

*Professional paper*

UDC: 911.2:551.58  
DOI: 10.2298/IJGI1304057C

## **BROWNFIELD REDEVELOPMENT AS A MEASURE FOR CLIMATE CHANGES MITIGATION**

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Received 15 April 2013; reviewed 17 June 2013; accepted 27 November 2013

**Abstract:** This paper explores brownfield renewal as a measure of sustainable land use. The aim was to highlight the brownfield redevelopment as a strategy for mitigation of negative effects of climate changes. Emphasis was put on innovative concepts in brownfield redevelopment, which involve land recycling, application of ecological and sustainable solutions. Main case studies are from Austria. Their analysis and evaluation show which concepts and strategies are used in successful redevelopment projects, and which strategies give the best results. This shows that brownfield renewal can have positive effects on regulation and mitigation of climate changes. Finally, guidelines for climate changes accountable and redevelopment will be derived. Research methodology is qualitative and combined, comprising of data analysis, case studies (field work, interviews with relevant actors), analysis of case studies and evaluation according to previously defined criteria, synthesis of results and generalisation and interpretation of results.

**Key words:** climate changes, industrial areas, sustainability

### **Introduction: Climate changes**

Climate change refers to any change in climate over time, due to natural changes or due to human activities. Climate changes affect the great number of activities (agriculture, forestry, fishing, tourism, energy sector and infrastructure), as well as ecosystems, health of living organisms and biodiversity. Zones that are especially vulnerable are densely populated areas, as well as marine and coastal ecosystems and areas. Vulnerability is the degree to which a system is susceptible to climate changes. Resilience is the ability of a system to absorb disturbances while retaining the same basic structure and way of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change (IPCC, 2007; WG II).

There are two types of responses to climate changes: reduction of greenhouse gas emissions and undertaking adaptation measures. Energy consumption is recognised as a main cause of climate changes and it is a source of 4/5 of the

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total gas emissions in EU (1/3 of which is caused by traffic) (EXPEDITIO, 2005: 38). This means that the energy savings are the fastest, most efficient and most economical way to reduce greenhouse gas emissions and improve air quality, especially in densely populated areas. Increasing the resilience to the effects of climate changes is an opportunity for investment in a low-carbon economy through the promotion of energy efficient concepts and the acceptance of ecological solutions. The European Commission research shows that the 50% reduction of greenhouse gas emissions will be achieved in the future through improvements in energy efficiency (COM, 2005 in EXPEDITIO, 2005).

### *Climate changes in Austria*

The characteristics of the climate changes in Austria are: higher average temperatures, warmer and drier summers, more days with temperatures of over 30 degrees Celsius and mild winters with less snow. These changes affect spatial development in several ways. Floods, extreme water levels, landslides, melting glaciers and rock escarpments occur as a result of climate changes affecting the tourism, forests and income from agriculture. Alps have been identified as particularly sensitive region. Expansion of residential areas and tourist sites increase vulnerability and it is expected that the cost of protection against potential damage will grow.

Austrian climate policy is based on two documents. These are: the National Allocation Plan and the Strategy for Climate Change. Ministry of Economy and Labour is the main government institution accountable for energy. Ministry of Agriculture, Forestry, Environment and Water Management is accountable for environmental protection and climate change. Ministry of Finance is responsible for setting the fees related to energy. Austrian Energy Agency is a non-profit research and policy institution established in 1977 with a mission to promote the rational use of energy and encourage the use of renewable energy sources and innovative technologies. Klima Fond Austria is a fund for climate and energy that was founded by the Austrian National Assembly in 2007. This fund has developed into an important actor in the Austrian policy regarding the climate changes.

