

## ▶ INTERNATIONAL PERSPECTIVES

# Sustainable Brownfields Redevelopment in the European Union: An Overview of Policy and Funding Frameworks

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**Abstract** This first article in a series of three on land reuse highlights sustainable brownfields redevelopment in Europe. Sustainability is a key European concept. Europe's densely populated urban areas are facing specific challenges that include urban sprawl and environmental pollution. Redeveloping brownfields, or reusing the abandoned built landscape, can positively impact the economic, social, and environmental health security of cities. Many European Union (EU) cities benefit from policy and financial assistance in renovating their urban areas. This article reviews the EU's policy and funding frameworks that support sustainable brownfields redevelopment. Brownfield site problems are common to many countries in Europe and around the world, and this article aims to share knowledge and resources that support the transformation of these abandoned or underused areas into public or private uses.

## Introduction

Where we live affects our health. Environmental risks are linked to 22% of the global disease burden and 23% of deaths worldwide (Prüss-Ustün et al., 2016). In Europe, environmental stressors are responsible for 15–20% of deaths in 53 countries (Landrigan et al., 2018). The densely populated European Union (EU) is not spared the negative impacts of environmental contamination. Approximately 70% of the EU population lives in urban or suburban areas (Publications Office of the European Union, 2016) that are challenged by urban sprawl; scattered development; urban dispersion; soil sealing (i.e., the capping of soil with impermeable materials such as asphalt roads, parking lots, and buildings) (Colsaet et al., 2018); and air, soil, and water pollution. These challenges threaten the sustainable development

process and impact economic, social, and environmental health security.

These problems may be exacerbated in the future as the population living in EU urban areas is expected to increase to over 80% by 2050 (Publications Office of the European Union, 2016). Millions of new urban residents will need housing, employment, and infrastructure that will limit available open spaces. In this context, the issues of safe land reuse, remediation, and productive use of underused, derelict, and contaminated lands—commonly known as brownfields—become more important than ever.

While the U.S. defines brownfields as “real property, the expansion, redevelopment, or reuse of which may be complicated by the presence of a hazardous substance, pollutant, or contaminant” (U.S. Environmental Protection Agency, 2021), in Europe there is

no common definition of brownfields. The concept, however, is generally associated with land contamination (Cobârzan, 2007; Grimski & Ferber, 2001).

Brownfields rehabilitation in Europe presents valuable opportunities for private investments and for limiting the practices of land taking and urban sprawl, making cities safer, healthier, and more attractive economically (European Commission, 2012). European urban development is part of the sustainable development mechanism and can improve the environment through brownfields reuse and reduction of air, water, and soil pollution (European Commission, 2016a). In recent decades, many EU cities successfully reused abandoned sites; for example, the regeneration of industrial and military brownfields occurred through support from the European Regional Development Fund/Cohesion Fund (European Court of Auditors, 2012). Concurrently, investments in green spaces fields (i.e., greenfields, which are undeveloped lands that are left “natural” in the urban landscape) and brownfields rehabilitation are seen as new development opportunities (European Commission, 2016b; Morar et al., 2019).

There are no EU standards to define contaminated sites and associated environmental health risks. This lack of standards is further complicated in that no single methodology defines site-specific remediation standards (European Environment Agency, 2017). Brownfields remediation, however, is a 2014–2020 EU priority that is incorporated in several policies, such as the 2030 Sustainable Development Goals and Agenda (European Commission, 2016a). EU policies take into account the direct and indirect impact of land use, including the use of undeveloped

