

SUSTAINABLE REDEVELOPMENT – FROM COAL MINE TO SELF-SUFFICIENT ENERGY TRANSFORMATION CENTER

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Abstract

The redevelopment of post-industrial sites, particularly former coal mines, presents both challenges and opportunities for sustainable urban transformation. This paper explores the comprehensive process of planning and transforming the post-mining areas of the Coal Mine “Rozbark” in Bytom, Poland – from the conceptual phase, through planning, to implementation.

The research, based on archival studies, planning documentation, cartographic analysis, and field observations conducted between 2020 and 2024, identifies financial support, adaptive spatial planning, and cultural heritage preservation as critical success factors. The findings highlight how innovative projects can integrate environmental, social, and economic goals, revitalizing degraded areas while addressing challenges like climate change and urban decline. The case of Coal Mine “Rozbark” offers insights into the sustainable transformation of post-industrial landscapes.

Keywords: Transformation of post-mining areas; Sustainable redevelopment; Cultural heritage; Renewable energy; Urban regeneration.

1. INTRODUCTION

The signing of the Paris Agreement in 2015 marked a significant milestone in global climate policy. The international community committed to limiting the global average temperature increase to 1.5°C above pre-industrial levels [1]. In response to this commitment, the Powering Past Coal Alliance (PPCA) was launched at the 2017 UN Climate Change Conference in Bonn [2]. The PPCA aims to phase out the full use of coal in OECD countries by 2030 [17]. The need for a transition away from fossil fuels was further emphasised in the “Silesian Declaration on Solidarity and Just Transition”. The Declaration highlights the social and economic dimensions of this transition [3,49].

The European Union was the first to set out a long-term strategy for the reduction of greenhouse gas emissions and has been taking steps towards the revision of its climate change plans [9,11,12]. Initially, the

EU pledged to reduce greenhouse gas emissions across the economy by at least 40% from 1990 levels by 2030 and to increase the share of energy from renewable sources in total EU energy consumption to at least 27% [48]. In 2019, the target to reduce emissions was raised to 55% and the intention to become carbon neutral by 2050 was announced [7]. Due to the strategic importance of hard coal in the country's energy policy, Poland was the only country to refuse to sign the commitment at that time [9,11,12].

Furthermore, the European Green Deal identifies the need for a comprehensive transition where all relevant sectors, including environment, energy, transport, industry, agriculture and sustainable finance, work together to achieve the main climate target [7,9]. For Member States, this means a slow transition away from coal-fired power generation and a reduction in the need for fossil fuels.

Poland had to revise its energy security strategy to meet international and EU standards. In 2018, The “Programme for the Coal Mining Sector in Poland” was adopted by the Council of Ministers. Its main objective was a fair transformation of the hard coal mining sector, assuming a gradual liquidation of thermal coal mining based on public support mechanisms [44]. Another important step was the adoption of the draft Energy Policy of Poland up to 2040 [43], which takes into account the need to conduct this process in a fair and solidary way, in line with the assumptions of the European Green Deal and COVID-19. This document sets out new directions for the country's energy transition based on three key elements: sustainable transformation, building a zero-emissions energy system and improving air quality, including:

- a 7% reduction in greenhouse gas emissions in sectors not covered by the Emissions Trading Scheme (ETS), compared to 2005 levels,
- a 21-23% share of renewable energies (RES) in gross final energy consumption
- increasing energy efficiency by 23% compared to PRIMES2007 projections
- and reducing the share of coal used to generate electricity to at least 56% [43].

The introduction of new regulatory frameworks necessitates a comprehensive reassessment of strategies for the redevelopment of post-mining areas, as their reutilization may serve as a critical catalyst for the transformation of local economies. Such processes could mitigate the adverse socio-economic impacts associated with mine closures by fostering new forms of community embeddedness within the region [31]. Within this context, the advancement and deployment of cutting-edge carbon dioxide emission reduction technologies within the European Union appear more advantageous than the relocation of industrial activities to developing countries [45]. Concurrently, although the decentralization of energy systems entails both novel opportunities and opportunity costs, former coal regions are emerging as primary beneficiaries of these transitions. In these areas, local prosumer communities are increasingly functioning as polycentric actors responsible for the management of shared energy resources [47].

In the pursuit of innovative applications for post-mining territories, Menendez et al. [38] investigated the potential for repurposing decommissioned mines into sites for underground pumped hydro energy storage, compressed air energy storage plants, and geothermal installations, presenting a case study of the integration

of these three technologies within a single location. Similarly, Madlener and Specht [36] examined the feasibility of converting abandoned underground coal mines in Germany into underground pumped-storage power plants. Their analysis underscores that, under appropriate conditions, such projects can achieve both technical and economic viability.

Additionally, other researchers have highlighted mining waste as a potential secondary source of raw materials, which could partially compensate for the limited availability of critical metals. They also emphasize the need for further research into the valorization of flotation tailings [32] and the utilization of methane emissions as an additional energy source [6,8,33]. Parallel investigations have been undertaken to develop methodologies for selecting optimal business models based on renewable energy and circular economy technologies in decommissioned coal mines. These studies aim to support the growth of the renewable energy sector, promote sustainable local economic development, and maximize the creation of green, high-quality jobs [34].

In Poland, extensive efforts are also underway to implement the guidelines outlined in strategic policy documents. These activities particularly focus on research initiatives and the deployment of projects enabling the extraction of energy from renewable sources. Key examples include the recovery and storage of thermal energy from mine waters [37, 35, 45, 50], as well as the construction of wind and solar farms on former mining sites [55].

An example that best illustrates the challenges associated with adapting post-mining areas to new functions, within the context of climate policy changes and the development of renewable energy, is the redevelopment process of the “Rozbark” Coal Mine in Bytom. Analyzing this case provides deeper insights into both the difficulties encountered during the adaptation of post-mining areas and the critical conditions that influence the effectiveness of such redevelopment processes. A comprehensive analysis of the transformation process — covering the stages from the mine's operation and closure, through planning and implementation, to the current utilization of the post-mining site — enables an assessment of the effectiveness of undertaken actions and the identification of key factors contributing to the successful transformation of post-industrial areas. It also reflects the challenges faced during the adaptation of post-mining sites, including issues related to securing financing, navigating legal and planning regulations, and responding to

changing trends and evolving assessments of the potential of such areas. Consequently, this example serves as a valuable reference for other regions facing similar challenges, emphasizing the need for integrated, multidisciplinary approaches to the post-mining transition.

2. MATERIALS AND METHODS

The objective of this paper is to provide a comprehensive overview of the strategic planning and transformation process of the post-industrial area of the Coal Mine “Rozbark” in Bytom, Poland. The research encompasses the following aspects:

- an examination of the transformation process, encompassing stages from mine operation and closure, through planning and implementation, to the current land use of the post-mining site.
- an evaluation of the practical implementation of spatial policies and architectural projects in the revitalisation of post-mining areas.
- an identification of factors influencing the successful transformation of post-industrial areas.

In order to achieve these objectives, a multi-method research strategy was adopted, combining archival analysis, spatial data processing, site investigations, and urban planning documentation review. The study was based on:

1) Archival research

Archival materials were collected primarily from the Archive of Surveying and Geological Documentation at the Higher Mining Office in Katowice. The focus was on:

- general and detailed mine closure plans, including their updates, used to reconstruct the procedural timeline and spatial interventions.
- historical land use maps from archival materials documentation,

2) Geodetic and cartographic data collection

Data from the municipal geodetic and cartographic resources of the city of Bytom were gathered. This encompassed digital cadastral maps and topographical maps, which facilitated the precise spatial identification and delimitation of the Rozbark mining area.

3) Identification and delimitation of the post-mining site

Utilising the integration of archival cartography, geodetic resources and contemporary spatial datasets, the research delineated the total extent of the former mining infrastructure and associated land parcels.

4) The collection and analysis urban and architectural projects

A component of the methodology entailed an in-depth examination of urban and architectural documentation. In this context, the examination encompassed a variety of documents, including competition submissions, project proposals from design studios and construction companies. The analysis placed particular emphasis on the extent to which the designs were realised.

5) Field investigations (2020–2024)

The site inspection was conducted in two phases over the period from October 2020 to October 2024. The objective of the site inspection was to observe and document the extant built environment, open spaces, and structural remains.

