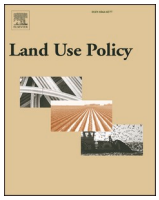
Land Use Policy 119 (2022) 106198

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol



Opinion paper on green deal for the urban regeneration of industrial brownfield land in Europe

Maria Rosaria Sessa [a,*], Alessio Russo [b], Francesco Sica [c]

[a] Department of Business Studies - Management and Innovation Systems, University of Salerno, Fisciano 84084, Italy
[b] School of Arts, University of Gloucestershire, Francis Close Hall Campus, Cheltenham GL50 4AZ, UK
[c] Department of Architecture and Design, Sapienza University, Rome 00196, Italy

ARTICLE INFO

Keywords:
Urban regeneration
Brownfield
Sustainability
Policy
European Green Deal

ABSTRACT

Economic, social and environmental sustainability are becoming more important in urban and territorial development policies in Europe and internationally. Recently, the United States and Europe have put forth the green deals proposing programmatic provisions for achieving territorial sustainability through the redevelopment of brownfield land into Sustainable Industrial Areas (SIAs). This opinion paper presents the benefits of the European Green Deal (EGD) policies as support for brownfield land redevelopment, SIA implementation and urban regeneration in light of the experiences of many countries in the European Union (EU). Moreover, this paper makes policy recommendations and discusses future research directions.

1. Background

Cities generate about 85% of the European Union's gross domestic product (Maestosi et al., 2020). They are also key in the provision of technological and social innovations, but have negative impacts on social and environmental systems (Maestosi et al., 2020). Actions implemented in the land produced multiple effects over time, such as significantly altering the balance between the natural environment and economic and social systems. According to assessments by the European Commission, an area of about 1000 km^2, which is equivalent to the surface area of Berlin, is permanently sealed in Europe every year as a result of building infrastructure, and road network construction (European Commission, 2018). The EU has set targets for member states that include zero soil sealing by 2050 (European Commission, 2019). To reach this objective is necessary to avoid the sealing off of natural areas and offsetting non-avoidable components with area renaturation of at least equal size which can generate the same ecosystem effects as those once provided by the compromised soils (Montanarella and Panagos, 2021). In recent years, there has been increasing demand for the restructuring and optimisation of urban built environments to promote high-quality urbanisation and sustainable urban development (Wang et al., 2021). Urban regeneration/renewal has garnered much interest among academics, policy-makers and government officials as a viable means of ensuring long-term urban sustainability (Wang et al., 2021). In particular, reusing and regenerating disused and abandoned areas is an important component of sustainable land use policy and planning (Klusáček et al., 2021). According to the literature, the basic issues addressed by urban regeneration policies are those relating to the degradation of the social, economic, and physical health of cities or portions of cities in the older industrialised economies of Europe and North America (de Magalhães, 2015).

At the international level, the United Nations (UN) adopted the 2030 Agenda for Sustainable Development, which provides a blueprint for maintaining peace and prosperity for people and the planet, now and into the future. The Agenda comprises 17 Sustainable Development Goals (SDGs), which are the specifics of an urgent call to action for all countries – developed and developing – to join a global partnership. Among these SDGs, Goal 11 refers to making cities and human settlements inclusive, safe, resilient, and sustainable (Nesticò et al., 2019).

The green growth of industry complexes is a critical issue for the pursuit of the UN's Agenda 2030, particularly in terms of sustainable industrialisation and urban regeneration. It is well established that the industrial sector is the engine for the national economy, but it also contributes the most to global environmental impacts, such as carbon and resource footprints and critical pollutant emissions (Dong et al., 2016; Mattoni et al., 2015).

* Correspondence to: Department of Business Studies, Management and Innovation Systems, University of Salerno, Via Giovanni Paolo II, Salerno 132-84084, Italy.
E-mail addresses: masessa@unisa.it (M.R. Sessa), arusso@glos.ac.uk (A. Russo), francesco.sica@uniroma1.it (F. Sica).

https://doi.org/10.1016/j.landusepol.2022.106198
Received 2 September 2021; Received in revised form 20 April 2022; Accepted 11 May 2022
Available online 26 May 2022

2. Introduction

This viewpoint aims to discuss the potential benefits of the EU Green Deal for the green redevelopment of industrial areas, provide recommendations for policy-makers and urban planners, and further future research. Following Frosch and Gallopoulos' seminal statement[1] in 1989, which popularised the metaphor of an industrial ecosystem comparable to natural ecosystems, the 1990s saw the emergence of industrial ecology as a theory that proponents claim can deliver the win–win outcome of sustainable development at the local or regional scale (i.e., the promotion of environmental, economic, and social value; Gibbs and Deutz, 2007).

