Toward New Circular Urban Economies: Regeneration Models for the Ecological Transition of Cities. European Cases and Initiatives.

Chiara Moretti, Roberto Bologna, Giulio Hasanaj
Affiliation:University of Florence
Email:chiara.moretti@unifi.it, roberto.bologna@unifi.it, giulio.hasanaj@unifi.it

Abstract
In response to climate change, cities must be reimagined as living organisms with sustainable urban metabolisms that efficiently manage flows. This article reviews scientific literature, policy reports, and European research to examine urban regeneration projects through the circular transition lens. It proposes new urban planning scenarios based on circular flows of both material and immaterial resources. Introducing the concept of Circular Urban Economy, the paper offers an alternative perspective in the circular cities debate by integrating circularity, nature-based solutions, climate change, well-being, and urban development to promote ecological sustainability and social equity. It explores urban transition processes grounded in regenerative design principles, emphasizing nature's role and local resource recirculation to transform degraded urban areas into ecosystems that enhance biodiversity and improve the well-being of citizens.

Keywords
Circular design; regenerative design; urban metabolism; critical urban space; ecosystem service.

Introduction

The circular economy is an increasingly emerging concept in the field of urban studies that seeks to create a more sustainable and efficient system for resource management. Contemporary cities guarantee high levels of functionality in many areas: from housing to transport, from educational to healthcare services, from employment to cultural opportunities. However, in order to provide such levels of efficiency, urban areas have been designed and built with considerable levels of sophistication, both in terms of materials and technology, making them hypertrophic and energy-intensive metabolisms that produce huge amounts of waste in the form of solid waste, water and air pollution. This factor contributes to increasing the fragility of urban areas, increasing vulnerability, reducing resilience to the effects of global warming and accelerating processes related to biodiversity loss. Ultimately, urban metabolism considers cities as complex systems that consume resources and produce waste.

During the 20th and 21st centuries, global CO2 emissions have increased from around 5 Gt to over 37 Gt per year (IEA, 2025). However, the absorption capacity of terrestrial and ocean ecosystems is limited to 19 Gt of CO2 per year, corresponding to the carbon budget available to the planet (Friedlingstein et al., 2023). Current environmental policies are consistent with a trajectory that could lead to a temperature increase of more than 3°C by the end of the century, exceeding the targets set by the Paris Agreement (IPCC, 2021). This scenario is associated with serious risks to biodiversity and human health (IPCC, 2021). (Fig.1)

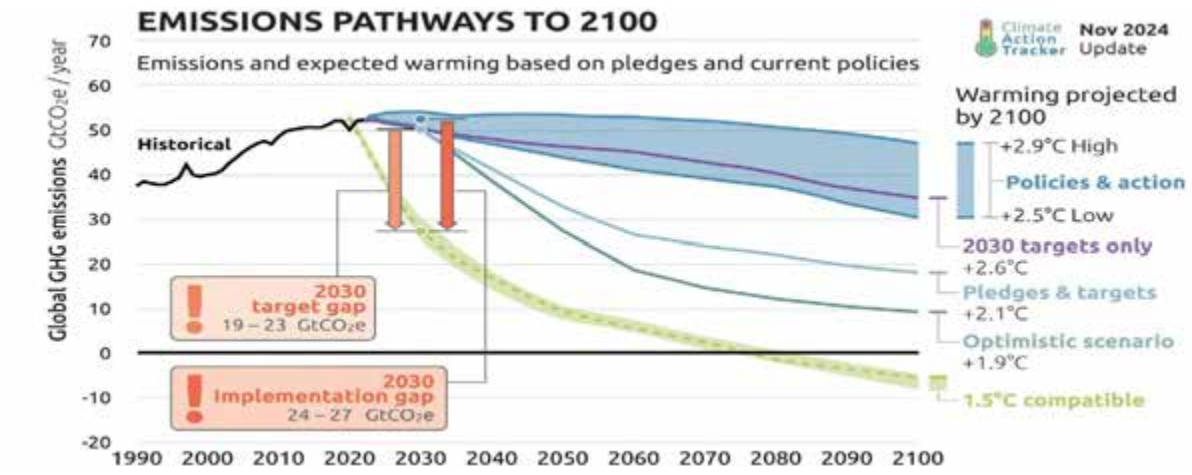

Fig. 1 – Global policies and pledges effects on greenhouse gas emissions and warming scenarios (Source: Climate Action Tracker, 2024)

Human actions have significantly altered 77% of the Earth's surface (IPBES, 2019), exploiting nature and its resources at a rate 1.75 times faster than the planet's ecosystems are able to regenerate (GFN, 2020; SCBD, 2020). The (distorted) use of natural resources is the main cause of air, water and soil pollution; waste, on the other hand, is tangible evidence of the degradation and waste that characterise the era in which we are living, the Wasteocene: an era marked by the continuous production of people, communities and places of waste, a global landfill that we must dismantle (Armiero M., 2021).

In this scenario, cities are a critical part of this mechanism as they consume 70% of the world's energy (UN-Habitat, 2022), use 75% of natural resources (Mancuso, 2023), emit 75% of CO2 into the atmosphere and produce 70% of waste (Luqman et al., 2023). In urban contexts, the linear management of resources (water, food, materials, energy) represents a development model that is no longer sustainable, as it contributes significantly to aggravating environmental problems such as resource depletion, ecosystem degradation, biodiversity crisis and loss of natural capital.

The climate crisis now requires a profound rethinking of the way we approach architecture. The year 2024 represented a critical threshold: the planet recorded its highest ever temperatures, far exceeding the +1.5°C limit set by the 2016 Paris Agreement. In just two years, global warming has accelerated to such an extent that even the most advanced scientific models are being called into question.

Until now, architecture has tried to respond through mitigation strategies, aiming to reduce the environmental impact of buildings. But this is no longer enough. The time has come to shift the focus from the goal of limiting damage to the urgent need to adapt. Adaptation means radically rethinking architectural design, imagining solutions capable of addressing the profound transformations already underway (Ratti C., 2025).