Each year about 150 million EURO is invested in the climate protection projects and the promotion of sustainable energy. The main agenda of the fund is *Zero Emission Austria. Klima: Aktiv* program aims to support energy efficiency and to increase the use renewable energy sources, through grants and related measures such as counselling. At the regional level, governments of nine provinces have a role in policy-making, determining the level of subsidies and in controlling the

energy companies. Regarding the buildings and their energetic performance, they are regulated by the rules and laws. State Government is, in collaboration with provinces, dedicated to the promotion of low-energy and passive houses. The goal is that 50% of new buildings meet *Klima: Aktiv* standards. In the document Austria Spatial Development Concept (OEROK, 2011, *3rd Strand - Climate Change, Adaptation and Resource Efficiency*) is stated that protection from climate change implies the preservation and expansion of forests, which contributes to reduction of greenhouse gases emissions. The reduction of emissions can be achieved by reducing energy consumption and increasing energy efficiency through replacement of fossil fuel use with sustainable sources. The same document mentions the following concept that could be taken in spatial development: a compact form of housing, careful and efficient use of land, building of energy efficient houses, underground multilevel parking instead of spacious parking lots typical for commercial areas, environmentally sustainable transport, recycling and renewal of land and buildings (OEROK, 2011). Austria is among the European countries with the highest share of renewable energy sources in total consumption, and with the largest share in the use of biomass for heating and energy production. European Union directive for the energy and buildings commits the public sector to start constructing by the 2019 only buildings which have almost no emissions and consume no energy (zero-energy buildings).

Austria is one of only five countries in the European Union which already fully meet the target set for the year 2020 - that at least 20% of energy comes from renewable sources (in 2005, in Austria, 21.3% of the energy came from the renewable sources). Government Programme 2008-2012 involves the reduction of GHG emissions by 20% and the increase in share of renewable energy in total energy consumption for 34% by the year 2050.

### **Connection between climate changes and urban development**

More than half of the world's population lives in cities today. This percentage is even higher in Europe and amounts about 70% (World Bank <http://data.worldbank.org/topic/urban-development>). Over 400 cities in the world have more than one million inhabitants. These data are important considering that over 80% of the carbon dioxide is produced in the million cities. As it could be concluded from this, climate changes and certainty in energy supply are directly dependent on the solutions applied in the consumption in cities. Physical development is very important factor for the climate changes and climate changes require a new approach to urban planning. The challenge for policymakers is to understand the impact of climate changes and to develop and

implement policies that provide the optimal level of adaptation. Spatial planning can reduce the sensitivity to changes in certain regions and to develop the adaptive capacity. Permanent transformation of agricultural land, forests and green areas into construction land and roads, leads to the loss of fertile land and to the destruction of ecosystems and damaging of the environment. On the other hand, in Europe there are 2,000 km<sup>2</sup> of abandoned industrial sites. These sites represent a great potential for the construction, and their activation would contribute to avoiding the sprawl. The construction sector has a great potential to influence the reduction of energy consumption and the production of greenhouse gases, through the choice of materials for construction and the amount of energy that will later be spent.

*Brownfield redevelopment and its significance for sustainable land use and adaptation to climate changes*

Land is a valuable resource and its effective use is essential for sustainable development. The threat to this is the urbanization and expansion of urban areas. Sustainable urban development involves protection of the natural landscape and the development of compact forms of housing. An important component of land use is the increase in the number of brownfield sites and the complexity of their renewal. In recent decades, as a result of changes in the industry, emerged a number of industrial areas that have lost their original function. The term brownfield indicates underused land and buildings with burdens caused by the previous use, whose reuse is difficult due to the presence of one or more factors which may include the pollution (English Partnerships, 2006). Brownfields are usually former industrial and military complexes. In situation when cities are constantly spreading at the expense of green areas, and former industrial locations in cities are unused, sustainable land use involves concepts such as land recycling and activation of unused buildings for new uses.

Recycling implies the reintegration of brownfield land into economic and natural cycles. Brownfield renewal may bring benefits on many levels: it can improve environmental quality, reduce urban sprawl and have the economic and ecological benefits. Taking this into account, brownfield is a resource. Brownfields usually have the necessary infrastructure and investments in the new one are not necessary. Their renewal supports the growth of compact cities, it reduces the commuting distance and car use, thus reducing gas emissions and saving energy. Preservation, adaptation and reuse enable time, energy and resources saving. According to the National Trust for Historic Preservation, it takes about 65 years for a green, energy-efficient new office building to refund the energy spent in demolition of the previous building and construction of the

new one. Brownfield renewal reduces the need for development on greenfield sites. The high density of development contributes to energy efficiency because there are fewer exposed surfaces - multifamily housing saves 20-50% of energy compared to single-family buildings. Infrastructure is cheaper in densely populated areas, and less energy is required for the construction and maintenance of the facility than at the city periphery.

