



Innovation opportunities for circular cities

Climate & Sustainability and Officine Innovazione





Index

Cities and circular economy: an overview	4
The Key Areas for developing a circular city	6
Material Cycle	8
Transport and Mobility Cycle	10
Resource Cycle	12
Water Cycle	14
Case Studies	16
The Open Innovation paradigm and Deloitte's approach	26
Closing remarks and take-home messages	28
Endnotes	30
Contacts	31

Cities and circular economy: an overview

The purpose of this outlook is to provide a snapshot view of the state of the circular transition in the urban environment, focusing on the four areas that could have the most impact on its development: material cycle, mobility, resources and water cycle. Opportunities arising from innovation applied to these areas will also be outlined.

The document focuses on cities for a reason that is twofold. On the one hand there's the current and projected urbanization levels: as of today, more than half of the global population lives in cities, but according to the United Nations, by 2050 it's going to be more than two-thirds (to be compared to less than one-third as recently as 1950). On the other hand, there's the energy/resources

consumption levels of urban centers: people in cities consume 78% of the world's primary energy, generate more than 70% of all carbon emissions, and are disproportionately vulnerable to climate impacts.

Cities thus represent both the greatest challenge and opportunity to keep global warming in line with the Paris Agreement goals.

Despite the recent increased awareness on the subject, **according to the latest global Circularity Gap Report , only 7,2% of the global economy can be considered "circular" in 2023** with evidence showing that the amounts of resources and materials used have been increasing, and are expected to double by 2050 compared to 2015 levels.

Only 7,2% of the global economy can be considered "circular" in 2023 with evidence showing that the amounts of resources and materials used have been increasing

Focusing on the Italian context, the improvements registered over the past 5 years have been smaller in terms of circularity compared to the other European countries that have been accelerating the transition, also due to the already positive trends that have been registered thus far. Indeed the 5th Report on Circular Economy conducted by the Circular Economy Network shows how **Italy is the most circular country among the top five EU economies** (Spain, France, Germany, Italy and Poland). In particular, the report presents how **Italy has one of the highest recycling rates in EU** (72% compared to an average of 53%), and a **very high resource productivity rate**, with 3.19 euro of GDP generated for every kg of resources consumed (the EU average, at purchasing power parity is 2.1 €/kg).

As a matter of fact, circular economy represents an opportunity for regions and cities to rethink production and consumption models, services and infrastructure and become fertile ground for innovation. Milan, for instance, is one of





the C40 Cities, a global network of nearly 100 international mayors that are united in action to fight against the climate crisis and are committed to using an inclusive, science-based and collaborative approach to cut their fair share of emissions in half by 2030.

Looking at the circularity of the city of Milan, we have many virtuous examples, as well as promising data. For example, as reported by National Geographic, there's a high rate of recycled waste (over 60%), where more than 50% of the wet waste is sent to composting or biomethane production. The recently developed Milan's district of CityLife is also an excellent example commitment to circularity, as more than 20% of materials came from recycled inputs, more than 95% of construction waste was sent for recycling, and a significant proportion of residential buildings use wood finishes from responsibly managed forests.

The role of innovation in the circular transition

Besides being the frontline in the challenges against climate change, cities are also the platform where financial, commercial and public plans converge. Circular development, as much as sustainable development, is in fact a transition that needs to be systemic in order to succeed, and relies therefore on a strong interconnection of areas, requiring innovative ways of (re)thinking the production systems and consumption.

Innovation and research are crucial to facilitate the implementation of a circular model through the introduction of new technologies, the creation of innovative business models, the design and activation of new collaborations.

Transitioning to a circular economy requires product, business model and ecosystem innovation⁴.

Firstly, there should be a **product innovation**, which consists in materials and products with **new design** and employing **new processes** and **technologies**.

Indeed, products need to be made with fewer, recycled, and renewable resources, with components easy to maintain and no hazardous materials⁵.

Beside product, the second relevant element to implement a circular paradigm is **business model** innovation. Taking Teece's definition from "Business Models, Business Strategy and Innovation" (2010), a business model refers to how an organization designs its mechanisms for creating, delivering and capturing value. Business model innovation refers to the "continuous organizational processes to create, diversify, acquire or transform companies' business models"⁶. Circular innovative business models aim to find new ways of providing value to stakeholders, systemically boosting resource efficiency and effectiveness along the product/service lifecycle to reduce the use of resources and the generation of wastes.

The third key element for the implementation of a circular paradigm is **ecosystem innovation**, which means providing new modes of interaction between a set of players (including producers, suppliers, service providers, end users, regulators, civil society organizations) to achieve a collective outcome⁴. To implement a circular approach, which is an economic model affecting more sectors and industries, it is key to perform collaborative efforts across the whole value chain, to leverage on network, technologies, resources, needed for scaling solutions and business models.

However, to scale innovations and the transition to circular models, investments are also necessary from both private and public sectors. Financing circular economy projects through seeds, grants and loans may help reducing the cost of capital and overcoming financial and information barriers.

The circular economy financing market has been increasing its activity over the last few years. From 2020 onwards, several leading international funds are focusing on circular economy as a source of economic growth and launched more than **10 circular economy-oriented funds** worth around



\$2 billion in assets in 2022. In addition, between 2021 and 2022⁷, major financial institutions issued **specific corporate bonds** with a **circular economy focus** for a total of \$10 billion.

Also, governments and municipalities should play a crucial role in boosting circular innovations, setting regulations and providing incentive subsidies. The EU is providing funding programs that also cover the circular economy, the three main instruments are: shared management funds, the Horizon Europe program, and the LIFE program⁸. Furthermore, the European Investment Bank (EIB) has been providing financial support to foster the development of circular economy projects. From 2018 to 2022 the EIB provided **€3.4 billion** to co-finance more than 100 projects related to circular economy in different sectors⁹. Another example of Institutional involvement in circular economy projects and financing is the European Circular Bioeconomy Fund, the first private venture capital impact fund exclusively dedicated to circular bioeconomy projects with technology readiness level above six and with a total budget of €300 million¹⁰. Moreover, in 2019 the EIB launched the Joint Initiative on Circular Economy (JICE), involving some European Union's largest banks and institutions such as the Italian "Cassa Depositi e Prestiti", with the **goal of investing €10 billion in the circular economy** by the end of 2023¹¹.

The Key Areas for developing a circular city

A city's transition towards circularity involves planning and creating a fruitful environment in which different stakeholders can play a role in taking circular action on different levels across the city. The **European Investment Bank** has defined a potential strategy facilitating the transition **from a "linear" to a more "regenerative" city**¹². The strategy starts with the involvement of

the relevant stakeholders, such as citizens and professionals, investors, financial institutions, research centers as well as companies and startups. It continues by assessing the **most representative sectors of the city**, focusing the analysis on their environmental impacts in order to identify the areas that are responsible for the highest footprint and therefore represent the biggest

challenge for a circular transition, such as the built environment, consumer goods and manufacturing, energy systems, mobility and logistics, waste, and water systems. Only after these preliminary and fundamental building blocks have been established, it is possible to envision the future of a circular city by starting a successful transition requiring substantial changes and a collaborative mindset¹³.





This outlook focuses on four **interconnected macro-trends** of strategic importance for improving the city's infrastructure towards a circularity model¹⁴:



A **Material Cycle** that includes built environment. The built environment interventions alone could reduce a city's total emissions up to 10% depending on the existing context. This includes a reduction in Scope 1 emissions from buildings of up to 56% and a reduction in Scope 3 emissions associated with the construction, up to 27%¹⁵.



A **Transport and Mobility Cycle** envisioning clean and shared mobility systems. The mobility interventions studied could reduce a city's carbon footprint up to 6%, including a reduction in Scope 1 transport emissions up to 49% and a reduction in the Scope 3 emissions associated with purchased vehicles, up to 14%.



A **Resource Cycle**, which deals with the more efficient use of natural resources available in the urban context, where reuse, repair, and recycling are facilitated and where assets/products are shared and recovered at the end of useful life.



A **Water Cycle**, that closes the loop on water use and considers wastewater as a potential resource that goes through various steps of reuse and recycling. Moreover, the design of the cities must be revised integrating innovative materials for buildings and constructions as well as nature-based solutions, with the goal of facilitating urban drainage by slowing down the surface water run-off and increasing the groundwater recharge. Rainwaters should be exploited as well, with ad-hoc installations able to capture and retain valuable water sources.