Conventional construction systems require a global flow of materials that are often untraceable. They depend on externalised and hidden spaces: copper mines, aluminium production sludge basins, and cement clinker calcination plants. The production and transport of materials require so much fossil fuel energy that the construction sector is responsible for 37% of global CO2 emissions (UNEP, 2022).

The concept of externalities was introduced in 1920 by British economist Arthur Pigou in his book "The Economics of Welfare" to describe the indirect costs that fall on individuals and territories not directly involved in the production of a good. This definition includes all the unaccounted consequences of production processes: emissions, waste, by-products and environmental impacts. Construction, in particular, is one of the sectors that generates the most externalities: every time we build, extracting resources, consuming energy, marginalising local skills and producing pollution, we contribute to a profound imbalance between the buildings we construct and the territories we transform. Taken together, these dynamics are the main cause of the environmental crisis. (Fig. 2)

Fig. 2 – Material extraction (Source: UNEP, Global Resources Outlook 2024).

Therefore, the built environment is a key lever for exploring how we can collectively engage in imagining a sustainable future. In an era marked by multiple crises, the ecological transition can no longer rely exclusively on established rules and methods: new, creative and interdisciplinary approaches are needed. Everyone's collaboration is essential. Only by integrating the social, economic and ecological dimensions can we initiate a truly circular, regenerative and sustainable transformation of our built environment.

It is possible to decouple economic growth from resource use and the environmental impacts it causes. This goal can be achieved by replacing prevailing linear growth models with regenerative and circular models for the preservation and enrichment of urban ecosystems and biodiversity. To combat climate change and reverse the current linear development model, we need to reconvert our production and consumption systems with appropriate economic, social, political and technological changes that go beyond conservation and restoration practices, towards a paradigm shift in the way we produce, use and reuse products and resources (IPBES, 2019) moving from an anthropocentric to an ecosophical vision that shifts the focus from humans to the ecosphere, integrating environmental, social and mental ecology to create communities integrated with nature.

Residues. From discarding to upcycling to reimagine cities as living organisms
"Nature produces no waste, no externalities. Every material flow is internalized in a continuous cycle. What if architecture followed the same logic? How can we balance the economies of construction with the ecologies of production?

Every time we construct a space, we deconstruct another (often in remote geographies across the planet). Buildings and the environment are therefore closely connected through a material link, and it is the responsibility of architects and planners to ensure that this link is positive." (Internalities: Architectures for Territorial Equilibrium, Spanish Pavilion at the Venice Architecture Biennale.)

Urban sites are complex, layered entities that are constantly evolving (Dovey, 2010). They can be described as an assembly of material things, flows and spatial connections that coexist. The relational understanding of sites also extends to the fact that every urban space contains a past, a present and a future (Hvattum, 2010), which means that they are dense, layered accumulations formed over time.

The challenges of circularity in urban areas call for a regeneration of cities based on circular design that brings about economic, social and environmental transformation without increasing the consumption of new resources and reducing the impact on the environment. Urban areas are characterised by a significant concentration of

material resources that accumulate over time (Gorgolewski, 2019) and, as the volume of built cities is expected to double by 2060, it is clear that the circular model will have to play a crucial role in cities in order to achieve the European Union's target of a zero-emission building stock by 2050. In order to meet these requirements and bring about a real paradigm shift in line with the principles of environmental sustainability and resource circularity, the design and management phases of interventions and the identification of the main urban challenges related to circularity play a central role (Atanasova et al., 2021;).

A fundamental aspect of this transition is understanding the key principles of the circular economy outlined by the Ellen MacArthur Foundation (EMAF, 2021) (Fig. 3):

- The first principle, "Eliminate waste and pollution", focuses on the goal of eliminating waste and pollution from the design stage onwards. This approach is not limited to managing waste at the end of the production cycle, but is based on intelligent design that prevents the creation of waste and minimises externalities. In this sense, energy efficiency, responsible use of resources and reduction of polluting emissions become an integral part of the economic system, contributing to the construction of a more equitable, resilient model that respects the ecological limits of the planet.

- The second principle, "Circulate products and materials (at their highest value)", is to keep resources in use for as long as possible. This promotes strategies such as reuse, repair, reconditioning and recycling. In this way, the aim is to improve efficiency in the extraction of new natural resources, optimise energy use and reduce losses within the system.

- The third principle, "Regenerate nature", concerns the need to regenerate the urban environment by integrating it with nature. This will ensure the long-term provision of essential ecosystem services such as clean water supply, climate regulation, soil fertility and biodiversity protection.

FIGURE 1 **THE CIRCULAR ECONOMY PLAYS A CRUCIAL ROLE IN BENDING THE CURVE ON BIODIVERSITY LOSS**

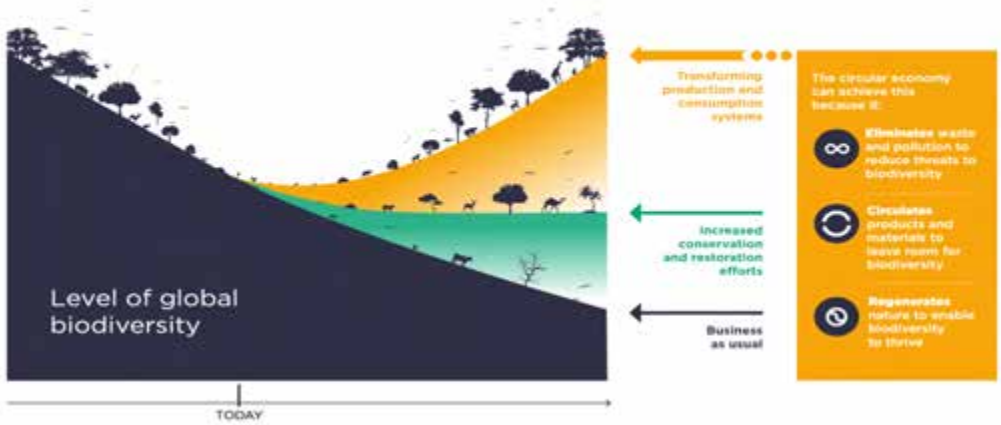

Fig. 3 - The three basic principles of the circular economy to contrast biodiversity loss (Source: Ellen MacArthur Foundation, 2021)

Resource-intensive urban lifestyles have made cities big, rich, and diverse stores of raw materials, which constantly depend on flows of goods and services to keep them running. Green and fair urban spaces can only happen if we take action that deals with urban areas as places of unsustainable consumption and socio-economic inequality at the same time. This is why urban communities characterised by regenerative design and development are desirable, as they aim to improve urban liveability while reducing the environmental footprint of cities by closing material cycles (Girardet, 2015). Increasingly circular urban economies are the means, and regenerative urban planning is the goal.