The site inspection was conducted with the following objectives in mind:

- to create a photographic inventory of the current state of land use and infrastructure.
- to assess the technical conditions and functionality of post-mining structures.
- to assess the degree of implementation of projects.

6) Cartographic and quantitative spatial analysis

The cartographic analysis of land use classification was based on collected archival, publicly available spatial information systems and geodetic data, as well as field investigation data. The analysis was conducted in accordance with the author's prior typology of post-mining land use [13,16].

7) Comparative analysis of field observations and research findings

Results obtained during site inspections were compared with archival, cartographic, and planning data to verify the consistency between planned redevelopment strategies and actual land use outcomes. This allowed identification of spatial and functional discrepancies, assessment of implementation success, and recognition of unforeseen dynamics in land transformation.

8) Planning framework analysis

The legal and spatial planning framework was analysed based on local planning documents, such as the Study of Conditions and Directions of Spatial Development of the City of Bytom and valid Local Spatial Development Plans (LSDP). The objective of this study was to evaluate the alignment of redevelopment initiatives with formal planning directives and to ascertain the existence of any planning constraints or facilitations within the transformative process.

3. THE CONSTRUCTION, OPERATION AND DECOMMISSIONING OF THE MINE

The history of the Coal Mine “Rozbark” (originally the “Hainitz” mine) dates back to 1856, when the “Heinitz” mining field was granted. The construction of the mine began only after Otto Friedlander took over the property, and in 1878, coal production started, with the first shafts, Stalmach and Bończyk, being sunk. [29]. In 1890, the mine was acquired by the heirs of Georg von Giesches, who continued investing in the development of new mining levels and the exploitation of new areas (Hope and Heinitz Extension). During this period, important infrastructure was built, including a guildhall, powerhouse, smithy, firehouse, two administrative buildings, and a management building, designed by Emil and Georg Zilmann [29,56]. After the Second World War, the name of the mine was changed to “Rozbark”, after the district in which it was located.

For the residents of Bytom, the Coal Mine “Rozbark” was not only an industrial workplace but also a central element of social life. It was the eco-

nomic and cultural foundation of the city. It played a key role in the city's development, especially for the Rozbark district, whose identity, spatial layout and social structure were strongly linked to the mine's functioning. Workers' settlements, public buildings, shops, schools and places of worship and social life were built around the mine. The daily life of the district's inhabitants was organised around the rhythm of the mine's work. Interpersonal relationships were shaped by shared work and family experiences of mining. There were also many social, cultural and political events that built a sense of community and shaped local identity.

The decommissioning of Coal Mine “Rozbark” began in 1999 and took place in two stages. The first stage involved the restructuring of the entire company, which included the merger of part of the mine with the liquidated Coal Mine “Centrum-Szombierki” and the establishment of an independent mine called “Bytom II”. In 2004, with the decision to fully close Mine “Bytom II”, the following actions were initiated: the closure and securing of selected underground workings and shafts, the prevention of hazards associated with the

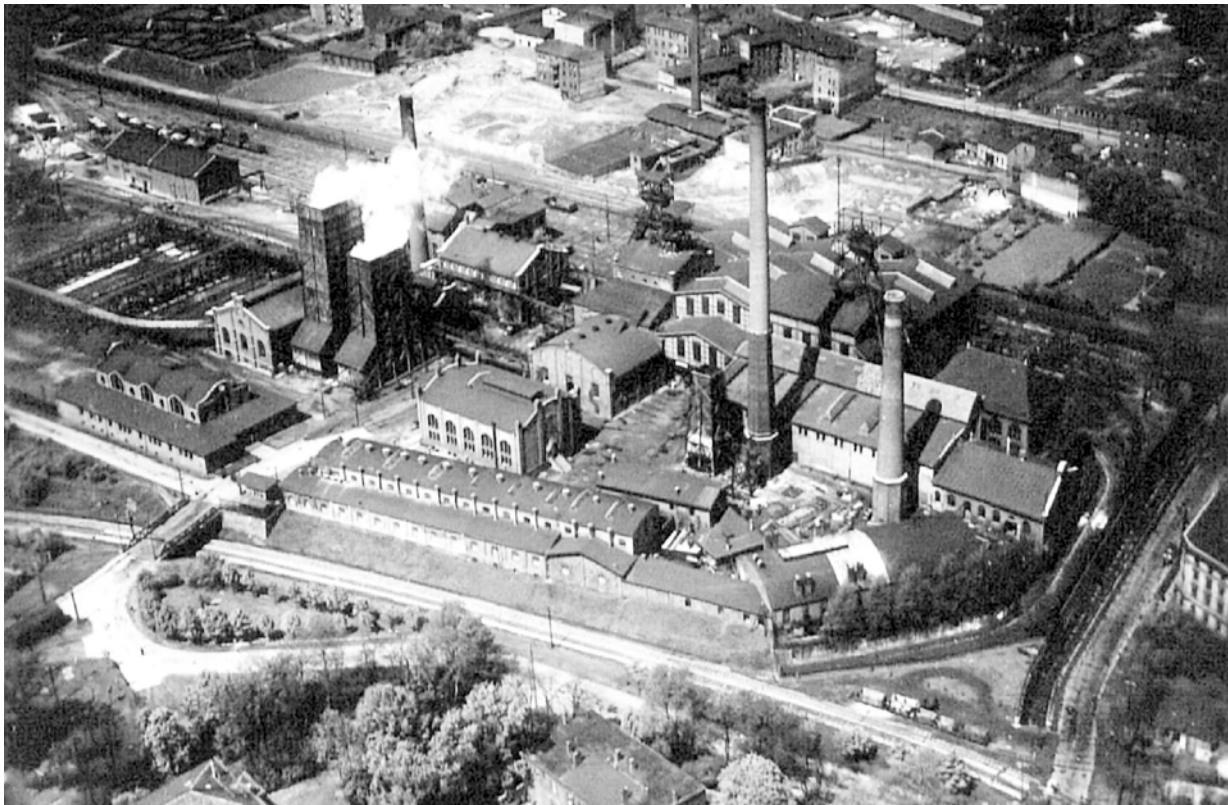


Figure 1.

Archival photographic documentation of the Coal Mine “Rozbark”(1927).

Source: <https://polska-org.pl/10026860,foto.html?idEntity=7794217> (access date 2.10.2022)

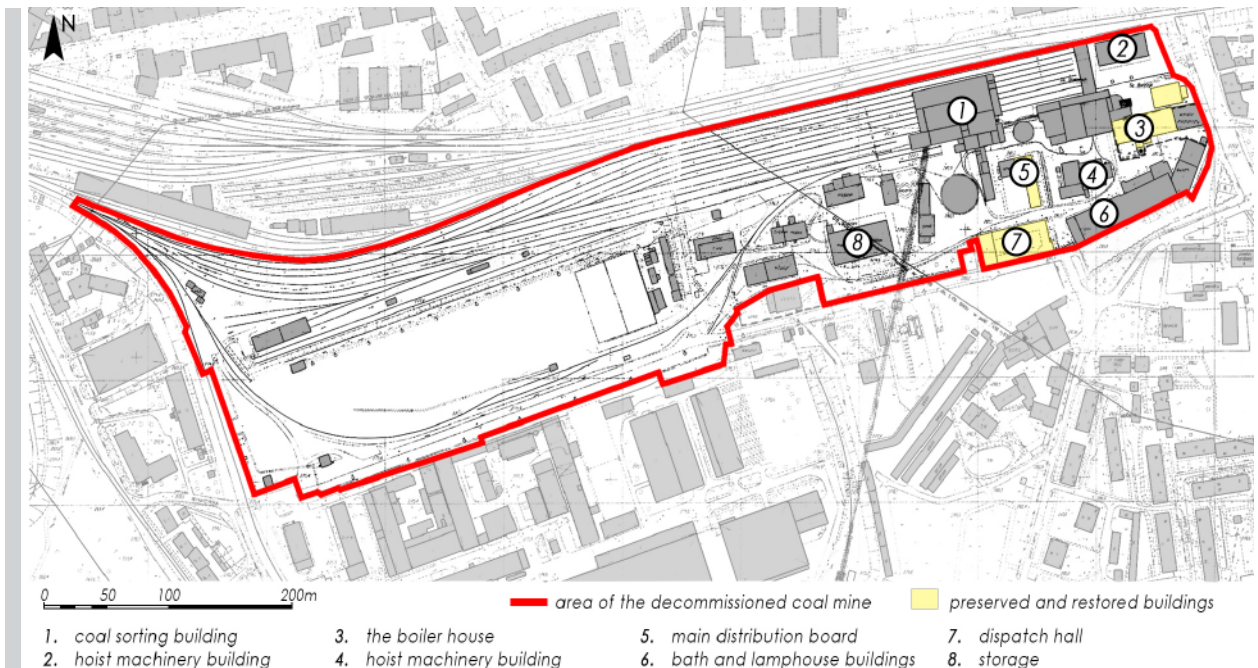


Figure 2.