Material Cycle



Considering that more than one third of the global resource consumption is related to the construction activity, housing and providing services for the world's population will inevitably require additional material use in a sector that is extremely resource intensive¹⁶. A circular built environment reduces the environmental impacts of the construction sector, by becoming a regenerative system that optimizes resource use and minimizes waste while staying within the planetary boundaries.



Innovation areas for the circular city

Key benefits from adopting a circular approach with the development of the built environment include the possibility to regenerate disused spaces while reducing the need for new construction, improve urban land use and increase resource-efficiency both from a material and energy perspective, and finally, reducing air pollution by using green façade and nature-inspired designs¹⁷.

CIRCULAR DESIGN

Design buildings for adaptable and flexible use making the construction phase more circular by using innovative technologies (e.g. Building Information Modelling).

ENERGY EFFICIENCY

Optimization of energy by implementing low-tech and smart solutions (i.e. bioclimatic, and passive design, Building Automation System). **Integration of on-site energy production** in buildings, for example by installing photovoltaic panels on roofs and micro-wind systems.

RECYCLABLE AND BIO-BASED MATERIALS

Design a building thinking about its dismantling and subsequent use of the materials involved to increase the **re-circulation of resources in a closed loop perspective**. **Locally source materials** to minimize displacement and use eco-design to include **materials of biological origin** in the construction.

NATURE-BASED SOLUTIONS

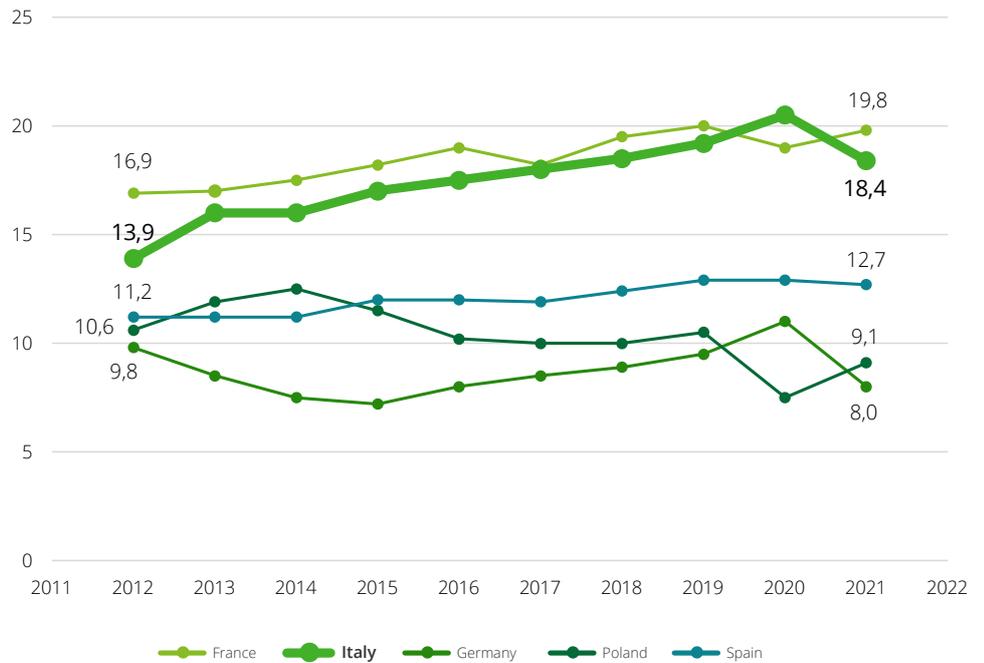
Buildings could be useful for water collection and improve CO₂ sequestration through the **application of nature-based solutions** such as green roofs and walls.



FOCUS ON ITALY

According to the analysis presented in the 5th report on Circular Economy in Italy the strong growth of the construction sector linked to the incentives for buildings renovation was one of the main factors affecting the negative trend in the rate of material use from recycling in 2021 compared to the previous years (standing at 18,4%, 2,2% less than 2020), since the sector still depends mainly on virgin raw materials. There is a big potential for closing the loop on construction and demolition materials and waste, starting from building with resource-efficient construction techniques and rethinking the end of life of buildings as material banks sourcing circular materials.

Figure 1 | Utilization rate of recycled materials in the main 5 European countries, 2012-2021 (%)



Source: Eurostat



Transport and Mobility Cycle



Current practices in urban mobility include high dependence on individual car ownership and fossil fuels, creating high levels of urban congestion, pollution, noise, and the depletion of finite resources. Dependence on individual cars in cities also means high amounts of urban land devoted to parking and because most of the vehicles are powered with internal combustion engines, they represent a large source of emissions¹⁸. With urbanization and the demand for urban freight rapidly increasing, the need for more effective urban mobility solutions is pressing¹⁹. A circular transport and mobility cycle includes a more efficient and less intensive use of vehicles, a shift towards public transport biking and the development of innovative mobility and logistic as a service solutions with the aim to use fewer material per person, reduce urban land use designated to parking and drastically cut emissions.

Innovation areas for the circular city

Core benefits of a circular economy model applied to the urban mobility and transport system include reducing virgin material consumption for vehicles, eliminating waste and pollution, maximizing infrastructure, vehicle and land utilization, and lowering use and operation costs.



SHARED AND ACTIVE MOBILITY OPTIONS

Development of **compact cities**, that foster shared and active mobility options (i.e. public transport, ride-shares, walking, cycling) with an innovative **road network design** for efficient traffic flow management by using IoT to monitor and regulate traffic flows.

ZERO EMISSIONS VEHICLES

Design **zero-emission transport** vehicles and energy grids that use innovative renewable sources (i.e. hydrogen) at urban scale.

RECYCLED MATERIALS

Strategically **sourcing** infrastructure **materials** using recycled, alternative and renewables ones, such as recycled and crushed cement or stones (aggregates) in road construction, or recycled plastic to build bike paths.

LOGISTIC AND MOBILITY AS A SERVICE

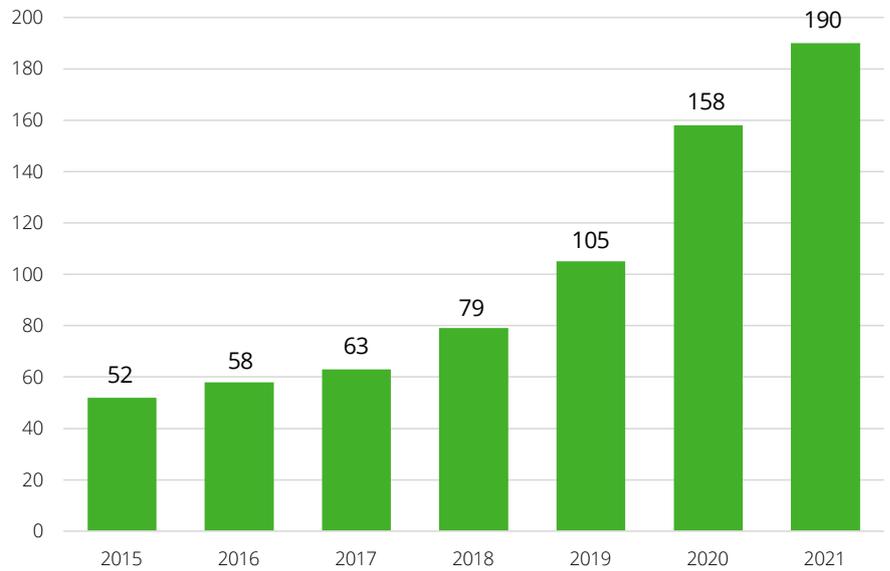
Multimodal transport as an integrated and shared service, on the one hand by adopting **Mobility as a Service** schemes that give citizens access to a diverse set of transport options that offer seamless, multimodal trip planning, dynamic pricing, sharing, e-ticketing, and payment services via one online platform. On the other hand, developing **Logistic as a Service solutions** that manage transport services through cloud base platforms for an efficient planning and optimal use of vehicle capacities.



FOCUS ON ITALY

The 5th Report on Circular Economy in Italy presents promising data on shared mobility, a sector that is growing steadily and strengthening nationwide. The Sharing Mobility National Observatory, sponsored by the Italian Ministry of Environment and Energy Security, the Ministry of Infrastructure and Transport and the Foundation for Sustainable Development, developed a dedicated indicator to monitor the adoption of shared mobility services, represented by total number of shared mobility services active in one year considering all the main sectors of activity (carsharing, bike sharing, scooter sharing, carpooling and aggregators). The trend is positive and the number of **shared mobility** services has increased in the last year by **more than 20%**, from 158 to 190. The last release of the European Shared Mobility Index 2022 compares the average number of shared mobility services per city in European markets: Italy, with an average of 12 shared mobility services per city is the second country in Europe after Germany.