In this sense, the design of the built environment plays a decisive role, as it affects not only the quality of urban life but also society's long-term contribution to resilience to anthropogenic climate change and the depletion of

natural resources. Therefore, in order to respond effectively to the principles of the circular economy, a radical rethinking of the design and management of urban infrastructure is necessary.

At the urban level, society is transforming. As a result, there is a need to adapt the availability of spaces and buildings to new requirements. The urban regeneration process must necessarily take these changes into account, seeking to find appropriate solutions for each phase of the city's transformation. Research programmes and planning tools must recognise the vital role of cities and urban areas in the use of global economic resources, as they account for the vast majority of global consumption. This consumption puts considerable pressure on the environment, which is why the Circular Urban Economy (CUE) aims to support cities in becoming more resource-efficient and reducing their impact on the planet. The CUE encourages cities to implement circular measures that address socio-economic inequalities, promote social cohesion and improve access to urban resources, services and green spaces.

The introduction of Nature-based Solutions (NbS) in cities for resource management and to contribute holistically to the three principles of the circular economy leads to the reshaping of existing linear management into circular management. NbS play an important role in "keeping resources in use", mainly through the recovery and reuse of water and nutrients, and by giving new life to waste materials generated by other local production chains. In particular, their multifunctionality opens up a wide range of implementation possibilities: from transforming their outputs so that they fit into the value chain, to absorbing waste from other production chains to create an integrative urban supply chain.

Starting from the assumption that urban areas must be understood and addressed in relation to their use of resources and their socio-economic preconditions, the CUE aims to support the planning and design of urban places characterised by regenerative urbanism: by this term we mean liveable and green communities that are supported by circular flows of resources. Circularity should not be the ultimate goal, but rather a tool for creating healthier, more inclusive and regenerative urban communities that rely on closed material cycles to reduce their environmental footprint. We imagine cities and urban areas with restored natural resource cycles that support a high quality of life for their inhabitants, creating a transformative push towards healthy, attractive and green urban spaces. Through regenerative urban planning, we must think of cities characterised by restored natural resource cycles that support a high quality of life for their inhabitants.

The role of European policies in the circular transition: the New European Bauhaus Facility 2025-2027

In recent years, the concept of urban regeneration has evolved to become increasingly multidimensional and strategic in response to the growing complexity of urban transformation phenomena. The Urban Agenda for the EU (2023) frames urban regeneration as an integrated vision and action aimed at combating urban decay through economic, social, environmental and physical interventions, with the goal of sustainably improving the economic conditions and quality of life of residents. At the global level, UN-Habitat (2022) proposes a complementary interpretation, emphasising the participatory, inclusive and resilient nature of the process, which aims to transform declining urban areas into sustainable communities that are attentive to human well-being, social cohesion and adaptation to climate change. These definitions converge in recognising urban regeneration not only as a set of physical interventions, but as an integrated and sustainability-oriented process capable of responding to contemporary challenges related to ecological transition, spatial justice and social cohesion.

The urgency for Europe to take a leading role in global environmental governance and sustainable innovation has never been more evident. Given its significant historical carbon footprint, Europe now faces a dual and significant responsibility. Not only have European countries played a predominant role in the intensive consumption of planetary resources in the past, but in many cases they continue to do so at a rate that remains unsustainable (Dm, 2024).

Throughout Europe, profound transformations are taking place that affect both human and non-human communities. The idea that places are dynamic entities in constant flux (Dovey, 2010) is confirmed by the current reality.

In many areas, these changes are occurring particularly rapidly: buildings, infrastructure and public spaces are being rapidly constructed, modified, demolished or redeveloped. These processes have a significant impact on resident communities, as well as on future communities that will inhabit these territories.

In this context, the transition to a more circular, regenerative and systemic conception of the built environment requires a profound rethinking of decision-making practices. An integrated approach is needed that takes into account the three fundamental dimensions of sustainability: economic, environmental and social (Grupe Larsen, 2024). To effectively guide these transformations, it is crucial to activate profound levers of change capable of affecting systems at their roots. An effective green transition requires the construction of shared and imaginative visions of the future. Collective approaches to planning and storytelling are therefore essential, promoting new ways of thinking and acting in our living spaces, within societies and economies. In this perspective, it is essential to develop innovative languages, methods and tools that avoid the reproduction of unsustainable models, while promoting imagination, hope and creativity as transformative resources (Moore, 2023).

Many cities are experimenting with strategies for sustainable development and circular use of resources. A significant example of this is the "European Circular Cities Declaration", which aims to support the circular transition of municipalities, offer a shared vision of "circular cities", highlight the challenges of creating a closed-loop economy, and build a community of local authorities that share experiences, challenges and achievements. Trends show a growing number of circular initiatives at European level in support of cities and an increase in the adoption of strategies and action plans to guide the circular transition. Similarly, awareness-raising programmes on circularity for citizens and European instruments are also particularly important. In this regard, the New European Bauhaus (NEB) represents a fundamental pact as it supports actions for healthier and more resource-efficient urban environments with a particular focus on air, water, nature, biodiversity, waste and the circular economy.