Development plan for Coal Mine “Rozbark” area on the Chorzowska Street. Source: Author study on the basis of data from the Archives of the State Mining Authority in Katowice

decommissioning process, the removal of surface facilities, the repair of mining damage, and land reclamation [42].

At the time of its decommissioning, the Bytom II Mine included the area of the Coal Mine “Rozbark” (approximately 14.85 ha) and the “Barbara” Shaft (approximately 6.9 ha). The main site of the former mine was located in the central part of the city of Bytom, along Chorzowska Street. It was surrounded by residential and commercial buildings to the east, and factories, wholesalers, and warehouses to the south. To the west of the mine was the Coal Mine “Szombierki” and the historic settlement of Wzgórze Małgorzatki. The northern boundary of the site was marked by a railway siding adjacent to the Bytom – Katowice railway line, which simultaneously separated the mine from the historic areas of the city center [42].

Most of the mine’s buildings were concentrated on the eastern side of the plant. These included the shafthead and hoist machinery buildings for the “Bończyk” and “Stalmach” pits, the boiler house, the smithy, the dispatch hall a complex of bath and lamphouse buildings, the 6kV electrical substation, and facilities for treatment, storage, and workshops. The total built-up area in this part of the mine was approximately 20400 m².

In the western part of the mine, there were coal storage yards and settling ponds (approximately 2.37 ha). Outside the fenced area of the plant, there were administrative and office buildings, the director’s villa, the telephone exchange, and the handling and weighbridge buildings.

The closure of the Coal Mine “Rozbark” was a turning point, triggering strong emotions and fears for the future of the town among former workers and the wider community. The decision to close the mine brought with it many social problems, including an increase in unemployment, a deterioration in the living conditions of former workers and their families, and a reduction in the income of the local community. As a result, the closure of the mine not only created an economic crisis, but also deep uncertainty about the future fate of the site and the possibilities for its future development.

Redeveloping Coal Mine “Rozbark” represents a major challenge for the local authorities. Not only in terms of economic, social, spatial and environmental issues, but also in terms of cultural and identity issues. To preserve part of the original post-industrial heritage on 8 July 2007 the complex of mining buildings of the former Coal Mine “Rozbark” at Chorzowska Street was entered into the National Register of Monuments and Sites

(registration number – A/213/07). It consisted of a the dispatch hall (1911), a boiler house (1915), a machine room building of the “Bończyk” shaft (1907) and a retaining wall (1886) [10]. These objects have been left without proper protection and conservation. Due to the deterioration of their technical condition, the buildings of the smithy and the locksmith’s shop were demolished in 2012.

4. THE PLANNING AND IMPLEMENTATION OF THE TRANSFORMATION PROCESS

4.1. Transformation concepts

With the decision to decommission the Coal Mine “Rozbark”, discussions began on how to develop the site and finance it. One of the first concepts was the transformation of the post-mining area



A – view of the development of the Coal Mine ‘Rozbark’ site (from architectural and urban planning competition),
 B – view of public spaces and revitalised mine buildings,
 C – view of the interior of the dispatch hall

Figure 3.
 Concept for the “Rozbark” Dance and Movement Theatre on the site of the former Coal Mine “Rozbark” – visualisations.
 Author: P.A. Nova S.A. Source: https://www.pa-nova.com.pl/pl/Panova/Nagrody_i_wyroznienia (access: 4.02.2020),
<https://bytom.naszemiasto.pl/ruszaja-prace-na-terenie-bytomskiej-kwk-rozbark-bedzie/ar/c3-1312029> (access: 29.05.2023)



Figure 4.
“Rozbark” Dance and Movement Theatre (2020). Source: Author’s photograph

into a garden city (on the model of land art). Its author was the French artist Jean-Paul Ganem [28].

However, the local authorities preferred to redevelop the post-mining area in order to create as many new jobs as possible, given the wide range of social problems caused by the closure of the mine. Therefore, the Bytom authorities had started negotiations with the British company Mayfield Poland, which was interested in transforming the area into a residential and service complex. The concept also included the use of the city’s cultural potential and the creation of a new home for the Silesian Dance Theatre on the mine site [30].

Following the takeover of the mine area situated at Chorzowska Street by the municipality and the withdrawal of Mayfield Poland from the investment, the City of Bytom organised an architectural and urban planning competition for the concept of the development of the former “Rozbark” mine area in 2010 [25]. The submitted concepts were intended to show the directions and possibilities of transforming the area and to support the process of planning and preparing the necessary documentation for further investments (including changes to the study of conditions and directions of spatial development, development of a local spatial development plan, application for project funding).

4.2. Designs and their implementation

4.2.1. Dance and Movement Theatre “Rozbark”

Recognizing the cultural potential of the city and the lack of facilities for the cultural institutions associated with it, the municipal authorities of Bytom decided to use the premises of the decommissioned Coal Mine “Rozbark”, acquired from SRK SA, for the Dance Centre “Bytom”. The investment was aimed at establishing the Faculty of Dance Theatre in the historic mine buildings [39].

In the first stage, the works were limited to the renovation of the dispatch hall and the administration building, together with the surrounding area. The interiors of the historic buildings provide space for: a professional theatre stage with an auditorium for about 200 seats, rehearsal rooms, a conference room, administrative and catering premises. The functional program has also been supplemented with accommodation for guests and future students of the art of dance. Furthermore, the facilities were supposed to be fully adapted to the needs of disabled persons [39].

The construction works start in March 2012. The project was supported by EU funds from the Silesia Regional Operational Programme for 2007–2013 and public grants for culture and heritage.

In March 2014 there was a grand opening of the theatre. The event included a tour of the theatre premises, classes and workshops, and performances by the Buratino Puppet Theatre from Bydgoszcz and the Polish Dance Theatre from Poznań [179,41].



Figure 5.
Climbing and Strength Sports Centre (2024). Source: Author's photograph

4.2.2. Climbing and Strength Sports Centre “Skarpa”

The next investment aimed at preserving the historic buildings of the Rozbark mine involved the transformation of the former boiler house into a climbing and strength training centre. The project's objective was to create a multifunctional space for climbing within the post-mining area, designed to accommodate various age groups and experience levels. The functional program includes areas for fitness classes, cross-training, a parkour zone, a street workout area, a sauna, off-road running tracks, an outdoor gym, and a rope climbing room, as well as over 3,000 m² of climbing walls (both indoors and on the building's façade). Additionally, the facility's design includes meeting rooms and accommodation [14].

In 2018, the concept received funding from the EU, specifically from the Regional Operational Programme of the Silesian Voivodeship 2014-2020, as well as from the budget of the City of Bytom and the Ministry of Culture, National Heritage, and Sport (UM in Bytom, 2010; Skarpa, 2020). The design documentation was prepared by a.s. studio Adam Szwarc [15,18].

During deconstruction works in July 2019, a construction disaster occurred when the chimney of the former boiler house collapsed uncontrollably onto the building's structure. This event significantly delayed the project timeline and resulted in additional costs [4].

By September 2021, the first outdoor facilities – including a climbing wall, parkour zone, street workout area, off-road running track, and outdoor gym – were opened to the public, followed by the completion of the interior of the modernized boiler house two months later [5]. Today, the Climbing and Strength Sports Centre is one of the largest in Europe (Fig. 5).