In recent decades, the establishment of industrial ecology principles, such as the development of Sustainable Industrial Areas, has become important for the enhancement of regional economic systems (Barile, 2011) as well as for implementing policies that promote long-term sustainability (Gibbs and Deutz, 2007). SIAs development was proposed as a solution to the environmental problems arising from the high number of productive areas of traditional agglomerated industry (Sessa et al., 2021). Although there are some progressive globally distributed SIAs, linear productive areas development retains the mainstream industrial agglomeration model and it thus has not transitioned into SIAs development (Susur et al., 2019). In a worldwide context, SIAs are often related to Eco-Industrial Parks (EIPs), based on the principles of industrial ecology (Beltramo et al., 2014). These principles refer to a new circular economy model that replaces the traditional linear model. The reference framework for the implementation of SIAs is based on four key performance categories: area management, environmental, social and economic performance.

Fig. 1 illustrates the overarching framework. The framework provides the basis for defining and setting prerequisites and performance requirements for SIAs. This baseline could ensure that SIAs comply with local and national regulations standardised (UNIDO, 2017).

The transition requires policies based on the principles of an ecologically and socially sustainable economy. Among the short-term strategies recommended by the European Commission for the reduction of land consumption, the greatest potential for sustainable development comes from the recovery and rehabilitation of existing building stock, referred to as industrial brownfield land redevelopment. Recently, the green deals have been hailed as an opportunity to create a low-carbon transition and a long-term strategy for urban regeneration through industrial brownfield land redevelopment into SIAs. The US Green New Deal resolution, introduced by Congresswoman Ocasio-Cortez and Senator Markey in 2018, is one of the first comprehensive programmes to combine climate change mitigation and the elimination of economic inequality. It aims "to achieve net-zero greenhouse gas emissions through a fair and just transition for all communities and workers" and "to create millions of good, high-wage jobs and ensure prosperity for all people of the United States" (Bloomfield and Steward, 2020). Following the American Green New Deal debates, a grassroots coalition of civil society groups – scientists, labour unions, indigenous peoples, and youth – launched the Pact for a Green New Deal (PGND) in Canada in May 2019 (MacArthur et al., 2020). In Europe, on 11th December 2019, the European Green Deal was presented by the European Commission. It set the goal of making Europe the first climate-neutral continent by 2050.

To achieve these objectives, policies that consider the redevelopment of industrial areas using innovative approaches, such as Nature-Based Solutions (NBS), green infrastructure, biophilic design and urban reforestation, are necessary.

3. The European Green Deal: Policies and practices

More than 30 years ago, the European Commission began to foster sustainable urban development through the framework programmes FP5, FP6 and FP7. The new president of the European Commission, Mrs Ursula von der Leyen, has outlined her priorities for 2019–2024, including her vision for a greener Europe: "Climate change, biodiversity, food security, deforestation, and land degradation go together. We need to change the way we produce, consume, and trade. Preserving and restoring our ecosystem needs to guide all of our work" (von der Leyen, 2019). In illustrating the three pillars characterising the Next Generation EU plan to invest a thousand-billion euros to support the member states in their recovery, kick-starting the economy by helping private investment and learning lessons from the last economic and social crisis – she invited the member states to work together for "[...] the European Green Deal and digitalization (that) will boost jobs and growth, the resilience of our societies and the health of our environment" (von der Leyen, 2019). This can be done "[...] not only by supporting the recovery but also by investing" in the development of a more sustainable, digital, social, and resilient European Union (von der Leyen, 2019). Specifically, the European Green Deal takes the form of a new growth strategy aimed at transforming the EU into a more just and affluent society with a modern, resource-efficient, and competitive economy by 2050, with no net greenhouse gas emissions and with economic growth decoupled from resource usage, while protecting citizens' health and well-being from environmental risks and hazards (European Commission, 2019). Thus, the main elements of the European Green Deal are climate action, clean energy, sustainable industry, environmentally friendly buildings and renovations, sustainable mobility, eliminating pollution, promoting "farm to fork" agriculture, preserving biodiversity, and prioritising research and development and preventing unfair competition from carbon leakage. Recent EU proposals combine the application of emissions trading to new sectors and a tightening of the existing EU Emissions Trading System, greater energy efficiency, a faster roll-out of low emission transport modes and the infrastructure and fuels to support them, the implementation of measures to prevent carbon leakage and the development of the tools to preserve and grow our natural carbon sinks.[2] Table 1 lists the main benefits of the EGD according to 2019–2024 priorities of the European Commission.[3] In our opinion, reforestation in cities around the world could significantly contribute to the climate change solution. Recently, Teo et al. (2021) calculated the global potential and limitations of urban reforestation and discovered that 10.9 ± 2.8 Mha of land (17.6% of all city areas) is suitable for reforestation, which would offset 82.4 ± 25.7 $MtCO_2e\ yr^{-1}$ of carbon emissions. Urban forests in Hangzhou, China, offset 18.57 per cent of the carbon generated by industrial companies yearly and store (through sequestration) an amount of carbon equivalent to 1.75 times the annual