TABLE 1

### The European Union 2014–2020 Funding Frameworks That Support Brownfields Redevelopment

Funding Mechanism	Overall Budget	General Objectives
Cohesion Fund	€74.8 billion	Reduce economic and social disparities and promote sustainable development by financing projects in the fields of environment and trans-European networks
European Regional Development Fund (ERDF)	€278 billion	Strengthen the economic and social cohesion in the European Union (EU) by correcting imbalances among its regions through: <ul style="list-style-type: none"> <li>• Convergence</li> <li>• Regional competitiveness and employment</li> <li>• Territorial cooperation (cross-border, transnational, interregional)</li> </ul>
Urban Innovative Actions	€372 million ERDF budget	Facilitate pilot projects for sustainable urban development
URBACT III	€96.3 million <ul style="list-style-type: none"> <li>• €74.3 million, ERDF budget</li> <li>• €5.5 million, national contributions</li> <li>• €16.5, local contributions</li> </ul>	Find new and sustainable pragmatic solutions for cities integrated with economic, social, and environmental urban topics
LIFE Programme	€3.4 billion	Instrument of funding for the environment and climate action
European Investment Bank	€243 billion capital base	Develop sustainable public–private investment, research, and innovation projects in line with EU environment objectives
URBIS	–	Provide an investment advisory platform
Horizon 2020	€80 billion	Identify new solutions for societal challenges to drive innovation-led sustainable growth

land and natural areas through urban sprawl and energy production.

With few exceptions (e.g., mining activities), the expansion and use of undeveloped land generally is connected with soil sealing. Limiting soil sealing can occur by reducing the rate at which greenfield sites, agricultural land, and natural areas are turned into infrastructure or settlement areas, or by reusing previously developed land such as brownfields (European Commission, 2012). Often, potentially contaminated sites are located close to city centers, offering attractive opportunities for investors. These sites can be redeveloped through planning, financial support, and administrative and governmental procedures.

### Methods

Our initial literature exploration highlighted previous networking and research

projects focused on brownfields redevelopment in Europe; these projects (BROWNTRANS, HOMBRE, CLARINET, CABERNET, COBRAMAN, COMMON FORUM, TIMBRE, NICOLE, RESCUE, and REVIT) highlighted the progress and successes of brownfields redevelopment plans. The information, however, might be either outdated or too general, which motivated our recent, more expansive literature review.

Using keywords of “sustainable development,” “urban development,” “brownfields policies,” “green infrastructure,” “environmental contamination,” “sustainable brownfields redevelopment,” “public benefits + brownfields redevelopment,” “brownfields + economic development,” and “brownfields funding” in PubMed, Toxline, Scopus, and Web of Science databases, we built a shared library of globally published literature related to brownfields. We then framed a series of

proposed publications and research activities based on our literature search results.

This article presents key aspects of our literature review and analysis regarding the European landscape of brownfields redevelopment via policy and funding frameworks. This effort is a first step toward fostering an understanding among academia, the public sector, and local private development interests of EU involvement in brownfields redevelopment.

### Results and Discussion

The high level of economic development, social cohesion, support for democratic societies, and commitment to sustainable development in the EU is designed for preserving the environment based on the choices we make today (European Commission, 2016a). Several policies and an extensive funding framework (Table 1) that promote and support sustainable brownfields redevelopment in Europe are described below.

### The European Union Policy Framework Related to Brownfields

*European Union 2030 Agenda for Sustainable Development and Sustainable Development Goals*  
The European Union 2030 Agenda for Sustainable Development and Sustainable Development Goals (2030 Agenda) includes sustainable development goals in the European policy framework and current European Commission priorities based on the three pillars of sustainable development: society, environment, and the economy (European Commission, 2016a). The 2030 Agenda a) calls for reducing negative impacts of urban activities and chemicals that are hazardous to human health and the environment and b) includes environmentally sound chemical management plans, reduction and recycling of waste, and more efficient use of water and energy. It also supports brownfields redevelopment by making cities and human settlements inclusive, safe, resilient, and sustainable; protecting, restoring, and promoting sustainable use of terrestrial ecosystems; and halting and reversing land degradation.

### 7th Environment Action Programme

The 7th Environment Action Programme (7th EAP) adopted by the European Parliament and the European Council of the Euro-

pean Union (Decision No. 1386/2013/EU) set forth objectives to be achieved by 2020 in its publication *Living Well, Within the Limits of Our Planet*, which incorporated a broad range of environmental and ecological concerns related to the protection of air, land, and water, while promoting sustainable economies and development (European Commission, 2014; European Environment Agency, 2013). The 7th EAP 2050 EU vision emphasizes prosperity and a healthy environment based on an innovative economy focused on minimal waste, sustainable management of natural resources, biodiversity protection, and low-carbon growth to achieve a “safe and sustainable global society” (European Environment Agency, 2013).