4.2.3. Playground “Gryfny”

Regardless of the works related to the construction of the Climbing and Strength Sports Centre, the Playground “Gryfny” was opened on the former mine site in April 2024. The investment was financed from the Citizens' Budget of Bytom. The playground includes: ladders, swings, sandpits, slides, tunnels, wooden balance boards, a carousel and benches on

springs, as well as interactive elements such as an imitation car cockpit, drums and a xylophone. The project was conceived as a publicly accessible leisure and sports space for children and young people, which would extend the range of recreational activities available in the city [20].

4.2.4. Concept for the Green Quarter of KWK “Rozbark”

Growing social awareness of the need to adapt cities to climate change, combined with the possibility of securing funding from the Just Transition Fund for the reuse of degraded areas, has enabled local authorities to look at post-mining sites in a new light.

In 2023, the Skarpa Climbing and Strength Sports Centre, which manages a significant part of the former Coal Mine “Rozbark” site, proposed further redevelopment of the mine site. Its aim is to create a modern and self-sufficient Green Quarter KWK Rozbark, which will produce energy from wind, solar, hydro, biogas and hydrogen sources (Fig. 6). The investment is divided into four projects: *Energy Transformation Centre*, *Training and Accommodation Centre – Green Transformation*, *Community and Educational Activity Centre*, Ecological housing estate for senior citizens. This initiative aims to set a bench-

mark for sustainable urban transformation and energy self-sufficiency, in line with broader climate adaptation and social inclusion objectives [15,21,24].

• Energy Transformation Center

A fundamental element of the Green Quarter KWK “Rozbark” initiative pertains to the advancement of sophisticated technical infrastructure, facilitating the generation and storage of electricity from renewable energy sources (RES). The projected investment encompasses the implementation of photovoltaic panels, energy storage systems, and an integrated energy management system. Furthermore, the initiative entails the establishment of a comprehensive technical infrastructure essential for the operation of RES installations, encompassing electrical, telecommunications, water supply, sewage, and stormwater networks. The entire site will be complemented by green spaces and paved surfaces to enhance functional spatial integration

In subsequent stages of the investment, the installation of both horizontal and vertical wind turbines, a hydrogen generator for energy production and storage, and other cutting-edge methods of generating electrical and thermal energy are planned.

Beyond its technological advancements, the project is also designed as an educational and research



Figure 6.
Concept for the Green Quarter of Coal Mine “Rozbark” – visualization. Source: <https://zielonykwartal.pl/zielony-kwartal> (access date 1.05.2025)

platform to promote and expand environmental awareness. Educational workshops will be organized for children, youth, and adults, demonstrating energy production from biogas and highlighting the energy potential of municipal waste. As part of these activities, children will have the opportunity to observe a biogas installation in operation and gain a deeper understanding of the critical role of waste segregation in environmental protection. Additionally, the RES infrastructure will serve as a research model, offering practical insights into various energy generation and storage technologies [15, 22].

• Training and Accommodation Centre – Green Transformation

The redevelopment and expansion project of the training and accommodation facility has been conceived with the aim of transforming it into a multi-functional complex, integrating lodging, gastronomy, social-educational, and sports functions, along with the development of the surrounding area. As part of this initiative, the adjacent space will also be adapted, including the construction of an outdoor water playground, which will serve as a natural extension of the building's indoor facilities.

The overarching goal of this initiative is to establish a contemporary infrastructure that will facilitate the operations of a day-support centre for children, youth, and families, incorporating educational and social initiatives. The newly developed space will be made accessible to students, cultural institutions, non-governmental organisations, and entrepreneurs, providing a diverse range of facilities. Beneficiaries will have access to climbing infrastructure, outdoor sports facilities, and a newly constructed swimming pool, which is an integral component of the project [15,23].

• Social-Educational Activity Centre

The project involves the construction of a Socio-Educational Activity Centre, with a focus on the restoration of the historic mining bathhouse on Kilara Street and the redevelopment of 0.49 hectares of post-industrial land. The renovated facility will accommodate a range of functions, including gastronomic, socio-educational, commercial, and sanitary activities, integrating diverse community-oriented services. A key component of this initiative is the establishment of the Rozbark Initiatives Centre, which will include:

- Szynek Klubu Rozbarskiego – a traditional social space,

- Izba Rozbarska – a recreated living space reflecting the historical atmosphere of the Rozbark district,
- Izba Tradycji i Nowoczesności – an exhibition area bridging regional history with modern innovations.

The surrounding area will be transformed into a recreational and socio-cultural activity zone, designed to host local events, festivals, and the annual Rozbark Days. This space will also serve as an educational hub, fostering local identity and heritage preservation, while promoting community engagement and cultural continuity [15,22].

• Ecological housing estate for senior citizens

As part of the ongoing redevelopment of post-mining areas, plans include the new construction of a senior housing community fully powered by renewable energy sourced from local resources. The residential units will be designated for long-term rental for individuals aged 60 and above, with a closed-loop energy and water system ensuring low maintenance costs, thereby enhancing the investment's overall attractiveness.

This initiative aims not only to promote sustainable environmental solutions but also to provide comfortable and secure living conditions for senior residents. By integrating advanced ecological technologies, the project seeks to establish a model for energy-efficient and socially inclusive urban development, demonstrating the potential of post-industrial land repurposing for future-oriented housing solutions. [22,23,27].

The Green Quarter KWK “Rozbark” concept has received the approval of Bytom's local authorities, who support the integration of private and public capital in the project. Additionally, in November 2023, the Marshal's Office of the Silesian Voivodeship granted financial support of 34.5 million PLN from the Just Transition Fund to implement five key investment initiatives [15,22,23].

The Green Quarter KWK “Rozbark” project exemplifies an innovative approach to post-mining land revitalization, integrating environmental sustainability with local community needs. The first phase of the investment is scheduled for 2024–2025, marking a significant step toward sustainable urbanization and post-industrial renewal. By replacing former coal mining sites with renewable energy production facilities, the project directly responds to contemporary social and environmental challenges. Through the application of advanced technologies, the city of Bytom is actively addressing the demands of the energy transition, reducing greenhouse gas

emissions, and enhancing climate adaptation strategies. This initiative is a new direction for transforming industrial heritage into a future-oriented, sustainable urban environment.

4.3. City spatial policy of coal mine “ROZBARK” area

Simultaneously with efforts aimed at acquiring the land of decommissioned of Coal Mine “Rozbark”, the city of Bytom initiated work on amending planning regulations. In 2011, the City Council adopted a study on spatial conditions and development directions. The post-mining areas along Chorzowska Street and Wojciech Kilar Street were designated as commercial service areas (U1), encompassing trade, non-production services, gastronomy, and collective housing. The goal of regulation was to enrich the cultural, educational, office and administrative offer of the city. Plans included the establishment of a choreography and ballet center, as well as institutions integrating cultural and higher education functions [51]

The Local Spatial Development Plan for the post-mining area has further specified the provisions of the study [52]. The land of the decommissioned mining facility was divided into three zones. The first of these included former mine buildings on Chorzowska Street, which was designated for the development of cultural services (UK), including concert halls, cinemas, a dance school, cultural centres, art galleries and artistic and entertainment services. Moreover, the zone encompassed public spaces, such as a city square and accessible green areas, herein referred to as an “urban garden”. The central part of the site was allocated for the development of hotels and gastronomy (UM), while the area of the former storage yards and railway tracks was designated for the construction of service buildings, including office and administrative buildings, retail establishments, and craft service facilities. Throughout the entire post-mining area, the local spatial development plan allowed for the construction of sports facilities. The document also defined a new transportation network with accompanying greenery and the location of an underground parking facility [52].

The recent amendment to the Act on Spatial Planning, effective from 2024, has introduced new regulations in Poland. The amendment requires all municipalities to replace their existing study of spatial conditions and development directions with general plans and to develop a municipal development strategy [53]. This provides an opportunity to intro-

duce necessary changes to local regulations, thereby supporting the execution of policies that are oriented towards the ecological and social development of urban space.

5. PRESENT LAND USE

By December 2024, 19.7% of the land of the decommissioned of Coal Mine “Rozbark” located along Chorzowska Street had been redeveloped. The predominant function of the area consists of service facilities (educational, cultural, sports, and recreational), which, together with transportation and investment areas, cover 2.9 hectares of this site (Fig. 8).