[1] The origins of industrial ecology trace back to at least the late 18th century and Thomas Malthus' study of the relationship between population growth and economic output. The literature developed in various ways over the next two centuries.In 1989, Scientific American published what would prove to be a seminal article in the field of industrial ecology. The article by Robert Frosch and Nicholas Gallopoulos was the catalyst for a symposium held by the US National Academy of Sciences in the early 1990 s that has been heralded as a founding event for the modern field of industrial ecology. Their groundbreaking definition of industrial ecology is "the means by which humanity can deliberately and rationally approach and maintain sustainability, given continued economic, cultural, and technological evolution. The concept requires that an industrial ecosystem be viewed not in isolation from its surrounding system, but in concert with them. It is a systems view in which one seeks to optimize the total materials cycle from virgin material, to finished material, to component, to product, to obsolete product, and to ultimate disposal. Factors to be optimized are resources, energy and capital" (Frosch and Gallopoulos, 1989).

[2] https://ec.europa.eu/clima/news/delivering-european-green-deal_en (last accessed: 2021.08.13).

[3] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en#thebenefitsoftheeuropeangreendeal (last accessed: 2021.12.21).

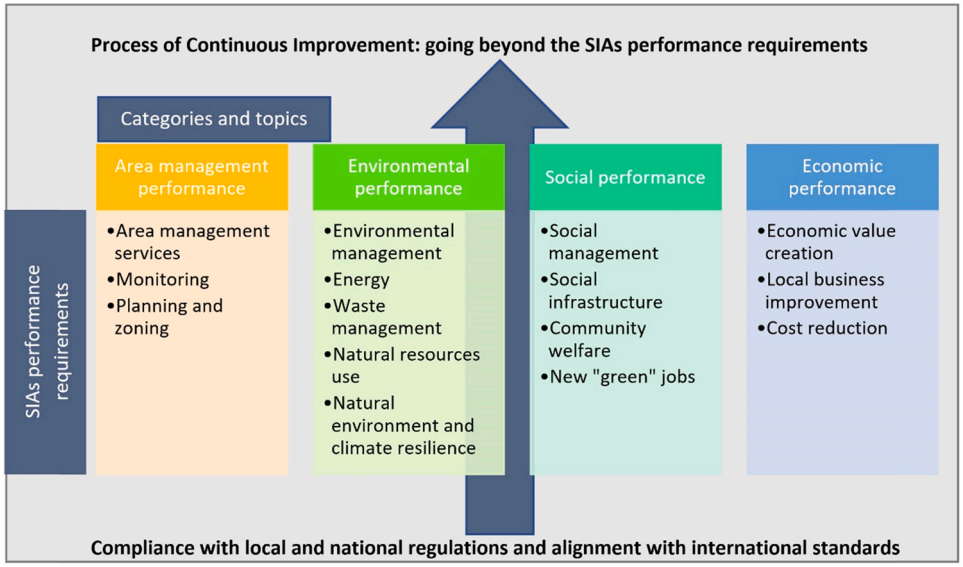


Fig. 1. SIAs performance requirements.
Source: own processing on UNIDO (2017).

Table 1
Main benefits of the European Green Deal.