The 7th EAP focused on conservation of natural resources and the environment, reduction of environmental health risk, and establishment of sustainable cities—all of which align with brownfields issues. In the EU, water pollution, air pollution, and chemicals are among the public’s top environmental concerns (data.europa.eu, n.d.). Reducing environmental exposures to contaminated sites such as brownfields can protect the health of affected populations. With a projection of 80% of the population living in urban or suburban areas by 2050 (European Environment Agency, 2013), environmental problems and pressure on green or natural areas could intensify. Cities will likely need to integrate urban sustainability mechanisms with innovative solutions to address environmental challenges (European Commission, 2011). The 7th EAP’s focus on sustainable cities can promote brownfields redevelopments as opportunities for sustainable redevelopment.

#### *European Environmental Directives: Waste, Water, and Air Quality Legislation*

The European Waste Framework Directive states that soil contaminated by fuels leaking from underground tanks should be regarded as waste (European Commission, 2018a). This directive addresses water pollution and promotes discovery and monitoring of environmental contamination. Similarly, the European Air Quality Directive (European Commission, n.d.-a) focuses on air quality impacts of specific contaminants from both natural and industrial sources in ambient air via the 2008 Air Quality Directive and the Fourth Daughter Air Quality Directive.

Coupled with broader policy initiatives, the existing environmental directives can support cleanup and redevelopment of brownfields (e.g., the Waste Framework Directive can address petroleum contamination, a common contaminant in brownfields). The European Water Framework (European Commission, 2000) and Air Quality Directives can address water and air contamination associated with brownfields such as from plume migration, runoff, and air emissions.

#### *Urban Agenda for the European Union*

The Urban Agenda for the EU supports cooperation among EU member states, cities, the European Commission and other stakeholders; it aims to stimulate growth, liveability, and innovation in EU cities and to identify and successfully tackle social challenges. This agenda promotes the “better” agenda: better regulation, better funding, and better knowledge related to policy making and implementation. The Urban Agenda priority themes relevant to brownfields redevelopment are the sustainable use of land; sound and strategic urban planning; limiting greenfield consumption; and urban regeneration, including social, economic, environmental, spatial, and cultural aspects (European Commission, 2017).

#### *Soil Thematic Strategy*

Adopted in 2006, the Soil Thematic Strategy proposed protection of soils in the EU. While the European Commission withdrew a proposal in favor of a Soil Framework Directive, the strategy included an official report that explained why a high level of soil protection is needed; a proposed directive to protect EU soils; and an impact assessment of economic, social, and environmental impacts of different options to be considered in the preparation of the final strategy (European Commission, n.d.-b). The strategy promotes minimizing additional land acquisition and limiting, mitigating, or compensating soil sealing, calling for efficient use and restoration of previously acquired land (Colsaet et al., 2018), which can prevent development of green areas and aligns with the reuse of already built abandoned areas (i.e., brownfields).

#### *European Union Biodiversity Strategy for 2030*

The EU Biodiversity Strategy for 2030 presents a long-term plan for protecting nature and reversing degradation of ecosystems.

The strategy was conceived to build societal resilience to future threats, such as climate change, forest fires, food insecurity, or disease outbreaks. This strategy identifies specific objectives to be completed by 2030, including a larger network of protected areas on land and sea, a Nature Restoration Plan to sustainably manage degraded ecosystems, measures for transformative change, and measures to track a global biodiversity framework (European Commission, n.d.-c).

The EU Biodiversity Strategy for 2030 advances the European Green Deal to make Europe climate neutral by 2050 by supporting green technology, sustainable industry and transport, and pollution reduction (European Commission, n.d.-d). The strategy can promote healthy and sustainable communities through brownfields reuse focused on protecting and creating green space, restoring watersheds, reducing the urban heat island effect, protecting the night sky and wildlife, and turning blighted and abandoned spaces into community assets.

