, and **although this distinction of approaches is needed there is still a lack of standardization of the metrics used.**

The trade-offs:

Inside complex systems like cities, **trade-offs are common and this data must be seen as a transversal conversation between qualities, not as simple numbers.** For example the fact that more electricity is consumed might also mean that less fossil fuels are used, and high values of electricity consumption might just represent a transition phase of the city. In relation to the black-box phenomena it is hard to tell what a number or percentage is representing.

Quantitative - Qualitative metrics:

Tools that offer qualitative and quantitative results do feel like a much more complete assessment in the sense that they **understand in a more personalized way the complexity of issues**. The fact of offering a combined data analysis helps with the creation of more defined strategies that combine traditional KPI's with CE lines of action. However synthesizing such complexity is a really hard task and the **support of more advanced technology or human intervention could be perceived as a positive function.**

Indicators valences and granularity:

CE is scalable and so are some tools, however taking this scalability to a city context is resulting into different tools with different objectives and uniformity among these. By the other hand **the capacity of offering different granularities of data helps the projection and creation of more precise actions** in line with the stakeholders objectives and enable CE practices.

Projection for action:

In some cases the **applied actions do not have established metrics** and the difficulty of projection increases creating big barriers to more innovative visions. Ideally there could be experimentation options within the tool that allow measurement though a **"Learning by doing" perspective (AI).**

Objective driven:

Cities are adaptive systems and change all the time, different assets, enablers and knowledge are always entering the system. In this sense when evaluating CE performance it is important to have a focal point and a base point in order to evaluate progress.

Third parties:

Usually the given data as an input for the evaluation of the performance is a self-generated data, this could represent a problem, not necessarily because of the validity of the data (which could also be a problem is what is in game is a certification) but because the **possible misunderstanding for the uploading of data.**

Learning from connecting/sharing:

In some cases tools do not rely on the creation of more complex indicators for evaluating and communicating the CE performance, actually this is done by **sharing experiences of success and failure of different stakeholders.**

Engagement and time relevance:

A **follow-up of the applied or in-application actions is relevant for prioritization of objectives and actions**. In some cases as a marketing strategy, in other cases as a desire of completeness, a follow-up with analogue or digital tools do offer an extra value.

Visualization:

A good visual, intuitive and transversal communications is key for the good functionality of the tool. This helps data to be clear not only for data analysts but for every person/stakeholder in need of an interpretation.

Holistic view:

When applying indicators in different contexts these may show different values of circular performance, however the performance applied in real life could be the same. **The importance of understanding the context in a holistic way is huge, this gives sight of enablers, advantages or disadvantages and risks that might become a priority for circular performance.** For example a factor such as the maturity and projection of a city can make a difference in the ratio of new material vs. recycled material used

Communication:

Percentages and quantity values are usually the go to for communication of the performance, however if there is a **need of more assertive communication suitable for anyone it is important to give values of reference.** For example, one cubic meter could be considered as a moderate quantity of water, however it depends if it is being compared to a lake or to a pool.

03

PUBLIC UTILITIES: UMs

3.1 Introduction

As seen in the last chapter cities are composed of various subsystems which at the same time are dependent on various infrastructures. When we talk about infrastructures we refer to connective structures that enable people in a city to get the resources they need, enhancing people's standards of living. **Infrastructures are composed of 2 types of structures: Hard structures and soft structures** (CFI, n.d.). **Hard structures are the physical systems,** spaces, materials and products that compose the connective network (eg. Telephone line, nuclear plants or a highway). **Soft structures refer to the institutions and services that help maintain the flows running,** and usually require human capital. (eg. educational, maintenance or governmental systems). These two structures always combine in order to assure the quality of the city AFPs.

Being public infrastructures so important for the right functioning of the cities, these become key elements for the transition of cities from linear models to circular models, and become crucial for the measurement of CE performance of a city. (City of San Diego, 2020) The quality and quantity of infrastructures define the nature of a city (Fernandez, 2017), hence, the perceived need of evaluating circularity within a city through the understanding of infrastructures is relevant for Sis.Ter.srl. However it would be really complex and time consuming to understand every single public infrastructure, that is why Circunet, the projected tool, has a **main focus in underground service infrastructure,** also known as public utilities.

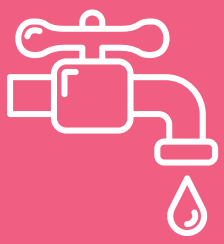
3.2 Public Utilities

Public utilities (PUs) are complex systems within cities, these are networks that have a hybrid control between public and private stakeholders. They can be seen as the **fundamental structures for urbanization, and must be planned, created, used, maintained and disposed of, according to the territorial context.** In this sense, territorial factors (ex. Tangible: Nature; and Non tangible: Economy) for each stage come and play an important role for the structuring of the network. Stages can be conditioned by a large series of factors such as the age of the city, the master urban plan, the technological access, the economical reach, administrative conditions, among others. Furthermore PUs are directly proportional to the size and urban density of a city, the bigger and more dense the city, the bigger and more complex the infrastructure. That said it is a tedious task to understand all single factors that influence the structuring and functioning of PUs, however **it is possible to identify macro topics that influence in the development of the networks and therefore their circularity.** The following chart tries to illustrate as many elements as possible that influence the functionality and conditioning of urban utilities.

Public utilities are a combination of entity-networks that furnish everyday necessities to the people of a territory at large scales. These networks can be divided in 4 main types, These four networks require soft and hard structures for their well functioning, and these will be our point of reference for the following chapters.

Electrical Energy Network

This includes generation, transmission and distribution infrastructures for various available energy sources (e.g. power plants, nuclear plants, hydroelectric dams, solar installations, wind farms, bio-energy systems).



Water Network

This includes supply, sanitation and the management of clean waste and surface waters, including irrigation, drainage and collection.

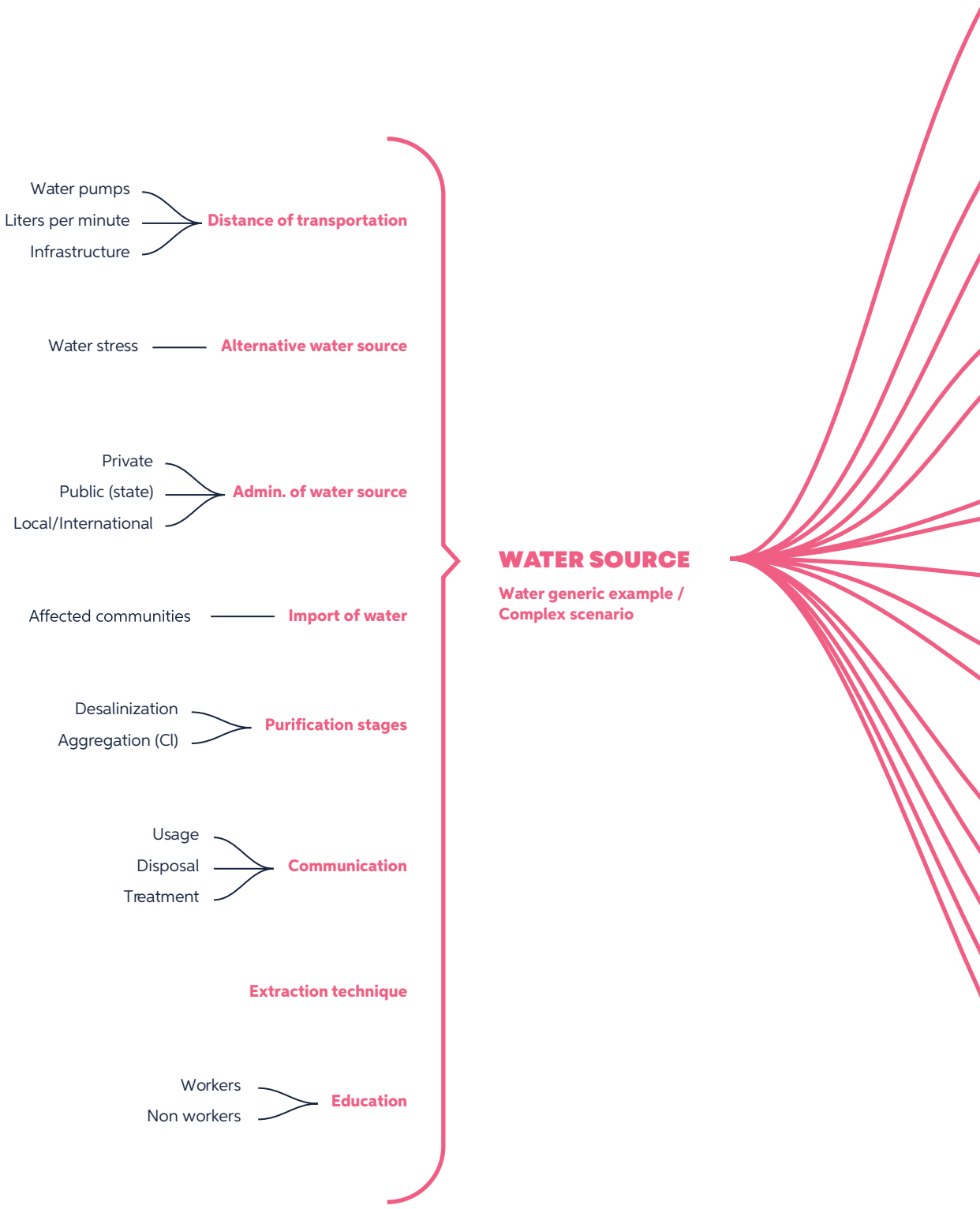
Communications Network

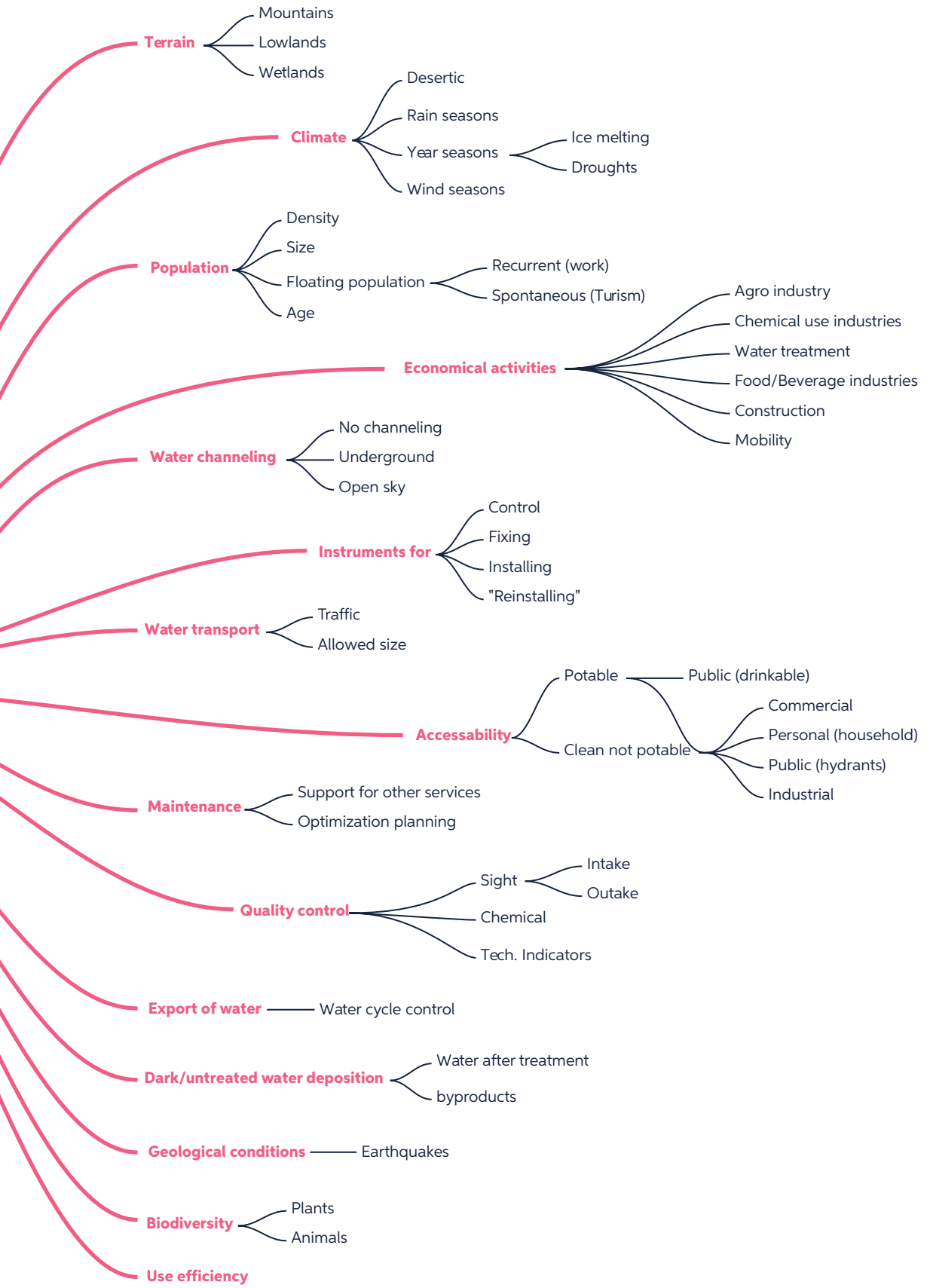
This includes telecommunications, radio, television, and internet infrastructures (including analogue and digital transmissions through various physical media such as copper, coaxial, fiber).

Natural Gas Network

This includes generation, transmission and distribution infrastructures for natural gas used for heating systems. Such as oleoducts, extraction sites and depositories.

MAPPING PUBLIC UTILITY CONTEXT




Terrain
Mountains
Lowlands
Wetlands
Climate
Desertic
Rain seasons
Year seasons
Ice melting
Droughts
Wind seasons
Population
Density
Size
Floating population
Recurrent (work)
Spontaneous (Turism)
Age
Economical activities
Agro industry
Chemical use industries
Water treatment
Food/Beverage industries
Construction
Mobility
Water channeling
No channeling
Underground
Open sky
Instruments for
Control
Fixing
Installing
"Reinstalling"
Water transport
Traffic
Allowed size
Accessability
Potable
Public (drinkable)
Clean not potable
Commercial
Personal (household)
Public (hydrants)
Industrial
Maintenance
Support for other services
Optimization planning
Quality control
Sight
Intake
Outake
Chemical
Tech. Indicators
Export of water
Water cycle control
Dark/untreated water deposition
Water after treatment
byproducts
Geological conditions
Earthquakes
Biodiversity
Plants
Animals
Use efficiency

All these factors will affect how PUs work within cities and make each city reality different from any other, conditioning their functional and structural complexity, and consequently the application of CE practices within it.

As shown by the chart PUs are complex networks that involve many stakeholders and interactions, which can only be aligned through systemic approaches. **For many PUs, a good implementation of CE principles could provide a framework that brings together all various elements of the network with an environmental stewardship, coupled with social and economic development.** (Miller & Perry, 2017)

One way of alignig these elements, understanding and measuring CE efficiency and performance is through the concept of **"urban metabolism", which sees the infrastructures as vital flows of the city and visualizes PUs not only as the sum of various elements but as the sum of the relations and emergent interactions between these.** The following chapter intends to illustrate the idea behind urban metabolism, however before going on it is important to clarify that the following vision for this thesis will enclose a standard situation of a medium-big city representative of an european union context, this vision also encloses a lens for smaller urban areas.

3.3 Urban Metabolisms

In order to allocate the limited resources in cities and promote sustainable development, public administrators have the challenge of quantitatively analyzing flows of materials and energy during the process of urbanization. Purely quantitative analysis gives a precise allocation of resources, and although accurate, it still misses the influence of the overall context beyond these flows**.** In order to have **a more transcending vision, one possibility is to examine these flows from the point of view of metabolisms,** such as in living organisms.

When talking about living organisms, metabolism is a special set of chemical reactions between internal structures of the organism that maintains its performance and life. Such reactions give the body the opportunity to develop, grow and multiply in response to environmental stimuli, while retaining its structure and well functioning (Samoylenko, n.d.). This scenario is also present within cities and some of the important structures that encompass these "sets of reactions" are PUs. This metabolic analogy provides a basis for the identification of resource flows of consumption and production, which as well as the flows within organisms must **maintain an equilibrium with the internal and environmental stimuli of cities.** For the case of cities, **the correct identification of these flows supports the formulation of more appropriate development plans and regulatory policies that sustains the cities integrity.**

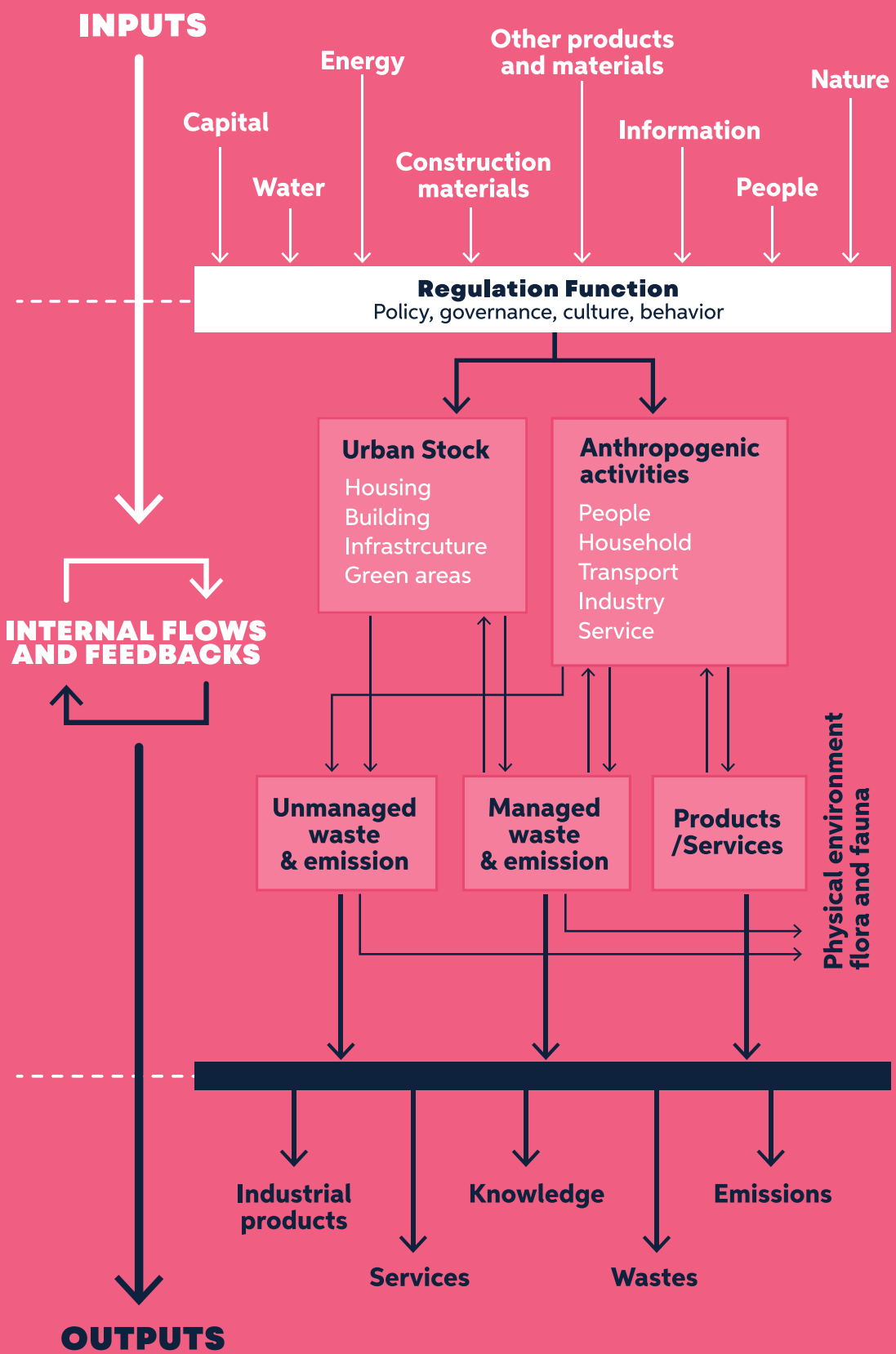
This socio-natural analogy of urban metabolism (UMs) was originally presented in the 1960s by Abel Wolman as a framework for the study of city-scale flows of materials and energy. His research was based in an hypothetical US city of one million people, and in order to quantify its flows he organized the city under the concept of UMs, defined by him as "all the materials and commodities needed to sustain the city's inhabitants at home, at work and at play" (Wolman 1965). Further research and interpretations of the analogy have been developed since that moment, bringing several new questions and visions of city metabolic flows. One further research that is worth to mention is that of Currie and Musango in 2017, they reshaped the definition of UMs with a richer understanding of flows in a real city context, they defined UMs as

"a complexity of socio-technical and socio-ecological processes by which flows of materials, energy, people and information shape the city, service the needs of its populace, and impact the surrounding hinterland."

(Musango, et al., 2017) This much richer definition integrates both quantitative and qualitative perspectives of the urban flows and comprehends **tangible and intangible aspects that shape the city dynamics.**

This more contemporary view of UMs can be systematically represented based on a framework proposed by Bai X. (2016) Bai's framework brings together visions of a **city as an ecosystem** as well as an organism. She identifies the dynamic presented in page 68.

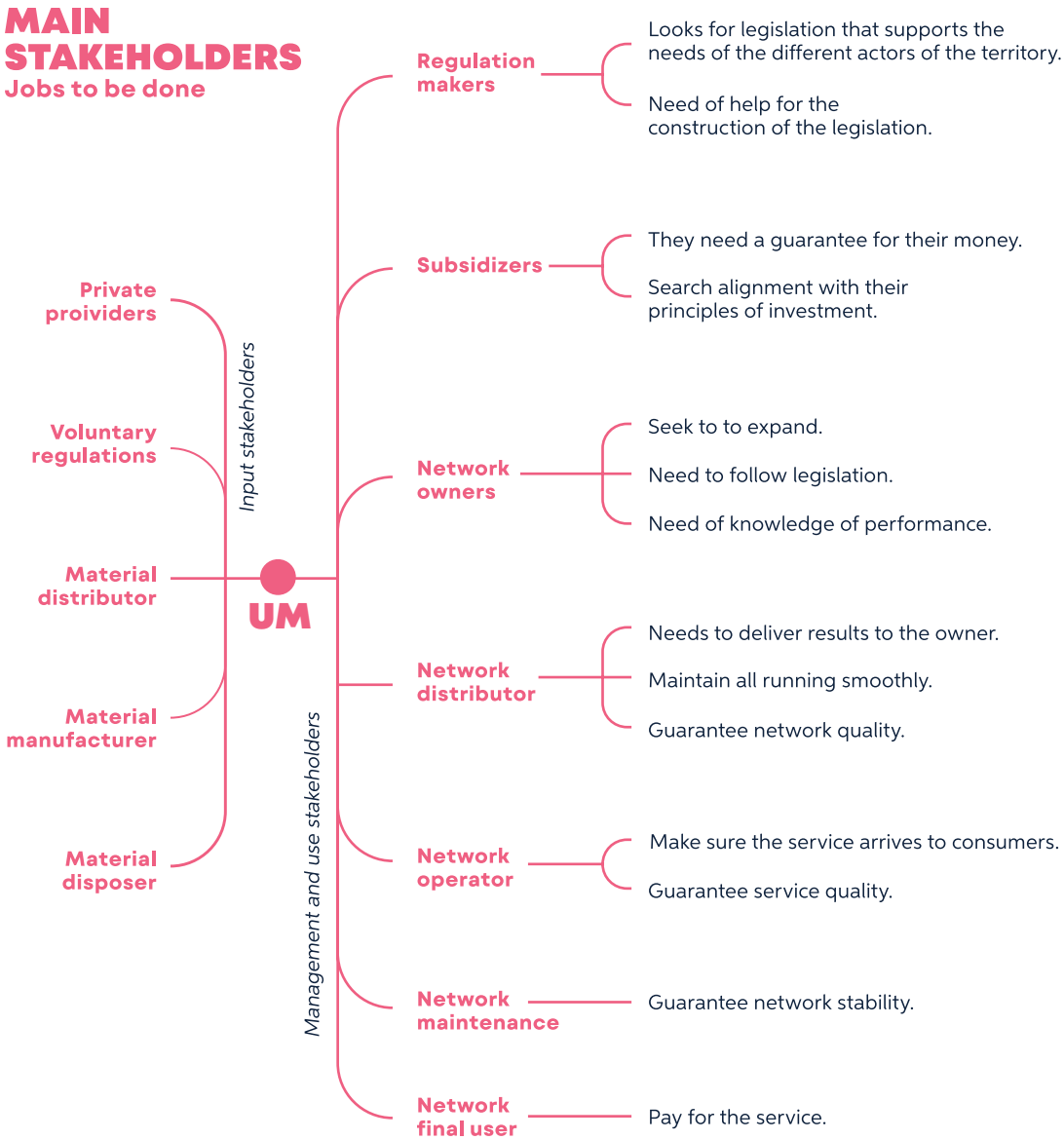
She mentions three basic steps of UMs, inputs, internal flows and outputs. The inputs are capital resources flowing into cities that become urban stocks either in its raw form or after a manufacturing process. Then internal flows enable and drive various anthropogenic functions complemented with services. These internal flows can loop within the city context and end up producing intended or unintended outcomes, some of these outcomes remain within the system boundaries while others are exported out of the core system. **By interpreting PUs in this way, we can understand what, when and why affects the flows of the cities** and therefore apply sustainability approaches for a transition from a linear metabolic model to a more circular model.


INPUTS
Capital
Water
Energy
Construction materials
Other products and materials
Information
People
Nature
Regulation Function
Policy, governance, culture, behavior
Urban Stock
Housing
Building
Infrastrcuture
Green areas
Anthropogenic activities
People
Household
Transport
Industry
Service
INTERNAL FLOWS AND FEEDBACKS
Unmanaged waste & emission
Managed waste & emission
Products /Services
Physical environment flora and fauna
Industrial products
Services
Knowledge
Wastes
Emissions
OUTPUTS

3.3.1 Urban Utilities: Main Stakeholders

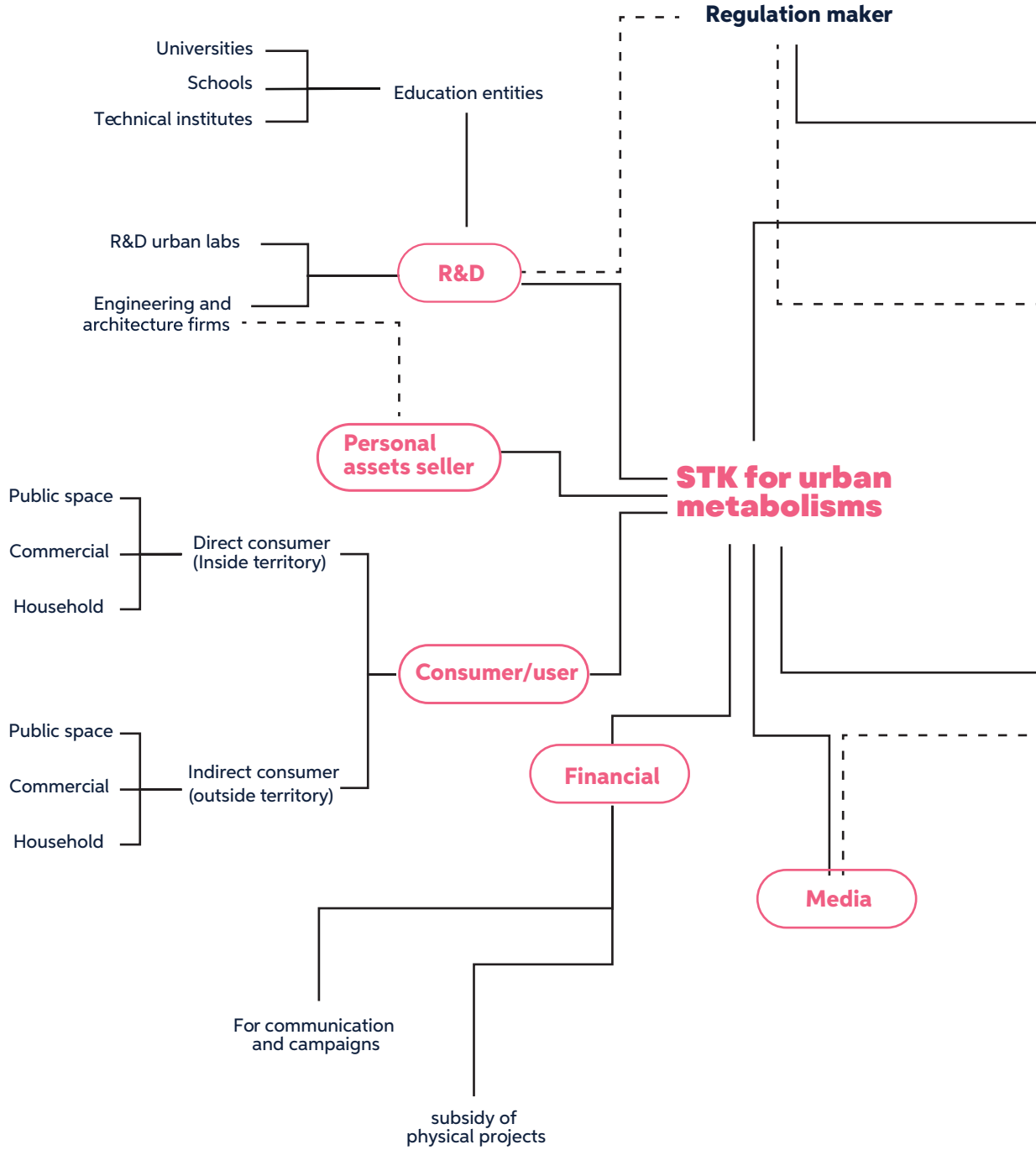
The previous chapter introduced a vision of the functioning of the flows of UMs. **For the case of Public Utilities these flows exist thanks to the interactions of various stakeholders that take part of the input, internal and output flows.** These stakeholders create a network of actions, processes and capital transfer that must be understood in order to apply sustainability approaches, and **although all networks are different depending on the territorial context we can clusterize main stakeholders by their roles within the network.**

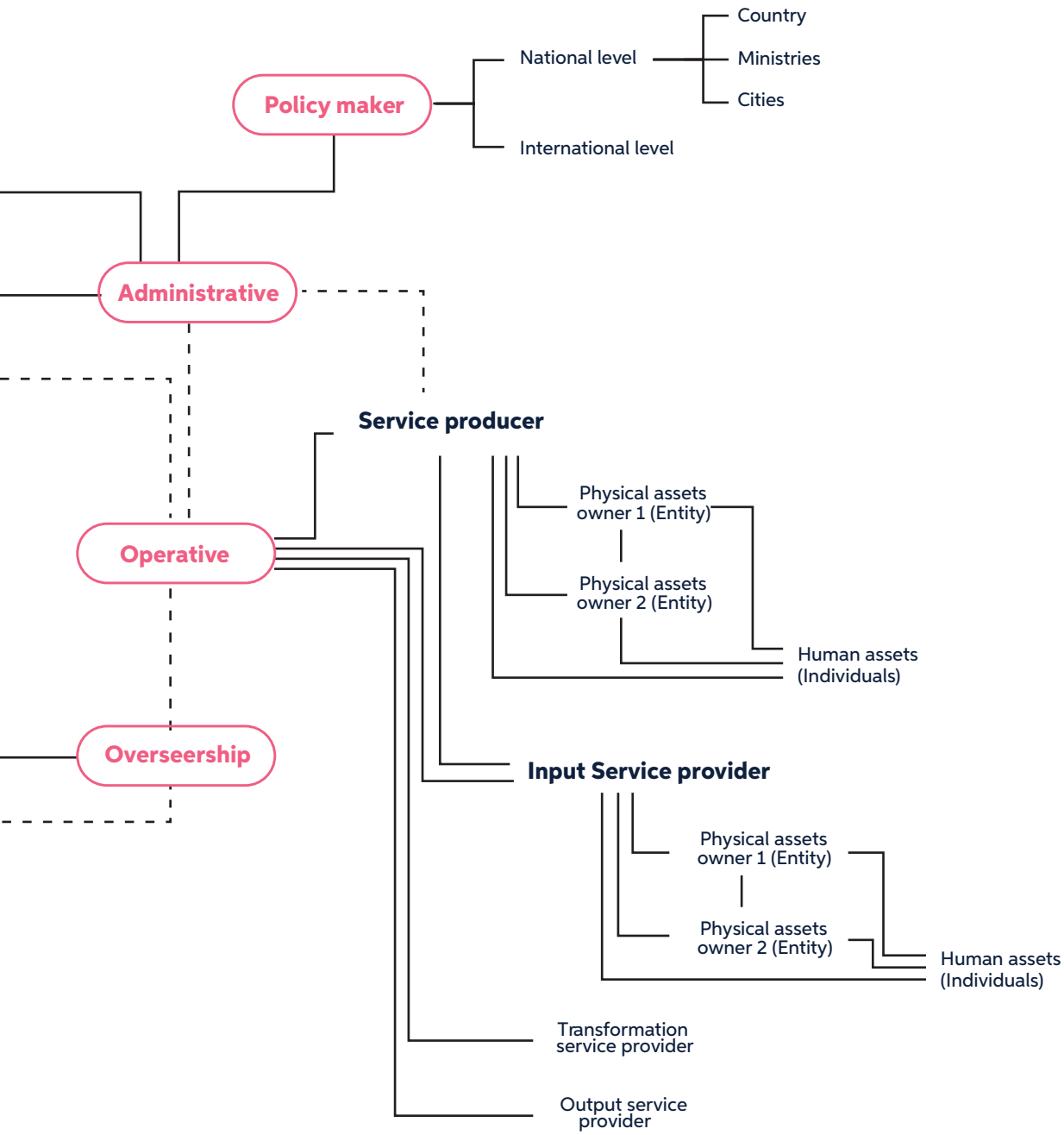
Although it is difficult to create a unified vision of the relations between these stakeholders, we can develop a basic networking among these based on the **Italian context.** This networking gives insight of the links between different stakeholders that work together for the well functioning of PUs.