	EGD Fields							
	Climate	Energy	Agriculture	Industry	Environment & Oceans	Transport	Financing & Regional Development	Research & Innovation
Actions proposed	*-European Climate Law* -Adaptation Strategy *-COP26 Climate Change Conference* -European Climate Pact *-Climate Diplomacy*	*-Energy System Integration Strategy* -Hydrogen Strategy *-Offshore Renewable Energy Strategy* - Wave of Restructuring *-Methane Strategy* -Trans-European Energy Networks	*-Common Agricultural Policy Reform* -Action Plan for Organic Farming *-Welfare of Farm Animals* -Nutritional Labelling *-Common Agricultural Policy Strategic Plans* -EU Agri-food Promotion Policy *-Sustainable Use of Pesticides*	*-Single Market Enforcement Action Plan* -SME Strategy for a Sustainable & Digital Europe *-Circular Economy Action Plan* - Circular Electronics Initiative *- Industrial Forum* - Public Private Partnerships *-Etc.*	*-Biodiversity Strategy for 2030* -Chemicals Strategy for Sustainability *-Organic Action Plan* -Environment Action Plan *-Blue Economy Strategy* -Zero Pollution Action Plan *-Sustainable Batteries* - "Farm to Fork" Strategy *-Etc.*	*-Strategy for Smart and Sustainable Mobility* -Connecting Europe Express	*-NextGenerationEU* -Recovery and Resilience Device *-Mechanism for a just Transition* -NextGenerationEU Green Bonds *-Sustainable Finance*	*-Horizon Europe (2021-2027)* - Europe's 2030 Climate and Energy Targets *- Research and Innovation to drive the Green Deal* - Research and Innovation Key Contributor to the new EU Climate Adaptation Strategy *- Etc.*
BENEFITS								
Longer lasting products that can be repaired, recycled and re-used **Cleaner energy and cutting-edge clean technological innovation** **Future-proof jobs and skills training for the transition** **Fresh air, clean water, healthy soil and biodiversity** **Globally competitive and resilient industry** **Renovated, energy efficient buildings** **Healthy and affordable food** **More public transport**								

Source: own processing on https://ec.europa.eu/info/strategy/priorities-2019–2024/european-green-deal_en#thebenefitsoftheeuropeangreendeal (last accessed: 2021.12.21).

carbon emitted by industrial energy consumption within the city (Zhao et al., 2010).

Regarding the sustainable industry sphere, industry manufacturing currently accounts for 20 per cent of the EU's greenhouse gas emissions (European Commission, 2020a). Brownfield land redevelopment is essential for sustainable industry management and urban regeneration in European member states. Major areas previously used for military, mining, industrial or commercial purposes are frequently beset by high levels of complex contamination. Regarded as problematic, many have become brownfield land, impeding the development of surrounding communities. Brownfields threaten scarce soil and water resources, cause environmental and health risks and have economic and social costs. Many useful and innovative technologies for brownfield exist redevelopment, as well as methods supporting decision-making processes, many have been developed in previous European funded research projects, but they are often only rarely applied to their full potential. Occasionally, the non-visibility of tools is the reason given by owners of problems, managers, local authorities and other stakeholders for not regenerating brownfields using the best available technology and decision support system measures. However, many mega-sites can be sustainably revitalised if efficient technologies are applied, potential reuse options are assessed holistically and relevant risks are quantified. The European research project TIMBRE[4] (Tailored Improvement of Brownfield Regeneration in Europe) used the EU 7th Framework Programme, to present the best practices of brownfield land redevelopment, demonstrating that this action is a worthwhile endeavour (TIMBRE, 2021). Best practice cases of brownfield land redevelopment in the European Union can be seen in Belgium, the Czech Republic, Denmark, France, Germany, Italy, Netherlands, Poland, Romania and Slovakia[4]. Some cases of brownfield land redevelopment have a greater number of actions and processes that have resulted in greater success. For example, the Park Spoor Noord Antwerp in Belgium and the Havenstad in

[4] http://www.timbre-project.eu/en/craiova.html (last accessed: 2021.12.21).