Figure 2 | Number of sharing mobility services* in Italy (2015-2021)



* Shared mobility services considered are: scooters/scooters/car-sharing

Source: Osservatorio Nazionale Sharing Mobility (Sharing Mobility National Observatory)



Resource Cycle

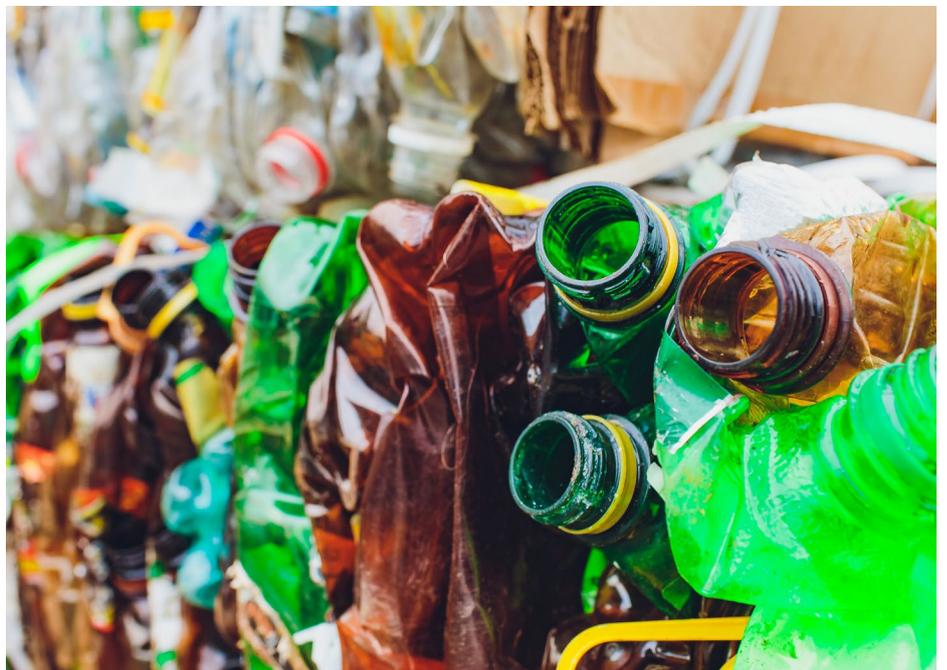


Citizens have access to several type of products in their daily life: food, consumables, electronics, clothes, all goods that enable them to have a good quality of life. In turn, the current linear model of production and consumption that makes this happen includes finite resource extraction, processing and high volumes of waste generation. Considering the future growth of the urban population, this type of mechanism is not sustainable. The **World Economic Forum estimates an increase of 116 % in material consumption** comparing the values observed in 2010 (41.1 billion of tonnes) with what expected in 2050 (81.8 billion of tonnes)²⁰. A step-by-step transfer from a linear to the circular approach is hence fundamental to face with the increasing demand of resources.

Adopting circular strategies is on the one hand the opportunity to develop effective and scalable waste collection, transport, and management methods and on the other hand it allows to valorize waste, through upcycling, reuse, recycling, and - only as a last resort - recovery, to generate added value.

Innovation areas for the circular city

Integrating circular economy principles in the resource cycle can lead to reduced virgin materials consumption, smaller amounts of waste and toxins, improved products utilization and a low-environmental impact overall.



ECO-DESIGN

The **eco-design approach** requires conceiving products and services in a circular perspective, made for reuse, repair and recycling.

ALTERNATIVE SOURCING

To reduce primary resource exploitation, a key solution is to **transform end-of-life materials into secondary raw materials** and reintroduce them into the flow, finding a new application within the urban context.

URBAN MINES

Cities should be regarded as **“urban mines”** providing large quantities of resources in the form of waste in a time of raw materials and energy crisis.

SMART TRANSPORT

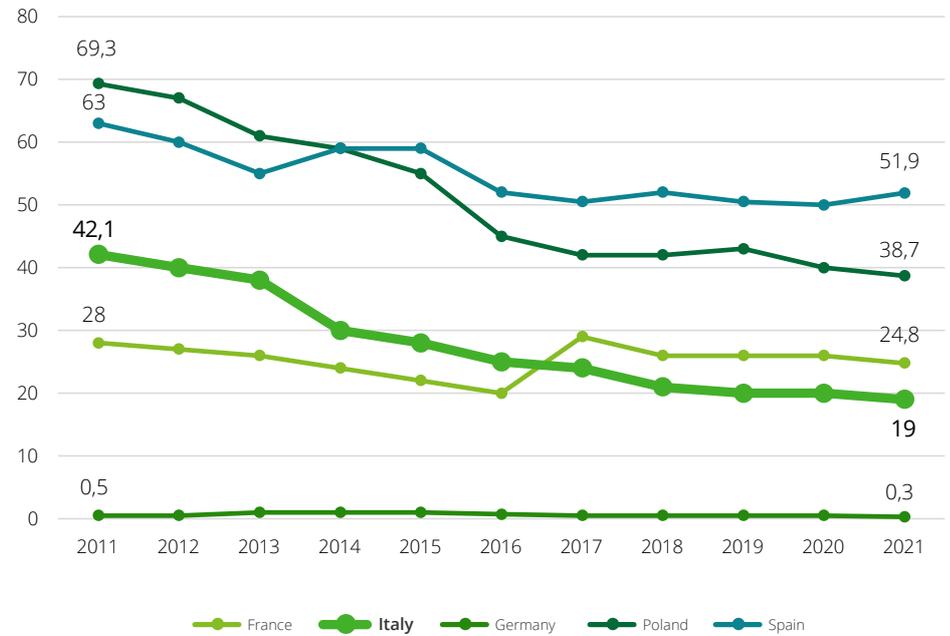
Smart transport for waste management can help reduce the environmental impact associated with the transport of waste collected in urban areas.



FOCUS ON ITALY

Landfilling constitutes a waste of resources and diversion from recovery and recycling, thus actively representing an obstacle to the development of a circular economy. For this reason, the disposal of solid waste in landfills should be limited to non-recoverable and non-valuable fractions only. The European Commission has set a target, limiting to 10% the amount of solid waste that can be disposed in landfill. A target that must be achieved by 2035²¹. If considering the trend of the past 5 years, in Italy the amount of municipal waste sent to landfill has decreased by 23% (in 2021 19% of waste has been sent to landfill), but still above the 10% target fixed by the EU for the 2035²². Therefore, it is fundamental to enhance the recycling rate. As stated above, this is potentially achievable through the re-design of the consumer products as well as by implementing innovative technologies/solutions to exploit secondary material sources.

Figure 3 | Landfilling rate of municipal waste in the top five European countries, 2011-2021 (81%)²²



Source: Eurostat



Water Cycle



A circular economy approach should be applied to urban water cycle. Nowadays, water recovery systems from contaminated sources are not really implemented in urban areas with the consequent demand of significant volumes of fresh water supply. It is hence necessary to rethink and to redesign the water infrastructure aiming at developing a “circular” water management system²³.

Ideally, in a circular city the concept of wastewater should not exist, and the main goal should be “to close the loop on the water use”²⁴, synergistically integrating the water cycle within the urban planning²⁵.

Innovative water treatment systems should be integrated within the municipal treatment plants while renovating the water distribution system focusing on an efficient water supply. Indeed, an optimized “circular water management system” in urban environment would include not only the recovery of water from contaminated sources but also the correct management of the natural water sources, such as rainwater or surface/ground water, the latter delivered as potable sources.

Effective stormwater management, efficient distribution systems or the increase of evapotranspiration of the urban soil through the integration of nature-based solutions as well as slowing down surface water run-off while increasing groundwater recharge are examples of concrete actions to enhance a water circularity approach in cities. Thus, cities can become “water reservoirs”, exploiting an integrated combination of centralized and decentralized infrastructure at different scales.

Innovation areas for the circular city

A “circular water management system” would be achievable only through innovations in the water sector. An example is represented by the project “Milano città spugna” where various projects are funded to improve the water cycle in the urban ecosystem.