MAIN STAKEHOLDER

Who Conditions A Circular UM





For this thesis' purpose we must make a **focus on stakeholders directly linked with the operative and regulatory subsystems which have direct influence in the PUs infrastructure conditioning and management,** this because these are the potential clients of Circunet. However it is important to clarify that the influence of the other stakeholders over operative and regulatory stakeholders should also be seen as relevant. That said we can now continue with understanding how to model and approach sustainability in UMs.

3.3.2 Modeling UMs For Sustainability

According to various academic articles, **measuring and applying sustainability in UMs is equivalent to the theory applied in cities** as described in Chapter 2.4. However it is important to start narrowing the vision to a more suited and precise lens for urban flows. For example, new approaches like SUWM, Sustainable Urban Water Management, published by Ramirez-Agudelo and colleagues could support challenges for the transitioning towards more circular networks (Ramirez-Agudelo, et al., 2021). They propose **modeling PUs as non-linear systems; they give a big focus on the internal flows and feedbacks of the network** in order to understand how to reduce as much as possible the incoming and outcoming of new flows and take advantage of the present urban stock. However this is not the only applied approach towards the measurement and application of sustainability within UMs.

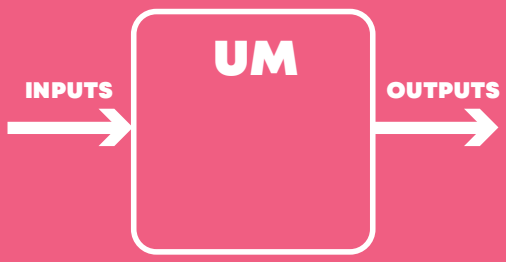
A full review for urban metabolism studies has been done by Berloin-Saint-Pierre and his colleagues' researchers in 2017. (Beloin-Saint-Pierre, et al., 2017) In this review they expose different formats of data collection in order to measure and approach sustainability and define models for strategic action. By gathwering this information they were able to conclude that **frameworks that model sustainability within UMs can be structured in 3 different ways:**

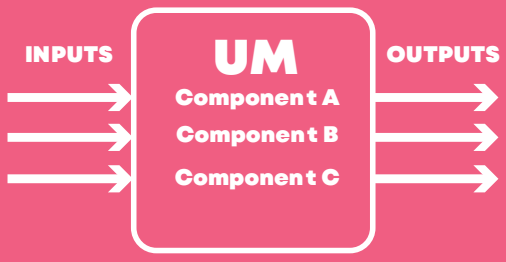
- **THE BLACK BOX**
- **THE GRAY BOX**
- **THE NETWORK VISION**

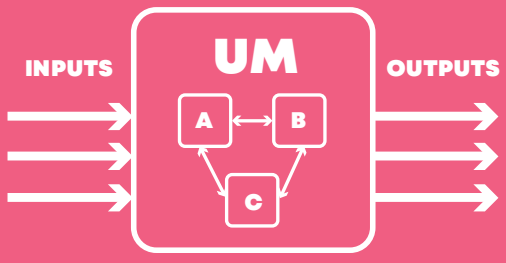
BLACK BOX
(BB)

GRAY BOX
(GB)

NETWORK
(NT)



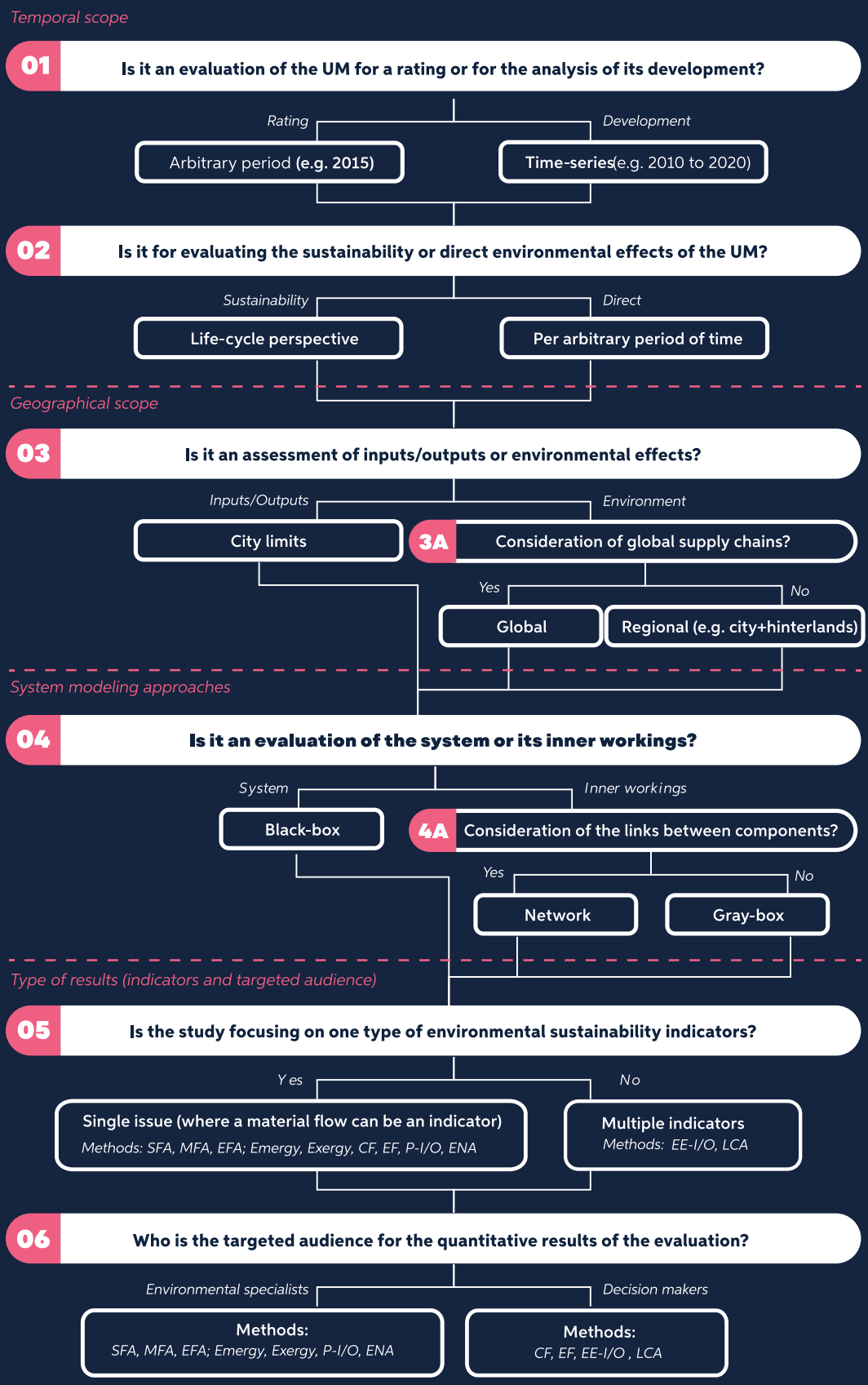




From a SD and CE point of view the ideal interpretation of UMs is the "Network" modeling strategy however as presented it has strong barriers of implementation, this because in order to create such a model **there is a need for high quality and quantities of data, cooperation and coordination of the network.** However it is possible to have hybrid or progressive models that unlock their ability of analysis through constructive processes, in other words, frameworks that, according to the data availability, shift from a "black box" to a "gray box" and then to a "Network vision" modeling strategy.

This hybrid modeling of the networks needs a structured pathway in order to understand which vision should be implemented according to different conditions of the network and the data available.

Berloin-Saint-Pierre and his colleagues also **suggest a modeled pathway for this purpose**. This pathway is divided into four levels of methodological choices, defined by the temporal and geographic scope, system modeling approaches, and types of results that the UM wants to approach (in this case the PU) for this last, they suggest different method frameworks. The following diagram shows a visualization proposed by Berloin-Saint-Pierre (Beloin-Saint-Pierre, et al., 2017):



Map of methodological choices that are used to answer different goals of the UM studies that have been reviewed in Belo-Saint-Pierre publication.

These proposed methodological choices can be relevant for different sustainability assessments of UMs, some scenarios offer more detailed information for the projection of strategies, others may offer more generic information for a shallow scanning of scenarios, however the methodological choices proposed by these pathways are just a small representation of many other possibilities. The following just represent a few more possibilities of elements that can be considered of transversal importance for the definition of an evaluation path of public utilities:

01 Is the study evaluating the impact of sustainable practices in future time?

The study may focus just on a present impact vision and ignore the possible future repercussions of actions or see the future impacts as one main condition for action. For example the economic growth of a city might represent major environmental impacts due to construction booms.

02 Is the assessment considering hinterlands and their impact?

From a geographical point of view, UMs sustainability assessments could consider causes and effects that occur inside and outside the UM boundaries due to their relation with other activities. For example a ban of “recycling dumping” in a country may affect entire supply chains.

03 Is the client wishing to work with the output data for specific actions or is it looking for generic strategies?

The data output may be seen as insight for internal elaboration, this elaboration may start from a generic strategic path where each client elaborated their own actions or as more precise and tailor made insights for puntual action, which in this case data should offer horizontal and easy communication throughout the different actors.

Such hybrid modeling for evaluation pathways and strategies, highlights the **need to understand the characteristics that shape and regulate UMs**, these help create methodological choices for the application of sustainable practices. Bai identifies **eight characteristics that condition UMs** (Bai, 2016), these at the same time are key factors for sustainability within the networks:

Energy and material budget and pathways:

What type, how much, and via what pathways are the dynamics of energy and material flows? What are the local and global impacts of such flows?

Energy and material efficiency:

How many social or economic services can each unit of resource consumption support? How much waste can these services support?

Flow intensity:

How intensive are the flows of the different capitals? Are these measured as flows per impact capita or per area coverage?

Ratio of resource depletion, accumulation and transformation:

How much of the input remains in the urban system? How much is exported? How long does the inflow material stay within the system?

Self-sufficiency or external dependency:

To what extent the UM's resource needs are met internally (within the territorial boundaries) or externally?

Intrasystem heterogeneity:

Do all the elements of the system have the same characteristics of the indicators mentioned above? How does the spatial context of the UM affect such heterogeneity?

Intersystem and temporal variation:

Does the above indicators change across cities' UMs and over time?

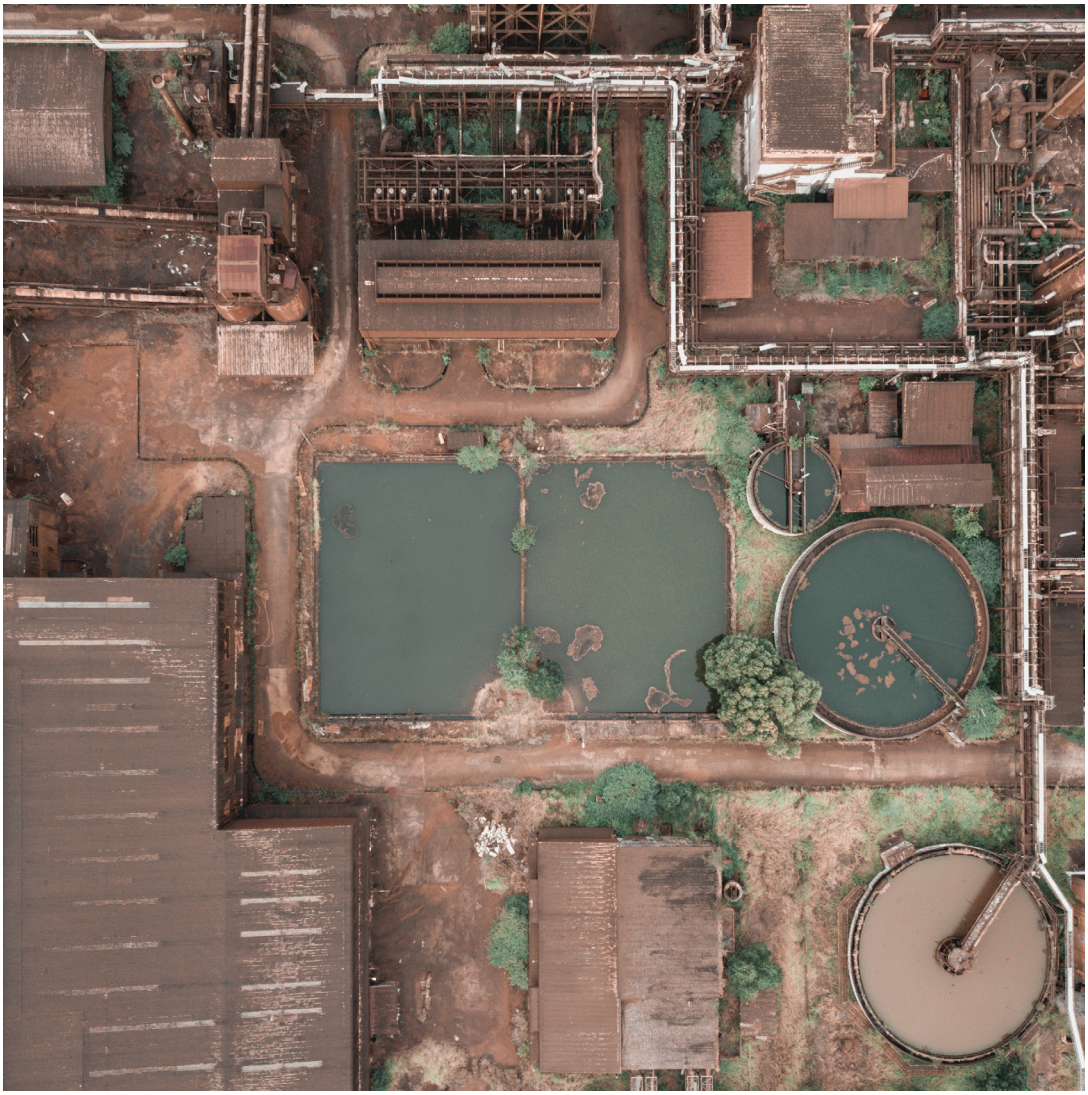
Regulating mechanisms and governing capacity:

What are the regulating mechanisms of the flows (e.g. law and order or management strategies), and what are their capacity and limitations for enabling or limiting action?

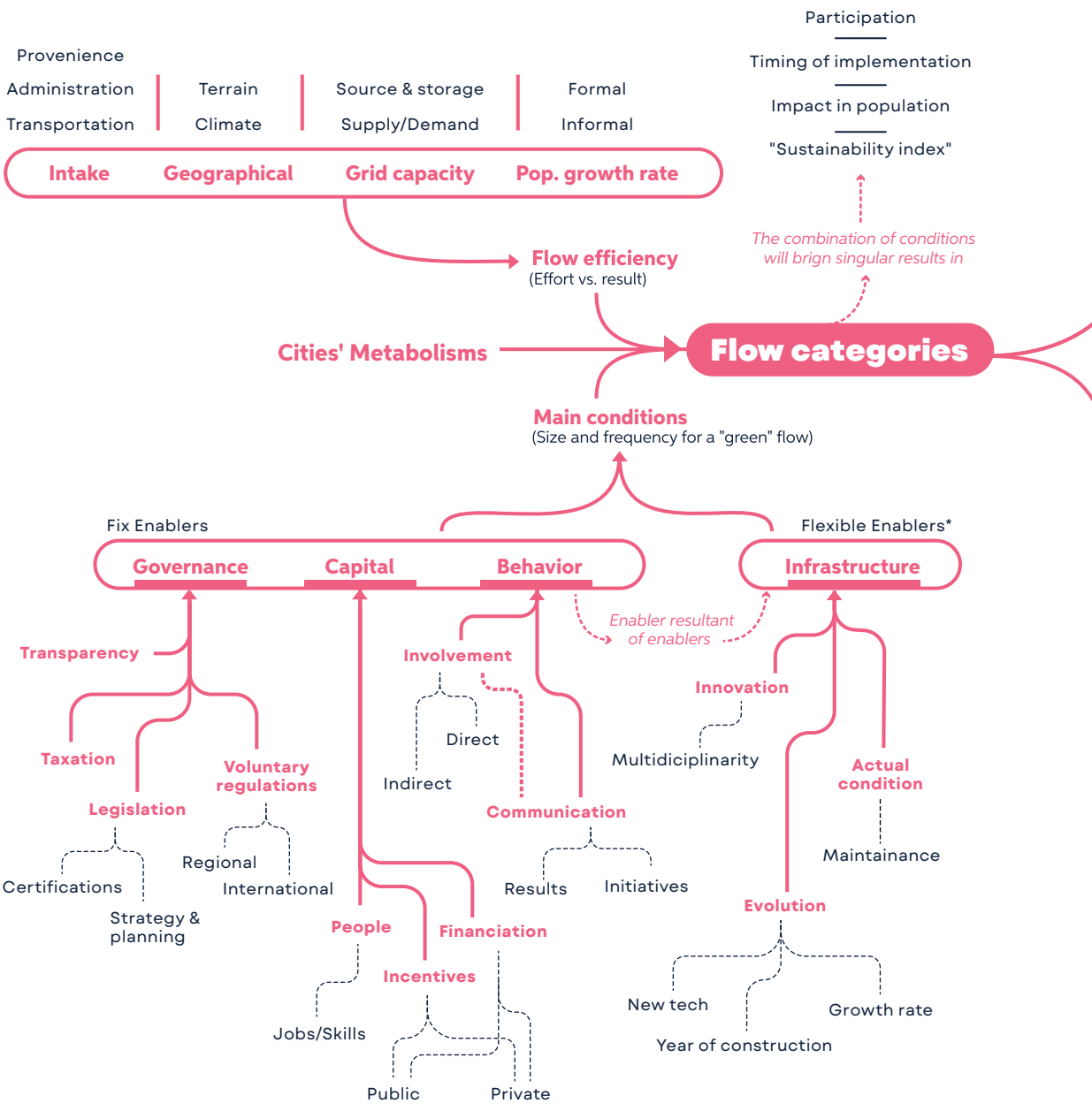
All these implementation strategies and methodological choices can be relevant for a circularity evaluation of PUs, and **according to the need of the stakeholders** some choices will fit better with general goals, others with specific actions, no matter which, t**hey can all provide decision-makers comprehensible information on the circular performance of the network** and the stakeholders as part of the network. Taking into consideration what these implementation strategies suggest, in order to apply holistic approaches towards a CE shift we must understand PUs with a systemic approach. (Beloin-Saint-Pierre, et al., 2017) In this sense we can evolve the proposed framework by BAI X. and understand the flows of UMs as a more complex system that is framed within time and space and is conditioned by the network of stakeholders.

3.3.3
Systemic Metabolisms

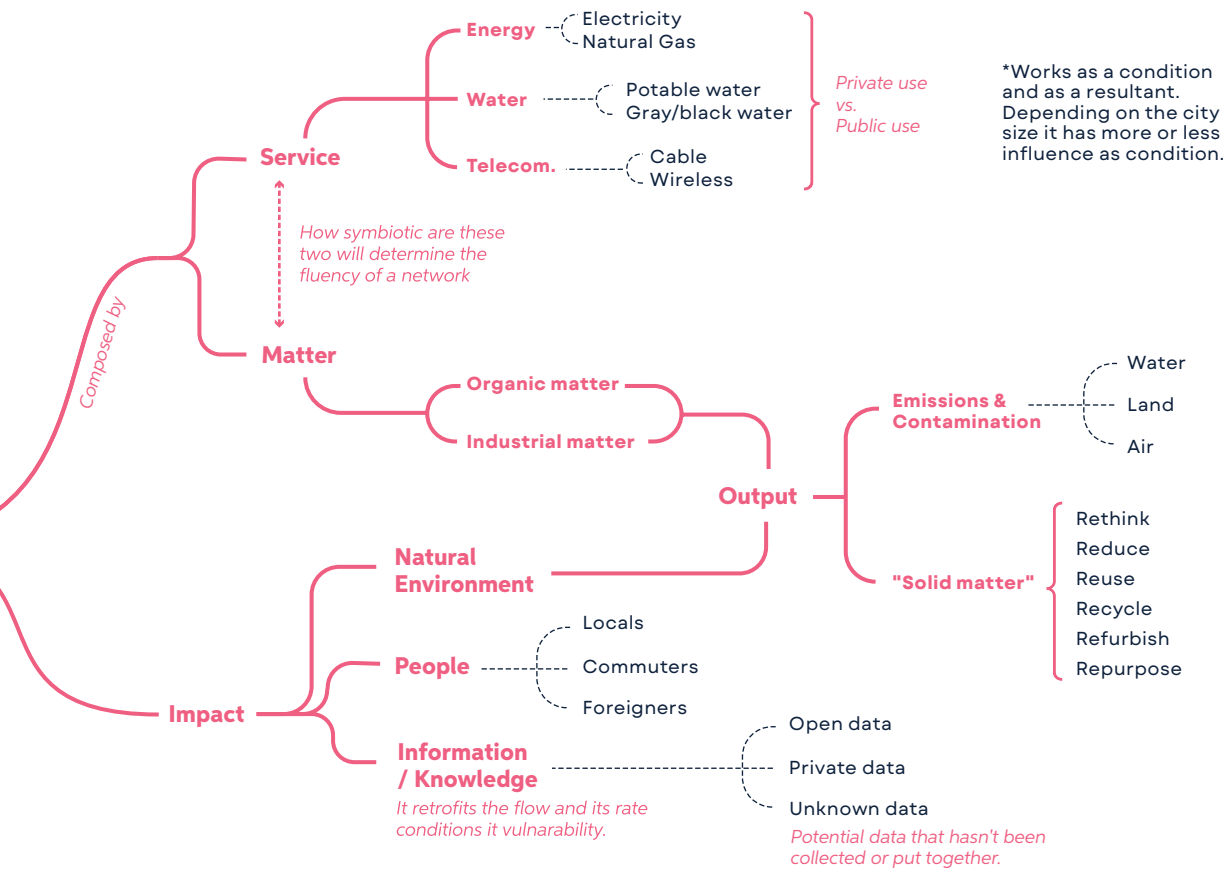
In order to evolve BAI's framework and understand **PUs as systemic flows we must grasp all different kinds of contextual condition**s that influence the principles and functioning of the flow [See focus 3: Flows principles]. These conditioning elements may exist in various forms, such as entities, processes, regulations, natural environment, population, among others, and might have either a positive or a negative impact over the shift towards sustainable practices. **These conditioning phenomena may be part of the physical or virtual boundaries of the network and impact it in different scales**, an impact that could be relevant for the entire network or for just small parts of it. **This systemic vision of PUs sees human wellbeing as the guiding scope that drives action,** therefore we can consider the following diagram as a magnifying vision of the proposed framework in chapter 2.4.1. The following diagram presents the proposed framework.



METABOLIC CONDITIONS



The diagram shows a generic vision of the conditions that influence the UMs' flows. This generic version is adaptable to any territorial conditions within the European union territories and should not be taken as an overall rule.



Parallel to this the stage of data maturity of the city should be considered. Communities with rich data collection and processing facilitate the metabolism assessment and may represent the ideal scenario, however as mentioned in the last chapter with less data-developed territories it is important to embark in a hybridization process of models.

As we mentioned, if available, the crossing of data allows a finer granularity that promotes more precise measurements according to the needs. A possible method for crossing data could be the identification of socioeconomic sub-systems. These subdivide the flows in different related compartments that interact with each other. (Wang, et al., 2020) Wang and his colleagues propose an 8 factor partition of metabolic compartments: agriculture, mining, manufacturing, recycling, domestic consumption, construction, transportation, and energy conversion, this division creates a more clear partition of the nature of the flows, hence allows an easier application of and SD vision and CE practices.

In summary, there are many experiences related to tools for measuring the degree of circularity, some come close to being recognized as indicators, others are just the beginning of a path that will ensure real applications to public or private realities.

FOCUS 3

FLOWS PRINCIPLES

Flow Rate
Amount of flow passing by through the channeling structure. For example in the water service it is measured as the volume of water.

Resiliency
Can the networks and flows adapt easily to changes of supply and demand? What is the loss for these changes?

Accuracy
How much of the flow entering the system gets to the designated points and how much is lost. Here it is also important to do a comparison between the upstream and the downstream.

Longevity
Is the flow expected to have a long lasting life? Are the downstreams turned into upstreams? and for how long?

Independency and dependency
How much of the upstream flow is generated within a local context? and how much is exported to other territories? How much of the downstream flow is treated locally?

Longevity
Is the flow expected to have a long lasting life? Are the downstreams turned into upstreams? and for how long?

Coverage
What percentage of the territory is covered by the public flows and how much need of private flows to fulfill their needs?

Ruling
What flows rule over other flows? is the flow under analysys being ruled by other flows not necessarily of the same nature? (for example energy and water are codependent in nuclear plants)

04

SUMMARY / INSIGHTS

HINTS OF WHAT TO DO FOR COPING CIRCUNET'S CURRENT GAP.

More than a summary this chapter presents insights that can be found in between lines throughout the last chapters. These insights will help in identifying key points for taking into consideration for the analysis of Circunet.

These insights are divided in 3 sections: City and UM Modeling, Measuring, Communicating.

Act local, impact global:

Cities are both global and local ruled, this due to the networks that conform them; these dynamic and diffuse boundaries make actions inside a local scale easily impact a global scale. Furthermore when talking about growth cities are interdependent in order to achieve it due to local boundaries and sub-systemic dynamics.

Overlapping layers of a city:

Networking of cities don't exist on the same level, although many horizontal relations occur at the same time also vertical relations exist and this vertical relations may overrule horizontal relations, creating this sense of hierarchy. These overlapping relations can exist among parts or subsystems.

Cities are infinite and ever-growing:

Cities have two types of boundaries, physical boundaries and virtual boundaries. Both conditioned by the other, however virtual boundaries have the capacity to evolve in dynamic ways both to the exterior and to the interior of the system.

Cities are adaptive systems:

Resiliency is an intrinsic characteristic of cities, however the flexibility of this resilient property is conditioned by the quality and quantity of networks that exist in both local and "global" scales.

Adaptation foresees an over-rule:

By understanding adaptability as a condition of change, this change is not random or chaotic. Adaptation brings the concept of a major overrule, an objective that coordinates the entire network. In the case of cities we can propose this to be the human well-being/quality of life as part of a community.

Flows within flows:

Cities are dynamically evolving, all the flows information, matter, energy and people converge and diverge in multiple ways, these nodes of conversion transform flows, nature and stream. This constant interchange of flows becomes an emergent condition of other flows.

Dependency of nodes:

Parts of a system act like communication nodes, where they receive, retain and emit flows according to their nature and task inside the network. These nodes do have a weight and a polarity (or multiple) inside the entire network which conditions the dependency of the network in the existence of these nodes.