Denmark have pursued many strategies (environmental, social and financial) for successful redevelopment, including using transport links, increasing the attractiveness of the site and objects on it, ensuring the availability of financial incentives, increasing the social status of the locality, implementing placemarketing and pursuing ecological responsibilities. Other industrial areas have not pursued an integrated vision of redevelopment options as is the case in the Czech Republic or Romania[4]. The same can be said for Italy which ranked 8th in the 2019 Eco-Innovation Index. While Italy's performance in 2019 was 12 per cent better than the EU average, with a score of 112, it has regressed by 1.2 points since 2017 (Gionfra, 2019). The country performs somewhat better than the EU average in terms of eco-innovation activities, eco-innovation outputs, and socio-economic results (Gionfra, 2019). However, the country's lowest performance is in eco-innovation inputs, where it scores 69 points, which is considerably below the EU average (Gionfra, 2019). Hurdles to future growth still exist, such as low Resource & Development spending and substantial variations in legislative procedures and performance between regions (Gionfra, 2019). There is also concern that redevelopment processes and strategies have not been increased, evaluated or improved in recent years. According to ISTAT research from 2012, these areas appear to make up 3% of the national surface area, covering an area of around 9,000 km^2; for example, in Lombardy, 200 abandoned productive areas occupy eight million square metres in just three provinces: Milan, Monza Brianza and Lodi.[5] The European Green Deal may provide the opportunity to survey these brownfields while considering their long-term regeneration. The UK Labour Party, the German Green Party, the Spanish Socialist Party, the Democracy in Europe Movement 2025 (DiEM25), and the European Commission have all proposed that a green deal, in various forms, should be given priority for future government policy-making (DiEM25, 2019). Fig. 2 illustrates the logic of the European Green Deal and urban regeneration through brownfield land redevelopment.

Implementing this green deal would facilitate the management of production areas using eco-efficiency standards and guarantee an integrated management system of environmental aspects, from the decrease and prevention of air, water and soil pollution to the protection of the health and safety of individuals. Thus, creating synergy between companies through joint management processes and/or the exchange of raw materials and energy can lead to economies of scale, an increase in the potential for innovation, the reduction of environmental impacts and greater competitive advantage.

This action of urban regeneration can be implemented to recover the existing environmental fabric, support territory development and provide sustainable infrastructures and services. (Fig. 3).

EGD policies could support nations that want to legislate on SIAs but have not considered the issue of urban regeneration, or countries that are approaching the environmental management of industrial brownfields. One of the most critical issues concerning the implementation of SIAs through industrial brownfield land redevelopment is the impossibility of referring to guidelines or indications that represent a single and coherent scenario of industrial development. The EGD industrial strategies mentioned above could fill this gap and meet the main objectives of SIAs: efficient use of resources, reduction of environmental impact and management of interactions between the environment and surrounding communities. Furthermore, from the analysis of the strategies and processes followed for the redevelopment of industrial brownfields in the TIMBRE context, results that lack innovative approaches such as green infrastructures or NBS, for the regeneration of industrial areas. For example, public parks were built in the heart of the city to provide green "lungs" for the dense population (Power, 2018). In some cases, these public parks have deteriorated and have even fallen into disuse (Power, 2018). The EGD may provide an opportunity to restore these parks as well as to revitalise brownfields as new growth magnets (Power, 2018). Policy-makers should incorporate ideas from the European Green Deal into future policies on sustainable industrial areas.

4. Conclusions

The industrial sector is vital to the future of Europe. It makes up more than 20% of the EU's economy and employs around 35 million people, with many millions more jobs linked to it at home and abroad. It accounts for 80% of exported goods and is a key reason for the EU's position as a top global provider and destination for foreign direct investment. Additionally, Europe's industry has a global competitive advantage in terms of high value-added products and services, as it leads by example by complying with the highest social, labour and environmental standards. Thanks to a strong innovation capacity, Europe is also a world leader in green technology patents and other high-tech sectors (European Commission, 2020b). These strengths must be channelled to transform and grow traditional and new industries towards achieving sustainability goals by 2050. In this regard, the European Green Deal offers a solid framework to shape strategies and policies to respond urgently to the climate change crisis. So, there is a green policies framework, but it remains whether there is the will and capability to translate them into green practices. Many companies have already integrated sustainability policies into their strategic plans. This decision stems from the need to comply with legal obligations or respond to market demands for more significant corporate social and environmental commitment. But, the distance between the declared and the action of an organisation is not easy to understand. Indeed, much remains to be done; otherwise, it would not explain the continuous succession of international initiatives promoting sustainability. More than specific tools, what is needed is a change in a company's culture, a city, and the entire society.