Despite the systematic renovation of the mining buildings has been ongoing for over 21 years, approximately 32.8% of the area remains undeveloped. The opportunity to transform them is further projects responding to the contemporary needs of the city and its inhabitants.

Nowadays, intensive construction work is underway on the post-mining areas as part of the implementation of the Green Quarter of KWK “Rozbark” (4.9 hectares). This project responds to contemporary challenges, such as the need to reduce greenhouse gas emissions and adapt to climate change. Through the use of modern technologies and the development of energy infrastructure, including photovoltaic panels and biogas installations, the former mining site is not only being revitalized but also becoming a symbol of energy transformation in the region.

The project is based on the principles of sustainable urban development, supporting a balance between the environment, economy, and society. By restoring the use of degraded areas, the investment mitigates the negative impact of human activity on the environment while simultaneously generating new jobs and creating educational and social spaces. Moreover, integrating energy infrastructure with educational and recreational areas enables Bytom’s residents to better understand the benefits of the green transition, fostering ecological awareness and local engagement.

Transforming the post-mining site into a renewable energy hub also reflects a commitment to the region’s future – laying the foundation for a low-emission economy, promoting innovative ecological technologies, and ensuring high-quality living conditions for present and future generations. This investment makes Bytom a leader in the transition from a mining heritage to an environmentally sustainable future.



A – section of the study on conditions and directions of spatial development

B – section of the local spatial development plan

Figure 7.

City's spatial policy of the Municipality of Bytom towards the post-mining areas of the former Coal Mine 'Rozbark'. Source: Uchwała nr XVI/204/11 Rady Miejskiej w Bytomiu z dnia 24 sierpnia 2011 r. [Resolution No. XVI/204/11 of the Bytom City Council of 24 August], Uchwała nr XXVIII/418/12 Rady Miejskiej w Bytomiu z dnia 25 kwietnia 2012 r. [Resolution no. XXVIII/418/12 of the Bytom City Council of 25 April 2012]

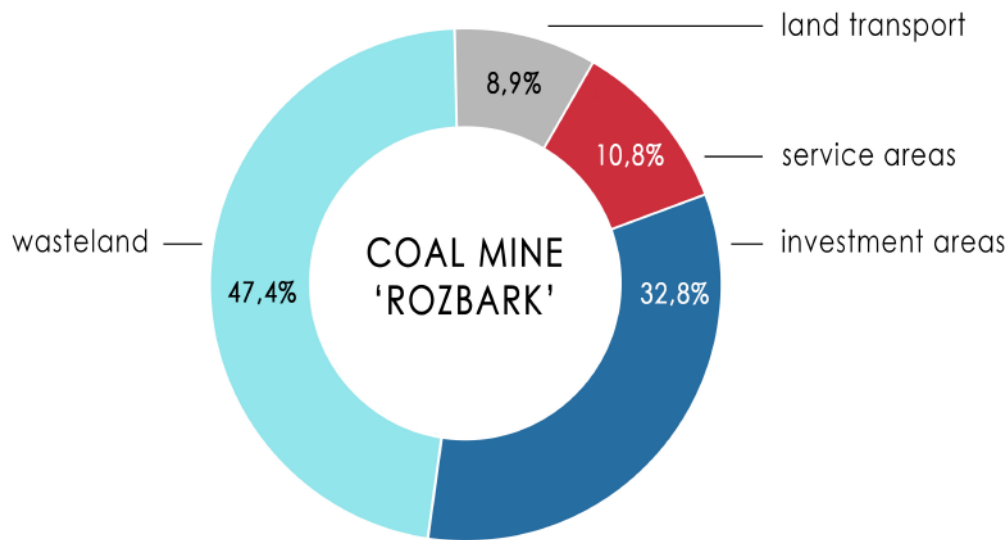


Figure 8.

Land use of the site of the decommissioned Coal Mine “Rozbark” in December 2024. Source: Author’s study

6. DISCUSSION OF RESEARCH RESULTS

The restructuring of the Coal Mine “Rozbark” initiated the gradual closure of the facility and the search for new ways to redevelop its land. The transformation of post-mining areas has been ongoing for over 21 years and remains unfinished (Fig. 9, Fig 10.).

Following the decision to part-close the mine, measures were implemented to ensure the viability of the operations and to mitigate any undesirable socio-economic impacts. These measures were very general and based on the geological and mining conditions present at the mine at the time and the legal conditions [42].

Parallel to the decommissioning process led by SRK S.A., the Bytom City Office has been considering future direction of redevelopment for the post-mining areas. The initial proposals were comprehensive, encompassing the area between Chorzowska Street and Łagiewnicka Street. These plans outlined a long-term vision for repurposing the closed mining facility and supported the processing of planning documents (Study of Conditions and Directions of Spatial Development and the Local Spatial Development Plan).

At the same time, municipal authorities made efforts to acquire part of the post-mining land, attract private investors, and secure additional funding, including resources from the Regional Operational Program of the Silesian Voivodeship. As the municipality assumed ownership of the area and external

partners withdrew, local authorities have decided to adapt the guildhall and administration building for Dance and Movement Theatre “Rozbark”.

The lack of funds to continue the initially planned redevelopment activities led to a prolonged period of neglect and underutilization of the post-mining site. As a consequence, the technical condition of the remaining cultural heritage structures deteriorated over time, ultimately resulting in their irreversible loss. This situation highlights the critical importance of securing timely and sufficient funding for safeguarding industrial heritage during transformation processes.

Subsequently, the persistent funding gap necessitated a revision of the initial investment strategy, shifting it toward solutions that would enable the acquisition of external funding for the restructuring of post-mining facilities. The newly adopted strategy focused on repurposing the buildings and surrounding land for sports and recreational purposes, thereby transforming the former industrial site into a new cultural and leisure hub for the city.

At the same time, these interventions introduced new nodes of activity within the Rozbark district. By strategically repurposing selected areas, the city was able to counteract further degradation of the neighborhood and initiate a polycentric development policy, aimed at enhancing accessibility to urban functions beyond the historical center. This approach also expanded the city’s recreational offerings, promoting social inclusion and improving the quality of life in formerly neglected urban quarters.