Time-history dependence:

Networks are fruit of their own evolution, and how they evolve will determine particular characteristics and may condition emergent properties. This makes cities time-framed and its evolution will be determined in different time rates, making prediction a really hard task.

Co-evolutionary development:

Cities have different rates of development and states of maturity, these rates condition how networks are created and the impact of individual vs. communal action. These states also condition the stability and diversity which are at the same time conditions of coevolution capacities.

Going digital:

Needs the integration of advanced digital tchnologies able to improve the phases of identification, collection, traceability, monitoring, analysis, evaluation and redefinition of the circularity of the social, economic and environmental processes and operations. (Gaspare D'Amico, et. al., 2022)

With all this said it is time to apply this theory to the evaluation of Circunet. The following chapter will introduce what it the tools for and how it works followed by a panoramic evaluation of its functionality according to the given insights.


Top Marketing Expenditures
Expenditures by Month

05

CIRCUNET

This chapter encloses information collected from conversations with Sis.ter, developed work by them and observation.

INTRODUCTION: WHY CIRCUNET

Although the circular economy is starting to gain strength in the private sector, one of the biggest gaps in the adoption of circular practices is the public sector. Policy makers and public service providers are still lacking more integrated tools that help a unified transition into a more sustainable system. By CE being such a recent matter of interest for public entities, they have no reference to what to do and how to do it, the transition towards a more circular system is still a matter of trial and error creating a need for frameworks that facilitate the identification and decision making without losing track of complexity. In order to address this gap urban areas are adopting different methodological approaches and rely in many cases on technological innovation, however these have no unified frame of evaluation nor can be compared among them. It is just recently that some frameworks have been developed offering more holistic approaches towards circularity in cities.

As previously mentioned, cities are very complex structures and it is very hard, if not impossible, to address them in their totality, and although circular practices could be applied in any aspect, to the date, a lacking area in the adoption of CE practices is public urban infrastructure (Ellen Macarthur Foundation, 2019), which has a great potential to improve resource efficiency, use, maintenance and disposal. **By transitioning into more efficient networks and optimizing resource systems, cities may improve the delivery and quality of public services while at the same time reducing one of the biggest negative impacts to the ecosystem.** In that sense public urban infrastructure is in need of tools that support this transition and eases the management and control of CE actions. That said, Sister.srl wants to offer public administrators and network providers a tool that supports the management of local networks in accordance with circular economy principles, allowing a unified mapping and understanding of the service's sustainable performance; this tool is called Circunet.

Chapter **5.1 has the intention of introducing circunet** by illustrating the current version of the tool, considered as a functional MVP. The chapter describes objectively the main characteristics of the tool which will be **further explored and critically evaluated in chapter 5.2.**

“Circunet will help public administrations and network managers to better manage local networks in accordance with the principles of the circular economy. It aims to measure local governance of networks, to improve knowledge of the local environment and enable easy monitoring of the circular economy strategies through relevant environmental and socioeconomic indicators.”

Circunet - Business plan

5.1
The Tool: Current State

Circunet is an in-developing project by Sister. srl, currently in a state of MVP. It is a digital tool with the objective of measuring and giving insight of the circularity performance of public utility networks; their final scope is supporting the transition of cities towards more sustainable practices with the help of an unified platform. In a few words, **this platform measures PUs circular performance through a set of questionnaires that clients must answer in order to map different factors of the network; at the end the platform processes the given answers to the questionnaires and gives a numerical value to the network's performance.** As of now the tool is based only on a digital platform with two different target users: Municipalities and Utility managers. They both play a different role inside Circunet's platform, however they are codependent by how the service has been structured. For the tool to work out, they both must come to an agreement for the use of the platform and must concur to deliver the required information in order to receive constructive feedback (processed data) that helps them evaluate their circularity performance.

5.1.1
Questionnaires

Before understanding the logical flow of the tool, it is important to mention that **all data introduced for the evaluation of the CE performance is introduced by the users and interpreted by the platform's algorithm.** That said, in order to grasp all the needed information of each utility service the platform **requires each utility-user to answer 4 sets of multiple choice questions.** For the current version, these set of questions are aimed to **5 different utility services,** described by Circunet as: Water Network; Telecomunications; Public Illumination; Electricity; and Gas network

All these sets of questions are based on CE principles and **cover 2 major aspects of the network: The management performance and the physical & service structure of the network.** These encompass themes such as material extraction, usage and disposal, administrative practices supporting sustainable actions, economical fundings, demographic context, among others. Once the questionnaires are completed, **the algorithm interrelates the answers of the 4 different sets for each utility-user and gives out a numerical score, representative of the circular**

Side note:
Both municipalities and Utility providers must come to a previous agreement outside the boundaries of the tool. For the purposes of the thesis we will leave aside the previous steps to the creation of a user in the platform, therefore for the coming descriptive part, we will assume each user knows what steps they should follow and why the tool works as so. Later on in chapter 5.2 its functionality and efficiency in communication will be analyzed.

performance of the network. In the future, with the collection of more data, these multicriteria questionnaires will feed circunet's database in order to offer a performance-vs-time evaluation.

All utilities receive similar sets of questions and variations are made according to specific conditions of each network. For each question the user is able to choose one answer. **The answer options are designed following the Likert scaling method based on an ordinal 5-point rating scale.** Each set of questions impacts the final score of CE performance differently; these are weighted differently since actions within different phases induce different impact scales, for example general management of the systems and technical aspects of the network have a different impact on the overall performance of the network.

[See appendix 1: Questionnaire For Municipalities]

[See appendix 2: Questionnaires for Water Network]

Electricity

Public Illumination

Water Network

Gas Network

Telecommunications

5.1.2
The Tool: How It Works

As previously stated, municipalities and utility providers have to work together in order to have a result of their performance. **Both users have parallel but complementary journeys within the platform** and must fulfill different actions in order to receive a result of their circular performance. Both journeys start after each user logs in, they will find themselves in the platform homepage that gives the first glimpse of the "Circular-meter" and the menu button, at that moment the platform notifies the users they have to fill up the respective questionnaires. From that moemnt the journey towards a circular performance evaluation goes as follows:

STEP BY STEP

01

Fills up the questionnaire for the municipality. This questionnaire has 7 questions and has the intention of giving an overall panorama of the territorial context.

02

Municipality goes to the **"Utility definition" section** in the menu and assigns the different available utilities to the available utility providers. The user must select the provider, then the service it is offering and in the case of telecommunications specify if it is fiber, wire or mixed transmission. (ideally the municipality should fill up all the different available services in order to have a complete feedback of the circular performance).

03

After the log in the utility will be able to see what services the municipality assign to them and will be **granted access to the questionnaires to that specific territory.** By clicking in the notification or in the icon for that assigned service the utility opens a questionnaire. Each services consonsists in 4 questionnaires (Mentioned below).

4 QUESTIONNAIRES

Evaluation Of The Provider

This set of questions are focused on the management and adopted policies of the system from an administrative point of view. These questions are the same for all services.

Materials And Design

These questions have the intention of understanding how the materials of the network are being selected, supplied and discarded.

SCAN ME FOR DIMOSTRATIVE VIDEO OF THE MVP PLATFORM

04

As soon as all the questions of each set are answered the back **algorithm of the platform will process the given information and will give a numerical score** and a radar graph that plots the performance for each thematic. This score represents the performance of the utility and of the municipality which receives the same score and chart for the performance.

05

After answering all the assigned questions the utility may go to the **"Difficulty of implementation" section** where they can see the performance of the service in comparison to other territories that have filled the questionnaire. This scattered plotting gives the percentages of circularity vs. difficulty of implementation (The section gives a view according to the 4 last questions of the municipality questionnaire.)

06

Only after all the assigned service providers answer the questionnaires **the municipality will receive an overall score of the municipality circular performance.**

Phase Of Use

Who uses it, how it is used and maintained and what technological advantages are available.

End of life

What precautions are taken for the discard of the network and how materials are being disposed of.

5.1.3 The Tool: 7 Sections

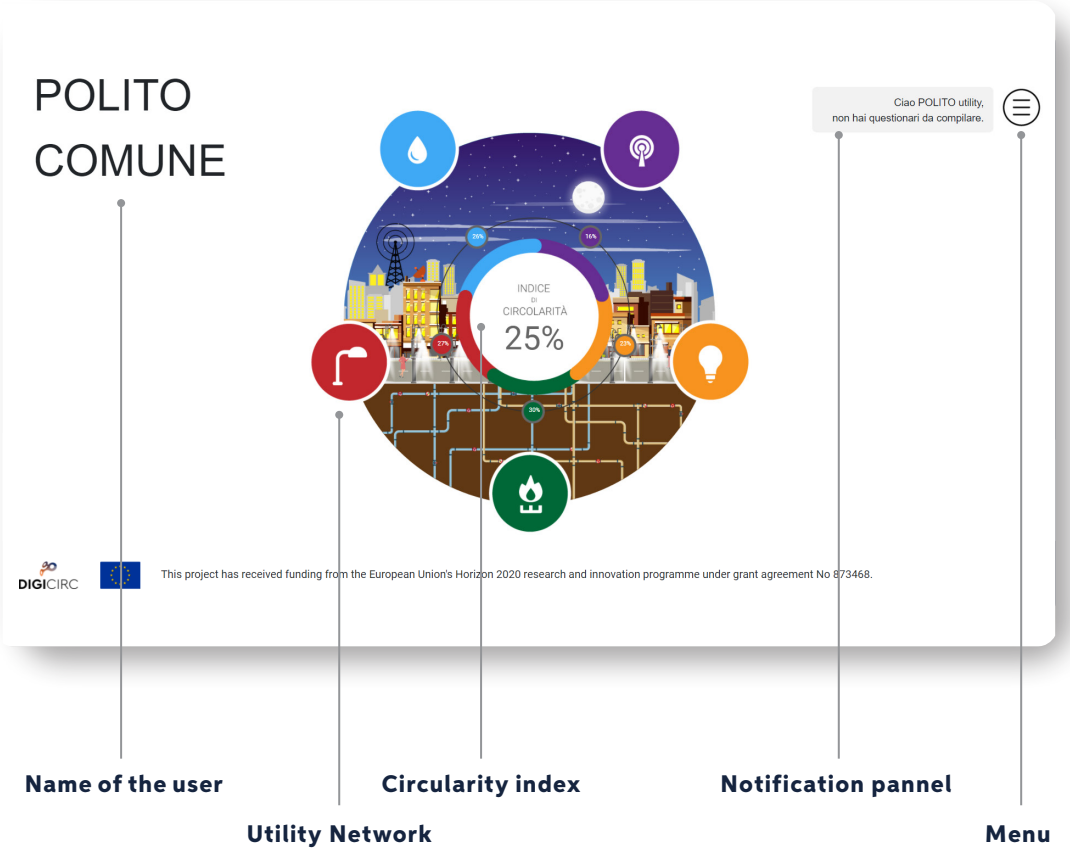
The tool has 7 main sections each with different functions, six of these accessible for municipalities and four for utilities. **In some cases the information from these sections is shared and accessible for both users, however they have different pathways and relations with these.** The seven sections are: (The following order does not necessarily represent the order of use within the tool.)

CURRENT MVP

Utility Follow-up / Home-page

(ACCESS: BOTH, MUNICIPALITY & UTILITY)

This section is the main instrument of the platform. Here the user can see their actual performance for circularity. This performance is given as an overall score, that comes from the average performance of the four questionnaires. Within this section there is also a small verbal and general description of the logic of the metrics used without going into detail.



Questionnaires For The Utility

(ACCESS: ONLY UTILITY)

These are the **sets of questionnaires** (above mentioned) that intend to gather data about the **network management** from the utility provider role.

RETE IDRICA

VALUTAZIONE DEL GESTORE DEL SERVIZIO

1) Qual è il livello di adozione e sviluppo dei seguenti strumenti nella vostra organizzazione (o sito)? Sistema di gestione ambientale conforme allo standard ISO14001

- ○ Non so/Non rispondo
- ○ Lo strumento è già stato adottato con successo ed è pienamente sviluppato nella nostra azienda
- ○ Stiamo adottando lo strumento che è in corso di sviluppo
- ◉ Stiamo effettivamente pianificando l'adozione e lo sviluppo di questo strumento
- ○ Stiamo solo valutando l'opportunità di adottare questo strumento
- ○ Non è stata considerata l'adozione di questo strumento

2) Qual è il livello di adozione e sviluppo dei seguenti strumenti nella vostra organizzazione (o sito)? Sistema di gestione ambientale conforme al Regolamento 1221/2009 EMAS

- ○ Stiamo effettivamente pianificando l'adozione e lo sviluppo di questo strumento
- ○ Non so/Non rispondo
- ○ Lo strumento è già stato adottato con successo ed è pienamente sviluppato nella nostra azienda
- ○ Stiamo adottando lo strumento che è in corso di sviluppo
- ◉ Non è stata considerata l'adozione di questo strumento
- ○ Stiamo solo valutando l'opportunità di adottare questo strumento

3) Qual è il livello di adozione e sviluppo dei seguenti strumenti nella vostra organizzazione (o sito)? LCA – Analisi del ciclo di vita

- ◉ Non so/Non rispondo
- ○ Stiamo adottando lo strumento che è in corso di sviluppo
- ○ Stiamo effettivamente pianificando l'adozione e lo sviluppo di questo strumento
- ○ Stiamo solo valutando l'opportunità di adottare questo strumento
- ○ Non è stata considerata l'adozione di questo strumento
- ○ Lo strumento è già stato adottato con successo ed è pienamente sviluppato nella nostra azienda

4) Qual è il livello di adozione e sviluppo dei seguenti strumenti nella vostra organizzazione (o sito)? Carbon Footprint / Impronta di carbonio (ad es.: secondo i requisiti della PAS 2050 o della ISO 14067)

- ◉ Stiamo adottando lo strumento che è in corso di sviluppo
- ○ Stiamo solo valutando l'opportunità di adottare questo strumento
- ○ Non è stata considerata l'adozione di questo strumento
- ○ Lo strumento è già stato adottato con successo ed è pienamente sviluppato nella nostra azienda
- ○ Non so/Non rispondo
- ○ Stiamo effettivamente pianificando l'adozione e lo sviluppo di questo strumento

5) Qual è il livello di adozione e sviluppo dei seguenti strumenti nella vostra organizzazione (o sito)? Water Footprint / Impronta idrica (ad es.: secondo i requisiti della ISO 14046)

- ○ Stiamo solo valutando l'opportunità di adottare questo strumento
- ○ Non so/Non rispondo
- ○ Non è stata considerata l'adozione di questo strumento
- ○ Stiamo effettivamente pianificando l'adozione e lo sviluppo di questo strumento
- ◉ Stiamo adottando lo strumento che è in corso di sviluppo
- ○ Lo strumento è già stato adottato con successo ed è pienamente sviluppato nella nostra azienda

6) Esprimere il suo livello di accordo sulla seguente affermazione. Le problematiche ambientali sono esplicitamente considerate durante il processo di pianificazione strategica dell'azienda.

- ◉ D'accordo
- ○ Poco d'accordo
- ○ Non so/Non rispondo
- ○ Molto d'accordo
- ○ Abbastanza d'accordo
- ○ Per niente d'accordo

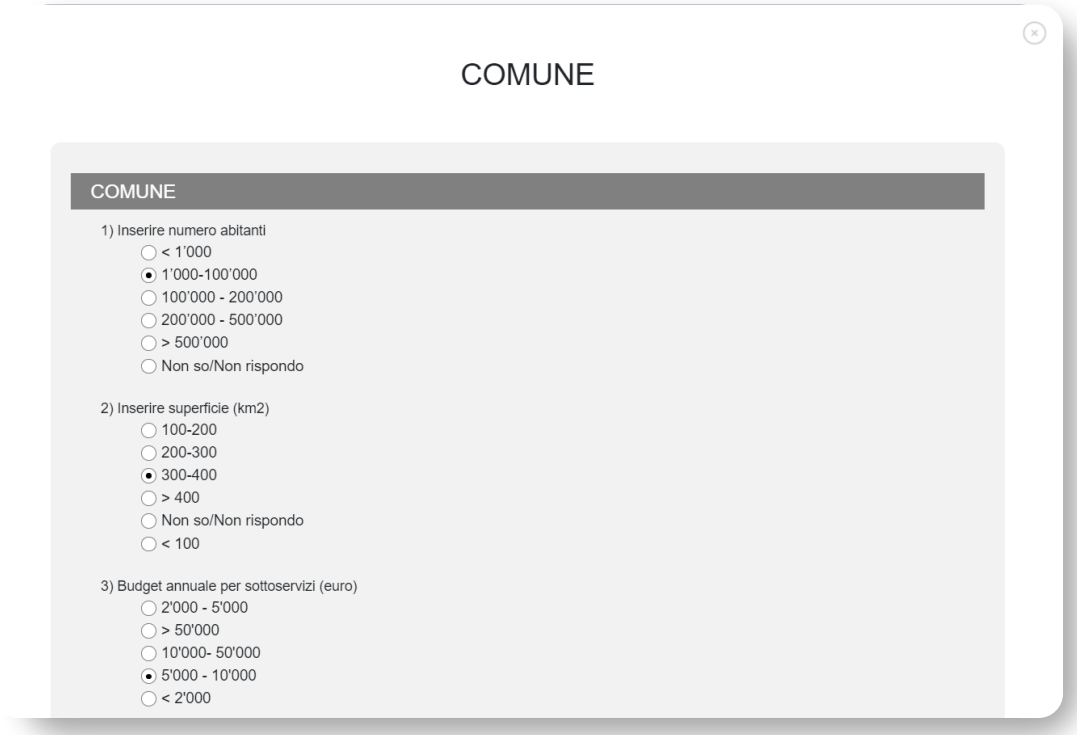
7) Esprimere il suo livello di accordo sulla seguente affermazione. La considerazione per l'ambiente naturale è espressa nella mission dell'azienda

- ○ Per niente d'accordo
- ○ Poco d'accordo
- ○ D'accordo
- ◉ Non so/Non rispondo
- ○ Molto d'accordo

Questionnaire Of The Municipality

(ACCESS: ONLY MUNICIPALITY)

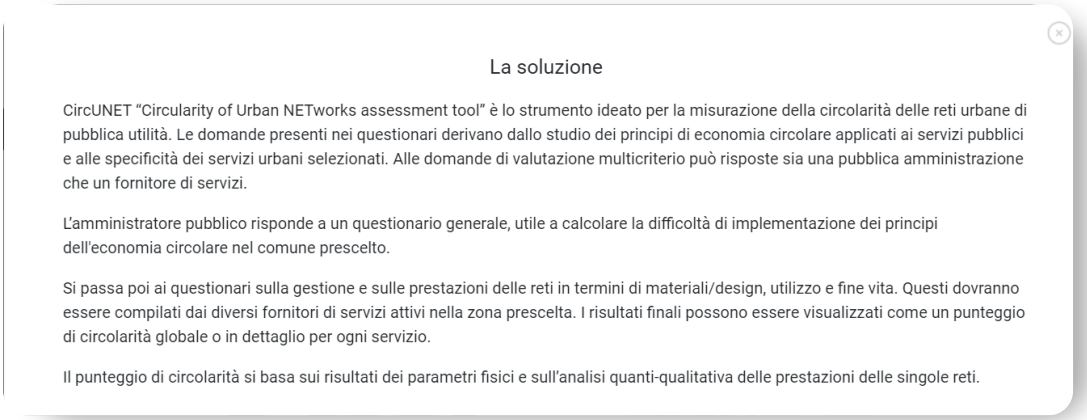
This is the **questionnaire** that intends to gather data about certain **conditions of the territory.**



About The Tool Menu

(ACCESS: BOTH, MUNICIPALITY & UTILITY)

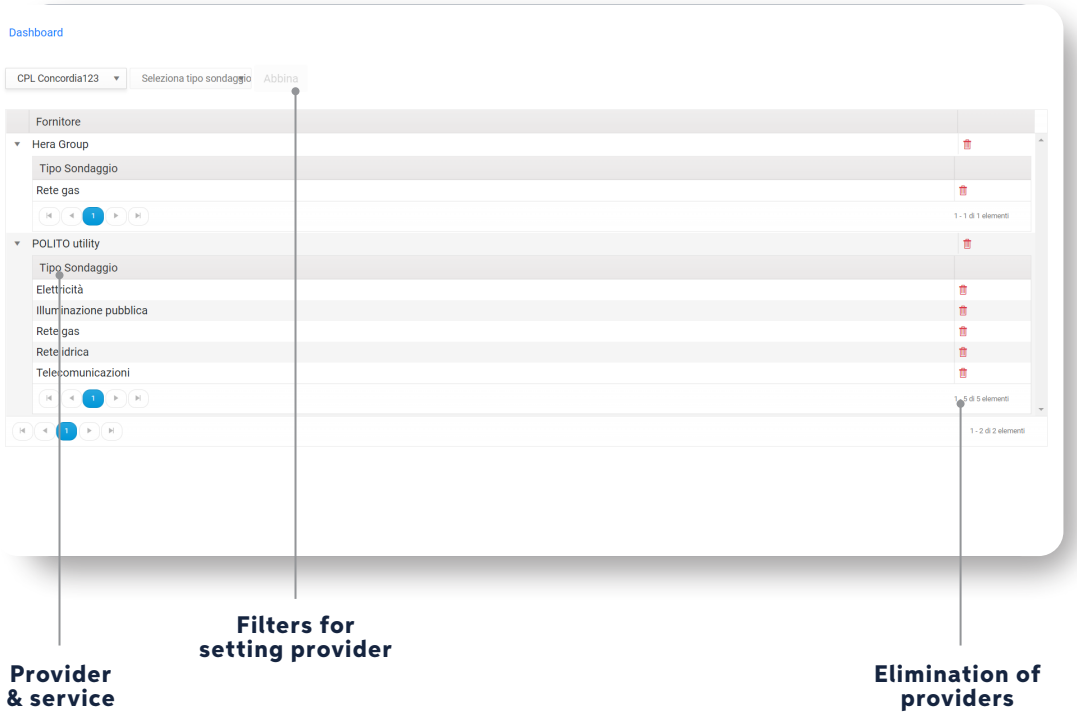
By clicking here a **small description**, in words, of how the tool functions will appear.



Administration Of Providers Section

(ACCESS: ONLY MUNICIPALITY)

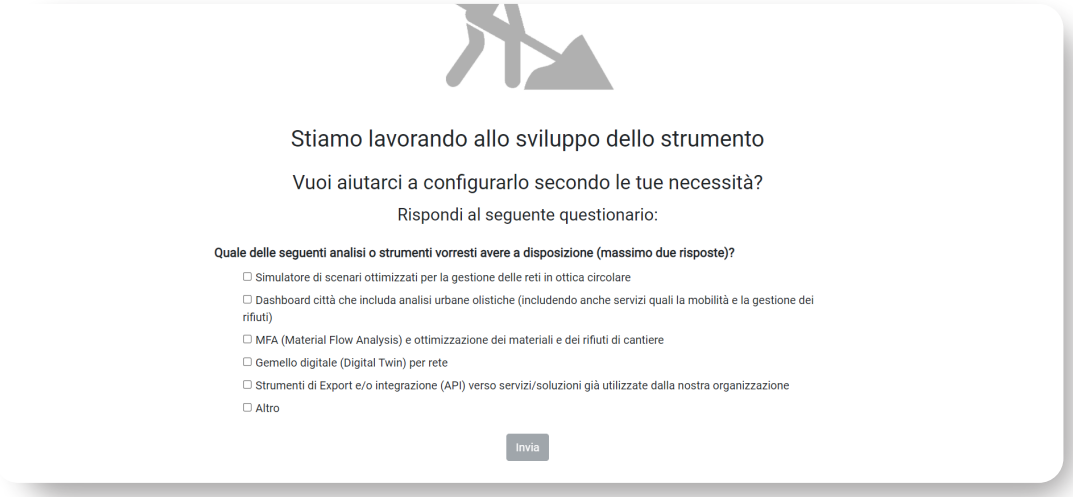
Is where the municipality can **select the provider of the urban utility for evaluation.** Here the municipality can specify who is the entity in charge of the management of the network.



Other Results And Analysis

(ACCESS: BOTH, MUNICIPALITY & UTILITY)

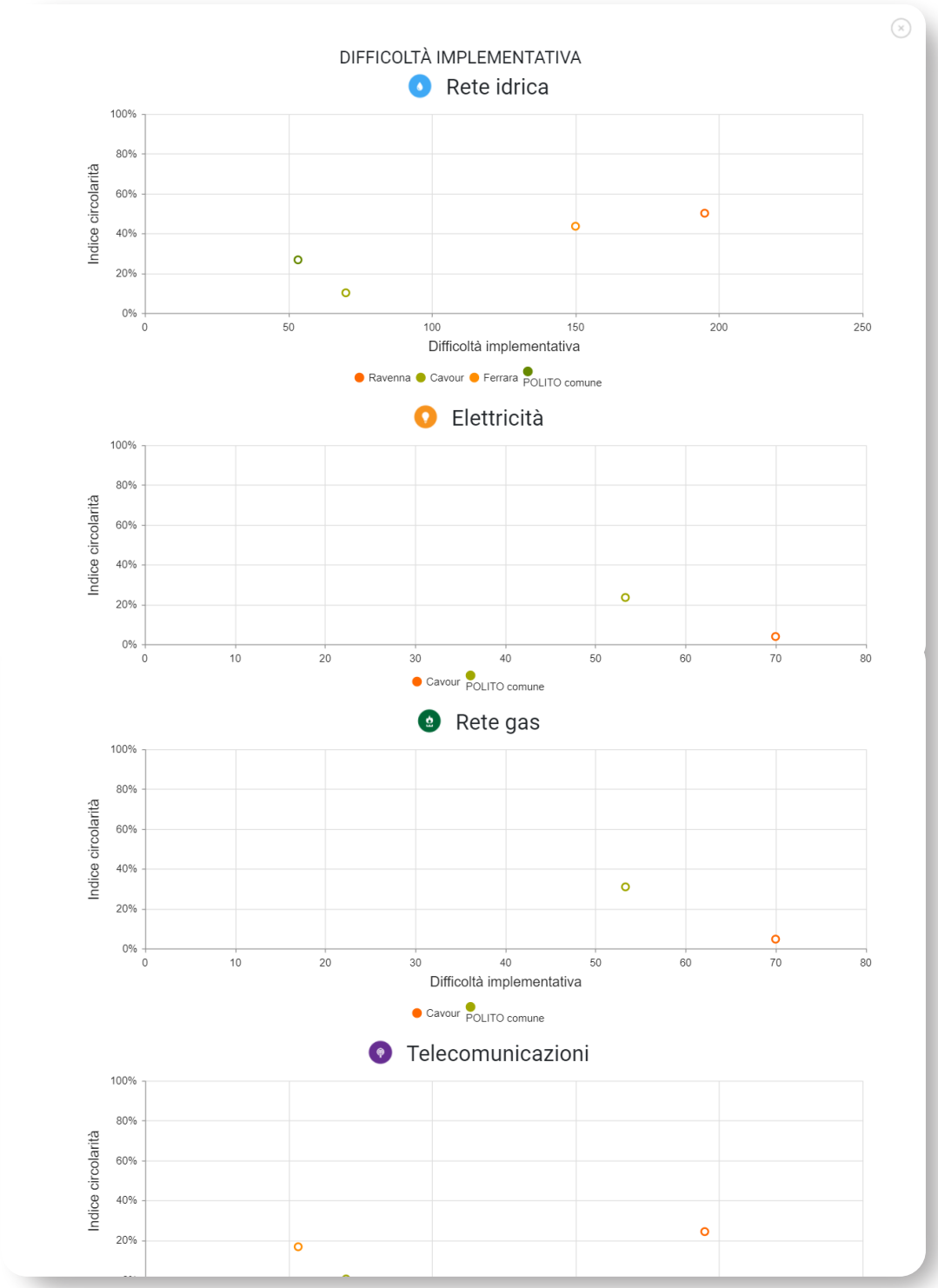
This section is still not developed, however there is a questionnaire that asks **what other tools or functions can be useful for the users.** Among the offered options there is MFA analysis, Digital twin and API integration.



Implementation Difficulty Section

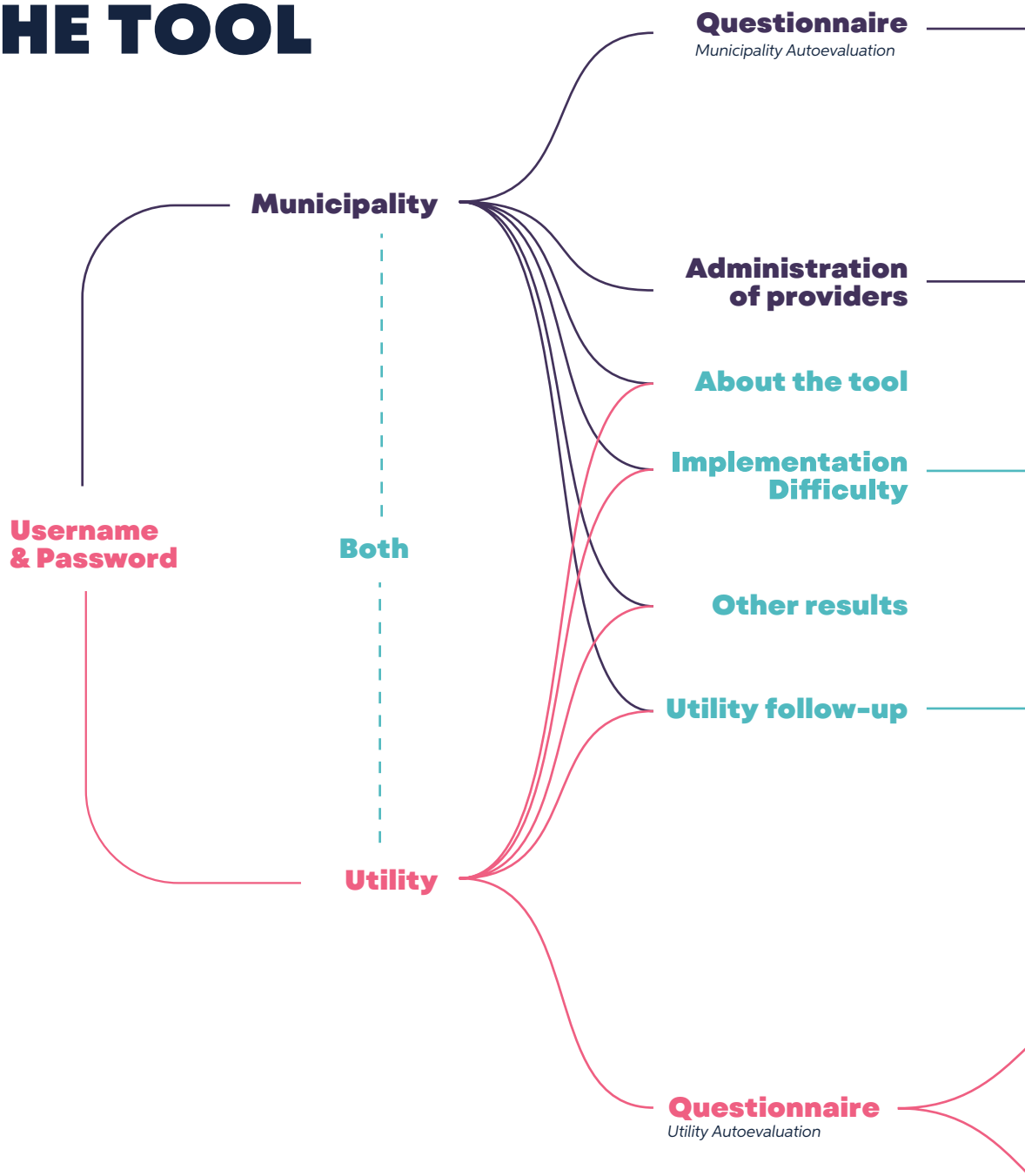
(ACCESS: BOTH, MUNICIPALITY & UTILITY)

Here, after answering the municipality questionnaires and receiving the results of the utility providers, the tool shows graphs that **indicate the grade of difficulty of implementation** compared with the rest of the municipalities that make part of the tool.