The NEB is an initiative of the European Commission that aims to transform the European Green Deal into tangible change on the ground, improving everyday life through sustainable solutions for the built environment and lifestyles. It combines sustainability with good design, inclusiveness, accessibility and affordability, while respecting the diversity of places, cultural heritage and European cultures. (EC 2023). The New European Bauhaus Facility 2025-2027 (EC, 2025) is a European Commission tool designed to accelerate the transformation of neighbourhoods through sustainable and inclusive design, focusing on promoting innovation, circularity and the use of biological materials. By prioritising the use of circular economy principles and resource-efficient materials, the NEB contributes to the Clean Industrial Deal's goal of reducing carbon emissions and improving the sustainability of industrial processes. By embedding its vision in local and regional contexts, the NEB aims to bring Europe closer to its inhabitants, strengthening ties and bridging disparities to create prosperous and inclusive communities. The Tool addresses the transformation of the built environment at the neighbourhood scale, understood as complete systems where people live, socialise and find services. The main objectives are:

- Transforming places with communities by enhancing public spaces and buildings and empowering local communities through greater involvement.
- Promoting a sustainable, circular and regenerative European building ecosystem that is inclusive, accessible, affordable, resilient and promotes health and well-being. It focuses on innovation in materials, products and methods and seeks to make the built environment and materials more adaptable and reusable.
- Developing new business and financing models to rethink the way projects are conceived, planned, executed and invested in.

The tool invites cities to use planning strategies aimed at rethinking urban metabolisms to support both ecological balance and social equity by promoting regenerative relationships between society and the environment. These are the themes of the second objective of the NEB Facility, which promotes projects and strategies to make neighbourhoods more sustainable, circular, accessible and regenerative, improving their climate resilience through the restoration of nature and biodiversity. It will do so by helping to rethink the way we design, build and use the spaces around us. Particular attention will be paid to the reuse of existing infrastructure and materials and to renovation. New technologies will also be explored to optimise construction methods and the resources used and reduce costs, while ensuring user-centred and place-based solutions that take into account cultural heritage, local and vernacular knowledge, reflect local cultural identity and meet people's needs. It will take a

more systemic and holistic approach to neighbourhoods, looking at energy or mobility systems, for example. Under this specific objective, the NEB Instrument will promote environments where nature can thrive, helping to restore biodiversity, reduce pollution and improve the health and well-being of all living beings. The choices and actions implemented by European strategies (Fig. 4) should serve as concrete and replicable examples, helping to set benchmarks for collective action in the fight against climate change and environmental degradation.

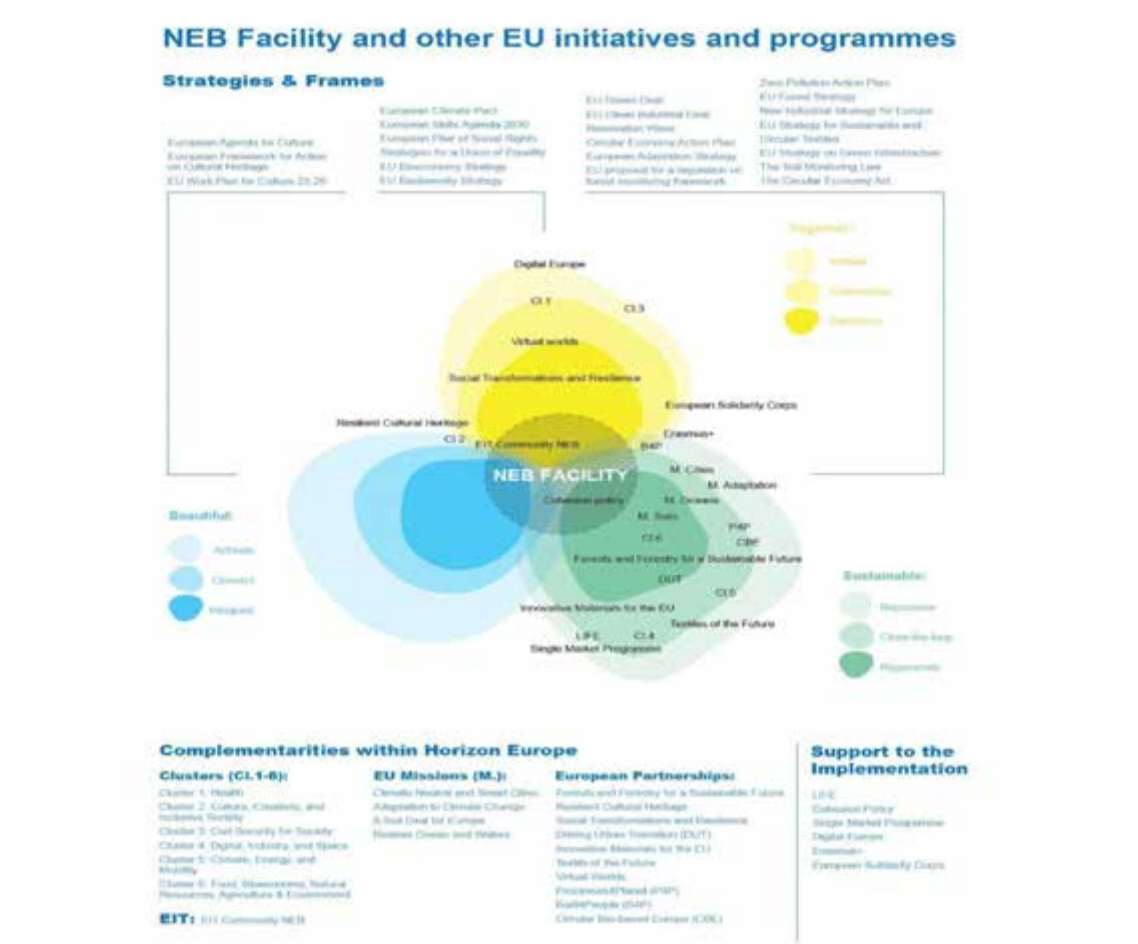

Fig. 4 - European Programmes and initiatives that support New European Bauhaus (Source: New European Bauhaus Facility 2025-2027)