Table 1. Changes in land use on global level

Global land use – areas unchanged (thousands km <sup>2</sup> ) and conversions 1987-2006 (thousands km <sup>2</sup> /year)							
From / To	Forest	Woodland /Grassland	Farmland	Urban areas	Losses	Gains	Net change
Forest	39,699	30	98	2	-130	57	-73
Woodland/Grassland	14	34,355	10	2	-26	50	24
Farmland	43	20	15,138	16	-79	108	29
Urban areas	Not significant	Not significant	Not significant	380	0	20	20
Total					-235	235	

Source: Holmgren, 2006, in: UNEP, 2007

A number of examples demonstrate that the brownfield renewal is a viable solution for a land use. In the following chapters will be discussed some of the projects in Austria.

### **Brownfield renewal in Austria**

Main challenges in spatial planning in Austria for the next decades are migrations of the population to urban areas and a growing need for business space, bringing the increase in pressure on urban areas, urban sprawl and loss of unbuilt land. These topics are closely connected with brownfield renewal and sustainable land use, and therefore also with the question of environment and its protection.

During the last 50 years, structural changes in Austria resulted with increase in a number of brownfields. Some industrial sectors disappeared, companies merged, and higher quality production is organised on smaller areas. In 2009 the term brownfield (*brachfläche*) was defined by the Austrian Standards Institute as a previously used site or part of a site, which is derelict or underused. Owing to the site characteristics, it offers a potential for reuse. In 2004 Austria had about

130 km<sup>2</sup> of brownfields, equaling 3,000 to 4,000 abandoned sites. Aside from brownfields in cities, a significant part of former industrial land is related to mining. Austria has a long history of mining and mining industry is seen as a part of cultural identity, especially in small and medium-sized mining towns. After the Second World War, mining industry started to decline. Although the mining areas are smaller than those in UK and Germany, all mining towns share the similar problems. After decline in mining industry, mining municipalities faced different problems: environmental degradation, decline in business and industry, economic crisis, high unemployment, outmigration, loss of human resources, lack of high-quality education, little administrative capacity and modest resources for strategy building and creative planning, financing and implementation.

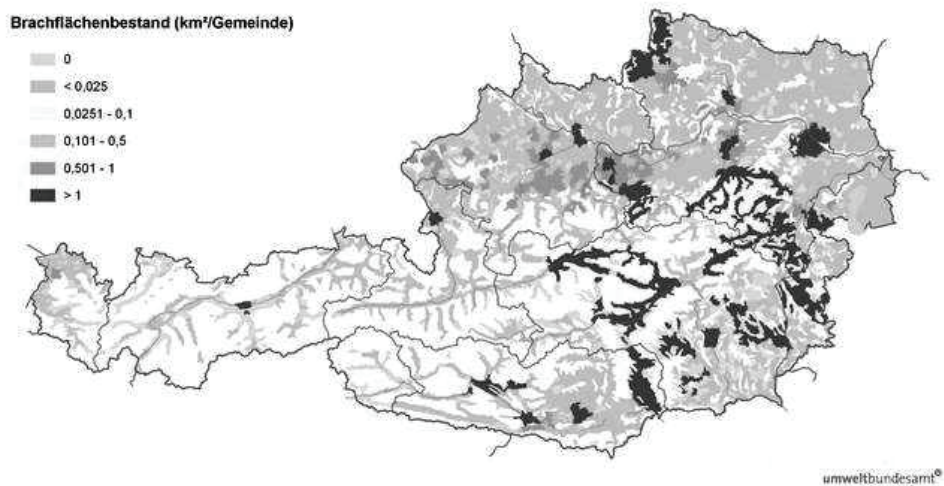


Figure 1. Map of brownfields in Austria in km<sup>2</sup>/municipality in 2007 – most brownfields are located in former mining regions in southern Austria and in bigger cities (source: Umweltbundesamt)