The following diagram represents a panoramic vision of the tool taking into consideration the 7 sections mentioned above. The diagram summarizes all the questions of the questionnaires into main categories of information, however the full questionnaires can be found in appendixes 1-5.

MAPPING THE TOOL



- Number of inhabitants
- Surface (km2)
- Annual budget for underground primary services (€)
- (%) of the territory presents archeological constraints.
- (%) of the territory presents hydrogeological constraints.
- Bureaucratic processes for authorizations (Time vs. Complexity)
  - For Rights of property
  - For Terrain characteristics

1. Select already subscribed utility
2. Select tipe of service offered
3. Manage list of utilities registered

Circularity index vs. difficulty

Implementation difficulty is based in the level of archeological, hydrogeological and bureaucratic constraints.

- Water
- Electricity
- Public Illumination
- Natural Gas
- Telecomunications

- **Water**
- **Electricity**
- **Public Illumination**
- **Natural Gas**
- **Telecomunications**

Overall score*

*Average score for the 5 different total scores for services *managed by the municipality*

Service overall score

Material and design score

Phase of use score

End of life score

Generic description of the metrics

Governance

Water Utility - 17 questions

- Adoption and development of voluntary regulations and actions
- Methodology and administration inside the company
- Company's networking and communication
- Provenience, maintenance and renewal of the installed network

Network

Material and design
Water Utility - 7 questions
- Optimization of the planned networks
- Packaging of the materials used for the net.

Use phase
Water Utility - 16 questions
- Maintenance and control (installed network)
- Optimization of the used resources
- Flow consumer touchpoints

End of life
Water Utility - 6 questions
- Prevention
- Residuals

5.1.4 Business Model

Till the date Circunet is only proposed as a digital solution, but open to the exploration of hybrid models between fully digital and traditional consultancy. Currently, their business model is based on the digital solution; Sis.Ter proposal is to **offer the tool as a pay per use software under a Software-as-a-Service model** (Saas). [See Focus 4: Saas model]

The idea is to provide this software to the market though a monthly or annual subscription service. The pricing scheme is based on the data storage required by the subscriber, defined in giga-bytes (GB). Prices are projected to be elastic and scalable according to the GB added after paying the entry level, ``the easy pack", which offers a hosting space of 5GB and the possibility of activating up to 5 users. In addition Sis.ter has considered providing an option within the tool that offers traditional consulting services with the scope of defining a roadmap for continuous improvement and follow up of lean design and circular approach. These traditional consulting services could be: Material flow analysis (MFA), Life Cycle Analysis (LCA), Assessment of greenhouse gas emissions (Bilian Carbone in France) and assessment of materials and waste produced by construction and demolition. All of these will be offered to municipalities, utilities and subcontractors in the network management value chain.

Below you can see the initial operational scheme developed by circunet. This scheme shows us how the tool intends to approach each possible client by offering different visions of the network's circular performance.

In this sense the **revenues for Circunet come from users subscriptions and consulting services.** These subscribers will be reached through online and offline channels, like public and private events, dedicated websites, social networks, direct contacts and conferences/webinars.

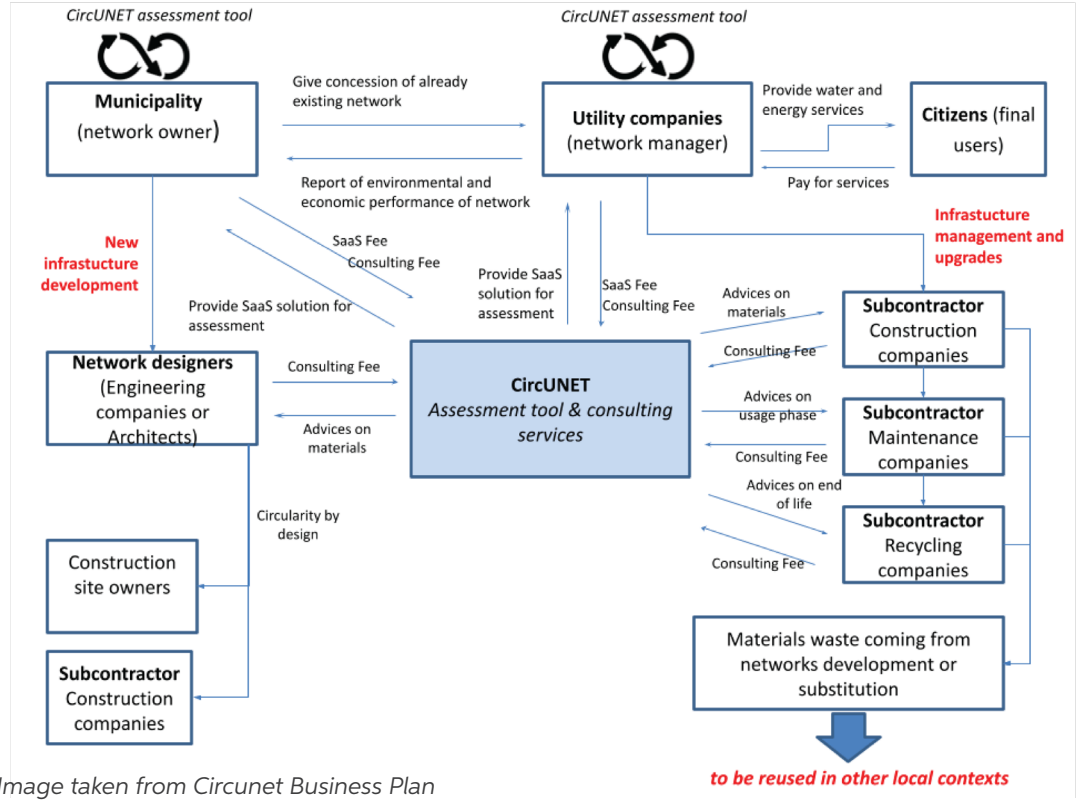


Image taken from Circunet Business Plan

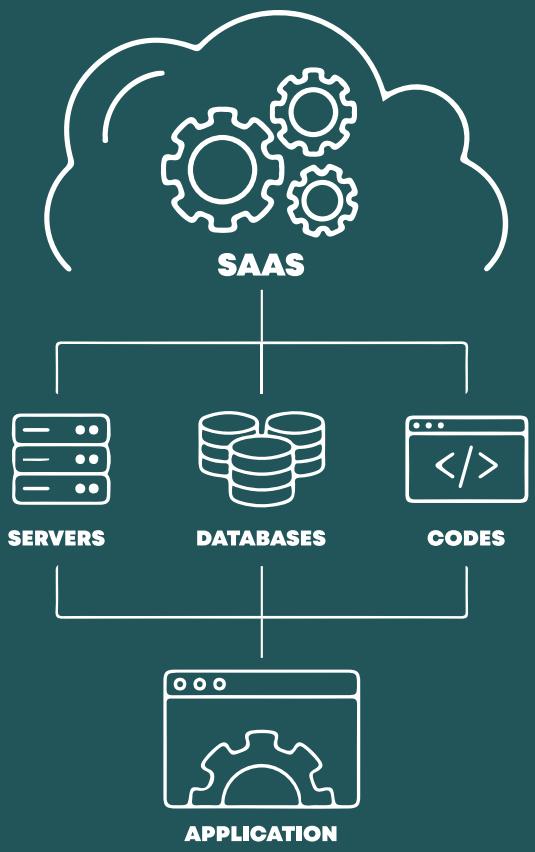
FOCUS 4

SAAS

Software-as-a-Service

(Oracle ,2022)

It is a cloud-based software distribution model in which the cloud provider hosts, develops and maintains a combination of servers, databases, and code to create software applications that can be accessed by users from connected devices on a pay-as-you-go basis. Ideally the provider manages all the hardware and traditional software, including middleware, application software, and security.



SaaS capabilities

“Connected, cross-business solutions”

Allows the connection and optimization of cross-departmental business processes, gaining a holistic view of entire stakeholders.

“Faster, more flexible update paths”

Access to new updated features on a regular basis, at the own speed of business, not on a provider’s timetable.

“Easy personalization”

Enables easy personalization of solutions for business needs and preserve valuable customizations through updates.

“Data portability”

Saas software allow, to easiliy visualize, and analyze data to see trends and patterns and incorporate third-party data for richer analytics.

“Built-in analytics”

Access to data in real-time, avoiding time-consuming data-egress costs. Leading to faster innovation leveraging embedded technologies.

“Enhance productivity with built-in self-learning and adaptive intelligence”

Innovate quickly and continuously across the entire value chain with AI, machine learning, chatbots, digital assistants, IoT, blockchain, and other emerging technologies.

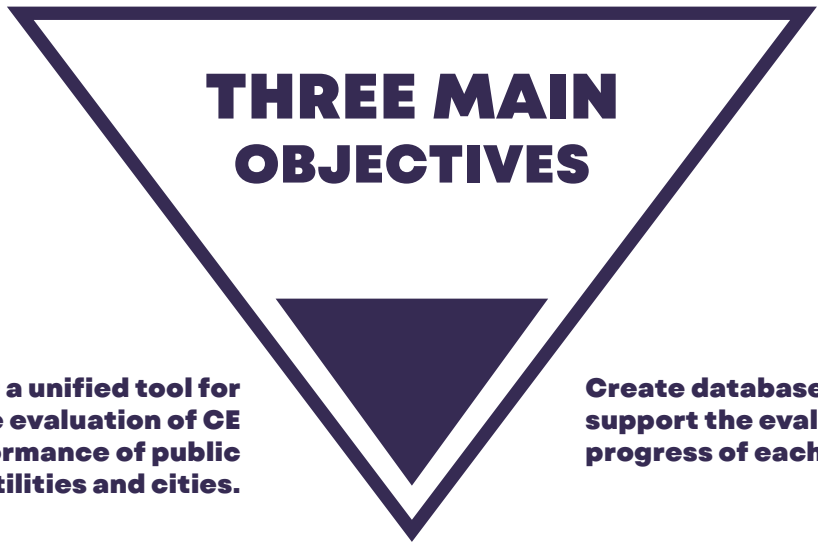
CRITICAL EVALUATION OF THE TOOL

This proposed evaluation of the tool has the purpose of understanding the capacity of Circunet of reaching its main objective. Added to this the idea is to propose along this evaluation, opportunities for Circunet to reach in a much accurate way its target audience, offering a robust tool with more added value for clients. Along with this evaluation, other than taking into consideration the research framework constructed along this thesis work, the "BI Tools for Data analysis" topic will be introduced.

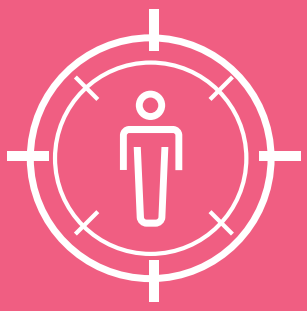
5.2.2 Evaluation Guidelines

First of all it is important to emphasize the purpose of the tool. We can extrapolate 3 main objectives form their actual Business-plan:
- Help adminstrators
- Unified network
- Support and progress

Help public administrations to better manage local networks, setting goals and managing the transition towards sustainable practices in accordance with the CE principles.

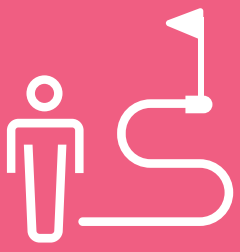


The following step is to go in deep in the functionality and structuring of the tool in order to understand if these 3 main objectives are being reached, and up to what grade. For this we can state **3 main transversal questions that will guide a more critical evaluation of the tool:**



Is the target audience being reached?

For which audience has the instrument been created and tested? Does the audience match the instrument? Is more testing needed? Is the instrument adding value to the audience? How is it adding value? Is it a sustainable instrument for the audience's needs?



Is it fulfilling its purpose?

What does the instrument measure? How does Sis.Ter define what they are measuring? Does its use match with what is being needed? Does the use of the tool match with what it is being offered? Are the outputs suited for what it is being offered? Are the used metrics and tools appropriate for fulfilling the intended measure?

What are the ideal conditions for the tool to work?

What context or environment is the instrument intended for? Is this context flexible? What inputs are needed for its ideal functioning? Are these inputs flexible? Is there an ideal use of the instrument? What happens with the tool if that ideal path can't be fulfilled?

FOCUS 5

FEEDBACK FROM REAL USERS

In the mean time of the evaluation of the tool, Sis.ter was able to involve 2 realities, testing the tool in its actual state, gaining some feedback of the tool and its functionality. The summary of this feedback can be found in Circunet's presentation of the business plan. These went as follow:

Rennes, France

(215.366 inhabitants municipality):

Sis.ter involved Engie (international multi-utility company) for the test and validation of the Gas questionnaire and general usability of the platform.

Feedback:

"Engie were satisfied and they found it interesting to have some questions about actions they don't carry on but could, for instance, improve the logistics of the delivery on pipes. Also, Rennes Métropole showed their interest in defining circular economy objectives for the networks, as part of a broader territorial environmental policy. More specifically, they are interested in material flows of building site and excavated material waste in the case of an extension of the heating network; the choice of fuels for the boiler room in connection with the objectives of reducing GHG emissions (energy recovery from waste and wood energy, for wood, the origin and impacts associated with transport)

The questionnaires were answered in 45 minutes, and customers were very satisfied with the experience (time spent, formulation of questions, interest in answering these questions). We identified some improvement points as :

- **Questionnaire to be created for heating network with question on boiler room and fuels.**
- **Synthetic report to be improved to better put into perspective the circularity index obtained and to propose courses of action.**
- **In the French market, CircUNET can also be linked to regulatory approaches or ADEME funding. (Sis.Ter, 2021)**

Cavour, Italy

(5.473 inhabitants municipality)

Sis/ter involved the municipality administration and technicians for the test of all sets of questionnaires and general usability of the platform.

Feedback:

"They showed interest in the platform. They reported some possible optimizations on the "municipality" questionnaire. Technicians had some problems with some questions because they were not able to involve the specific service manager for answering this or that question, but in general the feedback was positive." (Sis.Ter, 2021)

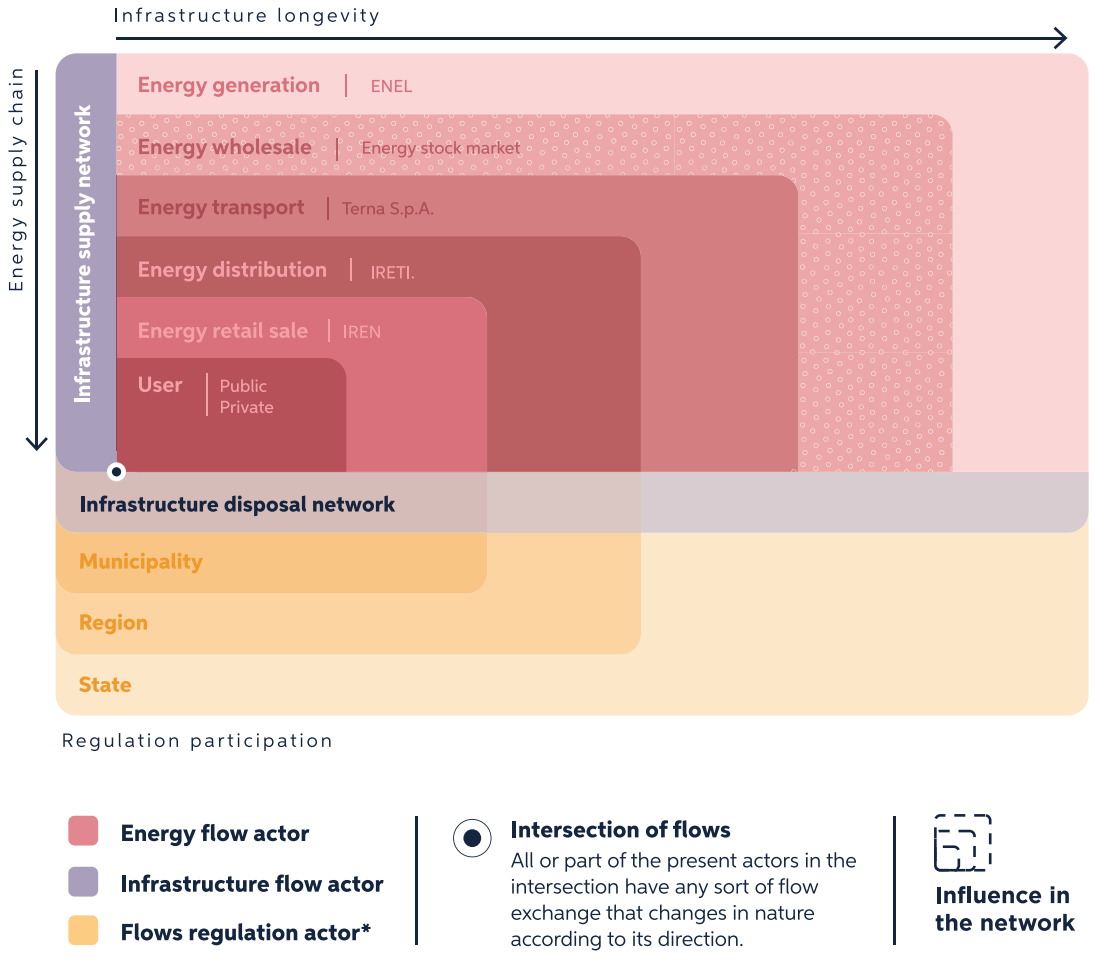
5.2.3
Utilities as Networks

In order to evaluate the tool as a product we first need to understand **what the tool should offer and how it should approach potential clients**. We know the tool intends to map the circular performance of public utilities, and for doing so the tool bases its mapping on the evaluation of circular performance of the Network Manager stakeholder. **Here lies the first critical point of the tool. The circular performance of public utilities can't be based on a single stakeholder,** as stated previously, public utilities are conditioned by an entire network of actors that influence the management of the public utilities. **However not all stakeholders that make part of the network are potential clients for circunet.** As stated before, potential clients for circunet are those with direct power of decision over operative and administrative features of the public infrastructure. In order to define who these potential clients are and what is their relation and role within the network **we can propose a diagram that represents a general vision of the supply chain of the resource (pg. 108).** Before doing so it is important to highlight the fact that not all supply chains are the same and stakeholders within these will always vary according to the territory we are referring to. That said, **for purposes of this study we will focus on the Italian context and limit our vision to the 5 metabolisms previously stated.**

Let's take for example the energy supply chain. This is a chain that starts with the production of energy, which is then transported in mass across the country, then regionally distributed and sold to users. **Each step requires different actors which influence each other**, however only the generation, transport and distribution stakeholders can be considered as network managers, the other actors just influence the actions of these stakeholders but do not have the power of decision over the infrastructure. By the other hand, we have the public administration which are those stakeholders with the power of regulation over Network Managers, and for the case of Italy the public administration can be also considered as a consumer.

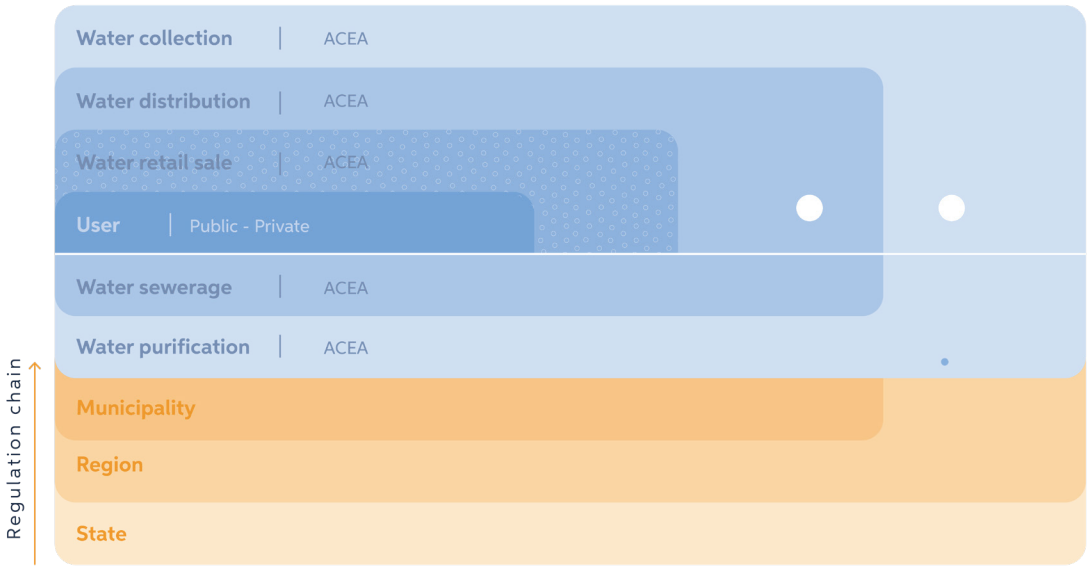
It is a chain that works both in the physical and virtual boundaries of the territory and involves various actors. So when asking who these public administrators and network managers are, the answer will definitely be: It Depends. It depends on how wide and transversal our vision is. At the same time the question **"How circular a local utility is", is blurred and ambiguous, also depending on the limits we established for what "local"means.**

Other two examples could be the water network and the telecommunications network (TLC) supply chains. For the case of the water supply chain, this has two big differences with the energy supply chain. Firstly, this is a smaller network with a regional focus, and in many cases one same stakeholder is in charge of the entire supply chain; added to this regional regulation has a bigger impact within the network. Secondly, the supply chain does not end up with the consumption of the resource but it also involves a disposal phase. Next we have the TCL network, ruled by a completely different supply dynamic, where software is transversal and the public administration is much more punctual.
That said, we can state that Circunet has a wide range of potential clients and they all have different impacts in their respective networks, therefore they should all be approached in different ways. Furthermore in order to have a complete panoramic vision of the circularity of the public utility which brings value to public administrators **it is relevant to understand how network managers influence each other, understanding up to what extent they make part of the hard and soft structures that compose the urban utility.**



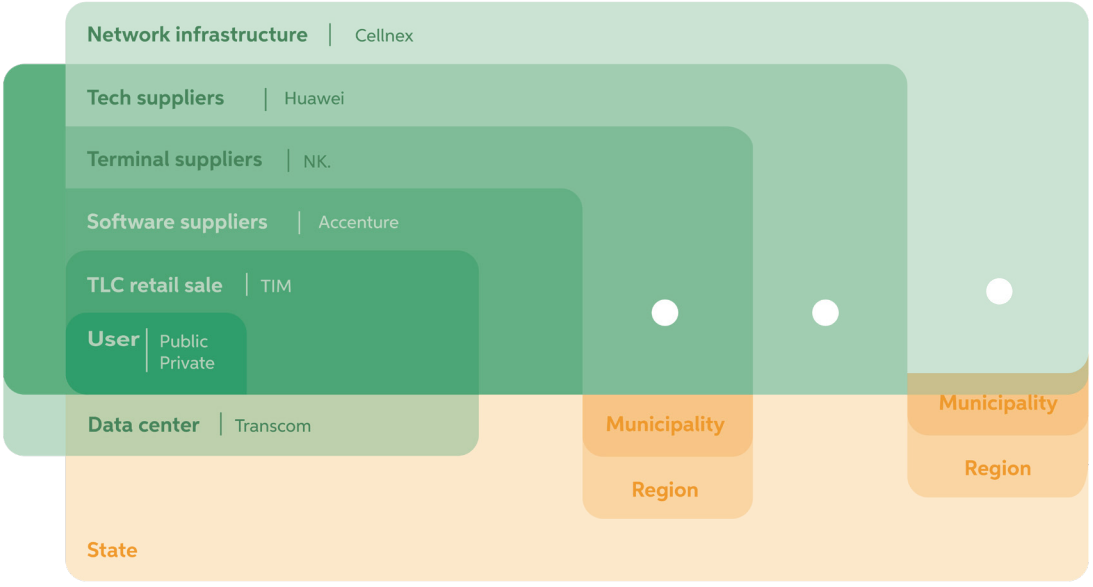
These have the double role of regulation and clients.

Filiera aqua può essere controllata dallo stesso ente a livello regionale



CRITICAL POINT:
Monopoly eases transfer of communication but increas-
es the lack of transparancy to other entities

Telecom - Funziona come una rete Unica



CRITICAL POINT:
Not easy regulation and very long chians of production
that depend in external parties to the ainnetwork.

5.2.4 Better Management: Data As Product Of Value

By visioning public utilities as networks we can state that different clients are searching for the same value proposition: **"better manage local networks according to the principles of the circular economy."** To understand how circunet can deliver this value to the clients we first need to define what "better management" requires. According to various studies a **better management requires, these are 5 points mentioned in column A of the diagram below.**

One of the best ways to achieve these 5 points is being able to c**ollect, interpret and communicate data in assertive ways.** (Centre for Education Statistics and Evaluation, 2016) In the case of Circunet this data treatment should allow "measure local network management, improve knowledge of the local environment, and enable easy monitoring of circular economy strategies through relevant environmental and socio-economic indicators." (Circunet, 2021) In other words, for Circunet, data is the input and output of the tool and must give value to each client by mapping, measuring and giving insight of circularity within the utility.

A

Transparency

Clear objectives and actions

Strong R&D for innovation

Assertive assessment of performance

Hard skills and "human skills"

Thus, data treatment by Circunet, should alleviate Network Managers and Public Administrators' critical pain points for the transition from linear models to circular models, offering instruments for needs mentioned in column B.

B

Ease in circularity related decision making

Reliability in circular networking

Cohesion towards circular growth

Widespread communication of circularity

Cross-functional knowledge of assets (of all types) and actions that support circularity

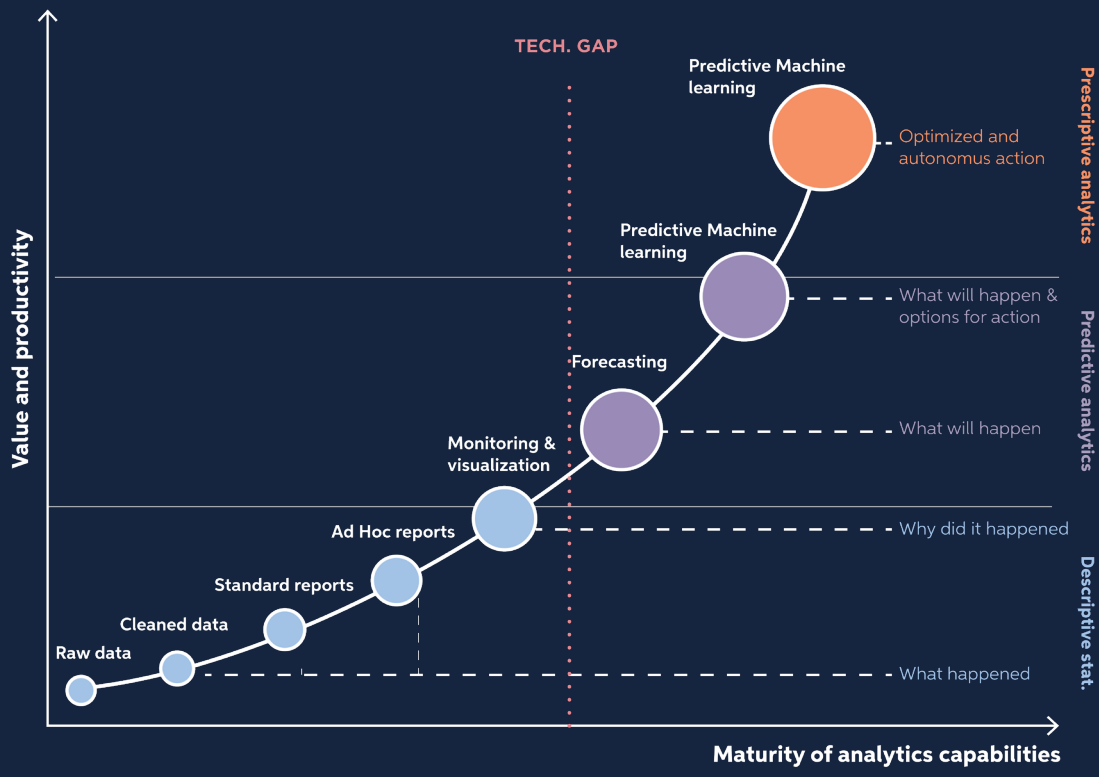
Conflict resolution towards circular models.

That said, it is important to ask the following question:

HOW COULD CIRCUNET COLLECT AND DELIVER QUALITY DATA THAT SIGNIFICANTLY HELPS CE TRANSITION?