European experiences in regenerating existing abandoned spaces through circular economy processes.
In order to address the various urban challenges and prepare cities for new development based on the recovery, reuse and recycling of materials and resources, starting from the design phase, but also in the management and maintenance phases, it is essential to adopt a holistic and systemic approach that carefully assesses flows. An initial survey of scientific literature, urban governance and European policy guidelines has highlighted the importance of promoting a systemic and innovative architectural model capable of contextualising individual interventions within a broad framework of transformation, taking into account the complexity of urban contexts. Although all urban challenges related to the circular economy can make a concrete contribution in the field of architecture, those related to the recovery of the built environment and construction waste and the protection and enrichment of urban ecosystems and biodiversity are of particular interest for the future urban development of cities as they deal, on the one hand, with waste from construction and demolition work and, on the other, with the transformation of impermeable urban surfaces into resilient and biodiverse natural infrastructure systems (IPBES, 2019; EC, 2020). and, on the other hand, the transformation of impermeable urban surfaces into resilient and biodiverse natural infrastructure systems (IPBES, 2019; EC, 2020). In order to identify some significant strategies,

solutions and tools adopted in experiments to regenerate existing abandoned spaces through circular economy processes, a survey of case studies was carried out (Table 1 shows the most relevant projects) according to four fundamental axes for decarbonisation: waste, materials, inclusion and biodiversity.

(1) The built environment as a resource mine. The Waste axis focuses on optimising the use of resources in urban areas, which are seen as complex systems containing buildings, infrastructure, technologies and material flows. This approach promotes interventions aimed at extending the useful life of resources through maintenance, renovation and repair activities, in order to interrupt linear flows and reduce waste production, thus increasing the efficiency of urban resource use. The built environment represents a resource of materials for the transformation of buildings and open space, offering great opportunities for circularity. In this sense, the design of the built environment plays a decisive role as it affects not only the quality of urban life but also society's long-term contribution to resilience to anthropogenic climate change and the depletion of natural resources. Therefore, in order to respond effectively to the principles of the circular economy, a radical rethinking of the design and management of urban infrastructure is necessary. In this regard, urban mining offers the opportunity to reshape our cities by converting waste into valuable resources.

(2) Circularity as an enabling tool for the transition of urban resources. The Materials axis analyses the value chains of natural and regenerative materials. In the case studies analysed, circularity is not conceived as an end goal, but rather as a set of tools for developing more resilient, inclusive and regenerative urban communities, characterised by closed material cycles that contribute to reducing environmental impact. The approach is based on closing material cycles, reducing environmental impact and restoring vitality to urban ecosystems, benefiting the quality of life of inhabitants. Conventional construction systems require a global flow of materials that are often untraceable. The transition to materials produced using regenerative methods allows for the use of materials or the production of resources with low greenhouse gas emissions, promoting biodiversity and the climate and avoiding damage to ecosystems (Filho et al., 2021).

(3) Social cohesion and integration of socio-economic dimensions in circular approaches. The Inclusion axis recognises the crucial importance of social dynamics in pursuing a circular economy. Therefore, measures aimed at mitigating socio-economic inequalities, promoting social cohesion and ensuring equitable access to resources, services and urban green spaces are encouraged. Urban areas are also considered privileged contexts for the application of new urban design principles geared towards inclusive regeneration.

(4) Towards regenerative urban planning: The Biodiversity axis promotes the adoption of regenerative design principles aimed at restoring natural resource cycles and creating sustainable, inclusive urban spaces capable of improving quality of life. This approach aims to generate green, resilient and socially cohesive urban environments capable of responding effectively to contemporary environmental and social challenges. Contributing to paradigm shifts in urban planning, design and architecture towards a biocentric perspective, in which urban areas and communities are further integrated into nature for a sustainable socio-ecological balance across urban-rural gradients.Table 1: most relevant experiments to regenerate existing abandoned spaces through circular economy processes analised.

Table 1: most relevant experiments to regenerate existing abandoned spaces through circular economy processes analised.

Project	Description	Axes				Pillars of the circular economy
		Was.	Mat.	Incl.	Biod.	
Kopfbau Halle 118 (Winterthur, Switzerland)	A concrete example of the recovery of an abandoned building is represented by the work carried out by the Swiss architecture firm Bauburo in situ and its partner company Zirkular, which, with the K118 pilot project, demonstrated how urban mining can be integrated into a modern building context, promoting the adoption of sustainable and circular practices. This case study highlights how, through innovative design and the use of recycled materials, it is possible to reduce the environmental impact of construction while maintaining the high quality and functionality of buildings.	•	•	•		Recovery of abandoned infrastructure Maximisation of the use Reversed planning process Reuse of materials Design for disassembly Strengthening community development Promoting social cohesion
Frank Areal (Basel, Switzerland)	Franck Areal, a new centre for social innovation, circularity and art, is a place where new connections are created: a centre for contemporary and urban dance, inclusive and cultural projects for young people, gastronomy and nightlife, as well as a space for regenerative and circular economy projects and an intergenerational housing project built with recycled construction materials and innovative energy technologies.	•	•	•		Recovery of abandoned infrastructure Maximisation of the use Reversed planning process Reuse of materials Strengthening community development Promoting social cohesion
La Ferme du Rail (Paris, France)	Located in the dense urban fabric of Paris's 19th arrondissement, on Rue de l'Ourcq, the urban farm and green oasis La Ferme du Rail provides an excellent example of possible circular approaches to the regeneration, reuse, protection and conservation of urban space for biodiversity through the active involvement of stakeholders. Developed over four years, this block creates an oasis of circular urban economy: it promotes a value chain that combines commercial activities with social and cooperative initiatives that benefit those who live there.	•	•	•	•	Recovery of abandoned infrastructure Maximisation of the use Reuse of materials Experimentation with natural solutions Urban renaturalisation Strengthening community development Promoting social cohesion