According to several sources (CLARINET; Battle; Marot, Cernic Mali, 2012; Siebelec, 2012), main barriers for bringing the brownfields back to use in Austria are:

- Lack of Government programs for support of the brownfield renewal at the national level;
- Lack of clear administrative procedures to handle brownfields, as a result, decisions are usually made on case-by-case basis;
- Lack of specific legislation for brownfields;
- Lack of incentives and detaxation for brownfield redevelopment;

- Lack of reliable data on brownfields;
- Brownfields are considered a low priority when it comes to receiving finances for redevelopment;
- Better conditions exist to invest on greenfield sites and therefore investors still prefer them;
- Problems related to potential contamination and costs of remediation;
- Unsolved ownership;
- Different interests of investors and the city; opposing interests within the city administration;
- In Vienna in addition to these barriers, significant problem is the site availability and a high price, especially for former railroad sites;
- More intensive use of cultural potentials of industrial sites can be hampered by low public support, lack of adequate legal support, finances and a consistent heritage conservation.

Actors in brownfield redevelopment process are: national government, regional government, local government, national institutions, private companies and NGOs. Federal Environment Agency (*Umweltbundesamt*) is responsible for the cleaning of brownfields, while the local government is responsible for brownfields redevelopment. There are no specific funding opportunities for brownfield redevelopment in Austria, but subsidies can be gained indirectly from other funding pools: housing, business, development and preservation of historical monuments. The amount of industrial brownfields and related problems in Vienna is relatively low, due to the lack of large industries. Unlike in former Eastern European cities, Vienna invested a lot into modernisation of the industry in order to avoid environmental problems. The City of Vienna offers no specific funding opportunities for brownfield redevelopment, but two general programs can be used for this purpose: *Wiener Wirtschaftsförderfonds* (Vienna Business Agency) for industrial sites and *Wohnfonds Wien* (fund for housing and urban renewal) for housing sites. One of the central concerns in the urban development plan of the City of Vienna (STEP 05, made in 2005) is a brownfield redevelopment. The actual contribution of brownfield redevelopment to urban development does not exceed 5%, but it is often essential for creating a new image or achieving a new economic profile (Siebielec, 2012).

### **Case studies from Austria**

#### *Sargfabrik in Vienna*

Sargfabrik is a residential complex for 120 people, located on the former coffin manufacture built in 1895. Sargfabrik was one of the pioneer projects in creating

apartments on former factory sites. Production stopped in 1967 and reuse was considered since 1984. The goal of the new project was to achieve the integration of housing and culture. The project was a social experiment, and attention was made to achieve the alternative and socially conscious way of life and the creation of the village in the city. In 1996 the first tenants moved in and in 1998 the state bought the other part of complex, where in the 2000 a new project named Miss Sargfabrik with 39 residential units was completed. Design was created in cooperation with Sargfabrik residents. In addition to housing, Sargfabrik contains facilities for children, the events hall, seminar room, restaurants, playgrounds, shared yard and gardens on the roof. Important decisions such as program, budget, and distribution of flats, are made at the annual meeting.



Figure 2. Sargfabrik (2012)

In the complex live people of different backgrounds, age and nationalities, and there are subsidies for tenants. Architect Sumnitsch says that the social aspect of the architecture is important, this is not only a residential building, but a way of life, in which residents are not anonymous to each other, but they live in the community (Pulse 01 (2009), Franz Sumnitsch of BKK-3 Architekten, [www.busch-jaeger.de/download\\_brochures/en/pulse/Pulse\\_01\\_09\\_GB.pdf](http://www.busch-jaeger.de/download_brochures/en/pulse/Pulse_01_09_GB.pdf)). The



project has received numerous awards, and long waiting list for move-in shows its success. However, the authenticity of a project is not big - only a chimney, building layout and a name Sargfabrik resemble the old factory.