#### *Green Infrastructure Strategy*

The Green Infrastructure Strategy promotes cost-effective alternatives to traditional “grey” infrastructure (the built environment) and offers many other benefits to EU residents and to biodiversity. This strategy describes green infrastructure as a “strategically planned network of natural and seminatural areas with other environmental features designed and managed to deliver a wide range of ecosystem services.” Green infrastructure incorporates a network of green and blue (water) spaces to improve environmental conditions and health and quality of life. It also supports a green economy, creates job opportunities, and enhances biodiversity, particularly in the EU’s heavily populated urban areas. Green infrastructure can result in healthier communities through cleaner air, improved water quality, and a greater sense of community (European Commission, 2013).

Turning grey infrastructure into green infrastructure through brownfields reuse is a natural solution to local planning problems. Green infrastructure can avoid building new infrastructure by a) reusing sites such as brownfields and b) incorporating natural spaces to provide less expensive and more sustainable solutions.

## The European Union Funding Framework for Brownfields

The “polluter pays principle,” which expects polluters to bear the costs of remediation or cleanup, applies to all EU funding and overall redevelopment mechanisms (European Commission, n.d.-e). It is not strictly enforced, though, and local municipalities and other development entities often must rely on alternative sources to fund brownfields redevelopment. Across the EU, solutions to this problem have included insurance policies, financial provisions, and bonds, but the liquidation of a property leaves no provision for cleanup, or alternately, the provisions are ignored by the liquidator due to insolvency and the predominance of company law. “Ultimately, lengthy legal battles may still result in the taxpayer covering the expense—in direct contradiction of the polluter pays principle” (European Union Network for the Implementation and Enforcement of Environmental Law, 2020).

Fortunately, although brownfields redevelopment often is funded by local sources or private investment, the EU also has a complex framework of funding to support regional, cross-border, and multicity (or member state) redevelopment projects. The primary funding mechanisms are the Cohesion Fund and the European Regional Development Fund (ERDF). There are also supplementary funding mechanisms that support sustainable development and environmental restoration projects. The following provides an overview of the EU funding framework, which is summarized in Table 1.

### *Cohesion Fund*

In its 2014–2020 Financial Framework, the European Commission improved funding opportunities for member states as part of the Cohesion Policy for environmentally oriented public goods and services (European Parliament, 2013). This policy outlines growth and development through clustering (i.e., actions focused on competitiveness), internal urban cohesion (i.e., redeveloping brownfield sites, preserving and developing the cultural heritage), or promotion of a more balanced, polycentric development (i.e., creating networking opportunities for urban areas and linking the physical infrastructure with communities) (European Council, 2006).

To reduce economic and social disparities, the Cohesion Fund dedicated €74.8 billion

to EU member states with a gross national income per inhabitant <90% of the EU average. The fund’s financial investments focus on preserving and protecting the environment by revitalizing cities and decontaminating and regenerating brownfield sites (European Parliament, 2013). The Cohesion Policy and Cohesion Fund have indirect effects on the environment and sustainability. As most communities already have infrastructure in place and no additional land is needed, a growing economy could lead to land use changes as well as national, regional, and local policies could encourage brownfields redevelopment. The post-2020 Cohesion Policy continues to support cleanup or reuse of brownfields; this issue will be reflected in the Operational Programmes (i.e., member states’ plans to implement EU funding during the program period) (European Commission, n.d.-f).

### *European Regional Development Fund*

ERDF can allocate €278 billion to the European Structural and Investment Funds of 2014–2020 so that cities can receive funding for “taking action to improve the urban environment, to revitalise cities, regenerate, and decontaminate brownfield sites (including conversion areas)” (Investment Priority 6, Point e; EUR-Lex Access to European Union Law, 2013). The ERDF funding directly mentions brownfields redevelopment (European Commission, 2021a).