LUMEN - Laboratorio Urbano Mensola (Florence, Italy)	This is a culturally-based urban regeneration project that redevelops municipal real estate, creates social interaction in an abandoned public space and aims to create a new cultural hub next to the newly created Mensola Park. LUMEN's mission is to create a space where people can independently build opportunities to actively participate in their community. Through participation and individual empowerment, LUMEN is committed to promoting creativity, civic engagement and urban regeneration, encouraging the creation of an environment in which every individual can contribute to positive change.	•		•	•	Recovery of abandoned infrastructure Management of disused public properties Maximisation of the use Temporary and flexible use of space Reuse of materials Urban renaturalisation Strengthening community development Promoting social cohesion
Buiksloterham (AmsterdamNetherlands)	Buiksloterham is a typical post-industrial district, just a short ferry from the center of Amsterdam. The development of Buiksloterham as a living lab for circularity has led to a significant strengthening of the local economy and a transformation of what could previously have been deemed 'unusable land' into a thriving neighbourhood. Currently, Buiksloterham is undergoing transformation from an industrial area to a mixed living and working area. With local stakeholders, Metabolic developed a set of interventions for improving the current situation through waste minimization, high levels of source separation, and improved recycling techniques.	•	•	•	•	Recovery of abandoned infrastructure Maximisation of the use Reuse of materials Promoting responsible consumption Urban renaturalisation Optimise water use Strengthening community development Promoting social cohesion
Bluecity (Rotterdam, Netherlands)	Since 2015, BlueCity has developed from a vacant swimming pool into a circular economy hub for the city and region. In 2025, BlueCity is a model city for the circular and blue economy and home to 55 entrepreneurs. It is a meeting place for pioneers and enterprising minds, where they develop a framework for action, whether to grow their impact, live a zero waste life, or develop a future-proof material. BlueCity's mission is to accelerate the transition from the linear to the circular economy through entrepreneurship. BlueCity is designed as a prototype circular city to be replicated on a large scale.	•	•	•	•	Recovery of abandoned infrastructure Maximisation of the use Develop a future-proof material Experimentation with natural solutions Optimise water use Strengthening community development Supporting entrepreneurs with knowledge about circular economy

Oosteroever Circulair District (Oostend, Belgium)	For the Oosteroever site, a comprehensive hypothesis for a circular district was developed, addressing all key dimensions: materials, water, biodiversity, and programme. The proposal emphasises the importance of systems research and the creation of an urban planning model to support the economic transition of the area. This approach aims to avoid fragmented developments lacking mutual interaction. Furthermore, sustainable solutions require an integrated strategy at the scale of the entire district.	•	•	•	•	Recovery of abandoned infrastructure Reuse of materials Promoting responsible consumption Urban renaturalisation Optimise water use Strengthening community development Promoting social cohesion
Darwin Eco-system (Bordeaux, France)	Darwin aims to regenerate an abandoned urban space while promoting a social, green and creative economy. It is a place where new models are explored to reconcile economy and ecology, based on cooperative and sharing principles. The initiative focused on the preservation and renovation of the original buildings while providing workspace for over 100 enterprises and (social and cultural) associations, as well as co-working facilities. The ecological transition is an important theme in the redevelopment of the area, both in the renovation of buildings and in the wider activities developed. The area has for example become a living lab for new (urban) farming techniques like aquaponics and micro-gardening.	•	•	•	•	Recovery of abandoned infrastructure Promoting responsible consumption Develop a future-proof material Experimentation with natural solutions Strengthening community development Promoting social cohesion

Strategies for circular urban regeneration. Systemic processes for the cities of the future.

We already have everything we need. The point is not to continue producing, but to learn to read what exists more carefully, to recognise its latent value and reactivate it. The built environment is not an exhausted resource, but a reservoir of potential: every building, every material used has a residual value that can be regenerated. This approach opens up a new aesthetic of architecture, in which reuse is not only an environmental necessity, but also a design language capable of expressing beauty, memory and innovation. From a systemic perspective, architecture takes on the role of mediator between ecologies and economies, becoming an active tool in decarbonisation and the reactivation of local economies. The transition from a linear to a circular model requires a profound transformation of design methodologies: it is not just a matter of changing materials, but of radically rethinking processes, value metrics and decision-making models. We must move beyond the logic of initial cost to embrace a holistic view of value throughout the entire life cycle of the work.

We are accustomed to considering demolition and disposal as inevitable stages of the building cycle. But today it is possible to overturn this paradigm: designing architecture and neighbourhoods that generate minimal waste, facilitating disassembly, reuse and recovery of materials. This means intervening not only on the built environment, but also on design habits, supply chains and regulatory tools, in order to build urban contexts that reduce waste production and maximise regeneration.

Circular urban regeneration is based on a compact, biodiverse and zero-land approach, where the useful life of buildings and materials is extended through reuse strategies and the use of materials produced according to regenerative criteria (EMAF, 2021).

The urban transformation projects analysed aim to promote and accelerate progress towards inclusive, regenerative and transformative urban futures and highlight the importance of collaborative efforts between policymakers, urban planners, environmentalists and communities to implement effective strategies to preserve and restore urban biodiversity. Based on the results obtained through the analysis of the state of the art and the observation of case studies, it emerges that the main strategies for circular transition through the creation of interacting and replicable models concern:

- Recovery of critical or abandoned infrastructure or urban areas;
- Maximisation of the use of existing building heritage through models of sharing and flexible use of space;
- Reversed planning process: form follows availability, the project develops constantly as the search for components progresses;
- Adaptive reuse of materials from existing infrastructure, through a detailed analysis of residual and reusable materials;
- Mapping of local surpluses, in collaboration with companies and local networks for the reuse of resources within projects;
- New internal balance of relations between ecologies and economies;
- Experimentation with natural solutions to increase the presence of urban greenery, promote biodiversity and create resilient ecological infrastructure;
- Dematerialising public space infrastructure and focusing on nature as infrastructure;
- Promoting social cohesion and a participatory approach ensuring that urban regeneration aligns with the needs and characteristics of local populations;
- Strengthening community development and civic awareness.