In order to answer this question we need to define what rules data quality and value. To understand the value of data as a product, we need to grasp a concept called the **"data life cycle".** This is a concept that frames how data gains value within different stages of maturity. There are various versions to which are these maturity steps, however we can base in the model proposed by SISENSE (2021), which divides the maturity steps into four:

Raw data | Descriptive statistics | Predictive analytics | Prescriptive analytics



There is a directly proportional increase in data complexity as the maturity rises. This complexity can be categorized in different sub-steps that determine how difficult it is to extract and communicate the desired data, and the more complex this becomes the more rich and valuable data is produced. For the case of CircuNet, the raw-data is the input for the platform, which is then processed and delivered in a higher complexity level, **however this level reached by Circunet barely arrives at the mid-term descriptive statistical phase, meaning that although data gains complexity and value, it is still low for a competitive product that understands public infrastructures in a holistic way.** In order to offer a more adequate product with a higher value for the needs of the target users, **Circunet must find ways for adding value to the processing and output data.** This will be later on explored for the definition of the business strategy.

This last point brings an important question within it, which is:

HOW IS CIRCUNET CREATING VALUABLE DATA FOR ITS POTENTIAL CLIENTS?

In order to answer that question we need to understand how Circunet is currently creating data for mapping, measuring and giving insight of circularity. To do so, a further analysis of the tool, **understanding in a richer way the circularity indicators proposed by the tool and the value structure of the tool itself** is needed, this evaluation can be driven through a multicriteria analysis.

5.2.5 Multicriteria Analysis Of The Tool

This multicriteria analysis has two main objectives: The first one is understanding which principles and actions of circular economy are present within the indicators and how they are applied. And how the application of these relate to the urban services, adding value to these. The second one is understanding how Circunet offers tools for data governance, and how this allows a more assertive comprehension and application of CE practices.

We can first understand the capacity of the tool for supporting the transition of UMs towards CE models, being this its main subject and purpose. For doing so we can base a set of criteria derived from the research framework of the first chapters.

CRITERIA + POTENTIAL	CIRCUNET MVP STATE
Which of the circular actions are being motivated and evaluated by the tool? (Chapter 2.5)	The tool evaluates all circular actions up to a certain way, in some cases this evaluation remains shallow and although the tool evaluates thes, it does not suggest or applies actions towards the improvement of these actions.
Is this the tool taking into consideration all the temporal phases of the network (planning, construction, use, maintenance and disposal)? (Chapter 1.4.1)	The tool does take into consideration different phases of the network life cycle, however it does not differentiate consequential to causal phases, evaluating every step as equal. Moreover there is no exploration of different actors and interactions between these phases.
Are the network and AFPs understood within different scales (nano; micro; meso; macro)? (Chapter 2.6)	The tool does evaluate if the users understand and apply CE within a macro, messo, micro and nano scale, however there is a strong emphasis in the macro and messo scales that are basically focused on the enablers for CE.

Are CE principles being applied and evaluated by the tool? (Chapter 2.3)

The does apply an evaluation of the CE principles although it does not relate these principles and give a clear distinction of why these should be evaluated to the users of the platform.

Are AFPs being mapped and correlated offering a holistic territorial understanding? (Chapter 2.5)

Physical infrastructure: Yes
Digital Infrastructure: Yes
Natural & Human resources: No
Private sector assets: No
Waste: Yes
Manufactured goods & services: Yes

They do influence the output of the data however they all have the same equivalency. The only distinctions are the set of questions.

Are circular city enablers being applied and evaluated by the tool? Which are being considered? ? (Chapter 2.5)

Evaluated:
All enablers are being evaluated in some aspect by the tool although not in an explicit manner.

Application:
The tool does directly implement only one enabler: Incorporate digital technology. However the tool is not offering a direct application of Design for the future, Rethink business models or Strengthen and advance knowledge.

Does the evolution over time of networks affect the circular performance? How is this evaluated? (Chapter 3.3.3)

The tool does offer an evaluation for different phases of the network. (Planning, use and end of life) This helps to identify specific actions that could be taken for different moments, however the impact of each indicator within that specific phase and with the general evaluation is vague or nonexistent.

Are hard and soft barriers maped and established as conditionants of CE performance? (Chapter 2.6)

Evaluation:
Yes, barriers for CE applications are evaluated. However it is not evaluated if the users do identify them. Both soft and hard barriers are taken into consideration.

How does the tool model UMs (Black box, Gray box, Network vision? (Chapter 3.3.2)

Evaluation:
The tool does not comprehend how users understand UMs. It assumes they see UMs as GBs. If this was the case the tool could implement a unifying vision for all the users and help them with the transition.

The tool does interpret UMs through a mix of a BB vision and a GB vision. For the utilities the model is more of a GB, they are interpreted as an independent flow within the city. For municipalities there it is more of

Implementation:
The tool models UMs as Black-boxes with hints of Gray-boxes, data input enters and data output comes out however users have no understanding of what is happening inside. The results for utilities come as 3 flows (sets of questionnaires) and for municipalities as 5 flows (the utilities)

Are territorial aspects being evaluated by the tool (Legislative, environmental, socio-cultural and economic)? (Chapter 2.4.1)

Evaluation:
The tool does not evaluate how these three factors are being involved. It mainly understands just economic or technological aspects. Not even the municipality questionnaire evaluates if these aspects are considered relevant within the territory.

Application:
The tool is not applying nor incentivizing the understanding or involvement of these factors or its impact within these aspects.

Is the tool evaluating the presence of transversal mindsets among stakeholders sharing information and knowhow? Is the tool implementing this transversal mindset?

Evaluating:
No, the tools do not evaluate the presence of transversal mindsets, it just evaluates if the mindsets are present somehow within the organization.

Implementing:
The tool does use a transversal mindset within the user, however there is no transversal mindset presented between stakeholders except for the graphs for implementation difficulty.

The tool applies its evaluation in silos? If it is, how are these structured?

The tool evaluates UMs as silos, and does not characterize the different stakeholders in charge of its functioning. UM's are represented by the managers of the infrastructure, however they are considered as one single actor.

Is the tool evaluating the connection a sharing between stakeholders? Is the tool applying or incentivizing the connection and sharing between stakeholders? ? (Chapter 2.6)

Evaluation:
The tool does not evaluate how stakeholders and users are connected among them.

Application:
The tool offers two types of connections between users: Municipality-Utility and Municipality-Municipality. For the first one the results of the municipality are directly connected to the results of the utility (not vise-versa). For the second one the municipalities may compare their difficulty implementation as a numeric representation. In this case the offered sharing is more of a competitive nature and not learning-constructive.

Is the tool evaluating if CE strategies applied by the users are objective driven? Are evaluations within the platform objective driven?

Evaluation:
The tool does not evaluate specific strategies by the users, it evaluates UMs from a global perspective.

Implementation:
The tool does not offer an application nor lecture of results taking into consideration specific objectives.

Does the tool apply clear and intuitive data visualization? Does this visualization give added value to the optimal functioning of the too?

For the data outputs the tool applies not complex visualizations that can be read by anyone, however this lack of complexity under-communicates the results, making these lose value.

For the data input it is very intuitive if the user knows what they are doing due to the fact that there are no instructions at all.

Added to the evaluation of the characteristics related to CE within the tool, it is relevant to take into account that data is the core and most valuable asset of the tool and how Circunet receives, interprets and delivers this data, has major repercussions in the functionality of the tool for all stakeholders. Taking this into consideration it is also relevant to develop a multicriteria analysis of the functionalities of the tool as a data instrument. This evaluation will be based on a framework proposed by Michele Iurillo, for the evaluation of data governance tools (Iurillo, 2020). This framework is based on qualitative indicators, representative of present characteristics used in data governance tools. Not all indicators suit the case of Circunet, therefore a preliminary filter of these indicators has been done. The framework will be used from the perspective of both users and the Circunet team.

HOW CIRCUNET OFFERS TOOLS FOR DATA GOVERNANCE?

Characteristic &Description	Presence in the tool	Side Note
Multi-Tenancy: Ability to manage more than one instance and the multiplicity of roles and projects.	Only utility users can manage various realities at the same time, however they are restricted by the limits of the territory.	Understanding multileveled and multilayered data. Big stakeholders are divided in many regions or departments.
Cloud Deployment: Ability for cloud deployment.	There is no cloud development, there is cloud storage.	Creation of immediate feedback and connection of data and users, and creation of data lakes. The use of cloud technologies is projected to be the future data mindset and APIs.
Usability of the Business Glossary: Ability to create taxonomies, manage and import business terms.	There is no possibility for the creation of user taxonomies, the users must have previous knowledge of the terminology used.	"API + Ease of involvement and use - Transversal use?"
Custom Attribute: Ability of naming and defining attributes.	There is no customization of the tool attributes.	Customization allows users to read in much easier ways the output data and have it in line with the internal languages. Partially open-sourced platforms allow users to have more tailor made evaluations with the creation of plug-ins.

Personalized Relationships: Can relationships be personalized?	Relationships can only be personalized by the municipality, based on the function of the relationship.	"Full traceability. Hierarchy"
Data Management Control: Ability to manage elements such as business terms, data policies & standards, data quality rules and metrics, master data rules and tasks and any other artifacts that are fully configurable.	The data given can't be personalized, nor the data output.	The lack of personalization of data creates a lack of value for data input and outputs. For the inputs it imposes barriers and delimitations forcing the entity to answer within these terms and as a consequence outputs are not in line with the needs of the entity.
Customized Roles: Define roles for each stakeholder that has access to all or part of the data.	There is a definition of the roles, questionnaires and actions may differ, however there is no separation to how the data is presented.	Choose a tool that does not have closed roles or, better yet, has role templates so you can create new criteria and rules at any time. - tomorrow a new figure can come out and the tool will be obsolete
Authorization Workflows: Define authorization workflows.	There is an authorization workflow, municipalities should grant access to utilities and municipalities don't have access to the answers. However these authorizations are only from "node-to-node"of the network. - Other than this the access and modification of data is open for the users at any time.	Country roles, regions, subdivisions, etc can be defined as the ideal target for answering specific questions, avoiding the data quality loss
Master Data Rule : Allow to create data enrichment rules, validation rules, create relationships between entities, create record matching rules, establish confidence thresholds, and create record consolidation rules.	Other than the algorithm and whitening of the questions there are no rules nor personalization of rules according to the different relationships, hence all actors act under the same terms.	espada de doble filo - quality data problem , se ve restringido al rule y no puede expresarse en su totalidad
Impact Analysis: Will the tool create an impact analysis, specifically for the assets identified in the data lineage?	There is an impact analysis given as a performance, in this sense there is no definition of where and what are the effects of the given data.	Is it possible to graphically visualize (with a graph database) the impact?
Hierarchy of Data Artifacts: Allow linking policies, rules, terms, and reference data, including automatically generating reports from the metadata and its management.	There is a hierarchy of the data, however this hierarchy is not shared with the stakeholders and is a back function of the tool.	Back-stage. Can't enrich data with only answers but with more research - Customize pro projection?

Data Quality Scorecard: Give a value to the quality of input and output data.	It is a multiple choice questionnaire which reduces the range of the data, however its quality has no classification option.	Don't underestimate the value of a scorecard, which lists information governance metrics, objectives, periodic status updates, and baselines.
Problem resolution: Ensure that the problem management and resolution process is fully documented	If a user has a problem with the platform there is no established process for resolution. There must be direct contact with the developers.	Na.
Support for Int./Ext. Audits: Each repository must have a data owner and can be audited for compliance with specific Data Governance policies	Data owners are defined, however there is no control of the data governance and management.	data dictionary, 2) whether the rules have been documented, and 3) who determines access controls.

IN THE END, THE TERM 'CIRCULARITY' MAY JUST BE ONE WAY TO MAKE US AWARE THAT WE NEED A MORE ENCOMPASSING, INTEGRATED AND RESTORATIVE SUSTAINABILITY PATH THAT INCLUDES PEOPLE AS MUCH AS TECHNOLOGY AND NATURE.

MICHIEL SCHWARZ, A SUSTAINIST LEXICON
2016


Principle
Education
? ? ?
2
Open
knowledge
Open
process
1
Community.

5.2.6
Main take outs:

INSIGHTS TOWARDS A CONCEPT

Generalization of stakeholders brings generalization CE.

Circunet indicators are not understanding how different stakeholders of various scales impact the network's circularity, therefore the mapping and measurement of CE practices remains vague and unlinked.

The platform presents a **blurred delimitation of the actors and their roles** within the platform which consequently makes unclear the scope of the tool. The fact of evaluating a city CE performance though the UMs performance is a valid action, as presented in the research framework (RF), however for doing so **the platform needs to understand in a much richer and deeper way the territorial conditions and relations.** Right now Circunet (CN) has a much richer comprehension of the UMs than the Municipality, making it actually a tool for the evaluation of public service providers and not for cities; cities become just a consequence of the UMs, however as seen in the RF is more about UMs being a consequence of cities. In line with this, **CN is offering an evaluation of the tool as a closed system, with fixed actors**, and from CN perspective the sum of these compose the city and therefore its performance, however cities are open systems, constantly changing dynamics and with intrinsic flows therefore they can't just be defined though a pure reductionist vision.

No considerations of the real context for CE evaluation.

Circunet maps current practices within a perfect case scenario leaving aside contextual conditions that influence the lecture of indicators and generation of insights, making no room for assertive measurement and insight creation.

Because of the lack of a holistic vision of the municipality as an enclosing context of the UM, **the link between utility and municipality is very generic and weak for the creation of valuable insights.** Indicators should be flexible and evaluate CE according to the territorial context, let me illustrate this point with an example:

[Network: Water network | Questionnaire: Use phase | Question: 11]
The manager of the service uses an active management system for the pressure?
"Il gestore del servizio utilizza un sistema di gestione attiva delle pressioni?"

It may seem a question with not much back story, however the implementation of a management system for pressure control depends on various territorial factors, for example one of the biggest challenges for achieving a controlled water pressure is the topography of the territory, a hilly terrain may cause stressed pressure and increased difficulty of the system; another example is the amount of industry clusters in the territory, industries by day consume constant and heavy flows of water that drastically stop at the end of the day, building up pressure that may cause problems with the pipelines. In this sense defining if there is active management is just part of the story, in some cases there might be no need for the presence of the active management, while in others the need is such that it might exceed the economical reach of the city. For example a small city, with low growth rate, no industrial background situated in a flat terrain probably has less need for active pressure management systems all around the system, and the low stress created to pipelines might elongate their lifecycle. In this case if the city/municipality wants to define key actions for the CE transition, there is a big chance that those with a major impact are administrative actions. On the contrary, a big city, with fast growth rates, big industrial background, situated on a hilly terrain, probably has a faster change rate of pipelines and active pressure controls. In this case if the city/municipality wants to define key actions for the CE transition, there is a greater chance that those related to maintenance have a major impact for the network and could be prioritized as strategy for CE implementation.

Vague communication for data input.

Currently circunet offers a general evaluation of the network and does not differentiate how to communicate with the possible stakeholders. This lack of differentiation and language adaptation for different stakeholders makes it difficult to ensure the quality with which data is interpreted and given.

The tool offers a vague communication all along its elements and functions, this has a great repercussion in the quality and usefulness of the questionnaires and results. This vague communication is not helping users to have an easy and conscious experience throughout the platform. In the case of the questionnaires the sets have no introduction of what they are evaluating or why. This creates the first **doubt of "who should answer these questions and what for?"**, parallel to this, the questions have no explanation to why they are relevant for a CE transition and what they are trying to measure, making the user just a data provider that may have a small take out of the data. The **questions also present a lack of explanation** for the possible answers, **the fact of using a likert scale makes the processing of the data easier, however misleads the real results and do not provide precise information if needed,** so it might not be a suitable evaluation tool for some purposes of various entities that need more punctual insight. Let's illustrate this last point with an example:

[Network: Electricity network | Questionnaire: Evaluation of the management of the service | Question: 16]

In what percentage does the service manager invest in innovative solutions of the sector?
"In che percentuale il gestore del servizio effettua investimenti sulle soluzioni innovative nel settore?"

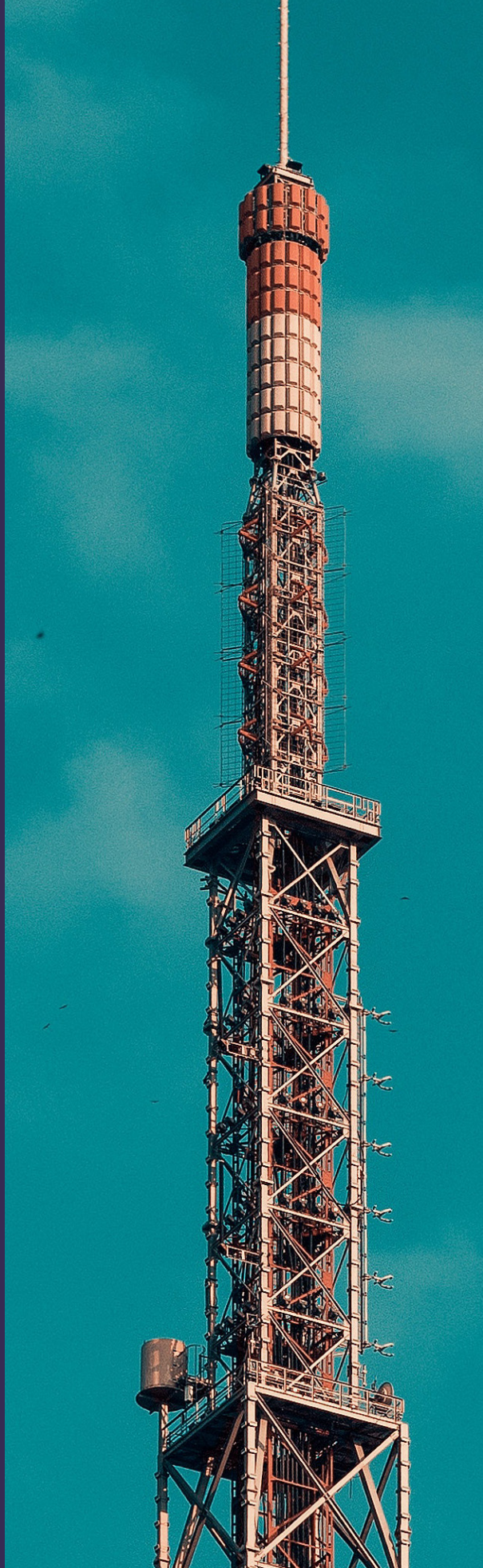
Here the formulation of the question and answers is very confusing. Let's start with the question: Firstly the question says: "in what percentage does the service manager invest [...]", so the doubt would be, percentage of what? of possible things to invest? Or Of the manager's budget?, then it says, "[...] in innovative solutions of the sector." Here the doubt is, what are innovative solutions? Are all innovative solutions in line with CE principles? And when talking about the sector, what are the limits of the sector? Is investing in electric cars also part of the electrical sector?. So as you can see the questionnaires present ambiguous questions that can be answered in such subjective ways that the quality of data for comparison is lost. **There is no "right or wrong" answer towards circularity and it is impossible to create a ruling base if there is no assertive communication of the elements of the tool.**

A number with no tools for interpretation.

Circunet bases its support to stakeholders in a numerical result however it does not offer its clients instruments for the interpretation and construction of value from the given data output.

Considering that the tool offers as a final output a single numerical value that stands for the circularity of the network, **clients might see Circunet more as an certification assessment than as a tool that helps network stakeholders the management and transition of the infrastructure towards circularity.** This misconception not only brings a gap for the tool value proposal but it also makes the use of a Likert scale unreliable due to the fact that entities would use the tool not as a constructive instrument but as a comparative instrument. **This has a negative consequence on the data quality and reliability** due to the fact that entities don't want to show a negative faculty of themselves and may just take the decision of not answering or misleading the given answer.

Taking into consideration the question mentioned in the previous output: The possible answers to the question are: Less than 10%; Between 10-30%; Between 30-50%; Between 50-70%; Between 70-100%; Don't know, Don't answer]
For the case of the answers, the fact of subdividing these in percentage ranges, gives no real difference between blocks of information, for example a city might have a 29% as an answer while another city a 30% as an answer and they will be categorized as completely different answers, although they are basically the same, again misleading the circularity performance results. In this sense **the tool should not give such importance to the measurement of indicators but more to the relation that exists among these and what can be produced with that.**



No identification of the external network.

Circunet is not mapping the networks and stakeholders that influence actions within the network, losing sight of valuable enabling assets that may work as an active part for the transition towards circularity.

The fact that the tool is considering all utilities the same for all territories, creates a gap between the surrounding context and the network. This gap increases by not mapping what and who composes and conditions the public utilities. As discussed in the RF there are various conditions that may influence the flows of UMs, however these conditions are not present everywhere nor work in the same way. For example a "private organization" may become a key stakeholder for the research and development (R&D) that incentivises innovation for the networks, however these private organizations are not present everywhere. A good example of this case could be cities with universities, for instance universities may provide the public administrators key insights for the development of more sustainable networks as in the case of the city of Turin which has a close relation with the Polytechnic of Turin and University of Turin, this might motive the city to actively invest in R&D through the investment on education. By contrast cities like Cavour don't have such easy access to big R&D departments and probably base their insights in cross-regional agencies that have a much more general perspective of the territory but still support the networks. Another evident example has been provided through the feedback of Engie-France where they specify they have a relation with the ADEME agency, an agency that supports the R&D for the French territory, but it is not present in other countries. An example of this misconception by the tool is given by the following question: "What percentage of total costs from the R&D department is destined to the research of innovative solutions in the CE/Smart city sector?" The question is **not taking into consideration if there are the possible variations for doing and investing in research,** assuming the only way is by having an R&D dedicated department.

Comparison of data between realities lacks of value.

Circunet is proposing a tool that allows the comparison between cities, however for doing so it standardizes how cities' dynamics work and how the given indicators impact the UMs, this takes to the standardization of data as an output losing complexity and value.

Circunet offers a tool for the comparison of circular performance and difficulty of implementation between cities and utilities, however for doing so it standardizes how indicators impact all possible realities. This **standardization ignores intrinsic dynamics of the territory, keeping data at a low complexity level and therefore at a low value**. Therefore the output data offered by the tool lacks the capacity for the creation of insights and does not support the transition towards circularity. That said, clients would value much more a personalized vision of how indicators impact their own context, instead of standardizing for comparing who is more circular. In this regard, **the tool might shift from a communication "to others" vision to a communication "with others"; the shift towards circularity is not about reporting data but about construction of data.**

No consequences not causes for circular action.

Circunet is not measuring the impact that the presence of circular actions has over the network and the territory performance. The tool limits up to a mapping of what is happening but does not understand why it is happening and what are the consequences of it happening.

Indicators don't explore what is causing circularity to exist within the network, just if it exists, leaving no space for insight of how to foment it. (Prevention strategies) By the other hand, indicators don't understand the consequences of applied and non applied practices, this limits the prioritization and projection of objectives. (Mitigation strategies). The tool has no comprehension of the impacts of the infrastructure and the applied actions towards the CE economy over the territory and the community. This lack of comprehension **creates a blank space for the creation of strategic paths towards circularity.** At the same time this creates a **black box mapping of the network, where the process of evaluation remains a mystery for the users** and the lack of detailed output data makes it impossible to have a clear understanding of how indicators influence the circularity within the network, blurring the limits of what is relevant for the network and what is not.

CONCLUSION

This evaluation reveals various insights and by merging these we can conclude circunet is not understanding the networks as part of a context but as an isolated event that has no cause or consequence of its actions, therefore, when processing the data, circunet is offering a standardized output for non-existent realities.

This gap between the network and the context makes it impossible to add value for an active and conscious transition towards circularity.

This situates the network within "hermetic scenarios" leaving no room for adaptive valuable measurement of CE and insight creation.

NETWORK / *VALUE GAP* /

CONTEXT

No active and conscious transition towards circularity

This makes us wonder,

HOW OTHER TOOLS AND FRAMEWORKS REDUCE THIS GAP?

How can other approaches, map, measure and give insight of the circularity, generating valuable data for different customers?

5.2.7
Tool Benchmark:

IN SEARCH OF OPPORTUNITIES

Now the question that remains is, if approaches offered by different tools are able to add value to the data and how they do it. For this **I did an analysis of different tools related to Circunet's proposition, with the scope of understanding how these treated data and proposed indicators for the mapping, measuring or insight creation of circularity.** The following comparison table intends to give insight of where Circunet is situated and what it can learn from other practices.

WCCD - ISO 37120 Series: Indicators For Resilient Cities

MI-ROG

Circulitycs

Material Circularity Indicator

GRI 306 (2019)

CTI Tool

Circle City Scan Tool

CE- Cities Programme / DOWGHNUT VISION

Circularity Calculator

Impact Wizard

Circular Indicators

Knowledge Hub

C-Calc

EUROSTAT - Circular Eocnomy

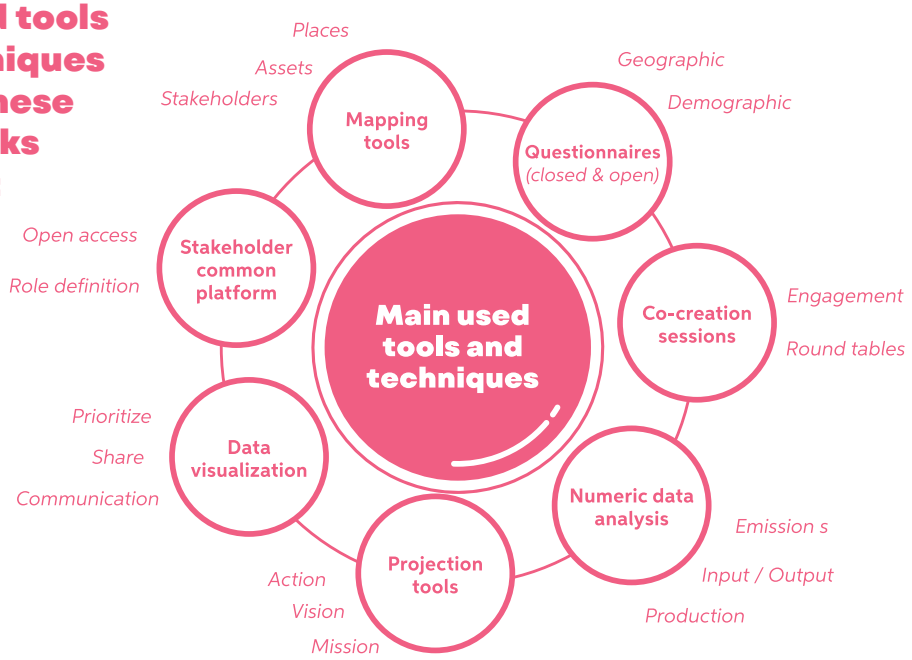
Circular Economy Toolkit

Cityloops

Cradle To Cradle Certified

EEA Report No 2/2016

Main used tools and techniques used by these frameworks and tools:



Four Main Outcomes Form The Benchmark:

1 CE performance frameworks should be in the grade of **displaying and understanding the complex nature of urban areas by understanding all major sectoral systems.** Mapping stakeholders and functional interactions and intra-actions in a holistic and comprehensive manner. Conceptual diagrams, charts and processes could help to structure complexity though graphical displays of all the variables of the interactions and the taken part of each stakeholder.

2 **CE performance frameworks should incorporate foresight tools** into the planning processes of CE actions, helping the projection and direction of more holistic future visions of the city. With the help of these tools the frameworks should be in grade of continuous reconfiguration of actor-networks and knowledge, and city systems context, such as societal, economic, technological, environmental and historical factors.

3 CE performance frameworks should develop new and **more transversal communication tools that help the involvement of local stakeholders from multileveled realities analyzing complex urban issues.** These tools should catalyze the alignment between involved stakeholders, as well as facilitating the management of conflicts and disagreement among them.

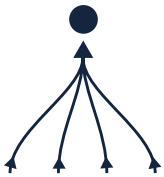
4 CE performance frameworks should allow the **combination of quantitative and qualitative indicators** that allow innovative and contextual research approaches capable of interconnecting and handling problems with the support of collective intelligence.

FOUR MAIN OPPORTUNITIES FOR CIRCUNET TO IMPLEMENT

Various good practices came out from this benchmark, however I want to highlight four key opportunities that may add value to Circunet's proposed solution.

Process the needed data with a defined evaluation scope for each client.

It is important to understand what the evaluation is for in order to define the elements involved that play a role for the creation of indicators and therefore the evaluation of circularity.



Differ paths for clients and then network these according to their needs.

Filtering the relevant measurements for each, giving a more precise evaluation by filtering and weightnig the relevant indicators for each stakeholder for a panoramic but precise vision of circularity.

Valuable data is created by understanding the net impacts of the measured practices.

Value is generated by understanding how practices impact the circular performance, giving insight to potential strategies for change.

Understand actions and behaviors' drivers, enablers, barriers & impacts. Understand actions and behaviors' drivers, enablers, barriers & impacts.

It is relevant to understanding why circular actions occur or not, by relating drivers and barriers for these actions. This allows more holistic approaches towards circularity.

5.2.8
The four fundamental questions

WHO, WHEN AND WHERE IS HAPPENING?

CONTEXT

The idea of this question is specifying who is being evaluated, and **framing** the processes and actions of this stakeholder by the territorial and temporal context. This framing conditions the impact the influence actions have in the overall circular performance. (This will also condition the impact of the following three questions)

WHAT IS HAPPENING?

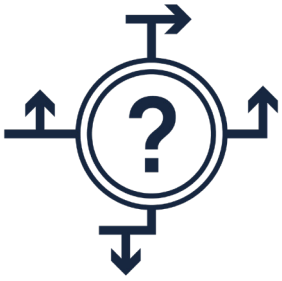
CE ACTION + CONSEQUENCES

The objective of this question is mapping **practices** that are being taken in accordance with CE and their consequences within the network and the territory. (By only mapping this element, we can understand the gross impact* of actions towards CE within the stakeholder evaluation)

"GROSS IMPACT"

Parallel to these outcomes we can extrapolate **4 fundamental questions that rule indicators within these tools,** they open entire spectrums of more precise questions according to the situation. These questions are not necessarily applied by all the studied cases, however **if combined these can create a holistic comprehension of the public utilities' circularity and add value to the output data**. These fundamental questions are mentioned above.

We can see these four fundamental questions as the founding process for evaluation of circular performance of UMs. Their combination may



WHY IS IT HAPPENING?

CAUSES

This question intends to map the **reasons** why CE practices are being taken or not within processes and actions of the stakeholder.

WHAT COULD BE HAPPENING?