Cities would benefit from using a circular water system by generating operational savings with both environmental and

economic benefits. Managing water efficiently in cycles within an urban area will decouple a city’s economic growth from water use, allowing cities to grow significantly without consuming more water, reducing natural resources consumption, stress on ecosystems, and containing the effects of overheating (e.g., heat island) and climate change (e.g., floods)²⁹. Furthermore, designing the urban landscape and infrastructure with green and nature-based solutions can increase the ecosystem services provided.

EFFECTIVE STORMWATER MANAGEMENT

It regulates the proper management of stormwater, through **stormwater retention, storage, and reuse**. Reducing surface run off (green roofs, communal rain gardens, green walls/facades) would increase rainwater retention. Rainwater harvesting systems could collect rainwater from roofs and other paved surfaces for on-site use that is stored until needed (flushing toilets, washing machines, car washing, irrigation)²⁶.

WASTEWATER: TREATMENT, REUSE AND MATERIAL RECOVERY

A circular water system is conceived to **differentiate between varying sources and qualities of water**, instead of treating all used water streams equally. Potentially, wastewater treatment technologies can be improved to deliver treated water to urban activities such as laundering and irrigation where high-quality water / is not required, thus moving a step further, towards a circular water approach. At the same time, the **concentrates** produced during the treatments can be **further exploited**, recovering valuable resources such as nutrients and fertilizers for industrial purpose²⁷.

DISTRIBUTION EFFICIENCY

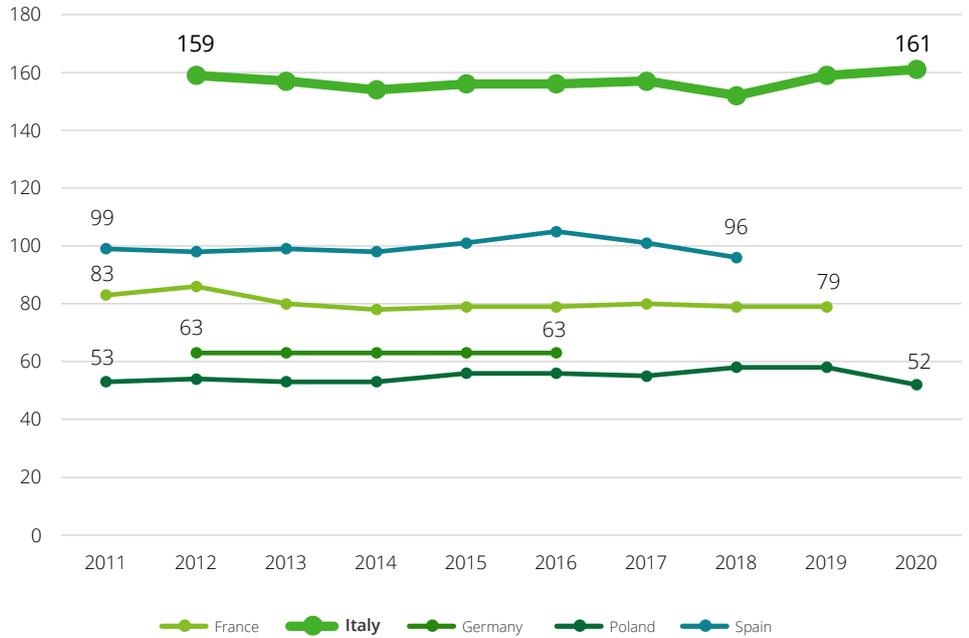
Local governments have an important role to play in providing pipes, water management and treatment infrastructure to ensure that water is safely handled. They can also play a role in monitoring privately run facilities to ensure compliance with environmental performance standards²⁸.



FOCUS ON ITALY

Figure 4 presents the data on fresh-water extraction delivered as potable water per capital, considering the main five European countries. The trend is clear: with 9.2 billion cubic meters (i.e., 161 m³ of water per inhabitant, as shown in Figure 4)³⁰. **Italy holds the record in 2020 in the EU27 for total fresh water** withdrawn for potable use from surface or groundwater bodies. This number is strongly affected by the incorrect management of the freshwater sources during the delivery process. Indeed, the Italian **water piping system is currently characterized by significant losses** within the water network, estimated to be the 42.2% of the total water volume supply by ISTAT. Therefore, it is of paramount importance to investigate and to develop new technologies aiming at minimizing this number. Through the reduction of the water losses within the delivery systems combined with the integration of innovative water/wastewater treatment techniques and the improvement of water drainage/storage, it is possible to reach a water circular approach in city.

Figure 4 | Drinking water withdrawals per capita in the top five European countries, 2011-2020 (m³/inh)



Source: Eurostat







Case Studies

MATERIAL CYCLE

Urban case

Università Bocconi

Innovative use case

Green Energy Optimization

P. 18-19



TRANSPORT AND MOBILITY CYCLE

Urban case

«CAMBIO –
The bikeplan of Milan»

Innovative use case

Peer-to-peer car sharing

P. 20-21



RESOURCE CYCLE

Urban case

The Circular Biocarbon

Innovative use case

AI-powered waste management

P. 22-23



WATER CYCLE

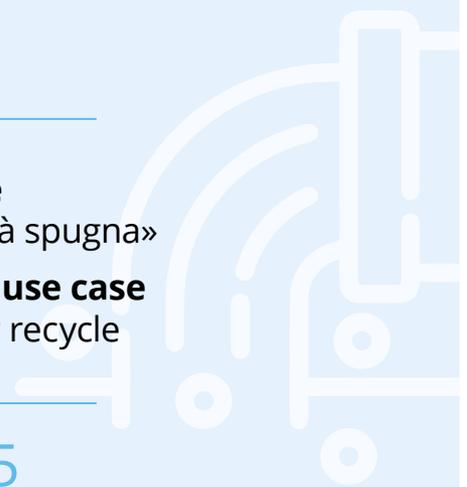
Urban case

«Milano città spugna»

Innovative use case

Wastewater recycle

P. 24-25





CASE STUDIES

Milan



N° people:
~ 1,4 MI



Location:
45°28'01"N 09°11'24"E

Capital of the Lombardy region, considered an “alpha global city”. Milan represents the third-largest economy among European cities. It’s a leader in sectors influenced by a circular economy approach (fashion, design, commerce & finance).



University of Bocconi

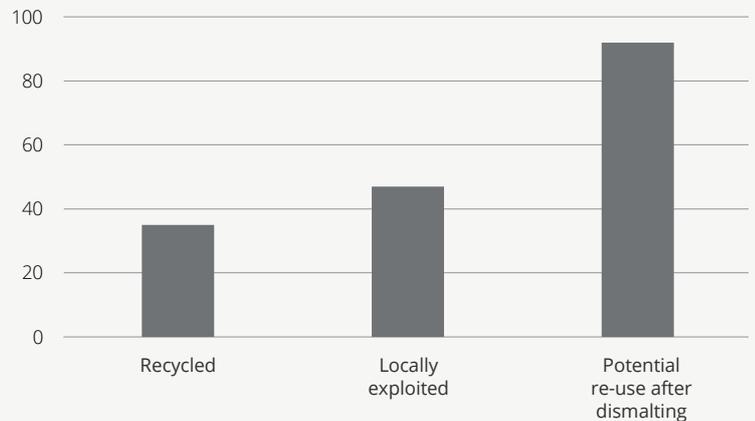


Footprint: **90,000 m²**

(35,000 m² reclaimed from the Milan Milk Factory)

KEY PERFORMANCE INDICATORS

Material use (%):



Energy:

Self-sufficient buildings thanks to the deployment of renewable energies (solar panels coupled with heat pumps).



How to implement a circular approach in the Material Cycle

Calling for Innovation:

- **Future buildings should be adaptable and flexible** through eco-design and Building Information Modelling.
- **Energy optimization via renewable source exploitation and smart solutions** like bioclimatic and passive design and Building Automation Systems.
- **Re-circulation of resources in a closed loop perspective** by using bio-materials in construction and adopting an end-of-life design approach (re-use of materials after disposal).
- **Application of nature-based solutions** to improve CO₂ capture & water collection.



INNOVATIVE USE CASE *in the* MATERIAL CYCLE

Green Energy Optimization

MARKET CHALLENGE

Conventional rooftop solar panels rise challenges such as complex engineering requirements during construction, heavy weight, intricate repairs, and maintenance. These elements make the assembly, installation, and maintenance of the solar panels more complex and costly.