Measuring the effectiveness of the projects analysed is the priority challenge that requires constant refinement of tools, continuous updating and improvement of results, and progressive deepening of evaluation methods, in awareness of the complexity and variability of reference parameters and the need to build a system for predicting effects throughout the entire life cycle for a regenerative and accessible urban system by design. The experiences studied show that the circular transition, with a view to climate neutrality, lays the foundations for an innovative vision of regenerative intervention, which aims to eliminate the concept of waste and refuse in the short to medium term (8-10 years, according to the European average) and invests, over the longer useful life phase, the entire range of material and immaterial resources in a perpetual self-sufficient cyclical process of decommissioning and regeneration.

Urban space can be configured as a regenerative ecosystem, guided by a zero waste approach that involves all resource flows, from design to management. Designing according to the useful life cycle of elements allows for the creation of self-sufficient and adaptive environments capable of resiliently addressing environmental, economic and social challenges. Circular design radically reformulates the relationship between construction and materials, focusing on the continuity of value over time and space. Reuse is no longer just a technical practice, but an evolving architectural narrative, where even buildings that can no longer be recovered become urban quarries, rich in materials that, as part of the existing heritage, acquire a cultural and environmental value greater than that of virgin materials.

CUE therefore proposes itself as an integrated, adaptive design model rooted in the territories, capable of generating environmental, social and economic value from what already exists. An approach based on proximity, nature and the enhancement of local resources, towards more equitable, resilient and regenerative cities.

If we look at this type of approach, NbS can be seen as a concrete application of the principles of circularity on an urban and architectural scale, through the mimicry of natural processes and the closure of ecological cycles (EEA, 2021). Artificial wetlands, vegetated channels, detention and infiltration basins, rain gardens, bioswales, renaturalised riparian strips and many other solutions act as decentralised biophysical systems, capable of filtering, storing and returning water to the natural hydrological cycle. These systems reduce pollutant loads,

mitigate flow peaks and recover resources (such as nutrients and biomass), in line with circular strategies for wastewater recovery (Li et al., 2020; EEA, 2021). NbS applied in urban areas to buildings and open spaces support the metabolic efficiency of urban systems, reducing energy consumption for cooling, greenhouse gas emissions and promoting passive ecosystem service flows (Pauleit et al., 2017). These results contribute directly to a circular reconfiguration of urban infrastructure without consuming new land (Pomponi & Moncaster, 2016).

Practices aimed at regenerating degraded soils increase carbon sequestration, improve soil fertility and promote biodiversity in urban and peri-urban areas. Such approaches are consistent with the principles of the circular bioeconomy, as they transform organic waste into productive inputs, contributing to the restoration of ecosystem functionality and increasing resource productivity in the long term (Lal, 2020; IUCN, 2020).

The integration of NbS into the theoretical and operational frameworks of the circular economy is not merely functional, but systemic. Both approaches emphasise resource cyclicality, multifunctionality and decentralisation, opposing linear and sectoral development models. The adaptive and feedback-based nature of NbS reflects the cyclical flows inherent in circular systems, reinforcing the need for their integration into sustainable territorial development strategies (Fischer & Newig, 2016; Kirchherr et al., 2017).

Fig.5 - 'Structure and flow' channels (efficiency) and 'network and exchange' (resilience) within a mycelial system (Source: National Institutes of Health)

The long-term future of our materials economy is regenerative. This transition requires a deep understanding of the impacts of systems, avoiding further degeneration of global biodiversity and land through green growth. Therefore, to imagine a post-capitalist future, it is important to promote circular, green and inclusive governance models. The CUE theme, through a proactive approach, encourages cities to implement circular measures that address socio-economic inequalities, promote social cohesion and improve access to urban resources, services and green and blue spaces. For this reason, new government tools must deepen urban transition processes according to the principles of regenerative design, strengthening the role of nature and the recycling of local resources to transform degraded urban areas into ecosystems that enhance biodiversity, combat climate change and improve the well-being and health of citizens.

Conclusions

The regeneration of degraded urban spaces according to the principles of the circular economy represents an urgent challenge but also a strategic opportunity to radically rethink our relationship with the built environment. The hegemony of the extractive economy over design culture has consolidated production chains so effective that they block the possibility of considering pre-existing materials on site as a valuable resource, improperly reducing them to waste. A paradigm shift, on the other hand, invites us to view these materials as a new form of urban stratification, an urban and anthropogenic mine from which to draw in order to promote infinite andregenerative production cycles. From this perspective, architecture should no longer be an act of replacement but a process of transformation, supporting a creative rebirth of our relationship with the built environment through an approach that prioritises reuse, regeneration and reintegration of materials on site, rather than demolition and disposal.

The adaptive reuse and regeneration of existing urban resources are the foundations of a new culture of urban renewal, which should guide all city operational plans according to the principles of "zero volume" and "no net land take". Unused or underused spaces represent a strategic potential for activating targeted urban policies

and strategies capable of responding sustainably to contemporary needs. It is therefore essential that local administrators recognise the social, economic and environmental impact that these places can generate and equip themselves with appropriate visions and tools to rethink urban planning logic in a regenerative and circular way. The temporary activation of abandoned buildings and areas can trigger participatory processes of active citizenship and local activism, offering citizens concrete tools to contribute to urban development. If systematised, this approach can lead to a more inclusive and resilient urban transformation.

The transition to regenerative cities therefore requires deep integration between spatial innovation, social inclusion and the protection of urban biodiversity. This is not simply a matter of adding up good practices, but of a structural change in the vision of the city: from an entity that consumes land and resources to an integrated ecosystem capable of self-regeneration. The promotion of biocentric planning, which reintegrates the built environment with natural processes, is one of the most effective levers for a just ecological transition.

For these changes to be effective and scalable, it is necessary to build a model consisting of policies, financial instruments, design regulations and collaborative mechanisms. The simultaneous development of tools such as material registers and passports, together with the creation of alliances between public and private actors and local communities, is essential to enable a truly circular institutional urban economy.

Through the implementation of the CUE, the goal is to create a cohesive ecosystem that not only anticipates future needs but also collectively guides the transition of cities towards systemic, equitable and transformative governance models capable of internally rebalancing the relationship between ecologies and economies.