PROJECTION

By having a clear mapping of the AFPs of the territory and the stakeholder we can algo understand **what can be done** differently towards a more circular network.

"NET IMPACT"

offer tools for the mapping, measuring and delivery of insight of circularity. Such understanding of networks allows more precise and personalized evaluation that supports in a more robust way the transition towards CE models due to the understanding of the net impact* of actions within the network.

***NET AND GROSS IMPACT**

The **net impact** is the weighted impact of taking, or not, an action towards circularity considering the context, causes and consequences. **The gross impact** is the non-ponderated impact of the actions with the context.

06

TOWARDS A NEW FRAMEWORK

Premise

Before projecting a unifying framework for Circunet to apply we need to first delimit what Circunet intends to be and what it does not. Furthermore Circunet intends to offer a tool for public administrators that gives insight of the circularity of the territory and supports the transition toward a more circular city. In order to do this the tool intends to understand in a holistic way the territory's conditions and cross them with the circular performance of the public utilities. However the tool does not intend to have a detailed look to every single element of the territory, but just to relevant characteristics that may influence the conditions of public utilities circularity. In a few words, Circunet intends to be a tool that understands public infrastructure in holistic ways, however that doesn't mean that it understands complex structures within every single element of the network. That said, to put things into perspective**,** it is important to bear with the fact that **Circunet is not, and will not be a solution for universal circularity of cities or UMs. The tool stands as an important element in the overall process of the CE transition of cities and public infrastructure, however there will still be a need for further and more detailed understanding of phenomena and elements that are indirectly affecting the circularity of UMs.**

6.1 | Intro

Considering all the previous research and evaluation outcomes we can now take a step forward towards the definition of a unifying framework that potentiates Circunet as a tool, **offering public networks a more valuable instrument that engages in a proactive shift towards sustainability.** For developing a framework that reflects all characteristics implied it is important to set guidelines that synthesize all mentioned criteria and guide its structure and purpose.

6.2 | Definition Of The Main Guidelines

Taking into consideration the outcomes of the research, the four fundamental questions previously set and the good practices identified within other frameworks and platforms, we can now take a step forward, towards the creation of a new framework for Circunet to implement. For doing so we can establish a **set of guidelines that drive the creation and definition of a suitable framework for circunet.** These guidelines are:

CE principles in urban infrastructure.

The framework should map drivers, enablers, barriers and impacts of actions and behaviors.

Systemic urban metabolisms

The framework should understand how structures relate and influence each other's circularity.

Urban context of complex cities

The framework should comprehend how urban context influences the performance of circularity.

Data analytics value

The framework should give complexity, richness and adaptability to the processed data, transforming it into useful insights.

We know that Circunet focuses on the evaluation of the infrastructure and for this, I set a series of actions for its evaluation. These **actions go in line with the proposed guidelines** therefore we can explore a **matrix that aligns these two and give insight of possible features** (intended as indicators) that Circunet may implement and the framework should take into consideration.

GUIDELINES	NEEDS	ACTIONS	FEATURES
CIRCULAR ECONOMY PRINCIPLES IN UI	• Incentivize a circular economy culture in UMs networks.	• Evaluate and implement core principles of CE for UMs. • Evaluate and implement enabling principles of CE for UMs. • Map territorial assets and products.	• Indicators for circular city enablers • Indicators for circular actions • Indicators for hard infrastructure • Indicators for soft infrastructure
SYSTEMIC URBAN METABOLISM	• Understand what are the drivers for urban sustainable practices. • Understand what are the barriers for urban sustainable practices • Human centered vision • Understand what role the user takes within the UM.	• Map inputs and outputs • Map relations • Map autopoietic structures • Map local value and actions • Understand societal impacts	• Indicators for virtual hinterlands • Indicators for physical hinterland
URBAN CONTEXT OF COMPLEX CITIES	• Apply and evaluate transversal sustainable practices. • Apply and evaluate punctual sustainable practices.	• Map the 4 main subsystems • Map the 4 connectors and conditions within the physical boundaries. • Map the hinterlands of the systems	• Indicators for societal systems. • Indicators for consumption systems. • Indicators for legislative systems. • Indicators for economic systems. • Indicators for technological context • Indicators for natural environment context. • Indicators for historical and cultural context.
DATA ANALYTICS VALUE	• Highlight data for insights • Prioritize insights for actions • Map actions for strategies • Create transversal knowledge • Create networking • Understand data availability	• Understand the macro objectives of the users. • Evaluate the know-how of the user. • Evaluate the evolution of the user. • Understand the	• Baseline indicators • Evolutionary indicators • Comparative indicators

AFTER STATING THESE GUIDELINES AND ACTIONS WE CAN NOW GIVE THE NEXT STEP TOWARDS THE DEFINITION OF THE FRAMEWORK.

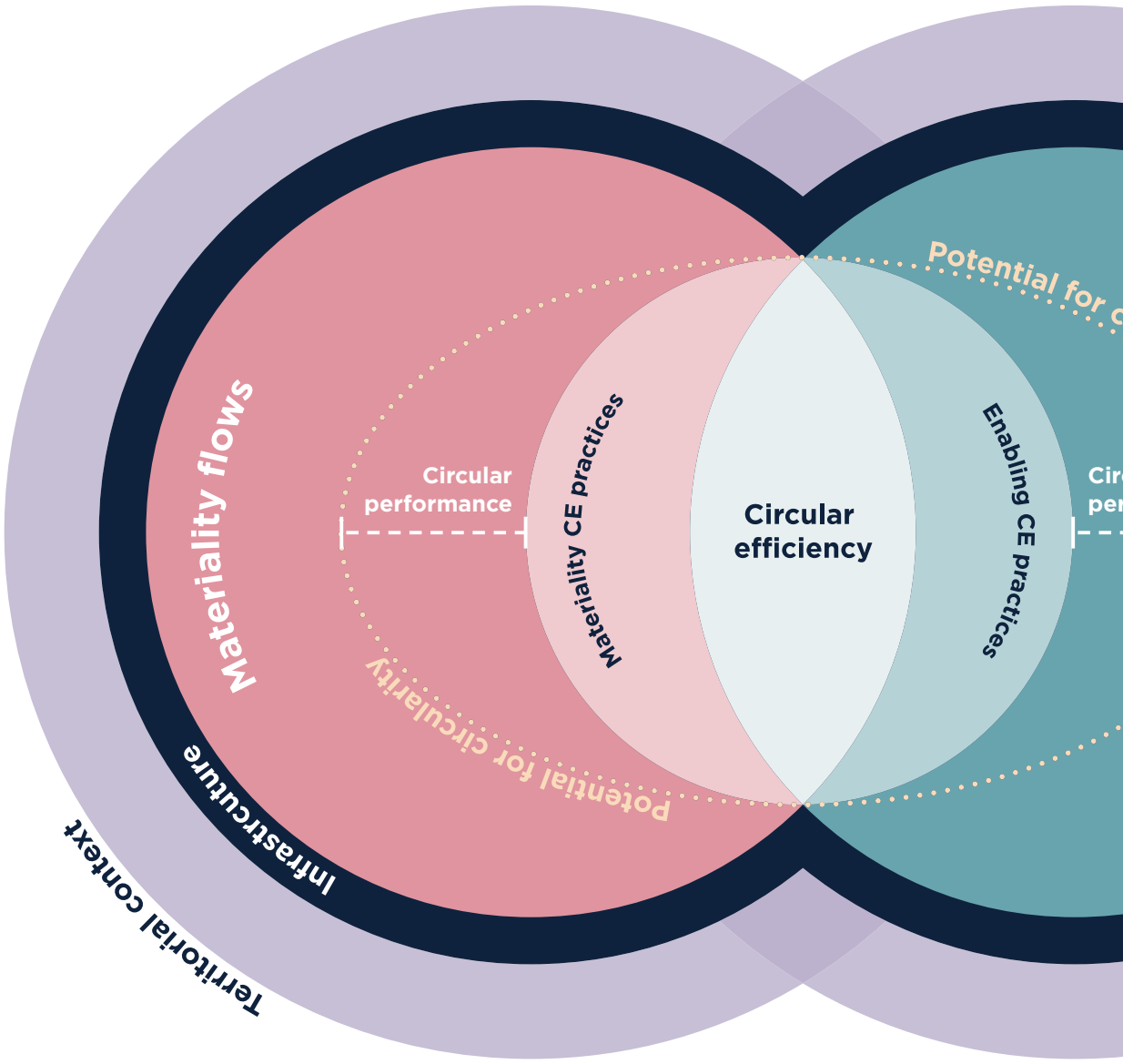
6.3
Evaluating Infrastructure Through Two Lenses

As previously said the main goal of Circunet and therefore of the proposed framework is evaluating circularity of the public infrastructure. For doing so Circunet offers a vision that takes into account various aspects of the network, the way these aspects are interpreted by the tool is in line with the principles of CE. **From this we can extrapolate two lenses for the evaluation of the infrastructures:**

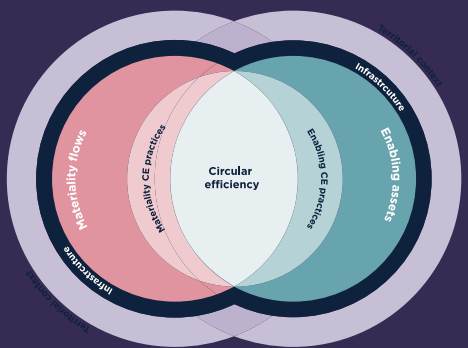
The first lens with the scope of mapping the flows that materials within physical structures must go through in order to become an active part of the network, this one we can call **materiality flows.**

The second lens has the objective of mapping the capacity and ability of the network for applying circular practices over these flows, this one we can call **enabling assets.**

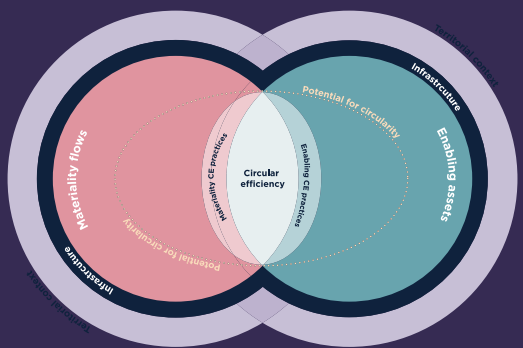
Circunet may base its evaluation of circularity by applying these two lenses. The idea is to map what exists within the infrastructure, what is being done towards circularity and what is the potential for circular practices. Having this mapped we can relate these two lenses, and according to how they interact with each other, **circunet will be able to define the circular efficiency and performance of the network.** This vision also leaves the doors open for the projection of strategies for reducing the circular performance gap and increasing the circular efficiency of the network.

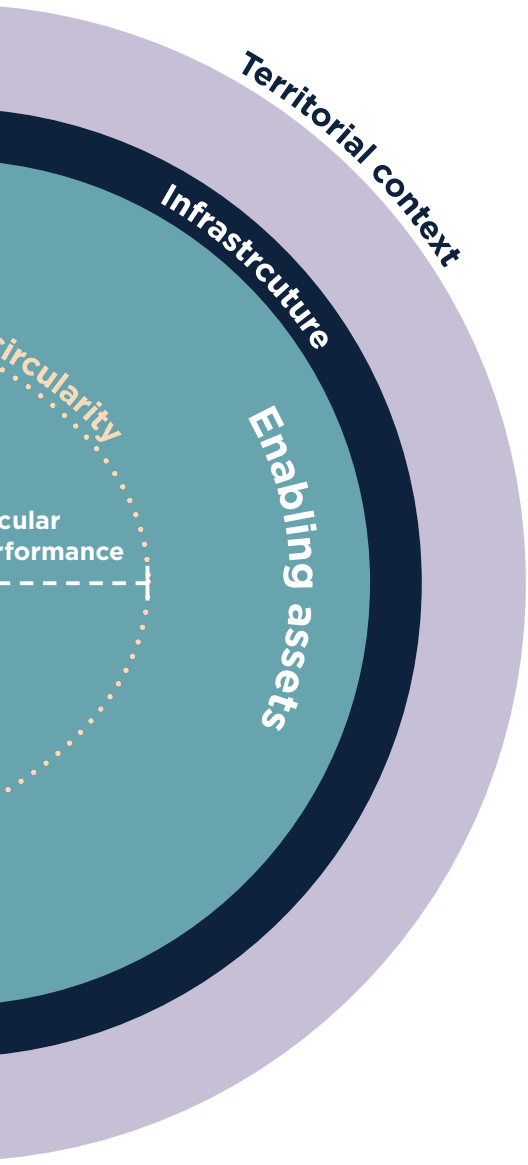


More efficient



More potential





TWO LENSES

Enabling CE Practices:

Existing practices/phenomena within the infrastructure that act as catalizers and channels of circular principles.

Circular Efficiency:

How efficiently are the enabling assets impacting in the application of circular actions within the materiality flows. (Enabling assets + materiality flows = Circular efficiency)

Circular Performance:

How much of the potential circularity within the specific infrastructure is being taken into advantage.

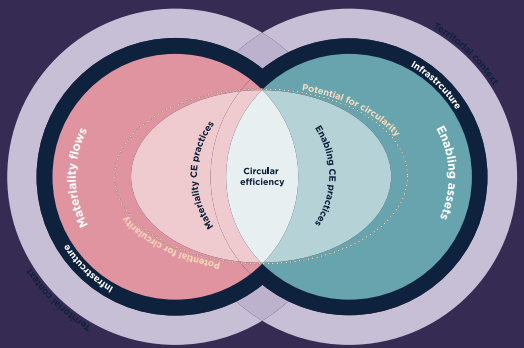
Materiality CE Practices:

Existing material flows within the infrastructure that are guided or ruled by circular actions.

Circular Potential:

What present systems and elements within the infrastructure are not applying circular practices but have the potential of shifting towards circularity taking into consideration the existing context that conditions these.

More performance



For applying these lenses, the evaluation of the infrastructure should take into consideration the territorial context that conditions the infrastructure. Moreover **it is pertinent to ask what should these lenses map specifically within the infrastructure.** In order to give an answer to this query we need to define what we intend with infrastructure for this framework and **what to measure from this definition.**

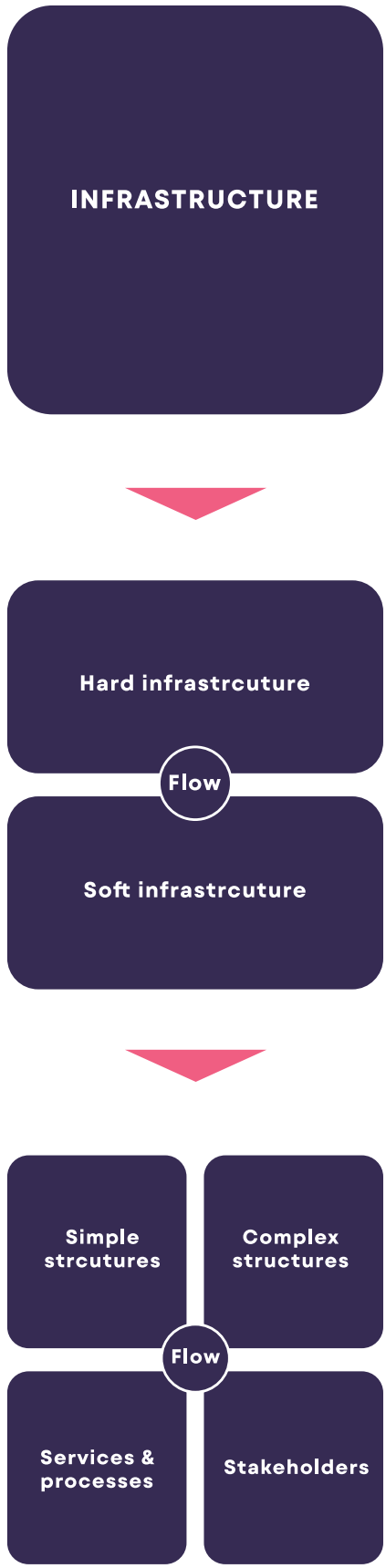
Defining Infrastructure For The Framework:

When referring to infrastructure we refer to more than just the physical network. We can divide infrastructure in 2, hard structures (being the physical network) and soft structure (being the entities and services for the well functioning of the physical network) and these can be further divided into simple and complex structures, services and processes and stakeholder.

That said, in order to map and evaluate circular efficiency and performance it is crucial to understand how these 4 categories relate with each other, understanding how their elements, functions, processes and phenomena are related to the nature and characteristics of the urban flow itself (water, energy, etc.)

Furthermore the full understanding of infrastructure involves the understanding of its external and internal context. The external context is the territory intended as a system. **The territory affects and at the same time is being affected by the infrastructure, this symbiotic relation defines emergent characteristics of the infrastructure itself which are key for the understanding of its functioning and the evaluation of its circularity.** By the other hand the internal context introduces us to different layers of the infrastructure itself. In other words, different layers of stakeholders, actions and processes define what the infrastructure is and how it works. Let's illustrate this understanding of infrastructure with an example:

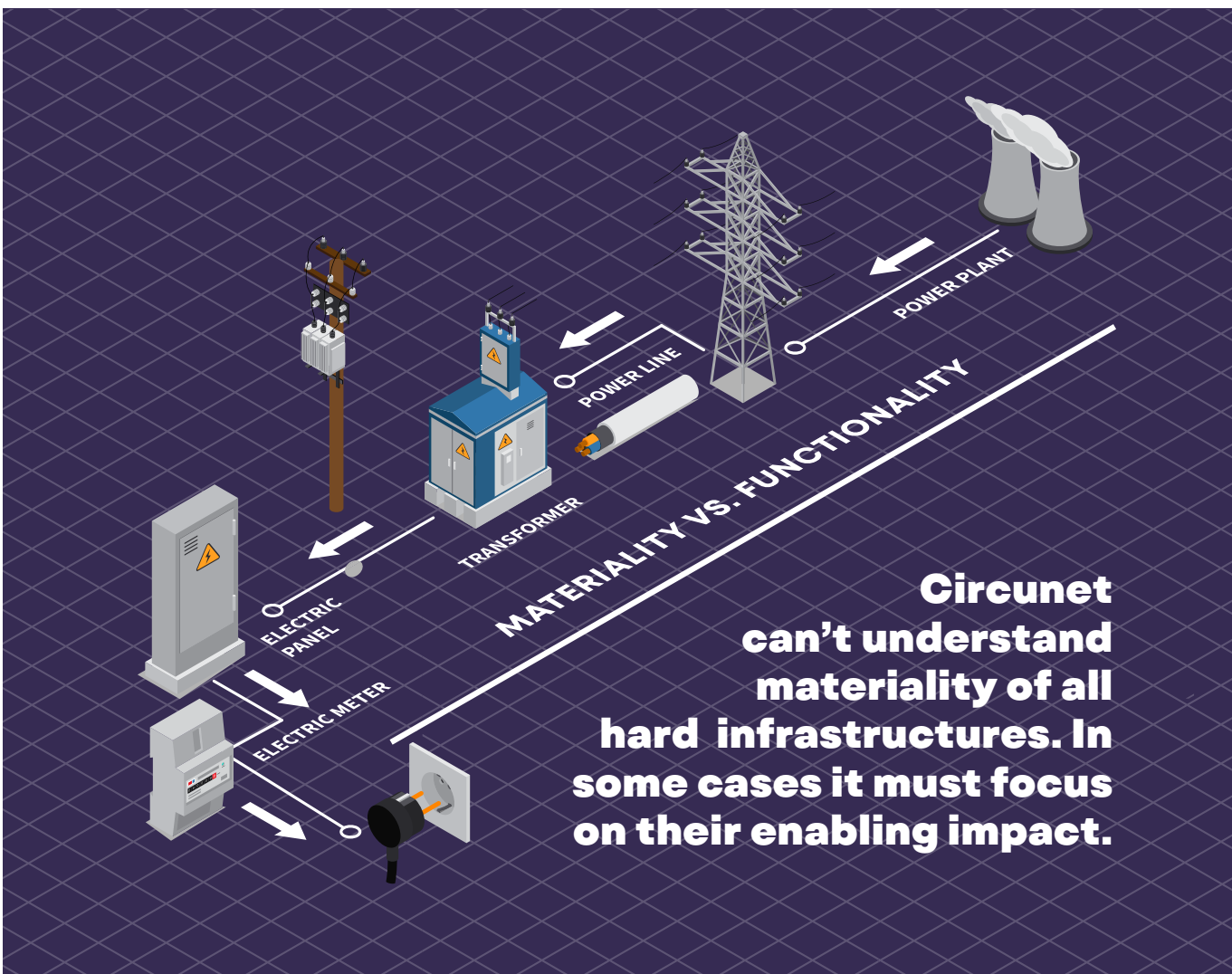
Let's take for example a generic stakeholder in charge of water distribution: First of all we can say water distributors have two types of hard structure components, complex and simple. **An**



example of a complex component could be a water pump. Water pumps are vital elements within the network functionality and how they operate influence how circular the network is, however we can also talk about how circular was the process for the production of that water pump, and that is where circunet puts the limit. **Circunet intends to understand how the functionality of the pump affects the circularity of the network but not how its materiality does, leaving aside third party processes for complex components.** By the other hand we have simple components; **an example of a simple component for the water distribution infrastructure could be the pipes.** Water pipes also influence the network's circularity by how they operate, however in this case we can talk about the materiality of the pipes and how the process of production affects how circular is the network; in this case Circunet's boundaries do comprehend third party processes.

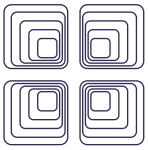
Furthermore these components co-exist with a series of services and processes that allow the well functioning of the flow, for example the maintenance service of the pump may guarantee circular features of the network like control of water loss. Added to this, such services and processes are conditioned and regulated by a series of stakeholders. In the case of the maintenance service it could be possible that the maintenance of the water pump can only be done by a third party expert who should be considered as part of the circularity of the network.

Taking into consideration the given definition for infrastructure**, we can project a complementary framework to the initial lenses** for the mapping of CE, a framework **that guides these two lenses in real life applications and allows a holistic and systemic vision of infrastructure;** a framework we can call **"The Clover Framework".**



THE CLOVER FRAMEWORK

The clover allows seeing the network as a whole and not as the sum of parts. The clover proposes Circunet to shift from a Gray-Box mapping of the infrastructure to a Network Vision of the infrastructure. **The intention here is to map all elements of the infrastructure and their relations within a temporal and territorial context, taking into consideration different levels and typologies of interactions.** In this sense, the clover measures circularity performance by understanding how elements within the network relate and interact.



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There are four typologies of interactions to be mapped: the **Inter-actions** (between elements); the **Hinter-actions** (between elements but with relation to the virtual boundaries); the **Intra-actions** (inherent phenomena that influence and create the flow itself); and the **Constitutional Relations** (relations between the different mapping categories that drive the application of CE practices within the network). These different interactions between scales, sub-categories and with the context are flows of capitals (Focus 2) that are regulated among them. By understanding these four typologies of interactions we can have a **mapping of the phenomena that occur all around the network within different scales and granularities of information.** The scheme allows us to have **different granularities of information** and being able to relate them or separate them according to the need. These levels of granularity are the scales for mapping. As shown in the diagram, these scales do influence each other and they all lie under the macro level (cities, country, international agencies).

Moreover, **the four sub-categories of infrastructure not only relate between each other but also influence each other.** A circular action within one category affects the other categories; this impact can be seen as a reaction chain that starts from a need generated within the context (as proposed in chapter 2.4.1). This need is then traduced in a circular initiative that flows to through soft and hard structures and at the end has an impact in the context itself.

By mapping UMs through the clover vision we can understand:

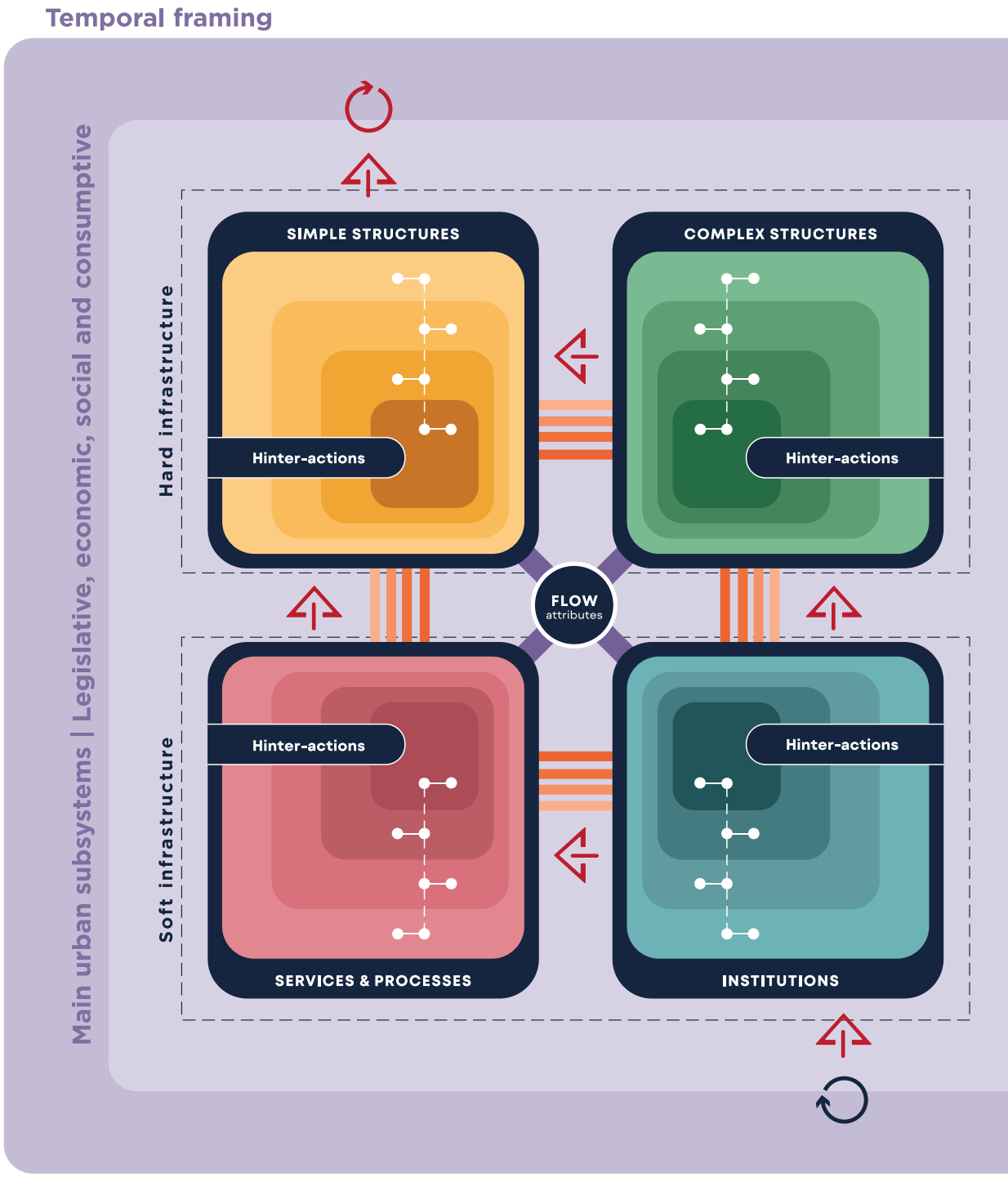
- **The energy and material budget pathways and efficiency;**
- **The flow intensity;**
- **The ratio of resource depletion, accumulation and transformation;**
- **The self-sufficiency and external dependency;**
- **The intrasystem heterogeneity;**
- **The intersystem and temporal variation;**
- **The regulating mechanisms and governing capacities.**

which are to the eight main characteristics that condition infrastructure proposed in chapter 3.3.2.

The clover allows a clear mapping of AFPs and their relations, which can then be understood by the two lenses: Enabling assets and materiality flows. Now, the question is how can Circunet create indicators that elevate this holistic mapping and lead to the evaluation of the CE potential, efficiency and performance of the network?

HOW CAN CIRCUNET CREATE INDICATORS THAT ELEVATE THIS HOLISTIC MAPPING AND LEAD TO THE EVALUATION OF THE CE POTENTIAL, EFFICIENCY AND PERFORMANCE OF THE NETWORK?

THE CLOVER FRAMEWORK



Scales for mapping

Different scales emerge accordign to the evaluation needed.

MACRO:
Cities, countries and intl. agencies. Metrics evaluate practices that pursue the change in habits, laws, programs and frameworks.

MESO:
Networks of industries and firms. Metrics evaluate how industrial symbiosis is working and how companies exchange flows and mutualize needs.

MICRO:
Companies and consumers. Metrics look for rates of green consumption and production.

NANO:
Departments, structure or teams. Metrics cover consumption actions and behaviours infuencing life expectancy of goods and services.

CE Action impact

Influence of elements among each other. Dictates enabling paths and barriers.

Influence cycle restart

At the end the infrastrcucture also has an impact on the urban subsystems an the impact cycle repeats within a different time frame.

Constitutional Relations

Interactions among subdivision categories within or between different scales. Dictate how enabling assets and materiality flows influence the CE of the network.

Intra-actions

Phenomena that emerge from the constant exchanging and scattering of relations along the network. These work inseparably and influence the flow itself.

Inter-actions

Relations between elements, within or between different scales of the same subdivision category. 4 main types: Competition, commensalism, mutualism and parasitism.

Hinter-actions

Relations present in the hinterlands are those that do not exist within the territory's physical boundaries but influence the territory. These exist at any scale.