SOLUTION

A cutting-edge technology is emerging for manufacturing flexible, lightweight, and efficient solar panels. These panels are designed to be seamlessly integrated into various surfaces that may not be able to accommodate traditional glass solar panels, including rooftops, sidewalks, bike paths, vehicles (e.g., cars, trucks) and even aircraft. Another notable advantage of these solutions are their reduced visual impact, as the solar panels are very thin. One Player realizing this technology recently signed its first commercial agreement with a major automotive group, expecting a supply of tens of thousands of solar panels from 2024 to be installed in the car manufacturer's vehicles.

Some examples of solutions:

Apollo Power

Flisom

Renovagen





CASE STUDIES

Milan



N° people:
~ 1,4 MI



Location:
45°28'01"N 09°11'24"E

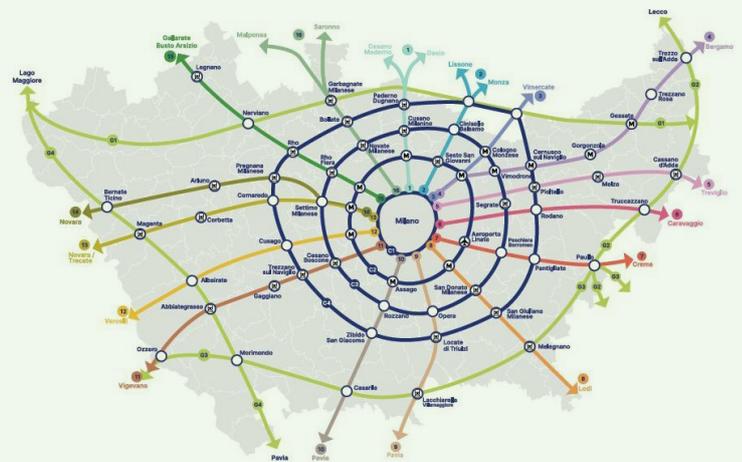
Capital of the Lombardy region, considered an "alpha global city". Milan represents the third-largest economy among European cities. It's a leader in sectors influenced by a circular economy approach (fashion, design, commerce & finance).



«CAMBIO - The bikeplan of Milan»



Goal: **750 km of cycling path**, to increase the amount of travel by bike and reach 20% of total trips and 10 percent of trips inter-municipal by bike.



86% of citizens

83% of train stations

77% of companies

74% of healthcare facilities

79% of high schools

69-85% of commercial facilities



How to implement a circular approach in the Transport and Mobility Cycle

Calling for Innovation:

- **Foster vehicle-free cities:** the higher uptake of active transport modes like biking is crucial to cut emissions from transport and mobility.
- **Development of bicycle corridors** to get people where they need to go quickly and safely.
- **Extra services to expand the accessibility** like info-mobility and interactive panels, internet connectivity, incident reporting, smart lighting, sensor technology for maintenance, bicycle flow measurement and many others, which can be integrated to structural features.

... are located within 1 km of a Cambio bike line





INNOVATIVE USE CASE *in the* **TRANSPORT AND MOBILITY CYCLE**

Peer-to-peer car sharing

MARKET CHALLENGE

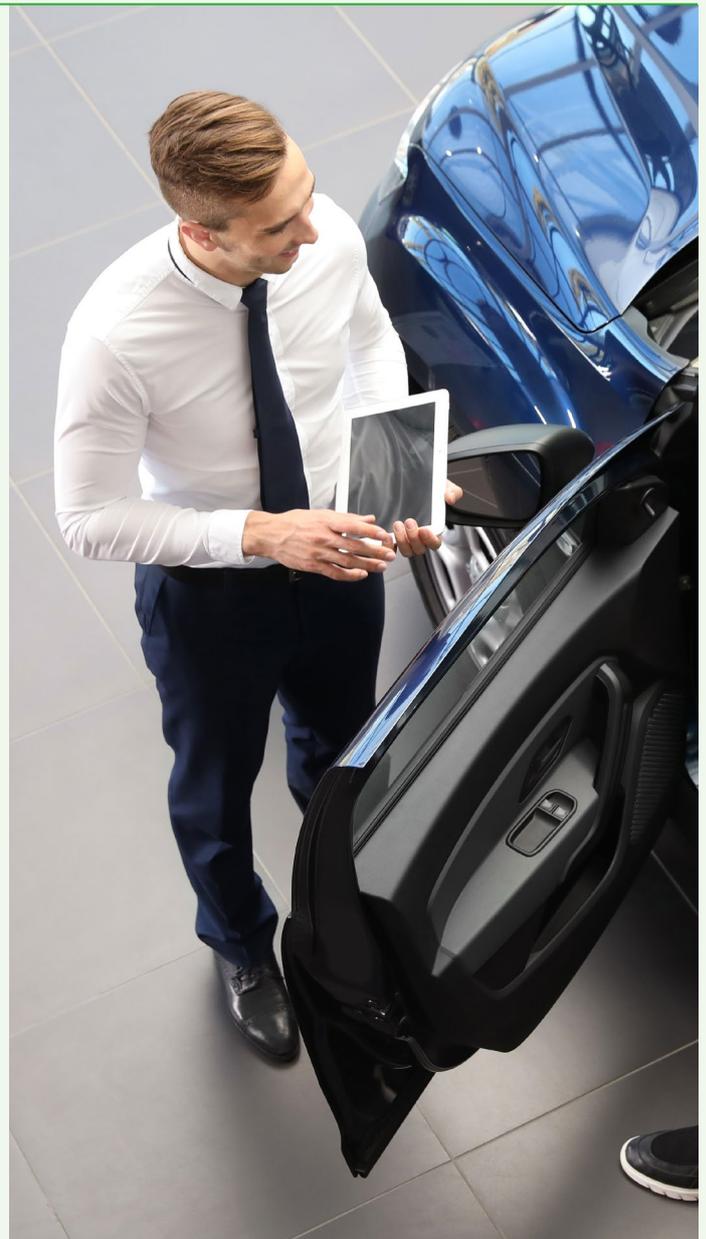
On one side, car hosts have unused cars on specific periods that are not generating any positive impact from a financial point of view, while on the other hand customers must face higher and higher rental prices for cars, often without the desired flexibility (e.g., delivery options, insurance, ...).

SOLUTION

Peer-to-peer car sharing platforms are emerging to allow car owners to rent out their own cars to customers. They can be considered as a sort of Airbnb for cars. The customers can either host their own car to the marketplace or can search for cars to rent on specific locations and dates. Given the latest increase in car rental prices, these solutions can provide a cost-effective solution in a market that is expected to grow, allowing for a more efficient and less intensive use of vehicles.

Some examples of solutions:

Turo
Getaround
Outdoorsy





CASE STUDIES

Milan



N° people:
~ 1,4 MI



Location:
45°28'01"N 09°11'24"E

Capital of the Lombardy region, considered an “alpha global city”. Milan represents the third-largest economy among European cities. It’s a leader in sectors influenced by a circular economy approach (fashion, design, commerce & finance).



The Circular Biocarbon



Investment:
15 MI € (H2020)



companies
involved: 7



universities
involved: 3

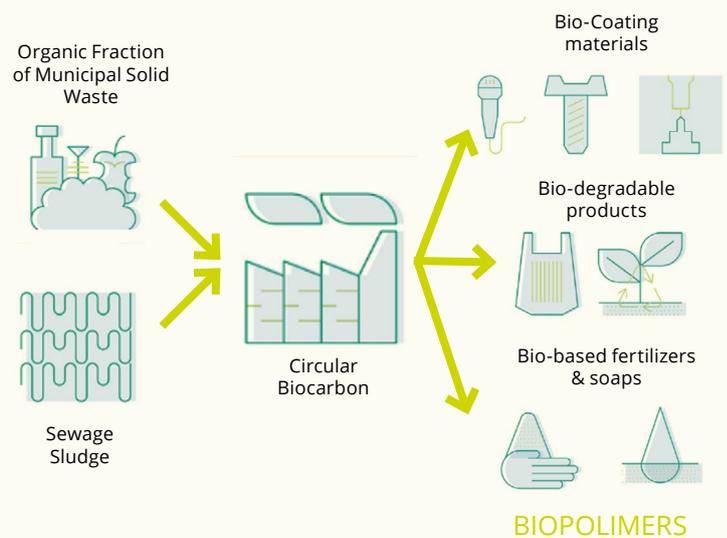


How to implement
a circular approach
in the Resource
Cycle

Calling for Innovation:

- **Product lifetime extension:** Innovative design approach to maximize the product lifetime. Utilization of more durable materials. Upstream evaluation tools to assess a “recycling strategy”: re-used, repaired and remanufactured.
- **Waste-handling systems:** Innovative waste treatment approaches and technologies. Improving recycling systems through digital innovation tools.
- **Cities as “urban mines”:** Exploitation of secondary resources. Development of tools to evaluate the product status. Data management system to quantify the ratio between primary and secondary sources deployment in cities.