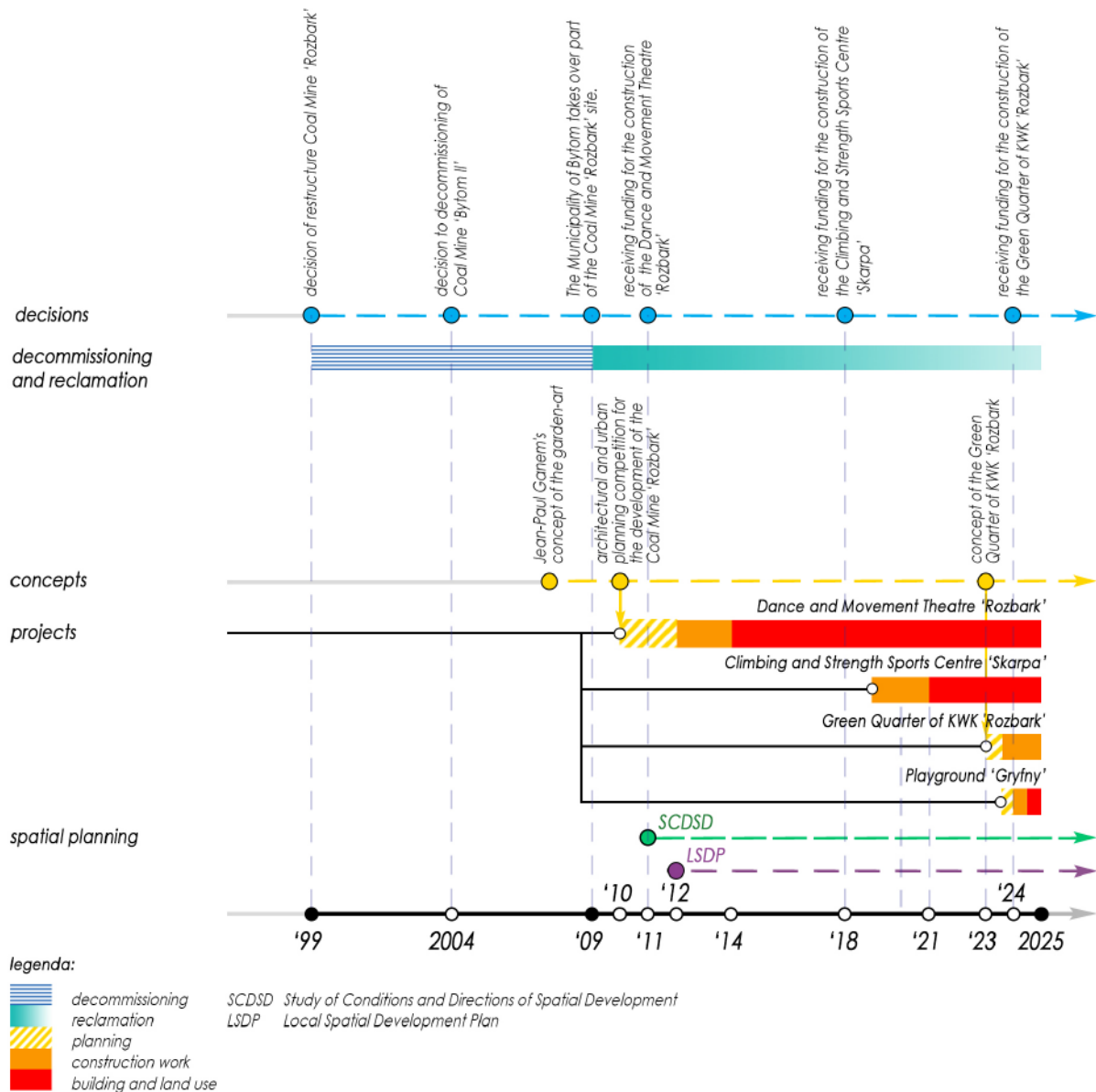


Figure 9.
Transformation process of Coal Mine "Rozbark". Author's study

These successful initiatives increased the economic and symbolic value of the site, attracting additional investment and laying the groundwork for broader redevelopment efforts. Furthermore, the rising societal awareness of climate change adaptation – combined with the availability of Just Transition Fund resources – enabled local authorities to reassess the potential of post-mining land through a contemporary, sustainability-focused lens. As of today, construction is underway on the site of the former Coal Mine "Rozbark" coal mine, aimed at establishing a self-sufficient energy transformation hub – the *Green*

Quarter KWK Rozbark. This landmark initiative marks a major step toward sustainable development, uniquely converting a former coal extraction zone into a renewable energy production landscape. By harnessing wind, solar, water, biogas, and hydrogen energy sources, the transformation reflects a paradigm shift – from a fossil fuel-dependent economy to one driven by sustainable, green energy. The project not only aligns with national and EU climate goals, but also offers an innovative model for the adaptive reuse of post-industrial territories.

Nevertheless, analysis of the transformation process at



A – construction of the Climbing and Strength Sports Centre (2020)

B – Climbing and Strength Sports Centre after opening (2023, 2024)

Figure 10.
Climbing and Strength Sports Centre. Source: Author's study

Coal Mine “Rozbark” revealed certain urban integration challenges. Despite the initial concept envisioning a cohesive urban and architectural layout that would integrate the former mine site with the surrounding city fabric, subsequent investments adopted a fragmented, point-based approach. These were limited to the adaptive reuse of selected structures – primarily the former boiler house – and adjacent parcels of land. Although these developments successfully created new public, cultural, and sports spaces that have strengthened social ties and fostered local identity, their spatial isolation from the broader urban structure undermines their long-term integration. Surrounded by industrial remnants, railway infrastructure, and a major traffic artery, these areas now function as “urban islands”, disconnected from Bytom’s main spatial network.

Despite these challenges, the ongoing redevelopment holds substantial potential for spatial reintegration. By transforming the previously enclosed site into an open, multifunctional urban area with recreational, residential, and service-oriented uses, the city has the opportunity to reconnect disjointed zones and restore spatial continuity. This process would not only revitalize degraded land but also contribute to urban cohesion, resilience, and inclusive development in post-industrial Bytom.

7. CONCLUSIONS

The adaptation of post-mining areas aligns with a broader European trend of transforming post-industrial spaces in accordance with the principles of sustainable development. Sustainable development, understood as meeting present needs without compromising the ability of future generations to meet theirs, integrates environmental protection, social inclusion, and economic growth. It serves as a framework to ensure that urban transformations foster long-term ecological balance, social equity, and economic viability. In this context, green technologies – including renewable energy systems, energy-efficient infrastructure, and smart resource management – play a pivotal role by reducing environmental impact and enhancing the resilience of revitalized spaces.

Modern revitalization efforts aim to integrate energy production, education, and social functions, creating new urban models based on self-sufficiency and climate resilience. The lessons learned from the revitalization of the former Coal Mine “Rozbark” in Bytom highlight several key principles essential for effective transformation.

First, a stable, diversified financing foundation is crucial for successful redevelopment. The Coal Mine “Rozbark” case demonstrates that a lack of continuous and reliable funding can halt investments, reduce the scope of originally planned activities, and, in extreme cases, lead to the irreversible loss of valuable cultural heritage. When funding ceased, the site remained unused for an extended period, resulting in the deterioration of structures and the loss of unique historical assets.

Securing funds from multiple sources — public funds (such as the Just Transition Fund, national and regional resources), private investments, and municipal support – is vital to initiate and sustain the transformation process. Without guaranteed financial backing, the implementation of redevelopment stages becomes practically impossible, often resulting in abandonment or forced changes in strategy, delays, or project discontinuation.

Secondly, the transformation process should be phased and adaptable to changing external conditions. Revitalization projects often span many years and are influenced by economic fluctuations, real estate market dynamics, availability of EU funds, technological innovations, and social preferences. Therefore, planning documents such as the Spatial Development Conditions and Directions Study and local development plans must include flexible, scenario-based provisions that allow strategies to be adjusted to current realities.

Thirdly, new investments must be integrated with the existing urban fabric and designed as multifunctional projects grounded in sustainable development principles. The Coal Mine “Rozbark” example revealed a critical problem of isolating completed structures from the broader urban context — investments were often isolated points lacking spatial and functional integration. To avoid such issues, a comprehensive urban plan covering the entire transformation area should be developed and consistently implemented, aligning with investors’ objectives and local community needs.

The redevelopment of post-mining areas should promote connectivity rather than fragmentation of urban spaces through functional, communicative, and social links. This is especially important for large post-mining sites located in city centers or near dense residential and service areas, where new uses can significantly impact urban balance and residents’ quality of life. Research indicates that multifunctional planning, incorporating residential, service, social, educational, recreational, and energy uses, is key to maximizing

the potential of such sites. This approach fosters sustainable development of the entire area, enhances its investment attractiveness, improves spatial cohesion, and delivers diverse social, economic, and environmental benefits.

Another critical element of successful post-mining transformation is the preservation and active use of industrial heritage. Rather than demolishing former mining facilities, adaptive reuse for cultural, educational, tourism, or service functions should be promoted. This not only preserves tangible industrial history but also strengthens local identity, increases spatial attractiveness, and lends a unique, authentic character to the area.

The transformation of Coal Mine “Rozbark” is a notable example of this approach. Despite initial financial difficulties and fragmented redevelopment, local authorities succeeded in rescuing and adapting key mining heritage elements for new social and cultural functions. Notably, the former miners’ changing house and administrative building were converted into the “Rozbark” Dance and Movement Theater — a cultural institution of regional importance attracting residents and visitors alike.

Studies show that preserving mining heritage often not only determines but also initiates the revitalization process of post-mining sites. At Coal Mine “Rozbark”, the decision to protect and utilize buildings listed as historic monuments became a starting point for further revitalization and investment activities. This included converting the old boiler house into the modern “Skarpa” Climbing and Strength Sports Center, and, in the final stage, constructing a multifunctional complex focused on renewable energy production and education — the Green District of KWK “Rozbark”.

Heritage protection encompasses not only the physical preservation of architectural objects but also the nurturing of intangible values — the memories of mining communities, their identity, traditions, and way of life. Incorporating these elements into transformation processes enriches the cultural dimension of investments and enhances the chances of embedding new functions firmly within the social consciousness and urban space.