6.4.1
"The Clover" Within Circunet

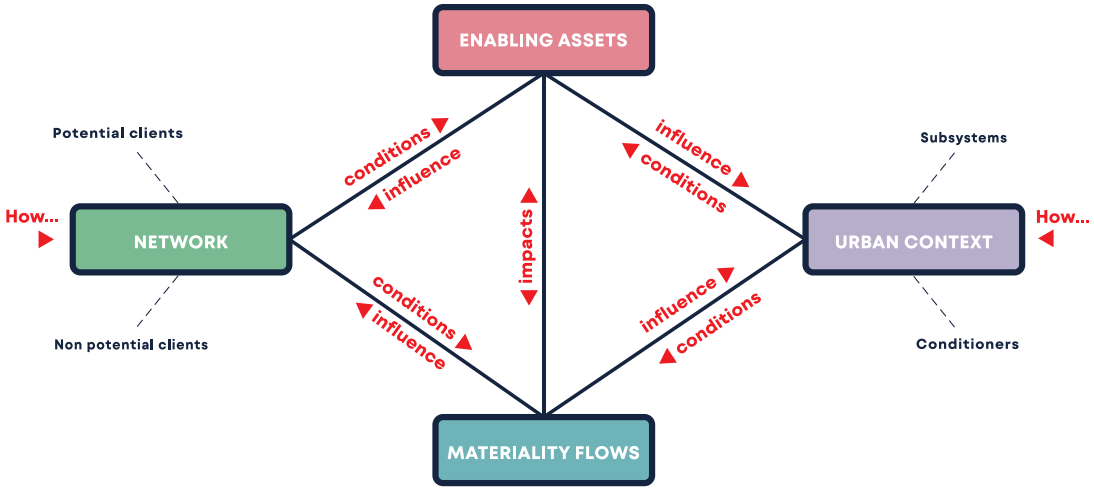
A BRIDGE BETWEEN NETWORK & URBAN CONTEXT

The clover shows us how to map and relate data but not how to measure it. In this sense we need to ask: **How can circunet generate indicators based on the clover?** However, this is not an easy question, because every urban metabolism and context is different from each other, and the gap between these two can't be standardized, therefore defining fixed indicators will not tell us the true circular efficiency and performance of UMs' infrastructure. Furthermore, Circunet is aiming for five different UMs which have completely different natures and should be evaluated in different ways.

That said, instead of proposing fixed indicators for each service, I want to propose **a more flexible tool that allows circunet ask the right questions in order to create adaptable metrics in accordance to the network and the urban context.**

In order to talk about adaptable metrics, we need to understand the impact something has over other things and how this impact may vary according to the situation. In this sense, the idea is to **understand the impact that networks have over the urban context and vice versa,** and how enabling assets and material flows condition the situation that varies that impact.

In other words, **I propose to create a bridge over the gap between the network and the context, by questioning how they are related with the two infrastructure lenses** (Enabling assets and materiality flows), and how their relation conditions and influences each other. Moreover this bridge keeps the nature of the lenses' framework by understanding the impact they have between each other; by understanding their relation we can measure the CE efficiency of the network.



This bridge allows us to develop **6 principal questions that create metrics for the evaluation** of circular efficiency and performance, which are:

How does the network conditions enabling assets that influence the urban context?

How does the network conditions materiality flows that influence the urban context?

How does the urban context conditions enabling assets that influence the network?

How does the urban context conditions materiality flows that influence the network?

How materiality flows impact enabling assets?

How enabling assets impact materiality flows?

However these questions are still too generic for circunet to create precise metrics. **In order to transform these questions from a generic state to a more precise and useful inquiry for Circunet, it is necessary to have a further understanding of the elements that compose the bridge.**

Network:

These are the **stakeholders** that make part of the infrastructure and influence circular practices. They might, or might not have the potential of being clients of circunet.

Urban Context:

Here we can base our definition of urban context from the proposed diagram of complex cities (chapter 2.4.1) In this sense we can state that the urban context is composed of 2 main elements: The **territorial sub-systems (Legislative, societal, economical and consumption) and the conditioners** that define the territorial boundaries (technology, infrastructure, history and culture and natural environment).

Materiality Flows:

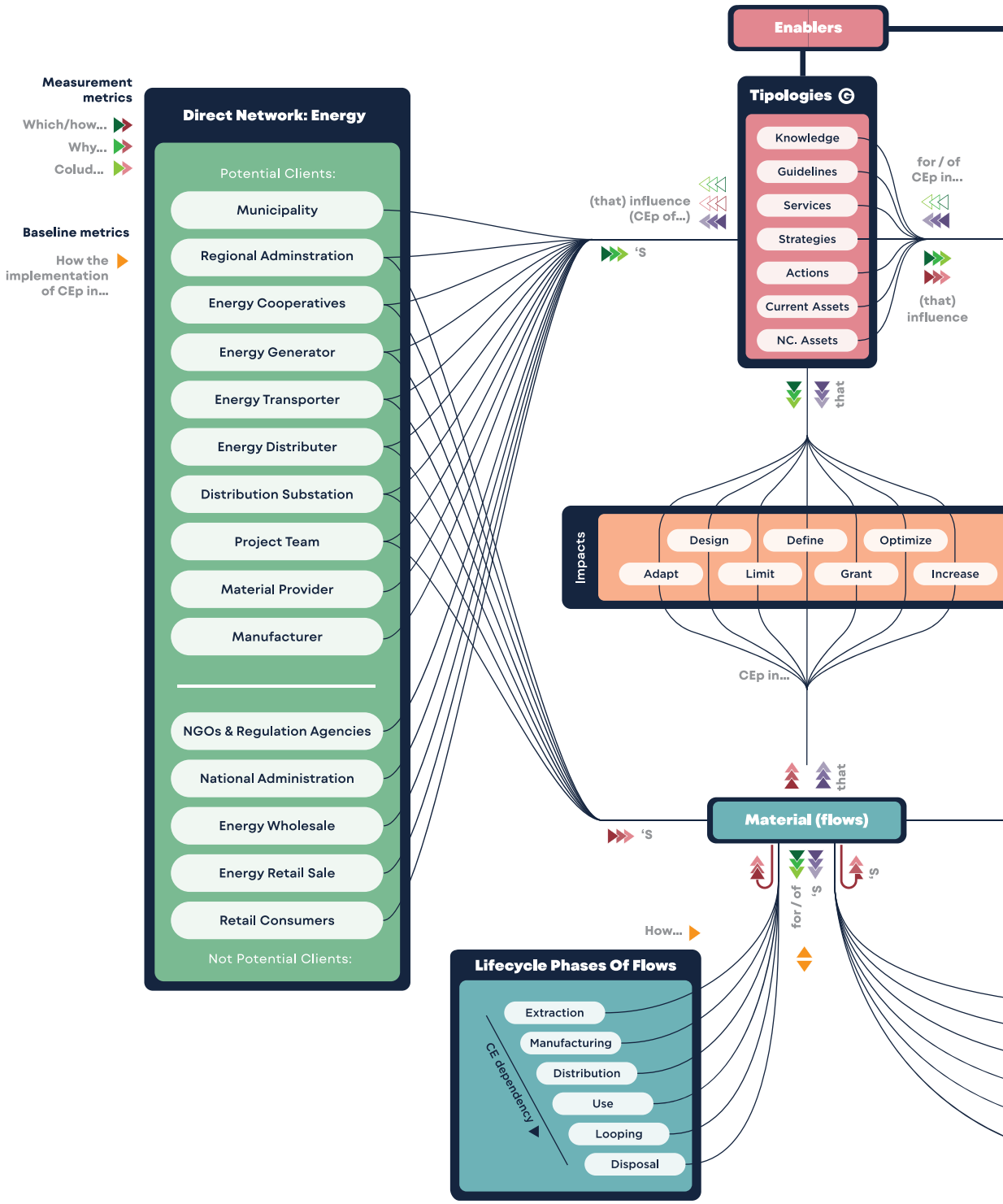
As previously said these are the **existing material flows within the infrastructure.** And although we can specify all the possible flows, we can define what are the main characteristics that define these flows. In this sense we can talk about the temporal existence of the flow (relating it to the lifecycle phases) and the flow principles (Focus 3).

Enabling Assets:

As previously stated these are the **existing practices/phenomena within the infrastructure that act as catalizers and channels of circular principles**. Here we can't talk about specific assets due to the vast … but we can talk about the typologies of these assets and different catalyzers that potentiate these assets.

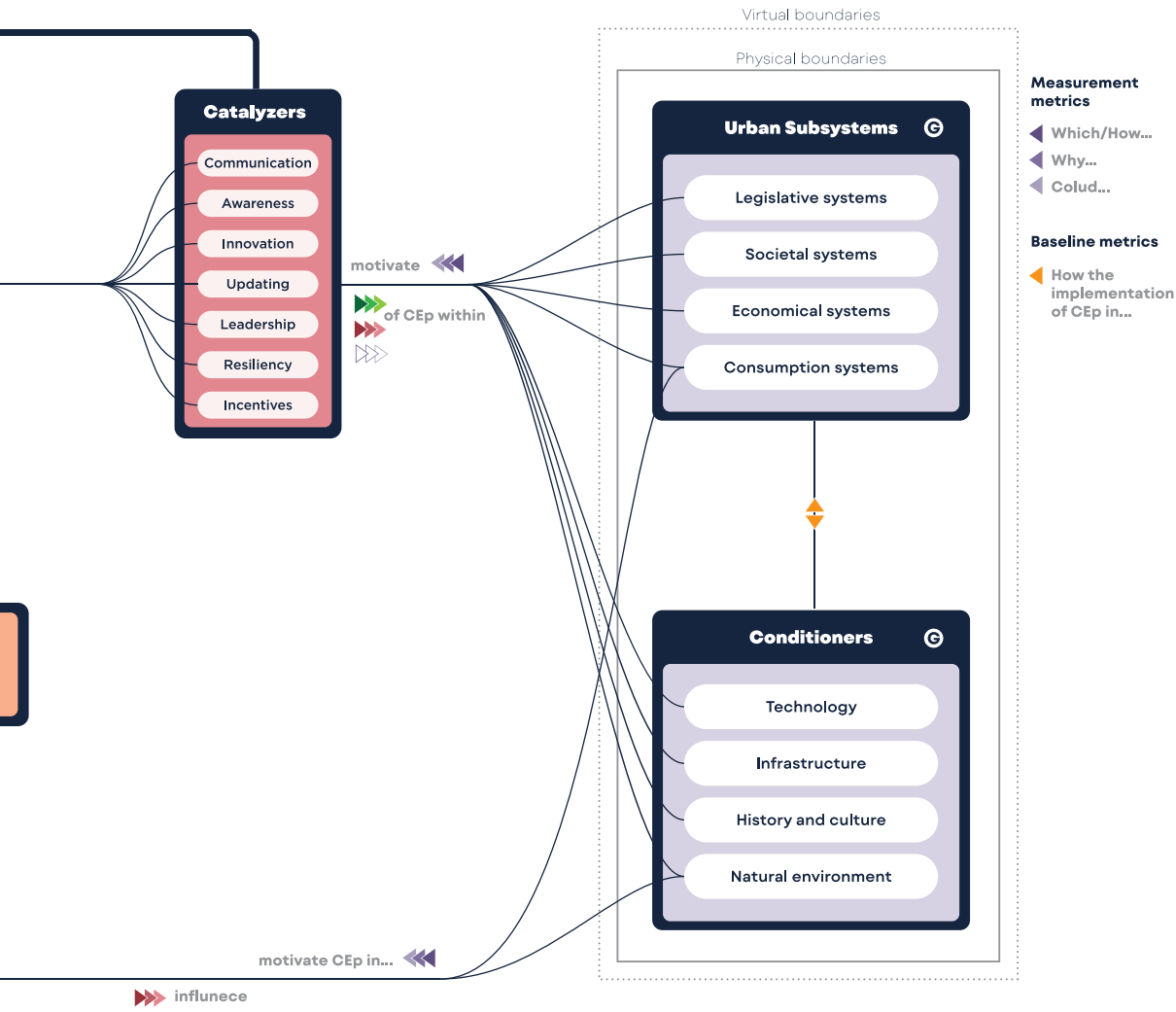
By understanding what composes these 4 elements in detail we can now propose different flows between these elements for the elaboration of more specific questions that take us to precise indicators. For this we can visualize a more complex bridge that decomposes the four main elements and create more elaborated question flows that are guided by the 4 fundamental questions stated in chapter 5.2.8. **The following diagram is an example of how to use this bridge with an unspecified example of an energy utility network,** however this bridge can be used with any of the previously mentioned networks.

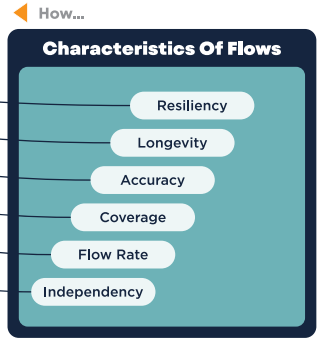
ENERGY NETWORK BRIDGE



CAN'T READ WELL?

SCAN FOR DIGITAL VERSION





Conventions

Measurement metrics
Measurements for understanding the efficiency and performance of circularity within the network.

Baseline metrics
Previous constructed knowledge needed for an objective evaluation. These set the ideal impact of CEp. (These use the same paths as the measurement metrics.)

Looper
Flow turns and changes direction to the starting box.

"Impact"
CEp: Circular economy practices

ENERGY UTILITY NETWORK BRIDGE EXPLANATION:

As shown by the diagram, the bridge is now formed of various blocks of information that decompose the original components. Within these blocks we can find different categories or elements that can be read as a single component or as a whole. **This bridge can be used as a tool for the construction of measurement metrics specifically designed for each network, giving insight of its CE efficiency and performance.** The bridge is capable of constructing 2 two main flow categories, one is for the measurement metrics and the other one is for the baseline metrics for projection. **The measurement metrics** map the four fundamental questions and as a result it is possible to offer a net impact of CE within the network. However circunet needs a **baseline knowledge** of the possibilities and opportunities that could exist in order to a tool that guides its clients shift towards circularity, and facilitate the decision making and identification of strategies, for actions that fulfill sustainable supply and demand of public infrastructure.

In this case these are generic elements, however **there could be a further specification of these elements according to the UM that is being evaluated.** For example for the enablers category, typologies block, the element "current assets" could be changed for "construction machinery". Added to this, the bridge explores the possible impacts that the two lenses may have over one another, which delimits even more what the metrics are looking for.

That said we can compose some examples of the construction of these questions:

Could pipe technology within physical boundaries motivate circulareconomy practices for material extraction?

Which energy-distributor's KPIs define circular economy practices of material flows for use?

Why IRETI's material manufacturing limit financial incentives that influence circular economy practices of the municipality?

How laws for reduction of emissions within virtual boundaries motivate awareness of circular economy practices in R&D programs that influence energy-generators?

6.5
Methodological Structure: A New Structural Value For Cirunet

For the last chapters we have presented 3 main tools/frameworks that can support circunet become a more valuable tool for the accomplishment of it original objective of helping public administrator and network managers. However these three presented frameworks are still dislocated from how Circunet as a digital tool works. Therefore the question that emerges is, **how can circunet integrate these three frameworks within its structure of data collection, analysis and distribution offered as a digital tool?** In this sense

we need to see these three frameworks as part of one same methodology that rules the structural value of the digital tool.

For this, we can relate this trilogy as a process of collection, analysis and distribution within the platform. That said, we can propose the following methodological structure: **The Bridge guides the input of data, The Clover guides the analysis of this data and The Lenses guide the output data.** This doesn't mean that these three should exist separately, they are always influencing each other.

Spheres:

Understand CE context within the network (This what circunet should give as main result).

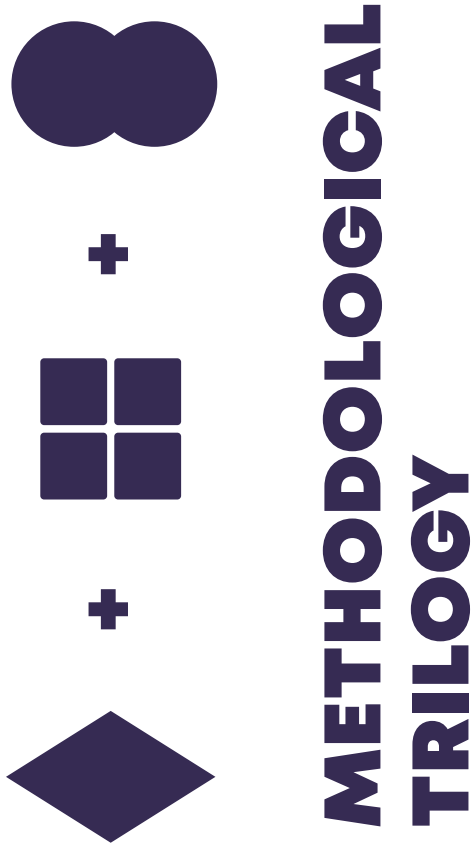
Clover:

Map the relations between the elements that compose the network and their CE quality (This is how circunet should map and evaluate the network and insight of CE net impact).

Bridge:

Evaluate the net impact of the elements that compose the network. (This is how circunet should construct indicators and insight of CE).

By adopting this methodology, the digital tool will be able to create specific metrics that understand infrastructure in holistic ways, eliminating the gap between the network and the context. Furthermore **this methodology allows Circunet to analyze data always taking into consideration the net impact of circular practices,** giving a more accurate vision of the challenges and opportunities each network has, which at the same time help Circunet to facilitate the decision of possible strategic pathways for circularity and **ease the prioritization of actions for a more efficient and effective transition towards sustainable networks.**



OUTPUTS AND CHALLENGES FROM A NEW METHODOLOGY

By applying this methodological structure the tool not only **offers a holistic approach** towards urban utilities but it also **sustains a unified vision** that welcomes **different scales and natures of stakeholders**, understanding their **uniqueness within their context.** It is a vision that opens the doors for Circunet to offer objective and accurate assessment, capable of understanding **different granularities of data**, from a quantitative and a qualitative nature. **The digital platform becomes not only a tool for evaluation of CE but also a tool that enables CE, it becomes an enabling asset of the network itself**, a space where different actors create knowledge by understanding their internal and external relations.

Moreover it allows **flexibility and scalability of the evaluation** of stakeholders, in this sense it opens the **spectrum of the potential clients for Circunet** and allows the correlation between them, this at the same time brings the possibility of scalability of the selection of **relevant measurements for each stakeholder**. Having the option of filtering the relevant measurements Circunet will be able to offer **data processing guided by each client's scope.**

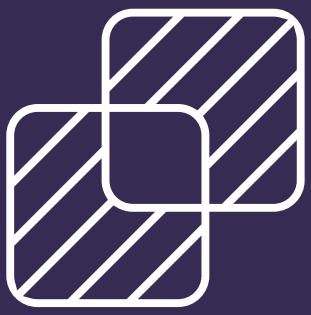
However, not everything is perfect within this methodology.

Circunet must face a series of 3 main challenges in order to offer a high quality solution for its clients.

Each challenge is presented within the 3 phases of the data (collecting, processing and output).

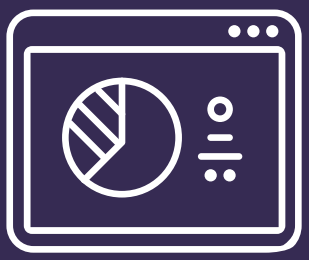
CHALLENGE FOR DATA COLLECTION:

A better and more useful assessment requires a high quantity of data input and in some cases **the tool must offer sensitive data clearance** (depending what we consider sensitive), in order to achieve transparency and full comprehension of the client. For this, **the tool must guarantee a high user engagement for the data construction and instruments that guarantee the data security and access.**



CHALLENGE FOR DATA PROCESSING:

Having more and more complex data also requires technological support in the grade of processing and giving results of the given data. In this case, data could arrive to such complexity that a standard digital tool for evaluation might not be enough for data analysis. For this purpose **it is important to have a grade of standardization, without sacrificing the unique comprehension of each network.**

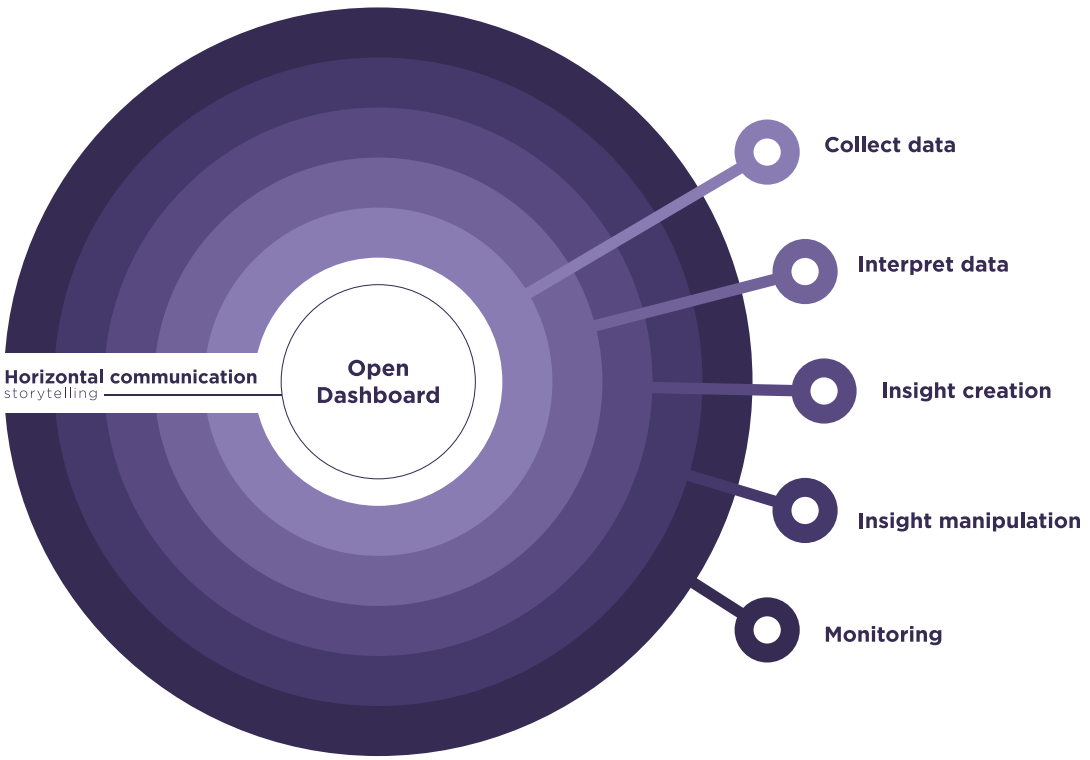


CHALLENGE FOR DATA OUTPUT:

At the end, the value of circunet lies in its capacity of communicating valuable information for the client which can be used and transformed as a strategic tool for the client itself. **It must be a transversal communication, so no matter who is the client, it can interpret the 4 fundamental questions.**

6.6
Towards A New Digital Platform

Taking into consideration the potential and challenges of the framework we can now give a step forward towards **a more concrete proposal for circunet as a digital platform.** First of all we can state how the tool should work. We can define **5 main stages within Circunet's functioning** which are: Data collection, data interpretation, insight creation, insight manipulation and data/process monitoring.



This proposal sets a digital platform with three major sections:

Questionnaires section:
Collection and preparation of data.

The dashboard section:
Visualization and management of data.

The projection section:
Linked, filtered and objectivized data.

These three sections combine technological based actions (data for evaluation of CE) and client based actions (data for action towards CE). **How these three sections link will determine how the three main challenges of data previously mentioned are alleviated**. By linking these sections in a coherent way Circunet will be capable of offering a comprehensive tool that gives transversal insight of circularity and a clear vision to the four fundamental questions.

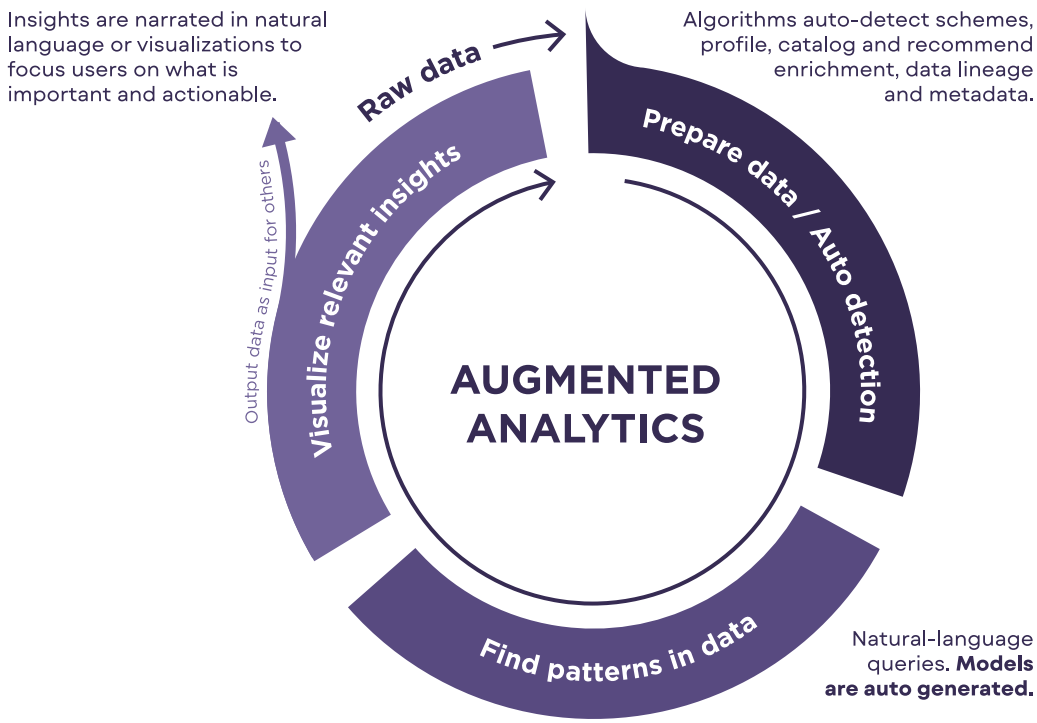
Now the question is **how to combine and adapt the platform's logic with each user's needs?** For that, the tool must offer a more flexible platform that understands and delivers the complexity, proposed by the trilogy framework, and delivers it in a more friendly and adaptable language for clients.

Circunet successfully increases the complexity and the value of data without sacrificing the unique reality of each network. For that **I propose an adoption of an alternative stage within data life cycle** (chapter 5.2.4) called

"Augmented analytics".

This concept refers tothe use of enabling technologies such as **machine learning and AI to assist and augment: data preparation; generation of insights;** and insight management though BI platforms. In a few words it is a series of algorithms capable of simplifying the complex structuring of data for insight creation and the delivering of this processed information in more natural languages, helping so in the development of transversal insights for the client and for the network. By adopting this new methodology of data processing **Circunet may offer a more engaging tool, that offers clients more flexibility and independence for data management, without losing its standardization (key for evaluation).**

In this way CircuNet shifts from focusing on the collection of more data, to focusing on how to link that data, enabling its conversion towards actionable insights and furthermore tracing their progress towards set objectives. Circunet will also be able to offer users a more user-friendly platform which **opens the possibility for companies to work in real time with data,** engaging even more their participation within the tool. Now, the question that emerges is: **how to offer clients this new proposal?**



6.6.1
A New Business Model For Circunet

Originally CircuNet proposed a SaaS business model, however it is important to re-think how to propose this Saas model taking into consideration the new methodology and platform functioning proposal. As mentioned before Circunet clients are the network managers and public administrators and they exist within various scales, and all these levels can be considered as different customers or are part of a whole. That said Circunet must adapt its business model taking into consideration these lavel scales and the relation they have.

Now the question is: **how can we propose a SaaS business and pricing model around all these possible users?** For this it is necessary to think of a flexible business model that adapts according to the needs of each client. This flexibility can be based in 2 main characteristics of the tool:

1. The type of output the platform is offering.

2. The added value offered by the platform.

These two, go in line with 2 business model concepts called: **Client fencing and client laddering** . (Samsung Next, 2020) **Client fencing** is a categorization of the typology of clients, according to their data processing needs (how data is linked within the tool for the creation of outputs). For example, for Cirunet, although potential clients have the same scope of better management, like municipalities and network providers, they both have different data processing needs because of the scale of their evaluation and actions (macro and micro respectively). It is important to note that fencing **is not about how big a client is but about the type of output the platform is bringing to that user.**

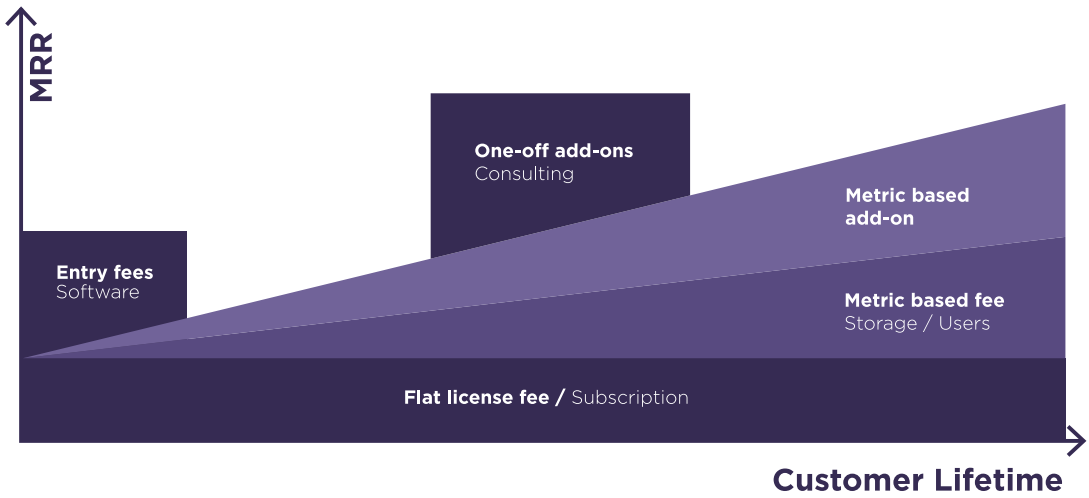
Within this client fencing there is another partition of stakeholders, which is the price laddering. **The laddering** is how different features and characteristics of the tool bring added value to the client. It is important to make note of the fact that it is not about creating a different value for the client, but about upgrading and optimizing the original value offered by the platform. For example, for circunet, a possible laddering feature is the integration of API's or the data storage capacity, which allow a more fluid use of the tool within the stakeholder structure.

Some features that may be useful for the pricing structure:

- Number of users
- Number of data
- Ability of connectivity
- Ability of programming
- Data secure
- Centralization of account
- Dedicated guide and success manager
- Integration of other formats and applications

By adopting these characteristics within the proposed SaS model of Circunet, we can give an overview of their pricing model structured by a fixed entry fee which is adjusted to a monthly/ yearly enrolment defined by the stakeholder categorization. Furthermore the tool may offer "add-ons" are the extra features that Circunet may offer as a service; these could be a 1 to 1 consultancy with the team, workshops for insight development, alignment sessions with different actors in the chain, among others.

New Pricing Model For Circunet



This model opens the door to the development of a new, upgraded and feasible digital tool, that helps the transition of public utilities towards more sustainable practices; a new Circunet.