FOAK flagship designed to **valorize** the Organic Fraction of Municipal Solid Waste (**OFMSW**) and sewage sludge (**SS**) into **added-value products**





INNOVATIVE USE CASE *in the* **RESOURCE CYCLE**

AI-powered waste management

MARKET CHALLENGE

Multi-utility companies have an increasing need to maximize the material recovery and purity employing innovative waste management approaches. In this field they are looking at solutions that make the recycling process more efficient, gaining more insights on waste composition and automating the sorting activity.

SOLUTION

AI-powered computer vision systems able to perform waste recognition, sorting and analytics are emerging. Indeed, these AI-based solutions can analyze all wastes to provide accurate data analytics, and link actionable insights (e.g., waste identification) with third-party existing systems. These technologies enable waste traders, waste centers, plant builders and manufacturers to increase the productivity of their sorting system, to control the quality of waste material, to reduce dependency on manual labor and to increase the number of recycled products.

Some examples of solutions:

Greyparrot

Recycleye

AMP Robotics





CASE STUDIES

Milan



N° people:
~ 1,4 MI



Location:
45°28'01"N 09°11'24"E

Capital of the Lombardy region, considered an “alpha global city”. Milan represents the third-largest economy among European cities. It’s a leader in sectors influenced by a circular economy approach (fashion, design, commerce & finance).



How to implement a circular approach in the Water Cycle

Calling for Innovation:

- **Increase of evapotranspiration:** Nature-based solutions such as green roofs, shared rain gardens, green walls/facades.
- **Slowing surface water run-off and increase groundwater recharge:** soil transformation through hydrophilic materials deployment. Quantification of rain waters through digital tools installation of new drainage systems to delivery water to the ground.
- **Water recovery from contaminated sources:** Innovative in-house water treatment systems for high-quality water recovery (flushing toilets, washing machines, car washing or irrigation).
- **Improving water infrastructures:** Increase water delivery system capillarity through new installations. Digital services and data storage to monitor the water infrastructure efficiency.



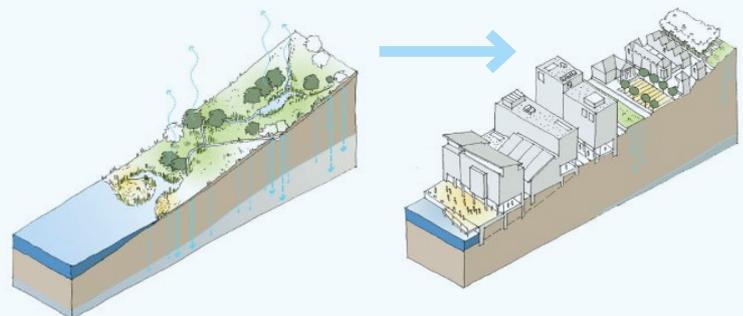
«Milano città spugna»



Investment:
50 MI € (PNRR)



projects:
90



Examples of funded projects

- 1 **Cesano Boscone:** innovative rainwater collection and storage to be re-used in urban areas
- 2 **Trezzano sul Naviglio:** installation of an advanced drainage system in traffic roads
- 3 **Solaro:** upgrading of an existing urban area with an innovative rainwater storage system
- 4 **Rho:** sustainable drainage systems integrated in parking slots



INNOVATIVE USE CASE *in the* WATER CYCLE

Wastewater recycle

MARKET CHALLENGE

Customers are looking for solutions that help them decrease water consumption and expenditure in their apartments. They are on average highly environmental aware and looking for solutions to reduce their water consumption by purifying and redistributing it, thus reducing their water usage footprint.

SOLUTION

Wastewater recycling solutions are emerging as an answer to excess water consumption and expenditure. New technologies can provide decentralized greywater recycling systems which allow customers to collect, purify and re-use water to cut consumption and waste-water emission. Such solutions can be easily installed at home and can collect the greywater used, disinfect it, and redistribute it to toilets, washing machines, irrigations, or swimming pools.

Some examples of solutions:

Hydraloop

Epic Cleantec

Orbital



The Open Innovation paradigm and Deloitte's approach

Given the relevance of developing a collaborative approach among ecosystem actors, to share information and resources and to accelerate the development of innovative solutions, companies have an increasing need to incorporate specific initiatives in their innovation strategies involving the research skills and assets outside the company. The understanding that the driver of change and innovation cannot be only internal, increasingly requires a structured approach to implementing an effective Open Innovation paradigm, which states that: "firms can and should use **external ideas**, as well as **internal ones**, and **access** internal and external paths to markets, to advance their **technological skills**"³¹.

Companies that leverage this approach tend to be more incline to recognize new opportunities and to develop adaptive capabilities that are essential to respond to emerging challenges and to remain competitive. This approach also helps companies to shift focus away from their core activities exclusively, and encourages connections within the ecosystem (startup, SMEs, Universities, research centers, tech and innovation communities, corporates) to undertake joint innovation paths.

In particular, startups are a major source of innovation, as they employ innovative technologies to invent products and reinvent business models. The startups that are operating in the circular economy



sectors are receiving a large amount of funding; according to EIT Climate KIC analysis, investment towards circular economy startups in Europe exceeded € 1 billion in 2022³².

Corporates that employ an open innovation strategy are increasingly looking to startups as a source of external innovation; several types of interactions between them can exist, based on the type of investment foreseen and the maturity level of the venture. Such interactions are all part of the Open Innovation paradigm and Deloitte supports their development with dedicated programs.

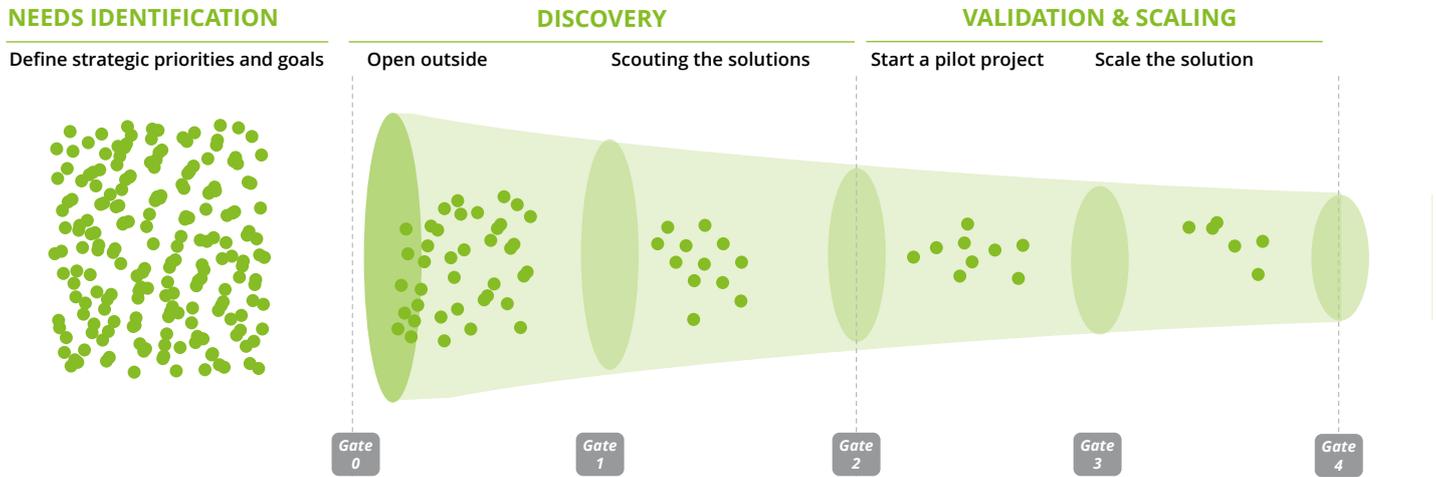
The **Corporate innovation programs** aim to develop industrial projects with leading international companies along the entire value chain, supporting the transformation of innovative ideas into new business opportunities and providing them with key resources and services.