In Sargfabrik and Miss Sargfabrik environmental aspects are taken into account. Applied concepts are: optimized energy consumption (energy-saving technology, good insulation), composting, solar water heating, heating for the pool is secured by PV panels, large windows allow maximum use of sunlight. Intelligent system of divided levels in sleeping areas increases useful built area in Miss Sargfabrik. All communal areas can be used by residents of both buildings. Parking spaces are reduced to minimum. There is an inner courtyard and a rooftop garden with fruits and vegetables grown by residents. Benefits of a green roof are reductions in energy consumption and carbon emission, reduced risk of flooding (due to absorption by the substrate and plants), improved local climate, pleasant and healthy environment, reduced traffic for transportation of goods, reduction in the transportation of the food (since part of food grown directly on the site), use of local compost, high degree of self-sufficiency, more control over the products, maintenance of biodiversity and the natural environment, as well as reduction of visual pollution caused by the light and provision of recreational activities on the location. An integrated irrigation system and rainwater collection were not provided since that technology was not available at the time of the construction.

#### *Gasometers in Vienna*

Gasometers were built in 1899 in Vienna. They were the biggest gasometers in Europe at that time and they were used until in 1975. They are protected as a cultural heritage since 1986. Vienna Business Agency has played an important role in the restoration of the site and acted as a mediator between the private and public sector. It owned about 20,000 m<sup>2</sup> of land that was sold three non-profit contractors who worked on the project. Four architectural teams that in 1995 won the competition, were in charge of the re-use of four Gasometers (Gasometer A - Jean Nouvel, Gasometer B - Coop Himmelblau studio, Gasometer C-Manfred Wehdorn and Gasometer D - Wilhelm Holzbauer).



Figure 3. Gasometers (2012)

The plan was to create a space with mixed functions that will be used throughout the day. Old facades were preserved. Reconstruction was completed in 2001. Subsidies for housing of the City of Vienna covered 22.5 million € of the total 181.7 million € redevelopment price. In Gasometers are now located restaurants, bars and cafes, cinemas, halls, National Archives of Vienna, a day-care center, offices, 615 apartments and a student dormitory. Common features of all four facilities are:

- Residential units at upper floors;
- Offices on the middle floors;
- Entertainment and shopping on lower floors;
- Shopping centres connected with bridges.

Gasometers are today one of the most famous rehabilitated brownfields in the city. Property for rent was released a year before the end of the project, and the flats were sold or leased before the opening of buildings for use. Performances of buildings that are relevant to this research are: high natural light due to large windows and lighted interior courtyards; trees and other plants are located in public areas of buildings; windows are small and numerous which contributes to the good insulation of the building; project is very well integrated into the city's

public transport network, reducing the need for the use of unsustainable modes of transport. Sustainable Transport in the city is based on two key principles to reduce residential mobility and achieve more ecological travel. These are: a) shortening the distances that people travel every day (which can be achieved through encouraging the combined functions) and b) shift in the hierarchy of traffic (pedestrian as the most effective mode of movement from the standpoint of energy should be the top priority, followed by cycling and public transport, while the car should be the last on the list).

Although Gasometers are recognised as a successful urban renewal project in the architectural and social terms, there are doubts about their economic viability. The project has contributed to the restoration of the previously poor and neglected area, and three of the four buildings are used for social housing. However, a large number of stores intended for commercial functions is now unused. Although only 8 minutes away from the city center by metro, cinema and shops do not attract enough people to visit Gasometers.



Figure 4. Helmut-List Halle (2012)

In 2003 on the site of a former factory was built a multi-functional, flexible hall of 2,000 m<sup>2</sup> - Helmut-List Halle. The steel frame of the previous building was

preserved (dating back to 1950s). The project was implemented in cooperation with the festival *Steirischer Herbst*, *Styriarte* and *Graz 2003 - Cultural Capital of Europe*, which are still being held in the hall along with a number of other events such as congresses, conferences and concerts.