The paradigm shift presented in the paper is not easy, but it is necessary and requires a joint effort that cannot be postponed and can provide policymakers with the tools and knowledge needed to expand related interventions in other urban contexts.

References

Armiero, M. [2021]. L'era degli scarti. Cronache dal Wasteocene, la discarica globale (M. L. Chiesara, Trans.). Einaudi.

Atanasova, N., Castellar, J.A., Pineda-Martos, R. et al. Nature-Based Solutions and Circularity in Cities. Circ.Econ. Sust. 1, 319–332 (2021). [Online] Available at: https://doi.org/10.1007/s43615-021-00024-1 [Accessed 21 March 2024].

Dark Matter Lab, A New Economy for Europe's Built Environment, White paper DML-NEBE-White-paper-_-Desire-Sep2024.pdf [Accessed 10 October 2024].

Dovey, K. (2010). Becoming Places: Urbanism/Architecture/Identity/Power. Routledge.

EEA (European Environment Agency). (2021). Nature-based solutions in Europe: Policy, knowledge and practice for climate change adaptation and disaster risk reduction. Publications Office of the EU.

EC (2023) Nuovo Bauhaus europeo: relazione sull'avanzamento dei lavori. [Online] Available at: https://eur-lex.europa.eu/legal-content/IT/TXT/HTML/?uri=CELEX%3A52023DC0024 [Accessed 18 April 2024]

EC (2023). Urban Agenda for the EU: Partnership on Sustainable Use of Land and Nature-Based Solutions. Brussels: European Commission.

EC (2025) - European Commission, NEB Facility Roadmap. New European Bauhaus. [Online] Available at: https://new-european-bauhaus.europa.eu/system/files/2025-03/NEB%20Facility%20Roadmap.pdf [Accessed 18 April 2025]

EMAF (2021). Ellen MacArthur Foundation. The Nature Imperative: How the circular economy tackles biodiversity loss . [Online] Available at: https://www.ellenmacarthurfoundation.org/biodiversity-report [Accessed 21 March 2024].

Fischer, L. B., & Newig, J. (2016). Importance of Actors and Agency in Sustainability Transitions: A Systematic Exploration of the Literature. Sustainability, 8(5), 476.

Friedlingstein, P., Jones, M.W., O'Sullivan, M., Andrew, R.M., Bakker, D.C.E., Hauck, J., Le Quéré, C., Peters, G.P., Pongratz, J. and Sitch, S., 2023. *Global Carbon Budget 2023*. Earth System Science Data, 15(11), pp.5301–5364. https://doi.org/10.5194/essd-15-5301-2023

Girardet, H., 2015. Creating Regenerative Cities. London: Routledge.

GFN (2020). Global Footprint Network. Calculating Earth overshoot day 2020: estimates point to August 22nd. [Online] Available at: https://www.overshootday.org/content/uploads/2020/06/Earth-Overshoot-Day-2020-Calculation-Research-Report.pdf [Accessed 21 March 2024].

Gorgolewski, M. [2019] The architecture of reuse. In IOP Conference Series: Earth and Environmental Science, Vol. 225.

Hvattum, M. (2010). Stedets tyranni. Arkitekten, 112(2), 34-43.

IEA (2025) – *Global Energy Review 2025*. International Energy Agency, Paris. [Online] Available at: https://www.iea.org/reports/global-energy-review-2025 [Accessed 18 May 2025]

IPCC (Intergovernmental Panel on Climate Change), 2021. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the IPCC*. [online] Cambridge University Press. Available at: https://www.ipcc.ch/report/ar6/wg1/ [Accessed 25 May 2022].

IPBES (2019). Intergovernmental science-policy Platform for Biodiversity and Ecosystem Services. Summary for policymakers of the global assessment report on biodiversity and ecosystem services, IPBES secretariat, Bonn. [Online] Available at: doi.org/10.5281/zenodo.3553579 [Accessed 21 March 2024].

IUCN (2020). Global Standard for Nature-based Solutions: A user-friendly framework for the verification, design and scaling up of NbS.

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127, 221–232.

Li, Z., Wang, Z., & Zhang, Y. (2020). Circular economy strategies for wastewater treatment: A review. Science of The Total Environment, 721, 137648.

Luqman, M., Rayner, P.J. & Gurney, K.R. On the impact of urbanisation on CO2 emissions.npj Urban Sustain 3, 6 (2023). [Online] Available at: https://doi.org/10.1038/s42949-023-00084-2 [Accessed 21 March 2024].

Mancuso S. (2023). Fitopolis, la città vivente. Editori Laterza. Roma.

Moore, J.W., 2023. World-ecology and the crisis of capitalism: The end of cheap nature. Verona: Ombre Corte.

Pauleit, S., Zölch, T., Hansen, R., Randrup, T. B., & Konijnendijk van den Bosch, C. (2017). Nature-Based Solutions and Climate Change – Four Shades of Green. In Kabisch, N. et al. (Eds.), Nature-Based Solutions to Climate Change Adaptation in Urban Areas. Springer.

Pomponi, F., & Moncaster, A. (2016). Circular economy for the built environment: A research framework. Journal of Cleaner Production, 143, 710–718.

Ratti, C., 2025. Alla Biennale 2025 l'architettura impara dalla scienza per combattere il cambiamento climatico. Il Bo Live UniPD. [Online] Available at: https://ilbolive.unipd.it/node/20815. [Accessed 17 May 2025].

SCBD (2020). Secretariat of the Convention on Biological Diversity. Global Biodiversity Outlook 5. Montreal. [Online] Available at: https://www.cbd.int/gbo/gbo5/publication/gbo-5-en.pdf [Accessed 15 September 2024].

UNEP (2022), UN Environment program, Global Status Report for Buildings and Construction, [Online] Available at: https://www.unep.org/resources/publication/2022-global-status-report-buildings-and-construction [Accessed 21 October 2024].

UN-Habitat (2022), United Nations Human Settlements Programme, Envisaging the future of the cities, World Cities Report. [Online] Available at: https://unhabitat.org/world-cities-report-2022-envisaging-the-future-of-cities [Accessed 21 March 2024].