Corporate Venture Capital refers to the activity of investing in startups characterized by high potential for innovation and growth, promoted by companies through direct investment. These **programs** aim at enabling the company to generate revenue and increase profits consistently with the current business activities, by bringing innovation to develop new products and processes, enter new markets, and/or consolidate current market positioning.

Deloitte's distinctive methodology towards innovation

Thanks to the existing collaborations with a large number of companies, startups/scaleups and players in the innovation ecosystem, Deloitte has gained extensive experience in the field and identified **five key steps** to take a tangible approach to Open Innovation:

Define strategic priorities and goals: since a real change in the "mindset" on behalf of the company is required, it is essential, as a first step, to clarify strategic priorities and to define goals and their implementation roadmap. Objectives must be concretely achievable and flexible because, when collaborating with different realities, it is common to interact with completely different mindsets and working methods.


Figure 5 | Deloitte's Innovation Funnel


Open outside: Once the strategic priorities have been clarified, the company can build its ecosystem, which is the set of companies, universities, research centers, startups, communities, associations that can provide and exchange useful elements for the innovation journey.

Scouting the solutions: another key point is the scouting phase, suitable for identifying new opportunities to invest in. It is essential to take a structured approach that involves searching, analysing, and selecting of solutions based on technologies and trends that align with the company's strategic goals and needs. The scouting criteria should be clear regarding, for example, the type of problem that needs to be solved, the maturity stage of the solution, and the scope and type of technology. This will provide a picture of possible innovation scenarios and enable the different solutions identified to be prioritized.

Start a pilot project: the best way to understand the benefits that a collaboration can yield for the company is to develop a pilot project. By defining specific KPIs and continuously monitoring the activities, it is possible to timely implement the necessary corrective actions. The approach under which the company should work is "trial and error", which involves being open to failures and accepting mistakes. Indeed, errors and failures are consequences of actions generated by the uncertainty, unpredictability and initial risks that are taken when introducing something new

and starting a path outside of predefined standards.

Scale the solution: Finally, after testing the solution according to the company's needs, it is desirable to define a gradual roll-out plan to implement it throughout the organization so that it can become an integral part of the company's processes.

Deloitte has designed and developed **innovation programs** dedicated to supporting companies during the stages mentioned above, with the final goal of enabling the **concrete application of innovative technologies and business models** in the market, bringing **tangible and measurable results** that generate value for the partners and players involved.

Typically, these programs involve a partnership model where a **corporate** works together with one or more **startups/ scaleups** that have already moved beyond the idea generation and development phase, to test, scale and integrate its product or service.

The effectiveness of Deloitte's programs is strengthened by the **activation and engagement of its ecosystem** in the different stages of the process. In fact, specific actors involved in the corporate innovation process are:

- **Research centers and universities**, who can contribute with distinctive knowledge on technologies and processes.
- **Tech & Innovation Communities**, that allow to get new technological skills and discover the new trends.

- **Media partners** who can effectively communicate the initiatives and increase its media resonance.
- **Commercial partners** who can support the scaling of the projects.
- **Investors**, who can provide knowledge and financial resources to each project.

Deloitte's innovation approach has been proven successful over time, as more than 3.000 startups have been engaged in Deloitte's programs, developing more than 50 pilot projects that in more than half of the times have continued to the scaling stage, with long-term collaborations among companies and startups.

The **CircularCity Innovation Lab** is the open innovation program developed by Deloitte Officine Innovazione and Deloitte Climate&Sustainability. It aims to find and develop the most promising solutions that can disrupt cities along some **key macro-trends** enabling the implementation of a **circular model**.

The initiative aims at creating a new and unique open innovation ecosystem within the city, where Stakeholders can interact and work together to implement new business, or improve current ones, capable of improving the lives of citizens and stimulate the urban development. The innovative solutions will be identified along four interconnected macro-trends of strategic importance for improving the city's infrastructure, optimizing the use of resources, and making the services offered to citizens more efficient.

Closing remarks and take-home messages

Although awareness on the necessity of a circular transition has been increasing and initiatives have been put in place, especially at an urban level, global research shows that much has yet to be done to improve the circularity rate in the world. The impact that circular cities can have on sustainable development is directly proportional to the expected increase in population that will be living in urban centres by 2050 (more than 2/3 of global population).

The areas where improvements and innovative solutions could achieve the greatest impact at an urban level are:

- **Material Cycle**, aiming at integrating the circular approach in buildings and infrastructures. This will focus the investments on the implementation of

e.g., (i) nature-based solutions, recycling materials and renewable energy sources in building as well as (ii) the road network design for efficient traffic and flow management through digital innovation tools.

- **Transport & Mobility Cycle**, that does not rely on the use of proprietary vehicles, but fosters shared and active mobility options and promotes innovative mobility and logistic as a service solutions enabled by digital technologies.
- **Resource Cycle**, focusing on technologies for the continuous improvement of the “reuse, repair, and recycling” way of thinking. This will include (but not be limited to) the implementation of (i) tools to promote the eco-design

of products, prioritizing the utilization of recycled over virgin materials or (ii) smart transport for an efficient and resilient recycling systems. Innovative waste-to-energy approaches will be considered to reduce landfilling while supplying “green” energy sources to the city’s users.

- **Water Cycle**, aiming at “closing the water cycle” (such as reappraising wastewater streams as sources for re-usable water) while reducing the freshwater supply to cities. This will involve the promotion of e.g. (i) new technologies for the recovery of high-quality water from contaminated sources, (ii) rainwater harvesting techniques or (iii) digital and efficient management systems for the abatement of the water losses along the supply chain.

ECONOMIC BENEFITS

- **Reduction of the costs of urban infrastructure and services** with the compact development of the urban environment.
- **Reduction of operation and maintenance costs** thanks to energy efficiency.
- **Job creation and investment opportunities** in technological innovations.

RESOURCE BENEFITS

- **Reduction of land-use** through compact city design.
- **Decline in the use of raw materials** thanks to the reduction of new construction sites and the use of secondary raw materials and technologies that require a reduced use of resources (eg.3D printing).
- **Drop in energy consumption** thanks to the energy efficiency of buildings and the use of means of transport with low energy impact.



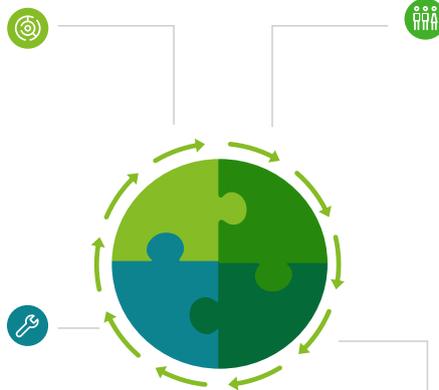
SOCIAL BENEFITS

- **Empowering of local communities** through planning compact cities and multi-use neighborhoods.
- **Increased well-being of citizens** with the design of buildings with high thermal comfort, efficient mobility with reduced traffic and agile travel times and a reduction of the heat island effect thanks to the use of green in buildings.
- **Safeguarding the health of citizens** by ensuring a reduction in sources of air pollution (eg replacement of thermal engine machines, boilers) and a reduction in noise pollution.



ENVIRONMENTAL BENEFITS

- **Reduction of GHG emissions** through the development of low-carbon mobility and the decrease in the use of fossil fuels in buildings.
- **Mitigation and adaptation to climate change** thanks to the design of buildings using Nature-based solutions (eg green roofs, green walls) that capture greenhouse gases and reduce waterproofed areas in cities preventing flood risks.





For each of these areas a snapshot of the Italian context has been provided, together with an overview of the opportunities for the circular cities and a case-study on the municipality of Milan.

What the data shared shows is, that urban environments are key to combat climate change and foster the circular transition,

while also being the first beneficiary in terms of better life quality.

The role of innovation has also been probed for the transition from a linear to a circular approach in the city. It's only through innovative thinking, technologies and collaborative solutions that we can mitigate the impact of cities on climate change.

It is thus fundamental to:

1. Involve the relevant stakeholders
2. Engage with the relevant stakeholders.

This is at the basis of the Open Innovation paradigm where information and resources are shared to accelerate the development of innovative solutions.