### *Urban Innovative Actions*

Urban Innovative Actions (UIA, n.d.) is based on Article 8 of ERDF and has a total budget of €372 million for 2014–2020; it makes direct funding contributions to support innovative approaches to sustainable land use and land use planning (i.e., remediation, restoration, and prevention of brownfields). The UIA indirectly contributes to sustainability through inclusive urban regeneration and sustainable urban development projects (i.e., improving quality of life, health, well-being, and upstream urban and regional planning).

### *URBACT III 2014–2020*

URBACT III 2014–2020 is an ERDF project to help Europe’s cities develop new, sustainable, and pragmatic solutions that integrate economic, social, and environmental factors. URBACT focuses on the intersection of the urban physical economy with themes of envi-

ronment, governance, inclusion, and economy. The environment theme, for example, concentrates on ecosystems (air, water, soil quality, pollution), climate change, urban sustainability and resilience, and linkages to economic challenges and social impacts of environmental interventions (URBACT, n.d.).

### *LIFE Programme*

In the 2014–2020 funding period, the LIFE Programme (L’Instrument Financier Pour l’Environnement) allocated €3.4 billion to cofinance projects in the environmental sector, particularly in the areas of air, chemicals, green and circular economy, waste, water, soil, and the urban environment. Funded projects will implement technologies and solutions that are ready for implementation in close-to-market conditions, at industrial or commercial scale, and during the project period. In 2020 there was €450 million available in the categories of environment, nature, and climate action (European Commission, 2021b).

### *European Investment Bank*

The European Investment Bank (EIB, 2017) is the bank of the EU and provides funding for sustainable public–private investment, research, and innovation projects in line with EU environmental objectives (European Council, 2012). EIB provides an infrastructure for large investments (e.g., brownfields redevelopment) focused on remediation of contaminated urban and industrial sites and renovation of housing and high energy-efficiency buildings.

### *URBIS*

URBIS, part of the European Investment Advisory Hub, is an urban investment advisory platform that assists urban authorities to facilitate, accelerate, and unlock urban investment projects, programs, and platforms, which also include brownfield redevelopment projects (European Investment Advisory Hub, 2021).

### *Horizon 2020*

Horizon 2020 is the largest EU research and innovation program, with €80 billion of funding available over 7 years (2014–2020). The program focuses on supporting excellent science and industrial leadership and tackling societal challenges in innovative ways (Horizon 2020 Programme, 2020).

FIGURE 1

**Red Barracks Brownfields Redevelopment in Oradea, Romania**



Note. Left and center images are before redevelopment and right image is after redevelopment. Photos courtesy of Cezar Morar (2016 and 2020).

**Case Examples**

The EU policies and funding efforts that support brownfields redevelopment have assisted scores of sustainable redevelopment projects throughout Europe. Many projects repurposed and regenerated brownfields, which fueled local community revitalization efforts on a broad scale.

*Policy Benefit Case Study: Brownfields Regeneration in Oradea, Bihor County, Romania*

The city of Oradea is in northwestern Romania, close to the border with Hungary. Between 1896 and 1912, large Austro-Hungarian military complexes composed of educational institutions, barracks, and other military facilities were built close to the city’s historical center (Borcea & Gorun, 2007). Postsocialist demilitarization in the 1990s, followed by the accession to the North Atlantic Treaty Organization (NATO, 2004) and to the European Union (2007) led to the abandonment, decay, or underuse of many military areas, resulting in deteriorated urban spaces that made no contribution to the local economy. To spur local development efforts, ownership of the majority of former military brownfields was transferred from central authorities (i.e., Ministry of Defence) to local public authorities in the early 2000s. The proximity to national roads makes the available sites attractive for potential investors (Local Council of Oradea, 2011).

In 2016, Oradea redeveloped several military brownfields, including the Red Barracks. Closed since 1990, these barracks consisted of

a large number of abandoned military facilities including bases, arsenals, depots, storage, and tank training areas that left behind soil contaminated with hazardous waste. Based on its 83 hectares size, existing infrastructure, and other amenities, the site was remediated and redeveloped into an industrial park as an alternative to the potential use of a greenfield (Figure 1). The site regeneration was sustainably planned, avoided urban sprawl, and reversed land degradation. The city financed the redevelopment using funds from local public authorities and private investment.