Today, also following the health, economic and socio-environmental crisis caused by the Covid-19 pandemic, it is necessary to change the way of doing business and act on the individual behaviour of citizens and, therefore, the lifestyles of consumers. In this scenario, everyone can play an important role. For example, local institutions can replace the logic of compliance with the result one. Furthermore, when considering sustainability as a strategic driver, companies are led to rethink processes and products and services. Thus, companies will have to work on reducing their carbon footprints and accelerating the transition by providing affordable, clean technology solutions and developing new business models. In doing so, business organisations will see positive economic results in terms of productivity, competitiveness and media image over the long term.

Finally, academic organisations can contribute to designing green and innovative solutions in synergy with all local actors.

5. Future research and recommendations

The European Green Deal encourages member countries to move to a more careful allocation of resources through investments in industrial brownfield land renewal projects (Colglazier, 2015). Such investments would support sustainable and integrated growth while respecting biodiversity and the existing natural components of the land. Recently, many countries have been pushing for an EGD policy to form a win-win relationship that benefits both economic growth and environmental protection, which have been perceived as conflicting priorities. Green policy in the global era is marked by the convergence of digitalisation and environmental protection, emphasising the importance of establishing smart infrastructure in response to the Fourth Industrial Revolution and climate change. This involves discussing environmental and economic responses including the development of green technologies, the promotion of green space and new job creation. Extensive academic and industrial efforts are necessary to find a solution to the problem of climate change, and the manufacturing sector needs to install specific

[5] https://www.senato.it/application/xmanager/projects/leg17/attachments/documento_evento_procedura_commissione/files/000/002/999/2015_07_29_-_ANCI.pdf (last accessed: 2021.08.29).

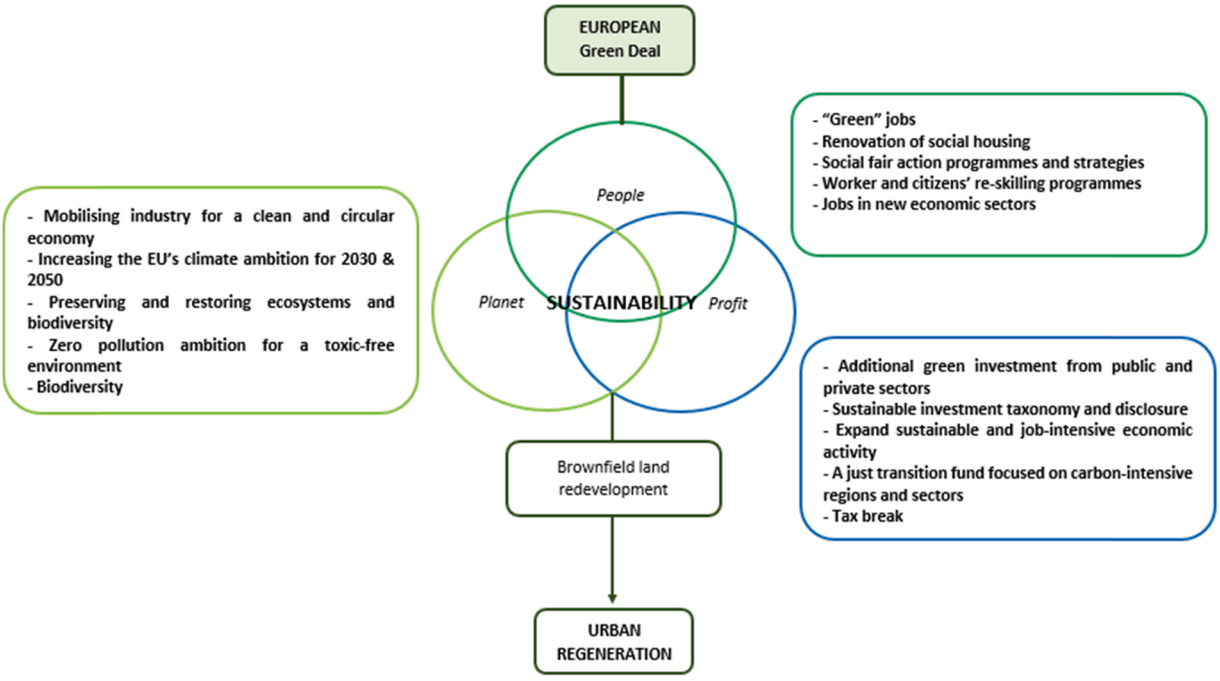


Fig. 2. From the EGD to the urban regeneration through brownfield land redevelopment.
Source: own processing.