Endnotes

1. "The Circularity Gap Report 2023", Circle Economy in collaboration with Deloitte, online.
2. "Rapporto sull'economia circolare in Italia 2023", Circular Economy Network, online.
3. "Rapporto sull'economia circolare in Italia 2023", Circular Economy Network, online.
4. Konietzko, Jan; Bocken, Nancy; Hultink, Erik Jan (2019). Circular Ecosystem Innovation: An Initial Set Of Principles. Journal of Cleaner Production.
5. Based on: European Environment Agency, De Schoenmakere, M., Gillabel, J., Reichel, et al., Circular economy in Europe – Developing the knowledge base, Publications Office, 2016, <https://data.europa.eu/doi/10.2800/51444>
6. De Padua Pieroni, M., McAloone, T., & Pigosso, D. (2019). Business Model Innovation for Circular Economy: Integrating Literature and Practice into a Conceptual Process Model. Proceedings of the Design Society: International Conference on Engineering Design.
7. "Unlocking the value of the circular economy", Ellen Mac Arthur Foundation.
8. OECD (2023), "Financing the circular economy transition", in Towards a National Circular Economy Strategy for Hungary, OECD Publishing, Paris.
9. "Circular economy Overview 2023". European Investment Bank.
10. ECBF, online.
11. "The Joint Initiative on Circular Economy. European Investment Bank", European Investment Bank (2021).
12. "The 15 circular steps for cities", European Investment Bank, online.
13. "A guide for developing a circular city strategy", European Investment Bank, online.
14. "Environmental Performance Indicators", European Investment Bank, online.
15. "Circular Cities: Impacts on Decarbonization and beyond" (2021), Arup and Enel.
16. "The Circularity Gap Report 2023", Circle Economy in collaboration with Deloitte, online.
17. "Circular economy in cities: Opportunity & benefit factsheets", Ellen Mac Arthur Foundation, online.
18. "Circular economy in cities: opportunity and benefits factsheets", Ellen MacArthur Foundation, online.
19. "The Circularity Gap Report 2023", Circle Economy in collaboration with Deloitte, online.
20. ["This chart shows the impact rising urbanization will have on the world"](#), WEF, online.
21. "Landfill waste", European Commission, online.
22. "Rapporto sull'economia circolare in Italia 2023", Circular Economy Network, online.
23. World Economic Forum Circular Cities (2021), "A circular water economy for cleaner, greener, healthier, more prosperous cities".
24. Oral, H., Radinja, M., Fiore, S., Kearney, K., Andersen, T. R., Krzeminski, P., Buttiglieri, G., Ayrál-Cinar, D., Comas, J., Gajewska, M., Hartl, M., Finger, D. C., Kazak, J., Mattila, H., Vieira, P., Piro, P., Palermo, S. A., Turco, M., Pirouz, B., Carvalho, P. (2021), "Management of Urban Waters with Nature-Based Solutions in Circular Cities—Exemplified through Seven Urban Circularity Challenges. Water".
25. Blauw M., van Hattum T., Jensen M. B., "Towards Water Smart Cities Climate adaptation is a huge opportunity to improve the quality of life in cities".
26. World Economic Forum Circular Cities (2021), "A circular water economy for cleaner, greener, healthier, more prosperous cities".
27. Arup, Ellen MacArthur Foundation & Antea (2018), "Water and Circular Economy: A White Paper".
28. Delgado A, Rodriguez D. J., Amadei C. A., Makino M., "Water in Circular Economy and Resilience (WICER)".
29. Oral, H., Radinja, M., Fiore, S., Kearney, K., Andersen, T. R., Krzeminski, P., Buttiglieri, G., Ayrál-Cinar, D., Comas, J., Gajewska, M., Hartl, M., Finger, D. C., Kazak, J., Mattila, H., Vieira, P., Piro, P., Palermo, S. A., Turco, M., Pirouz, B., Carvalho, P. (2021), "Management of Urban Waters with Nature-Based Solutions in Circular Cities—Exemplified through Seven Urban Circularity Challenges. Water".
30. EurEau: The European Federation of National Associations of Water Services (2021), "Europe's Water in Figures. An overview of the European drinking water and waste water sectors".
31. Chesbrough, H. W. (2003). Open innovation: The new imperative for creating and profiting from technology. Harvard Business Press
32. Start-Up Database - ClimAccelerator. (2022, November 8). ClimAccelerator. <https://climaccelerator.climate-kic.org/resources/start-up-database/>



Contacts

Stefano Pareglio

Chairman, Deloitte
Climate & Sustainability

spareglio@deloitte.it

Francesco Iervolino

Partner,
Officine Innovazione

fiervolino@deloitte.it

Daniele Strippoli

Partner, Deloitte Climate
& Sustainability

dstripoli@deloitte.it

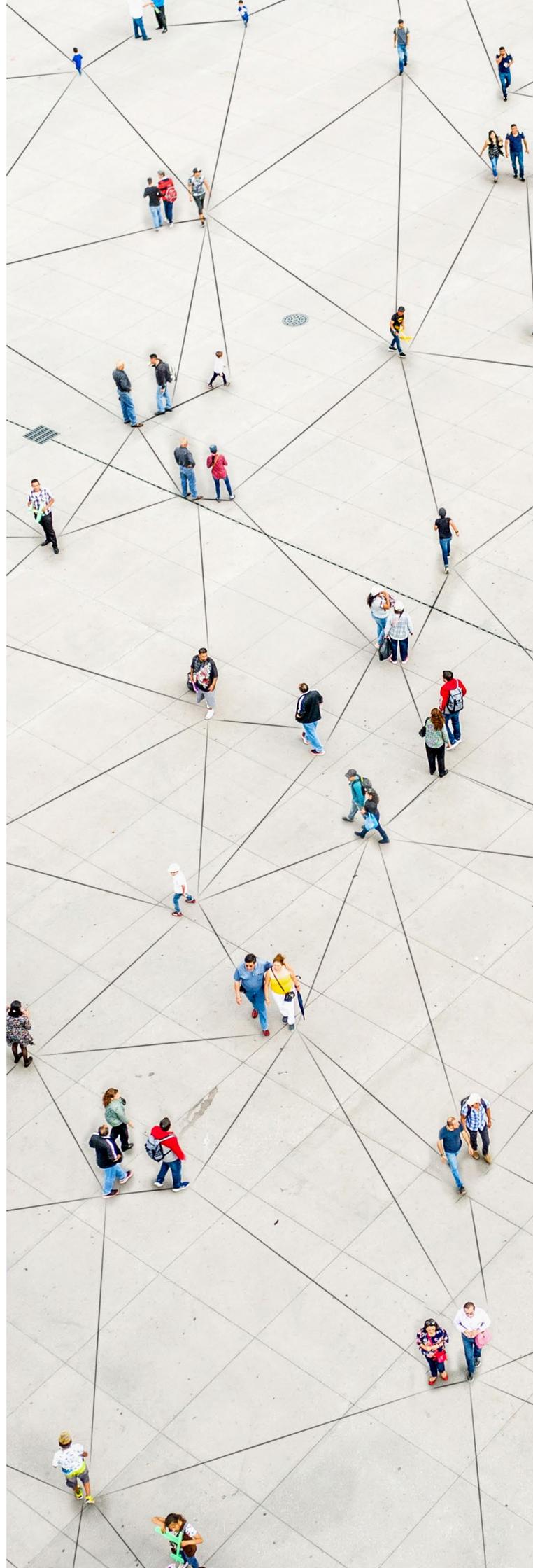
Anoushka Alexandre

Senior Manager,
Officine Innovazione

analexandre@deloitte.it

Special thanks to:

Alessia Arru, Ilaria Barbisotti, Enrico Camelin,
Nicola Capparelli, Ivan Cavella, Alfonso Di Nardi,
Alessandro Peccol, Gaia Fenaroli, Mattia Giagnorio,
Chiara Longhin, Chiara Lo Zito, Giorgia Ortolani,
Luca Tripodi.





This publication contains general information only, and none of Deloitte Touche Tohmatsu Limited, its member firms, or their related entities (collectively, the "Deloitte Network") is, by means of this publication, rendering professional advice or services. No entity in the Deloitte Network shall be responsible for any loss whatsoever sustained by any person who uses or relies on this publication to make any decision or take any action that may affect their business results.

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited ("DTTL"), its global network of member firms, and their related entities (collectively, the "Deloitte organization"). DTTL (also referred to as "Deloitte Global") and each of its member firms and related entities are legally separate and independent entities, which cannot obligate or bind each other in respect of third parties. DTTL and each DTTL member firm and related entity is liable only for its own acts and omissions, and not those of each other. DTTL does not provide services to clients. Please see www.deloitte.com/about to learn more.