The city integrated both local and EU policies in this large-scale redevelopment, including the City of Oradea Strategy for Sustainable Development 2015–2020, the EU 2030 Agenda on Sustainable Development, and the EU Urban Agenda. Fiscal facilities (i.e., tax exemption) are offered to companies within the industrial park (Local Council of Oradea, 2011; Morar et al., 2019).

*Funding Benefits: Examples From Greece, Latvia, and Belgium*

The city of Aigio in western Greece used ERDF funding of €2,296,258 to rebuild its seafront. Extensive renovation of the 2-km seafront was undertaken, resulting in an accessible recreational area that improved existing green spaces and quality of life for city residents. The investment fell under Investment Priority 6e, “Taking action to improve the urban environment, to revitalize cities, regenerate and decontaminate brownfield sites (including conversion areas), reduce air pollution, and promote noise-

reduction measures,” and Specific Objective 6.e.1, “Support for integrated urban development” (European Commission, 2019a).

In Riga, Latvia, €54,000,000 in ERDF funding was used in five urban regeneration projects: three were completed and two are in process. The funding was awarded to develop cultural assets and revitalize neglected areas. The goal was to create urban spaces that are attractive to residents, tourists, and investors. One project converted an old former factory into a cultural palace called VEF Cultural Palace, which has become a highlight of cultural life (European Commission, 2018b, 2019b).

Finally, in the Saint-Leonard district of Liège, Belgium, a former coal mining area with several brownfields was cleaned up and redeveloped to complement the city’s 1995 urban renewal initiative to build public and green spaces, public housing, and create a business incubator. The city used €963,800 in ERDF funding to clean up two adjoining brownfields and redevelop them into a business park that was integrated into the urban landscape. Early businesses included a furniture designer and a heating company that produced heating pumps and solar panels (European Commission, 2010).

**Conclusion**

Approximately 30% of the EU’s territory is spatially fragmented, affecting the connectivity and health of ecosystems and the ability to provide services and appropriate habitats. Despite improvements, water quality, air pollution, unsustainable land use, and soil degradation are still issues. Residents are still

exposed to hazardous substances, potentially compromising their health and well-being. Policies and funding that support sustainable and remediated environments (e.g., the EU 2030 Agenda for Sustainable Development and Sustainable Development Goals, the ERDF suite of funding opportunities, and the LIFE Programme funding) are promising opportunities to address these concerns. These opportunities can potentially reduce the loss of ecosystem services associated with future development or restore struggling ecosystems by improving air, water, and soil quality—ultimately improving overall environmental, economic, and community health.

While the EU does not have a formal definition for brownfields, we have highlighted the strong system of policy and funding frameworks that work synergistically to support brownfields redevelopment across the

region. By including brownfields remediation in their sustainability goals, many EU countries have preserved green spaces while meeting the needs of private and public companies through the creation of multiuse spaces that are fully integrated into the socioeconomic and cultural landscapes. Continued integration of sustainability and development goals, via remediation of brownfields and preservation of green spaces, will continue to improve public health and help heal our cities. These EU successes can highlight best land reuse practices that can be globally modeled. 🌍

**Editor's Note:** This review article is the first in a series of three that examine brownfields redevelopment as a subset of overall land use and reuse practices in Europe and the U.S. These articles are a result of a collaboration within the North American–European Land

Reuse Working Group, a subgroup of the Brownfields & Reuse Opportunity Working Network ([www.atsdr.cdc.gov/sites/brownfields/stakeholders.html](http://www.atsdr.cdc.gov/sites/brownfields/stakeholders.html)). This first article presents the landscape of EU policy and funding frameworks to promote sustainable brownfields redevelopment. The second article examines brownfields redevelopment in the U.S. via regulatory, public health, and sustainability lenses. The third article is a descriptive and visual analysis of brownfields in Europe and the U.S. The working group aims to share and highlight best practices to promote healthy and sustainable redevelopment globally.

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