Finally, the transformation of post-mining areas should be a participatory process, actively involving local communities at every stage — from planning, through implementation, to management of newly created spaces. Engaging residents through social consultations, participatory budgets and public debates is essential for the success of redevelopment initiatives.

Such involvement yields multifaceted benefits: it increases social acceptance of changes, reducing the risk of conflicts or resistance; enables better alignment of planned functions with actual community needs, boosting utility and effectiveness; and strengthens residents’ sense of agency, belonging, and shared responsibility for the urban environment.

Importantly, participation should not be a one-off activity but a continuous dialogue between administration and communities, allowing flexible responses to evolving needs and challenges. Well-designed participatory processes can also stimulate social activation in degraded areas, attracting grassroots initiatives, micro-enterprises, and educational or cultural activities.

In the case of Coal Mine “Rozbark,” participatory elements — such as establishing a cultural institution open to local activities and implementing projects financed by participatory budgets (e.g., the “Gryfny” playground) — positively influenced the perception of the transformation among residents. This demonstrates that active community engagement not only improves the quality of planning and implementation but also ensures the social and long-term sustainability of redevelopment efforts.

The transformation of post-mining areas is not merely a technical change of spatial functions but a complex social, economic, and cultural process shaping the future of entire districts and cities. The Coal Mine “Rozbark” case illustrates that success requires combining a long-term vision with flexibility, heritage protection with innovation, and spatial planning with community engagement.

Sustainable development and green technologies must be central to such transformations, as they ensure that revitalized areas contribute to climate mitigation, resource efficiency, and social inclusion. Incorporating renewable energy systems, energy-efficient infrastructure, and sustainable mobility within redevelopment projects enhances environmental performance while fostering economic resilience and social wellbeing.

Creating a model for transformation that integrates financing, urban planning, heritage conservation, and sustainability principles should become the standard for all post-mining regions in Poland and beyond. Only through this integrated approach will it be possible not only to revitalize degraded spaces but also to fully integrate them into modern, green, and inclusive cities of the future.

REFERENCES

- [1] 21th Conference of the Parties to the United Nations Framework Convention on Climate Change. <https://unfccc.int/process-and-meetings/the-paris-agreement> (access: 1.12.2023).
- [2] 23th Conference of the Parties to the United Nations Framework Convention on Climate Change. <https://unfccc.int/event/cop-23> (access: 08.02.2025).
- [3] 24th Conference of the Parties to the United Nations Framework Convention on Climate Change. <https://cop24.gov.pl/pl/> (access: 28.05.2020).
- [4] Bijak, S. (2020). W Bytomiu-Rozbarku powstaje Centrum Sportów Wspinaczkowych i Siłowych: Dodatkowe dofinansowanie do projektu stało się faktem. [In Bytom-Rozbark, the Climbing and Strength Sports Center is being created: Additional funding for the project has become a fact.], *Dziennik Zachodni*. <https://dziennikzachodni.pl/w-bytomiu-rozbarku-powstaje-centrum-sportow-wspinaczkowych-i-silowych-dodatkowe-dofinansowanie-do-projektu-stalo-sie-faktem/ar/c1-15351431> (access: 08.02.2025).
- [5] Bijak, S. (2021). W Bytomiu otwarto wewnętrzną ścianę wspinaczkową: Cały kompleks na Rozbarku oficjalnie już działa. [An internal climbing wall was opened in Bytom: The entire complex in Rozbark is officially operational.], *Nasze Miasto*. <https://bytom.naszemiasto.pl/w-bytomiu-otwarto-wewnetrzna-ściane-wspinaczkowa-caly/ar/c2-8533609> (access: 08.02.2025).
- [6] Duda, A., & Krzemień, A. (2018). Forecast of methane emission from closed underground coal mines ex-ploited by longwall mining—a case study of Anna coal mine. *Journal of Sustainable Mining*, 17(4), 184-194. <https://doi.org/10.1016/j.jsm.2018.06.004>
- [7] European Council conclusions, 12 December 2019, Retrieved from: <https://www.consilium.europa.eu/media/41768/12-euco-final-conclusions-en.pdf>, (accessed on 20.01.2023)
- [8] Fidalgo Valverde, G., Duda, A., Iglesias Rodríguez, F. J., Frejowski, A., & Todorov, I. (2021). Ground-water Risk Assessment in the Context of an Underground Coal Mine Closure and an Economic Evaluation of Proposed Treatments: A Case Study. *Energies*, 14(6), 1671. <https://doi.org/10.3390/en14061671>.
- [9] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism_en (accessed on 20.01.2023)
- [10] <https://dane.gov.pl/> (access: 08.02.2025).
- [11] https://ec.europa.eu/clima/eu-action/climate-strategies-targets_en (access: 08.02.2025).
- [12] https://ec.europa.eu/energy/topics/oil-gas-and-coal/eu-coal-regions_en?redir=1 (access: 1.12.2023).
- [13] <https://geoportal360.pl> (access: 08.02.2025).
- [14] <http://www.klub.skarpa.bytom.pl/> (access: 28.05.2023).
- [15] <https://mapadotacji.gov.pl/projekty/> (access: 08.02.2025).
- [16] <http://mapy.geoportal.gov.pl/> (access: 08.02.2025).
- [17] <https://poweringpastcoal.org/> (access: 1.12.2023).
- [18] <https://sztuka-krajobrazu.pl/4779/artykul/centrum-sportow-wspinaczkowych-i-silowych-skarpa-bytom> (access: 20.03.2023).
- [19] <https://www.bytom.pl/dla-mieszkanca/rewitalizacja-terenow-po-bylej-kwk-rozbark> (access: 20.01.2023).
- [20] https://www.bytom.pl/aktualnosci/index/BO_Bytom-Gryfny-plac-zabaw-w-Rozbarku-gotowy-/idn:41574 (access: 08.02.2025).
- [21] <https://www.bytom.pl/aktualnosci/index/Rusza-kolejny-etap-rewitalizacji-terenow-po-KWK-Rozbark/idn:41364> (access: 08.02.2025).
- [22] <https://www.bytom.pl/aktualnosci/index/345-mln-zl-dofinansowania-z-Funduszy-Europejskich-trafi-do-Bytomia/idn:40776> (access: 08.02.2025).
- [23] <https://www.bytom.pl/aktualnosci/index/18-mln-zl-dofinansowania-z-Funduszy-Europejskich-dla-Skarpy-Bytom/idn:41541> (access: 08.02.2025).
- [24] <https://www.bytomski.pl/kwk-rozbark-zmieni-sie-w-kopalnie-odnawialnej-energii>, (access: 08.02.2025).
- [25] https://www.panova.com.pl/pl/Panova/Nagrody_i_wyroznienia (access: 4.02.2020).
- [26] https://www.propertydesign.pl/architektura/104/bytom_ruszyla_budowa_centrum_aktywnosci_spoleczno_educacyjnej,46598.html (access: 05.01.2025)
- [27] <https://www.slaskie.pl/content/fundusze-unijne-dadza-nowe-zycie-poprzemyslowym-terenom>
- [28] <https://www.wnp.pl/gornictwo/na-teren-dawnej-kopalni-rozbark-powstanie-ogromne-dzielo-sztuki,90552.html> (access: 28.05.2023).
- [29] Jaros, J. (1984). *Słownik historyczny kopalń węgla na ziemiach polskich* [Historical dictionary of coal mines in Poland]. Śląski Instytut Naukowy.
- [30] Kaj (2009): Były „Rozbark” już w gestii miasta. Pokopalniane obiekty dla tancerzy [The former Coal Mine “Rozbark” already under the responsibility of the city. Post-mining facilities for dancers]. *Trybuna Górnicza*, 14(755), 8.
- [31] Keenan, J., & Holcombe, S. (2021). Mining as a temporary land use: A global stocktake of post-mining transitions and repurposing. *The Extractive Industries and Society*, 8(3), 100924. <https://doi.org/10.1016/j.exis.2021.100924>.
- [32] Kinnunen, P. H. M., & Kaksonen, A. H. (2019). Towards circular economy in mining: Opportunities and bottlenecks for tailings valorization. *Journal of Cleaner Production*, 228, 153–160. <https://doi.org/10.1016/j.jclepro.2019.04.171>