On the southern facade of the hall is located the solar panel measuring 350 m<sup>2</sup>, which annually produces about 26,000 kWh of electricity that goes into the public network. On display in the lobby can be seen the current value of daily insolation, daily yield and contribution to the reduction of CO<sub>2</sub> emissions. This hall is included in the wider project called Smart City project, which deals with the neighbourhoods in Austria that could become zero emission cities through the use of smart green technologies. Plan is to invest 25 million € in redevelopment project for the area around the railway station and the hall, named Waagner-Büro-Areal. This is an innovative, self-sustaining project that will use only energy produced on the site and will not have harmful emissions. It involves the construction of power plant which will produce energy for the entire area, the use of alternative energy sources such as geothermal energy, and replacement of the energy system in the hall making it independent of the environment. The first step will be to build a community center near the hall, and then will follow the construction of landmark - 40 m high tower which will serve as the fan/chimney of a power plant that generates energy for a quarter. By the year 2016, 2.5 ha of land will be developed for 1,000 people who will live there. Near the railway will be a car park with electric vehicles used through the car-sharing system. South of the hall will be the center of the quarter on more than 4 ha, with a kindergarten, shops and senior residencies. The company accountable for innovative energy solutions plans to design for the first time windows that produce electricity like solar cells. In addition to windows, facades and roofs will also collect the solar energy. The plan for this project is to become a model for the entire city, which should be developed in the future in a smart way.

### **Analysis and evaluation of brownfield redevelopment projects in Austria with regard to the climate changes**

For the purpose of project evaluation, the following evaluation criteria were defined:

- Efficient land use is rational and sustainable; it implies the limitation of the excessive growth; the use of brownfields, compact housing and appropriate population density.
- Ecological sustainability involves the efficient use of resources, reduction of the pollution and waste production, energy conservation,

use of renewable resources and sustainable forms of energy, as well as recycling.

- Regeneration of natural systems implies the establishment of elements of original ecosystems, thereby contributing to a better environmental condition, as well as to the improvement of living conditions; it involves the creation of open, green spaces and reconnecting with the nature. This often means reduction of the degree of construction.
- Application of climate changes accountable concepts: preservation of energy, sustainable transport, use of alternative energy sources.
- Sustainable economy is based on three principles: a) an attempt to compensate for the damage caused in the past to the environment and society, and to prevention of the emergence of new problems, b) focusing on the people and meeting their needs, and c) the local orientation. Sustainable economy also implies gradual abolishment of unsustainable industries and development of sectors that contribute to the development of sustainability such as environmental cleaning, recycling, public transportation, affordable housing and the production of healthy food.
- Transparency and participation indicate that the local community is involved in the redevelopment process in the stages of preparation and implementation. Participation implies the involvement of people outside the formal decision-making processes.
- Identity preservation - identity is a degree to which a person can recognize or recall a certain area as different and specific compared to other areas, because it has a strong, unique, or at least a different character (Lynch, 1981: 131). In the case of brownfield restoration, preservation of identity is linked to the concept of industrial heritage and its preservation.

Presented cases meet most of the criteria and represent good examples of brownfield redevelopment through principles accountable to the climate. It is evident that more recent projects devote more attention to this topic. This is partly due to the fact that the design accountable to the climate changes is becoming more present in the practice in developed countries, due to the increased awareness of this topic. Another reason for the growing accountability of projects lies in the fact that technologies that help combat climate change are becoming more and more available (the architect of the Sargfabrik regrets that the project did not incorporate technology for the use of wastewater and rainwater, because they were not available at the time). The case studies also show that the preservation of identity does not have the same importance in the

redevelopment projects. In the case of Helmut-List Halle, identity completely lost importance and energy efficiency solutions become a major issue. Furthermore, it is clear that changes at the building or district level do not directly influence wider areas. These projects contribute through the smaller interventions such as the reduction of emissions, the use of solar energy and land and building recycling, and therefore the effects of renewal are only experienced at a local level. However, all projects presented are significant as good examples whose principles should be applied to all redevelopment projects and thus have a global impact.