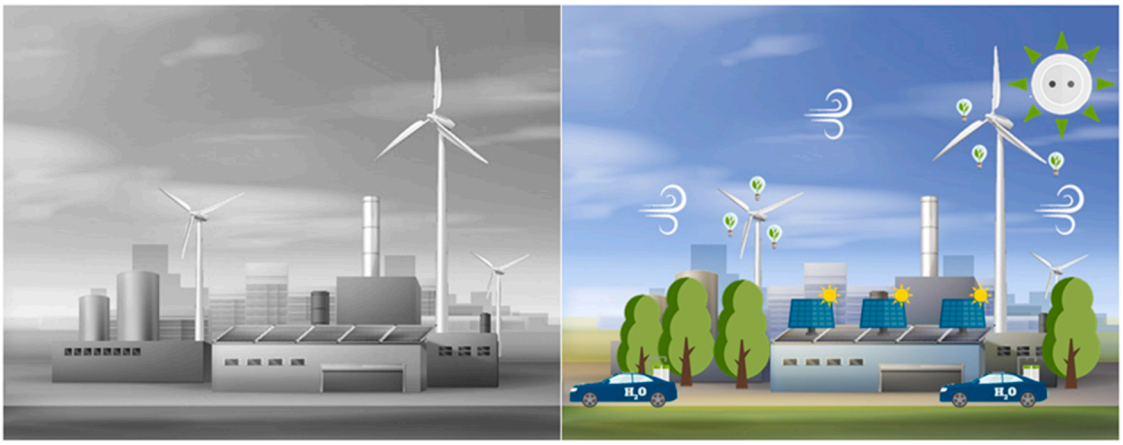


Fig. 3. Proposed representation of urban regeneration through industrial brownfields in SIAs. The left picture shows an industrial brownfield land without the implementation of sustainable design practices. The right one represents the integration between the industrial built system with sustainable projects aimed at the use of natural resources (i.e., Nature-Based Solutions) and renewable energy sources.
(Source: own processing)

countermeasures to ensure the security of the environment that is most tangible to the lives of humans. The first recommendation for decision-makers and academics is to consider the management of the ecosystem in urban contexts through Nature-Based Solutions. They include traditionally greening approaches and conservation and management actions aimed at securing the provision of Ecosystem Services (ES) and improving the health of citizens and the socio-economic territorial apparatus. Furthermore, ES knowledge can support decision-making systems in selecting alternatives, and also it can set the basis for the design of implementation tools, namely incentives and compensation schemes.

Another recommendation is to use the circular economy model for sustainable management of products, processes and industrial areas. In this context, it is possible to look to nature to find the solutions needed to increase our societies' resiliency, protect and restore ecosystems, and maintain the necessary economic growth without further undermining the planet. Nature-Based Solutions serve this ambitious and multifactorial purpose due to their inherent ability to tackle climate change while providing ecosystem and social benefits. Thus, NBS could stimulate the implementation of a circular model of sustainable economic growth in the form of SIAs from industrial brownfield land. This could contribute to the following: *i)* supporting sustainable urbanisation to stimulate economic growth and enhance human well-being while making the urban area more attractive, *ii)* restoring degraded ecosystems by improving their resilience and increasing the ecosystem services they offer, *iii)* climate change adaptation and mitigation with a focus on carbon storage and *iv)* improving risk management and resilience.

Finally, a further recommendation is for policy-makers. It refers to identifying and standardization of new procedures to seize all the opportunities provided by the local-global, conservation-innovation and

ecosystems service-economic growth relationship that permits supporting the selection among alternatives of brownfield areas for redevelopment with NBS.

Urban regeneration should practice regional revitalisation while considering the identity and environment of specific industrial areas, allowing urban infrastructure to be established and the local community to grow (Schuelke-Leech, 2021). Future research should quantify the monetary and environmental benefits of an EGD policy that supports a circular approach, NBS, green infrastructure and shared management for the regeneration and redevelopment of industrial areas. Future research could also look into how the EGD can be implemented to neutralise CO_2 emissions in European cities by regenerating both the production process and brownfield land.

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