- [33] Kretschmann, J., Efremenkova, A. B., & Khoreshok, A. A. (2017). From mining to post-mining: the sustainable development strategy of the German hard coal mining industry. In IOP Conference Series: Earth and Environmental Science (Vol. 50, No. 1, p. 012024). IOP Publishing. DOI 10.1088/1755-1315/50/1/012024
- [34] Krzemień, A., Frejowski, A., Fidalgo Valverde, G., Riesgo Fernández, P., & Garcia-Cortes, S. (2023). Repurposing End-of-Life Coal Mines with Business Models Based on Renewable Energy and Circular Economy Technologies. *Energies*, 16(22), 7617. <https://doi.org/10.3390/en16227617>
- [35] Łukasiewicz, E., Shamoushaki, M., (2022). Heating potential of undeveloped geothermal water intakes in Poland in the context of sustainable development and air protection, *Water Resources and Industry*, 27, 100175, ISSN 2212-3717, <https://doi.org/10.1016/j.wri.2022.100175>.
- [36] Madlener, R., & Specht, J. (2013). An exploratory economic analysis of underground pumped-storage hydro power plants in abandoned coal mines. FCN Working Paper No. 2/2013, Available at SSRN: <https://ssrn.com/abstract=2350106> or <http://dx.doi.org/10.2139/ssrn.2350106>
- [37] Magdziarczyk, M., Chmiela, A., Su, W., & Smolinski, A. (2024). Green Transformation of Mining towards Energy Self-Sufficiency in a Circular Economy – A Case Study. *Energies*, 17(15), 3771. <https://doi.org/10.3390/en17153771>
- [38] Menéndez, J., Ordóñez, A., Álvarez, R., & Loreda, J. (2019). Energy from closed mines: Underground energy storage and geothermal applications. *Renewable and Sustainable Energy Reviews*, 108, 498–512. <https://doi.org/10.1016/j.rser.2019.04.007>
- [39] Mikrut-Majeranek M. (2013). Miasto tańca – transformacja przestrzeni postindustrialnej w centrum kultury na przykładzie Bytomia i Śląskiego Teatru Tańca. [City of dance – transformation of post-industrial space into a cultural centre on the example of Bytom and the Silesian Dance Theatre.] *Studia Etnologiczne i Antropologiczne*, T. 13, 98–107
- [40] Nowacka-Goik M. (2012). Ruszają prace na terenie bytomskiej KWK Rozbark. Będzie Centrum Tańca. [Construction work is starting on the site of Bytom's Coal Mine Rozbark. There will be a Dance Centre.], <https://bytom.naszemiasto.pl/ruszaja-prace-na-terenie-bytomskiej-kwk-rozbark-bedzie/ar/c3-1312029> (access: 29.05.2023).
- [41] Nowacka-Goik M. (2014). Teatr Rozbark w Bytomiu. KWK Rozbark po remoncie z nową funkcją. [Rozbark Theatre in Bytom. Coal Mine “Rozbark” after renovation with new function.] <https://bytom.naszemiasto.pl/teatr-rozbark-w-bytomiu-kwk-rozbark-po-remoncie-z-nowa/ar/c13-2162079> (access: 29.05.2023).
- [42] Plan ruchu, Zakład KWK „Centrum-Szombierki-Rozbark” w Bytomiu. Część szczegółowa na rok 2001 [Movement plan, Coal Mine “Centrum-Szombierki-Rozbark” in Bytom, Detailed part for 2001] Bytom, Bytomska Spółka Restrukturyzacji Kopalń SA.
- [43] Polityka Energetyczna Polski do 2040 r. [Energy Policy of Poland to 2040] Warszawa, Ministerstwo Klimatu i Środowiska, <https://www.gov.pl/web/klimat/polityka-energetyczna-polski> (access: 1.12.2023).
- [44] Program dla sektora górnictwa węgla kamiennego w Polsce [Programme for the hard coal mining sector in Poland] (2018), Warszawa, Ministerstwo Aktywów Państwowych, <https://www.gov.pl/web/aktywa-panstwowe/program-dla-sektora-gornictwa-wegla-kamienego-w-polsce> (access: 1.12.2023).
- [45] Resak, M., Rogosz, B., Szczepiński, J., Działara, M. (2022). Legal Conditions for Investments in Renewable Energy in the Overburden Disposal Areas in Poland. *Sustainability*, 14(3), 1065. <https://doi.org/10.3390/su14031065>
- [46] Sadik-Zada, E. R., & Ferrari, M. (2020). Environmental Policy Stringency, Technical Progress and Pollution Haven Hypothesis. *Sustainability*, 12(9), 3880. <https://doi.org/10.3390/su12093880>
- [47] Sadik-Zada, E. R., & Gatto, A. (2023). Civic engagement and energy transition in the Nordic-Baltic Sea Region: Parametric and nonparametric inquiries. *Socio-Economic Planning Sciences*, 87, 101347. <https://doi.org/10.1016/j.seps.2022.101347>
- [48] Sobieraj, K. (2017). Wpływ porozumienia paryskiego na zmianę polityki klimatyczno-energetycznej Unii Europejskiej i unijnych regulacji prawnych w tym zakresie. [The impact of the Paris Agreement on the revision of the European Union's climate and energy policies and regulations.] *Ruch Prawniczy, Ekonomiczny i Socjologiczny*, 79(4), 177–190.
- [49] Solidarity and Just Transition Silesia Declaration (2018) Retrieved from: <https://data.consilium.europa.eu/doc/document/ST-14545-2018-INIT/pl/pdf> (access: 08.02.2025).
- [50] Szlązak, N., Obracaj, D., & Korzec, M. (2023). Wykorzystanie wody dołowej w odbiorze i wykorzystaniu ciepła skraplania z podziemnych układów klimatyzacji w kopalniach [Use of underground water in the collection and utilisation of condensation heat from underground air-conditioning systems in mines]. *Inżynieria Mineralna*, 1(1), 225–234. <https://doi.org/10.29227/IM-2023-01-28>.
- [51] Uchwała nr XVI/204/11 Rady Miejskiej w Bytomiu z dnia 24 sierpnia 2011 r. w sprawie uchwalenia zmiany Studium uwarunkowań i kierunków zagospodarowania. [Resolution No. XVI/204/11 of the Bytom City Council of 24 August 2011 on the adoption of an amendment to the Study of Conditions and Directions of Development]

- [52] Uchwała nr XXVIII/418/12 Rady Miejskiej w Bytomiu z dnia 25 kwietnia 2012 r. w sprawie uchwalenia miejscowego planu zagospodarowania przestrzennego terenu dawnej KWK Rozbark. [Resolution no. XXVIII/418/12 of the Bytom City Council of 25 April 2012 on adopting a local spatial development plan for the area of the former KWK Rozbark]
- [53] Uchwała nr XL/549/21 Rady Miejskiej w Bytomiu z dnia 22 lutego 2021 r. w sprawie uchwalenia zmiany Studium uwarunkowań i kierunków zagospodarowania przestrzennego Gminy Bytom. [Resolution No. XL/549/21 of the Bytom City Council of 22 February 2021 on adopting amendments to the Study of Conditions and Directions of Spatial Development of the Bytom Municipality.]
- [54] Ustawa z dnia 27 marca 2003 o planowaniu przestrzennym (Dz.U.2024.1130).
- [55] Woźniak, J., Pactwa, K. (2019) Possibilities for using mine waters in the context of the construction of heat energy clusters in Poland. *Energy, Sustainability and Society*, 9(13). <https://doi.org/10.1186/s13705-019-0195-2>
- [56] Wstępne sprawozdanie z inwentaryzacji obiektów przemysłowych w Województwie Śląskim [Preliminary report on the inventory of post-industrial facilities in the Silesian Voivodeship] (2012). Katowice, Śląskie Centrum Dziedzictwa Kulturowego.
- [57] Wyrzykowska A. (2022) The land use of decommissioned coal mines areas in the Upper Silesian Agglomeration (Poland), *Architecture Civil Engineering Environment – ACEE Journal*, 16(2), 57–70, <https://doi.org/10.2478/ACEE-2022-0015>
- [58] zielonykwartal.pl/zielony-kwartal (access date 1.05.2025 r.)