NO MATTER THE TYPE OF CLIENT, IT MUST FIND THE VALUE IT WAS LOOKING FOR IN THE OUTPUT PROVIDED BY THE PLATFORM.

07

CIRCUNET 2.0:
Proposal of a new platform

As a last phase of this thesis work, taking into consideration the new proposed methodology and business plan and gathering different practices from other platforms we can step towards a last phase, which is the creation of a first draft of the new digital platform: Circunet 2.0. This proposal is a first approach, and has the intention of demonstrating how these elements could come together within a concrete digital platform, therefore it should not be taken as a definitive solution but as a demo.

CONTENT INVENTORY

The previous chapters identified functions that the platform should offer in order to add value to the user. For this reason, as a first approach to this proposal a content inventory has been done, clustering and categorizing functions and elements for the proposal.

Data dashboard
Section for the management and visualization of the user's data. Personalization of data output.

Data view-board
For visualization and connection of data from the entire network. Demonstration of how the network is working as a whole towards circularity.

Introduction to the platform
It is really important to show users how to uwse the platform and engage them from the first moment.

Management of sensitive data
Organization and hierarchies of information that defines the access from other users.

Content divided by tags and filters
Organization of data by tags and filters that allows a more personalized and focal experience. Easier lecture and projection with data.

API features
Allow the integration of other formats and plugins within the platform. And create new access/integration routes from other platforms.

Timelines and history of progress
Data collection that gives a follow up of the progress of each user and reveals weak and strong points towards circularity.

Projection and milestone roadmap
Creation and organization of potential actions for the improvement of circularity. Link to KPIs of the stakeholder.

Creation of networks and groups
Creation of multi profile networks that feed from information given from various stakeholders.

Territorial linking
Create territorial profiles that can be linked to stakeholders. Build up an adequate description of the territory.

Adaptable questionnaires
Various routes of questionnaires will give a more adequate lecture of the circularity according to the given answers.

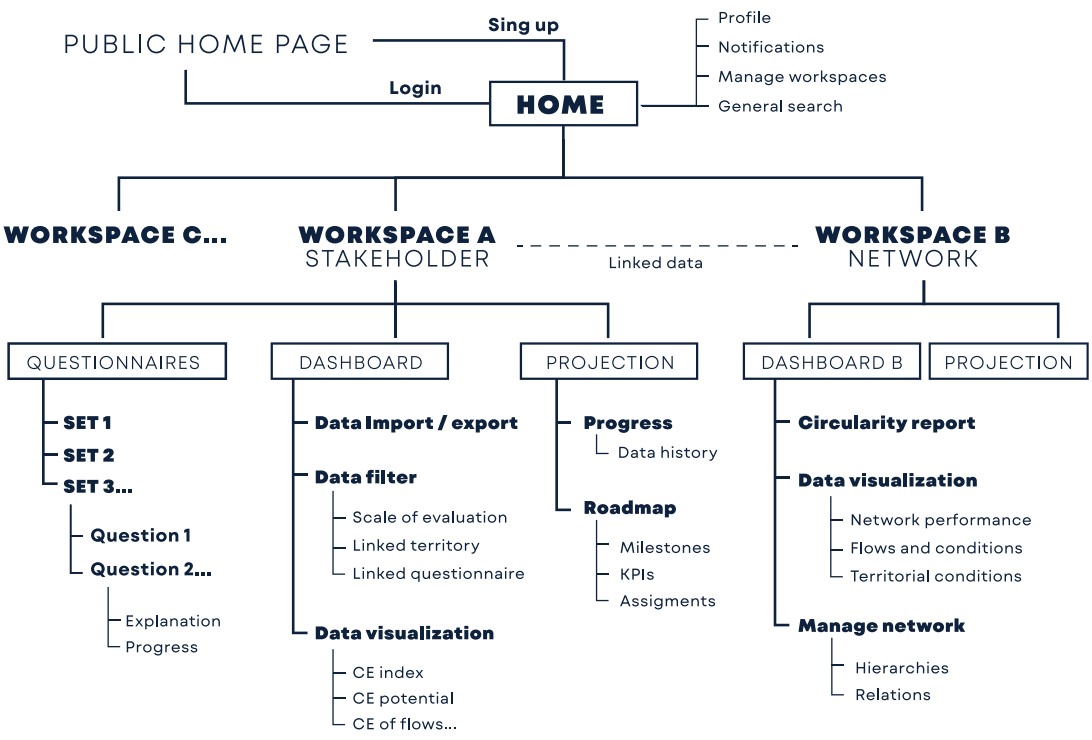
Automation-Programming section
Allow and guide users link data useful for them for the creation of strategies and action plans towards circularity.

AI - Algorithms
That links data, filters questionnaires and proposes possible actions for each specific reality.

Content in various languages
Translation of content in order to make it accessible to an international audience.

Learning resources
Offer extra resources to stakeholders for the creation of knowledge and application of CE within their practices.

USER EXPERIENCE



INTERFACE

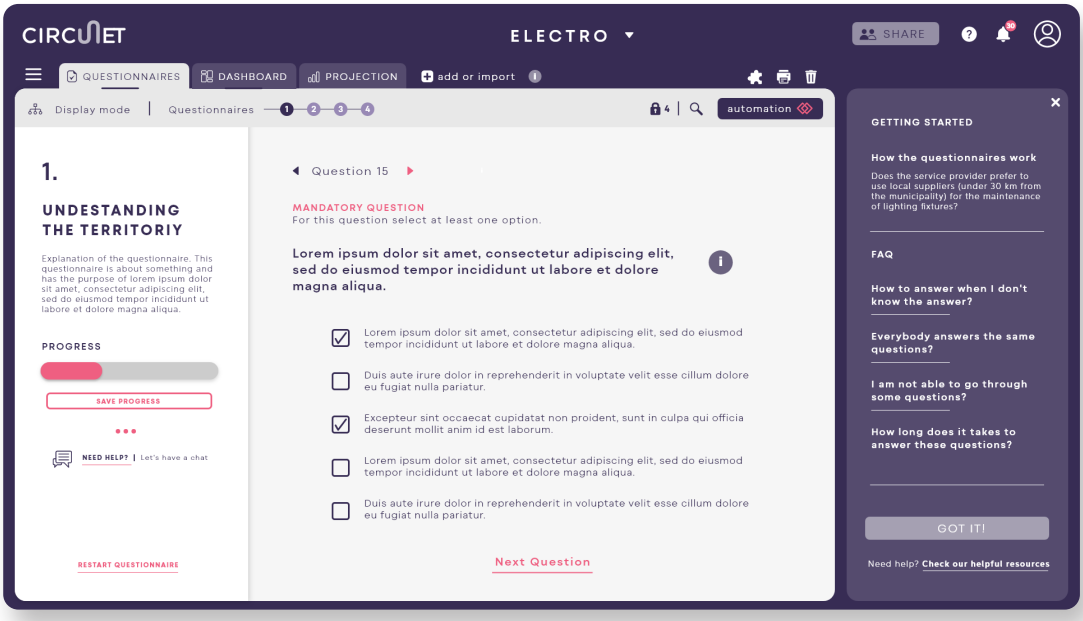
PROPOSAL FOR A NEW IMAGE

CIRCUNET

circularity for urban networks

CIRCUNET 2.0
INTERFACE

*The graphics and texts are for illustrative purposes only.


CIRCULET
ELECTRO
SHARE
QUESTIONNAIRES
DASHBOARD
PROJECTION
add or import
Display mode
Questionnaires
automation
1.
UNDESTANDING THE TERRITORIY
Explanation of the questionnaire. This questionnaire is about something and has the purpose of lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.
PROGRESS
SAVE PROGRESS
NEED HELP? | Let's have a chat
RESTART QUESTIONNAIRE
Question 15
MANDATORY QUESTION
For this question select at least one option.
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.
Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.
Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.
Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.
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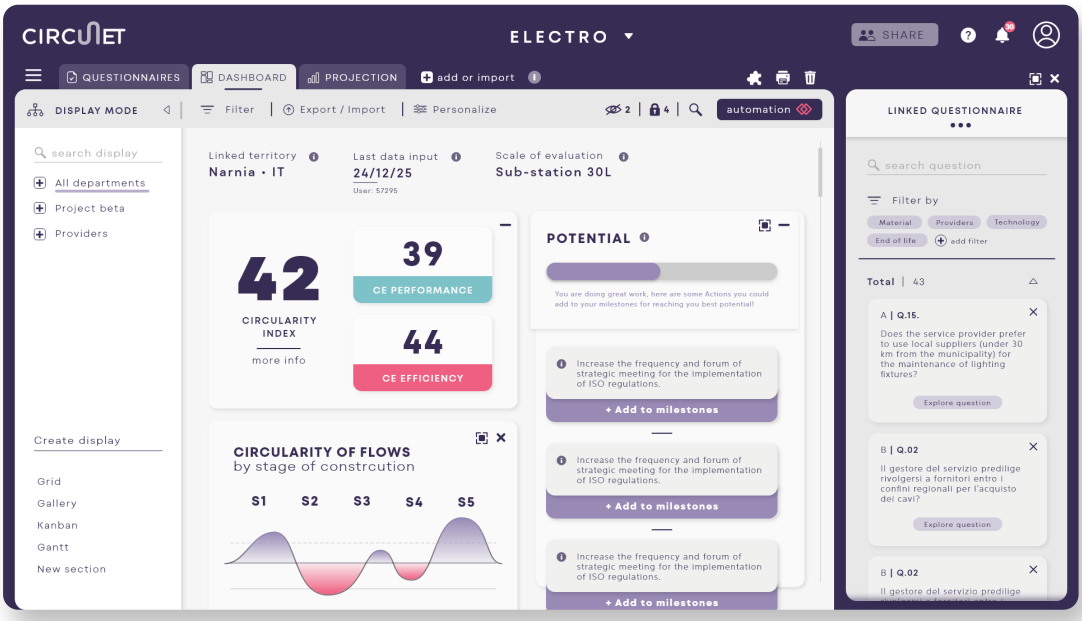
Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.
Next Question
GETTING STARTED
How the questionnaires work
Does the service provider prefer to use local suppliers (under 30 km from the municipality) for the maintenance of lighting fixtures?
FAQ
How to answer when I don't know the answer?
Everybody answers the same questions?
I am not able to go through some questions?
How long does it takes to answer these questions?
GOT IT!
Need help? Check our helpful resources


CIRCULET
ELECTRO
SHARE
QUESTIONNAIRES
DASHBOARD
PROJECTION
add or import
DISPLAY MODE
Filter
Export / Import
Personalize
automation
search display
All departments
Project beta
Providers
Create display
Grid
Gallery
Kanban
Gantt
New section
Linked territory
Narnia · IT
Last data input
24/12/25
User: 57295
Scale of evaluation
Sub-station 30L
42
CIRCULARITY INDEX
more info
39
CE PERFORMANCE
44
CE EFFICIENCY
POTENTIAL
You are doing great work, here are some Actions you could add to your milestones for reaching you best potential!
Increase the frequency and forum of strategic meeting for the implementation of ISO regulations.
+ Add to milestones
CIRCULARITY OF FLOWS
by stage of constrcution
S1
S2
S3
S4
S5
LINKED QUESTIONNAIRE
search question
Filter by
Material
Providers
Technology
End of life
add filter
Total | 43
A | Q.15.
Does the service provider prefer to use local suppliers (under 30 km from the municipality) for the maintenance of lighting fixtures?
Explore question
B | Q.02
Il gestore del servizio predilige rivolgersi a fornitori entro i confini regionali per l'acquisto dei cavi?
Explore question
B | Q.02

08

GENERAL CONCLUSIONS

The presented work of thesis has set the general objective of giving support to Sis.Ter for the evaluation and development of "Circunet" as a digital tool for circularity-assessment within public utilities. In order to reach this objective, a precise evaluation of "circunet"as a digital tool was carried out. For this, a preliminary research has been done and linked to the systemic design methodology. Thanks to this methodology, it has been possible to study the relevance that the tool has as a support for network managers, and it was concluded that the tool was still lacking an approach able to understand complexity and uniqueness of urban networks. Moreover Circunet was also lacking the capacity of traducing input data into actionable data that offered and added value for its clients.

That said, the core of this thesis work focuses on the definition of an upgraded tool: "Circunet 2.0". A platform based on a new framework for digital tools to assess circularity-performance within urban networks in a more systemic way. Based on this framework, Circunet can offer a more holistic understanding of urban networks and a more precise and accurate evaluation of circularity, by comprehending and linking the network and territorial context. This framework unites and creates value from the systemic design and circular economy principles, and impacts the territory and network stakeholders in multiple scales. The tool is now able to give each stakeholder a different role and importance within the network's circularity. It is a vision that allows network managers and public administrators better understand their circularity efficiency and performance, and manage their transition towards circular models with ease. This, thanks to the comprehension of their circular potential, which is given by the transparency and full understanding of the context elements and relations between the elements of the network. In this sense Circunet shifts from a passive tool that evaluates circularity, to an active tool that has a direct influence in the circular performance of the stakeholders and becomes a key instrument for the network. Moreover it is a tool with great potential of expansion to other public infrastruc-

ture and it is not easily replicable by others, due to the fact that it now focuses on the linking of data instead of the collection of data.

The implementation of this framework presents some challenges and limits for Circunet. First of all, Sis.ter is still not in grade of applying the previously proposed solution in a short period of time due to the technology and algorithms that must be developed for such tool. Therefore, its implementation must be gradually displayed, and a new MVP capable of offering a basic satisfaction of the proposed value must be the first step. For this, a combination of technological and traditional consultancy tools can be used in order to shape a well structured platform. Moreover, this early implementation must involve various clients within the different scales of evaluation in order to learn the specificities of each stakeholder, for this Circunet can develop interviews, focus groups and surpass trial and error sessions. Another challenge is the fact of it, being a self-administered tool which obies Sis.ter to have a strong strategy towards client engagement, which becomes a key for success of the platform and should go beyond the tool itself and involve also the services offered around the tool. Additionally, it is key to understand that "Circunet 2.0" is not the holy grail of circularity, and many more actions and instruments can be complementary to the tool itself. The tool is just another step towards fully sustainable urban infrastructure.

It is vital for Circunet to think of circularity as a scale of colors and not as a simple "black and withe" situation. The tool must think beyond the simple fulfillment of circular principles and understand networks as systems full of conditions and consequences, circular performance must be seen as the ponderated value of an entire ecosystem, full of dynamic flows, actors and actions.

09

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10

APPENDIX

01
QUESTIONNAIRE FOR MUNICIPALITY

COMUNE

Inserire numero abitanti

<1'000
1'000-100'000
100'000 - 200'000
200'000 - 500'000
> 500'000
Non so/Non rispondo

Inserire superficie (km2)

< 100
100-200
200-300
300-400
> 400
Non so/Non rispondo

Budget annuale per sottoservizi (euro)

2'000 - 5'000
> 50'000
10'000- 50'000
5'000 - 10'000
< 2'000
Non so/Non rispondo

Valutazione stato del territorio: nel comune di riferimento, in che percentuale il territorio presenta vincoli archeologici?

Tra 10% e 20%
> 30%
Tra 20% e 30%
Tra 0% e 5%
Tra 5% e 10%
Non so/Non rispondo

Valutazione stato del territorio: nel comune di riferimento, in che percentuale il territorio presenta vincoli idrogeologici?

Tra 0% e 5%
Tra 5% e 10%
Tra 10% e 20%
Tra 20% e 30%
> 30%
Non so/Non rispondo

Valutazione stato del territorio: nel comune di riferimento, considerando i diritti di proprietà del suolo, come valuteresti l'iter burocratico di autorizzazioni in termini di durata e complessità?

Non so/Non rispondo
Molto lento e complesso
Abbastanza lento e complesso
Sempre veloce e semplice
Solitamente veloce e semplice
A volte veloce e semplice, a volte lento e complesso.

Valutazione stato del territorio: nel comune di riferimento, considerando le caratteristiche del suolo, come valuteresti l'iter burocratico di autorizzazioni in termini di durata e complessità?

Non so/Non rispondo
Solitamente veloce e semplice
Sempre veloce e semplice
Abbastanza lento e complesso
Molto lento e complesso
A volte veloce e semplice
a volte lento e complesso

02
QUESTIONNAIRES OF THE WATER NETWORK

VALUTAZIONE DEL GESTORE DEL SERVIZIO

1) Qual è il livello di adozione e sviluppo dei seguenti strumenti nella vostra organizzazione (o sito)? Sistema di gestione ambientale conforme allo standard ISO14001

- Stiamo solo valutando l'opportunità di adottare questo strumento
- Non è stata considerata l'adozione di questo strumento
- Non so/Non rispondo
- Lo strumento è già stato adottato con successo ed è pienamente sviluppato nella nostra azienda
- Stiamo adottando lo strumento che è in corso di sviluppo
- Stiamo effettivamente pianificando l'adozione e lo sviluppo di questo strumento

2) Qual è il livello di adozione e sviluppo dei seguenti strumenti nella vostra organizzazione (o sito)? Sistema di gestione ambientale conforme al Regolamento 1221/2009 EMAS

- Lo strumento è già stato adottato con successo ed è pienamente sviluppato nella nostra azienda
- Non so/Non rispondo
- Non è stata considerata l'adozione di questo strumento
- Stiamo effettivamente pianificando l'adozione e lo sviluppo di questo strumento
- Stiamo solo valutando l'opportunità di adottare questo strumento
- Stiamo adottando lo strumento che è in corso di sviluppo

3) Qual è il livello di adozione e sviluppo dei seguenti strumenti nella vostra organizzazione (o sito)? LCA – Analisi del ciclo di vita

- Stiamo adottando lo strumento che è in corso di sviluppo
- Stiamo solo valutando l'opportunità di adottare questo strumento
- Non è stata considerata l'adozione di questo strumento
- Lo strumento è già stato adottato con successo ed è pienamente sviluppato nella nostra azienda
- Non so/Non rispondo
- Stiamo effettivamente pianificando l'adozione e lo sviluppo di questo strumento

4) Qual è il livello di adozione e sviluppo dei seguenti strumenti nella vostra organizzazione (o sito)? Carbon Footprint / Impronta di carbonio (ad es.: secondo i requisiti della PAS 2050 o della ISO 14067)

- Lo strumento è già stato adottato con successo ed è pienamente sviluppato nella nostra azienda
- Stiamo adottando lo strumento che è in corso di sviluppo
- Stiamo effettivamente pianificando l'adozione e lo sviluppo di questo strumento
- Non so/Non rispondo
- Stiamo solo valutando l'opportunità di adottare questo strumento
- Non è stata considerata l'adozione di questo strumento

5) Qual è il livello di adozione e sviluppo dei seguenti strumenti nella vostra organizzazione (o sito)? Water Footprint / Impronta idrica (ad es.: secondo i requisiti della ISO 14046)

- Non so/Non rispondo
- Lo strumento è già stato adottato con successo ed è pienamente sviluppato nella nostra aziend
- Stiamo adottando lo strumento che è in corso di sviluppo
- Stiamo effettivamente pianificando l'adozione e lo sviluppo di questo strumento
- Stiamo solo valutando l'opportunità di adottare questo strumento
- Non è stata considerata l'adozione di questo strumento

Esprimere il suo livello di accordo sulla seguente affermazione. Le problematiche ambientali sono esplicitamente considerate durante il processo di pianificazione strategica dell'azienda.

- Abbastanza d'accordo
- Non so/Non rispondo
- Per niente d'accordo
- Poco d'accordo
- D'accordo
- Molto d'accordo

6) Esprimere il suo livello di accordo sulla seguente affermazione. La considerazione per l'ambiente naturale è espressa nella mission dell'azienda

Molto d'accordo
Non so/Non rispondo
Abbastanza d'accordo
D'accordo
Poco d'accordo
Per niente d'accordo

7) Esprimere il suo livello di accordo sulla seguente affermazione. Quando le problematiche ambientali sono considerate nel processo di pianificazione strategica, il top management prende decisioni proattive e orientate al futuro.

Abbastanza d'accordo
D'accordo
Non so/Non rispondo
Molto d'accordo
Poco d'accordo
Per niente d'accordo

8) Esprimere il suo livello di accordo sulla seguente affermazione. Il responsabile ambientale partecipa alla definizione delle strategie aziendali.

Poco d'accordo
Per niente d'accordo
Molto d'accordo
Non so/Non rispondo
Abbastanza d'accordo
D'accordo

9) Il gestore del servizio verifica che i propri fornitori esterni (es. servizio di posa, manutenzione, ...) abbiano adottato strategie ambientali?

Sì abbiamo verificato e solo una piccola parte dei miei fornitori attua strategie ambientali
Sì abbiamo verificato ma nessuno dei miei fornitori attua strategie ambientali
Sì abbiamo verificato e una buona parte dei miei fornitori attua strategie ambientali
Sì abbiamo verificato e tutti i miei fornitori attuano strategie ambientali
Non so/Non rispondo
No, non ho verificato

10) Il gestore del servizio redige annualmente il Report di Sostenibilità?

Sì, da cinque anni a questa parte
Non so/Non rispondo
No, non ci interessa
Sì, da più di cinque anni a questa parte
No, non abbiamo mai redatto un report di sostenibilità ma abbiamo intenzione di farlo
Abbiamo recentemente redatto il primo Report

11) Il gestore del servizio aspira alla trasformazione all'economia circolare attraverso la partecipazione a bandi su progetti relativi al tema?

Sì, ogni tanto partecipiamo
Non so/Non rispondo
Sì, partecipiamo regolarmente
Sì, partecipiamo spesso
Raramente
No, non ci interessa

12) Il gestore del servizio sensibilizza attivamente i propri utenti all'efficientamento delle risorse tramite campagne pubblicitarie?

Poco
In parte
In buona parte
Non so/Non rispondo
Sì
No

13) Il gestore del servizio facilita la comunicazione diretta con i propri utenti tramite servizi online/ applicazioni per smartphone?

In buona parte
Non so/Non rispondo
No
Poco
In parte
Sì

14) Quale percentuale dei costi totali del dipartimento di ricerca e sviluppo è dedicata alla ricerca di soluzioni innovative nel settore Circular Economy/Smart City?

Tra 10% e 30%
< 10%
Non so/Non rispondo
Tra 70% e 100%
Tra 50% e 70%
Tra 30% e 50%

15) Quale percentuale dei costi totali del dipartimento di ricerca e sviluppo è dedicata alla ricerca di soluzioni innovative nel settore Circular Economy/Smart City?

Tra 10% e 30%
< 10%
Non so/Non rispondo
Tra 70% e 100%
Tra 50% e 70%
Tra 30% e 50%

16) Il gestore del servizio aderisce al programma Circular Economy 100 (CE100) dell'Ellen MacArthur Foundation?

No, perché non ne siamo a conoscenza
Sì, abbiamo recentemente aderito
No, ma abbiamo in progetto di aderire
No, perchè non ci interessa
Non so/Non rispondo
Sì, abbiamo

MATERIALI E DESIGN

1) Sono previsti interventi di rinnovo di porzioni di rete obsolete entro i prossimi 5 anni?

Sì, tutta la parte della rete obsoleta sarà rinnovata entro 5 anni
Sì, una parte della rete obsoleta sarà rinnovata entro un anno
Sì, una parte della rete obsoleta sarà rinnovata entro 3 anni
Non so/Non rispondo
Sì, tutta la rete obsoleta sarà rinnovata entro 3 anni
No

2) Nell'acquisto delle tubature per la rete fognaria, il gestore del servizio ha scelto di rifornirsi da aziende che usano materiale riciclato (es. PVC)? Se sì - in che percentuale (in peso) è stato utilizzato materiale riciclato nella produzione?

Tra 10% e 30%
Tra 50% e 70%
Non so/Non rispondo
Tra 30% e 50%
< 10%
Tra 70% e 100%

3) Nell'acquisto di tubature per la rete acquedottistica, il gestore del servizio ha scelto di rifornirsi da aziende che usano che producono prodotti con materiale riciclabile a fine vita (es. PVC)? Se PVC: in che percentuale?

Tra 30% e 50%
Tra 70% e 100%
Tra 50% e 70%
< 10%
Non so/Non rispondo
Tra 10% e 30%

4) Il gestore del servizio predilige rivolgersi a fornitori locali (sotto i 30 km rispetto al comune di riferimento) per la manutenzione della rete?

Spesso
Sempre
Non so/Non rispondo
Mai
Quasi mai
A volte

5) Il gestore del servizio predilige rivolgersi a fornitori entro i confini regionali per l'acquisto delle tubature?

Sempre
A volte
Mai
Quasi mai
Spesso
Non so/Non rispondo

6) Il gestore del servizio si informa riguardo alla pianificazione dei percorsi che i propri fornitori di tubature scelgono di adottare e ne richiede l'ottimizzazione?

Mai
Sempre
Spesso
A volte
Quasi mai
Non so/Non rispondo

7) Il gestore del servizio richiede ai propri fornitori di tubature di intraprendere azioni mirate alla minimizzazione degli imballaggi delle stesse (es. riduzione del peso, riduzione dello spessore, riprogettazione per ottimizzare i carichi, cambiamento di materiale di base per rispondere a logiche di ottimizzazione dei carichi)?

Non so/Non rispondo
A volte
Mai
Quasi mai
Sempre
Spesso

FASE D'USO

1) Nel caso di installazione di una nuova rete o manutenzione/rinnovo della rete attuale, sono state utilizzate o si pianifica di utilizzare tecnologie no-dig (minitrincea, trivellazione controllata), ovvero tecnologie che evitano gli scavi a cielo aperto?

Spesso
Mai
Quasi mai
A volte
Sempre
Non so/Non rispondo

2) Qual è la percentuale di utenti raggiunti dalla rete idrica nel comune di riferimento?

Tra 70% e 100%
Non so/Non rispondo
< 10%
Tra 10% e 30%
Tra 30% e 50%
Tra 50% e 70%

3) Qual è la percentuale di utenti serviti dalla rete fogniaria-depurativa nel comune di riferimento?

Tra 30% e 50%
Tra 10% e 30%
Tra 70% e 100%
< 10%
Tra 50% e 70%
Non so/Non rispondo

4) Il gestore del servizio utilizza sistemi innovativi di monitoraggio per identificare/localizzare guasti nella rete?

No
Poco
In parte
In buona parte
Sì
Non so/Non rispondo

5) Viene effettuata una regolare manutenzione delle rete per aumentare la vita utile dei componenti?

Solo su segnalazioni
Ogni due anni
Non so/Non rispondo
Ogni anno
Ogni trimestre
Ogni semestre

6) Il gestore del servizio si occupa di riparare/sostituire parti della rete per aumentare la vita utile dei componenti?

No
Sì
In parte
Non so/Non rispondo
In buona parte
Poco

7) Qual è la percentuale di perdite idriche stimata nel comune?

Tra 10% e 30%
< 10%
Tra 70% e 100%
Tra 50% e 70%
Tra 30% e 50%
Non so/Non rispondo

8) Il gestore del servizio ha intrapreso attività finalizzate al contenimento delle perdite, come distrettualizzazione delle reti?

In buona parte
In parte
No
Poco
Sì
Non so/Non rispondo

9) Il gestore del servizio utilizza algoritmi avanzati per l'identificazione delle tratte di rete da sottoporre a ricerca attiva delle perdite?

No
In parte
Non so/Non rispondo
In buona parte
Poco
Sì

10) Il gestore del servizio utilizza un sistema di telecontrollo per raccogliere i segnali di allarme (variazioni nella pressione e nella portata)?

Sì
No
In buona parte
Poco
Non so/Non rispondo
In parte

11) Il gestore del servizio utilizza un sistema di gestione attiva delle pressioni?

In parte
No
Sì
Non so/Non rispondo
In buona parte
Poco

12) Il gestore del servizio adotta misure contro allagamento ed eventi estremi?

Non so/Non rispondo
No
Sì
Poco
In parte
In buona parte

13) E' stato implementato un sistema di smart metering per l'utenza (sistemi che consentono la telelettura e telegestione dei contatori dell'acqua)?

Poco
In buona parte
Non so/Non rispondo
Sì
No
In parte

14) Vengono adottate soluzioni innovative per la gestione dei fanghi da depurazione?

Sì
Non so/Non rispondo
In buona parte
In parte
Poco
No

15) Sono presenti sul territorio punti di approvvigionamento di acqua potabile naturale e gassata refrigerata per il riempimento di bottiglie in vetro?

Sì
Non so/Non rispondo
In buona parte
In parte
Poco
No

16) Sono presenti sul territorio fontanelle di acqua potabile?

No
Non so/Non rispondo
Sì
In buona parte
In parte
Poco

FASE FINE VITA

1) Se presenti, è previsto un piano di sostituzione delle vecchie condotte in cemento-amianto?

Non so/Non rispondo
In buona parte
In parte
Poco
No
Sì

2) Negli ultimi 5 anni, nel caso di installazione di una nuova rete o rinnovo di una parte di rete:- in che percentuale (in peso) il materiale dismesso viene destinato alla discarica?

Non so/Non rispondo
Tra 70% e 100%
Tra 50% e 70%
< 10%
Tra 30% e 50%
Tra 10% e 30%

3) Negli ultimi 5 anni, nel caso di installazione di una nuova rete o rinnovo di una parte di rete:- in che percentuale (in peso) le tubature in PVC e polietilene sono andate a riciclaggio?

< 10%
Tra 50% e 70%
Tra 70% e 100%
Non so/Non rispondo
Tra 30% e 50%
Tra 10% e 30%

4) Negli ultimi 5 anni, nel caso di installazione di una nuova rete o rinnovo di una parte di rete:- in che percentuale (in peso) le tubature in ghisa sono andate a riciclaggio?

tra 70% e 100%
< 10%
Non so/Non rispondo
Tra 50% e 70%
Tra 30% e 50%
Tra 10% e 30%

5) Negli ultimi 5 anni, nel caso di installazione di una nuova rete o rinnovo di una parte di rete:- in che percentuale (in peso) le tubature in acciaio sono andate a riciclaggio?

Tra 30% e 50%
< 10%
Non so/Non rispondo
Tra 70% e 100%
Tra 50% e 70%
Tra 10% e 30%

6) Negli ultimi 5 anni, nel caso di installazione di una nuova rete o rinnovo di una parte di rete:- in che percentuale (in peso) le tubature in cemento sono andate a riciclaggio?

Non so/Non rispondo
Tra 70% e 100%
Tra 50% e 70%
Tra 30% e 50%
Tra 10% e 30%
< 10%

THANK YOU FOR READING