Table 2. Evaluation of brownfield redevelopment projects

Renewal project	Evaluation criteria						
	Efficient land use	Ecological sustainability	Regeneration of natural systems, provision of open space	Application of climate change accountable concepts	Sustainable economy	Transparency and participation	Identity preservation
Helmut-List Halle, Graz	*	*		*	*		
Sargfabrik, Vienna	*	*	*	*	*	*	
Gasometers, Vienna	*	*		*		*	*

### Results of the research: influence of brownfield redevelopment on mitigation of climate changes

As shown through the case studies, brownfield regeneration is not only a sustainable solution for the land, but it is also an opportunity for the introduction of sustainable solutions in the design. Measures in redevelopment of brownfields, especially recycling of land and buildings, have a direct positive impact on adaptation to climate changes. They increase the capacity for dealing with change. These measures will reduce emissions, increase resistance and make adaptation to the impacts of climate changes. The positive impact is reflected in encouraging a compact development, preservation of natural ecosystems, conservation of resources, and the reduction of energy consumption, which are the main causes of climate changes.

Table 3. Measures in brownfield redevelopment and their influence on climate changes

Measures in brownfield redevelopment	Projects that apply these measures	Anticipated impact on climate changes
Land recycling	Helmut-List Halle Sargfabrik Gasometers	Compact urban development, preservation of the natural environment
Reuse of buildings	Helmut-List Halle Gasometers	Compact urban development, preservation of the natural environment
Creation of green areas	Sargfabrik	Preservation of the natural ecosystems
Application of renewable energy sources	Helmut-List Halle Sargfabrik Gasometers	Reduction of emissions, reduction of energy consumption, and conservation of resources
Inclusion in public transport network	Gasometers	Reduction of emissions trough the reduction in car use
Mixed-use development	Sargfabrik Gasometers	Reduction of emissions trough the reduction in car use

## Conclusion

Spatial development is essential for dealing with climate change, its prevention and adaptation to it. Planning of the spatial development can reduce the sensitivity to changes in certain regions and may help development of adaptive capacity. Since today more than half the population lives in cities, and most of the carbon dioxide is produced in them, addressing the issue of climate change is directly related to the solutions applied in consumption in cities. Land is a valuable and limited resource, and its effective use is essential for achieving sustainable development. The threat to this is urbanisation and expansion of areas that cities occupy. Climate changes require a new approach to urban planning and one of the measures is brownfield redevelopment.

The paper examines brownfield renewal as a method of sustainable and liable use of the land. The task was to point out the connection between brownfield renewal and adaptation measures to climate change. The aim was to highlight the renewal brownfield as a strategy to mitigate the negative effects of climate change. Emphasis was placed on innovative concepts in brownfield renewal that in addition to recycling involve the application of environmentally friendly and sustainable energy solutions. The analysis and evaluation of case studies showed which concepts and strategies are used in successful examples of brownfield renewal and which solutions work the best. Based on that, it has been shown that the brownfield renewal can have positive effects on the regulation of climate

change, and guidelines and principles for liable land redevelopment were derived.

It has been shown that brownfields represent a great potential for the construction, thus avoiding the negative effects of urban sprawl and lowering the impact of climate changes. The construction sector also has the potential to influence the reduction of energy consumption and the emissions. Sustainable urban development involves the protection of the natural landscape and the development of compact forms of housing, which prevents the constant transformation of agricultural land and green areas into the construction land and roads.

Brownfield renewal is of particular importance in countries such as Austria, where one of the major challenges in the planning is migration to urban areas. Increased demand for housing and work space leads to the pressure on urban areas and to the urban sprawl. It is necessary to increase awareness of the importance of brownfield renewal and of the incorporation of climate-liable solutions, initiated through projects such as the Smart City. Awareness of the possible use of cultural resources that brownfield sites have is growing, even among private investors who want not only to preserve the original structure, but aim at social inclusion of the people into the project. Awareness about this issue and its significance are growing. Considering the fact that Austria is among European countries with the highest share of renewable energy sources in a total consumption, potentials for the further development of innovative, climate-liable solutions are great and case studies from this country can serve as good examples.

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