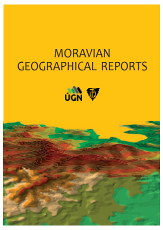

MORAVIAN GEOGRAPHICAL REPORTS

sciendo

The Czech Academy of Sciences, Institute of Geonics
Palacký University Olomouc, Faculty of Science

journal homepage: www.geonika.cz/mgr.html

doi: https://doi.org/10.2478/mgr-2024-0018

Challenges, dilemmas and success criteria of recycling coal mining landscapes

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Abstract

As our crowded and warming world continues moving away from fossil fuels such as coal, we are increasingly attempting to transform the landscapes damaged by mining into beneficial, appealing and valuable new uses. The post-mining transformation involves many dilemmas, often arouses land use conflicts and can reproduce environmental injustices. In the background of conflicts are diverging preferences for post-mining land uses from the perspective of various stakeholders. This paper examines key issues and dilemmas in post-mining transformation, including terminological inconsistencies, technical reclamation versus natural succession, heritage preservation choices, authenticity concerns, and success criteria issues. The underlying question we ask is: What is the future use of the coal energy landscape; that is, what should or could come next? To address this question, we provide a comprehensive literature review and an analysis of a sample of 28 case studies of good practice projects of reclamation or regeneration (i. e., recycling) coal mining landscapes from the Czech Republic. This study is distinctive in its comprehensive scope, analyzing a diverse range of recycling projects from surface mining landscapes to urban post-mining brownfields, with extensive analysis and findings. While the criteria of transparency and legitimacy of projects are essential for applying the principles of just transition, the criteria of efficiency and sustainability prove to be key measures of success according to which differences between projects appear in the longer term. The efficiency and sustainability are significantly associated with the multifunctionality of recycled landscapes and places and seasonality of their use.

Keywords: *Energy landscape; recycling; post-mining land use; restoration; reclamation; regeneration; sustainability; Czech Republic*

Article history: *Received 10 September 2024, Accepted 20 December 2024, Published 31 December 2024*

1. Introduction

Our need and use of coal has produced the most profound and widespread form of energy landscapes. Coal energy development has most clearly revealed our cavalier brashness toward maintaining any semblance of landscape integrity (Pasqualetti & Frantál, 2022). It has been more than 60 years since Wilhelm Knabe – one of the pioneers in the field of mine reclamation, ecologist and future German politician – described his experiences from visiting countries across Europe and the US since the early 1950's, studying various kinds of strip mine reclamation in its early stages of development (Knabe, 1964). It was only in the following decades that coal mining was to reach its production peak and resulted in drastic devastation of landscapes, environment and people's health in many regions, particularly in the European coal heartland, including the area of Germany, the Czech Republic and Poland (Osička et al., 2020).

While the reclamation of degraded landscapes has been carried out for decades along with mining expansion, the scope of devastation in the affected regions is much greater[1] than the extent of restoration, reclamation or regeneration – actions increasingly lumped together as "recycling" (Pasqualetti & Smarden, 2025; Pasqualetti et al, 2024). The problem of recycling does not only concern surface coal mining (which undoubtedly has the hugest spatial impact), but the post-mining landscape are also remains of underground mining in the form of heaps, dumps, embankments, sinkholes, tailings ponds, and the infrastructure of, buildings and equipment used for coal mining, processing and transport (see e.g., Mulková & Popelková, 2024). In many regions, these landscape structures and objects have the form of brownfields – for many years abandoned, vacant, derelict and often contaminated lands and premises, which have

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[1] For example, in the Czech Republic, it has been estimated that the reclamation of landscape has so far taken place on less than half of the area affected by coal mining (Europe in Data, 2022).

become barriers to local development, contributors to urban sprawl, burdens degrading the value of surrounding properties, and potential hazards to human health and the environment (Krzysztofik et al., 2012; Martinát et al., 2016).

The ongoing energy transition has witnessed a gradual decline in coal mining, the shutdown of coal-fired power plants and the closing of mines[2]. The recycling of post-coal landscapes is a huge global challenge, one which is associated with many problems and dilemmas, often bringing about land use conflicts and reproducing past environmental injustices (Beckett & Keeling, 2019; Klusáček et al., 2025). Traditional forms of technically and economically demanding reclamation still prevail in practice, however, the reclamation projects are facing local impacts of climate changes (Pawelczyk, 2018, Bulovic et al., 2024) and some turn out to be environmentally and economically unsustainable. In contrast, the potential and positive effects of spontaneous natural succession are being more and more emphasized (Hendrychová et al., 2020; Pešout et al., 2022). However, leaving the post-mining landscape to nature is confronted with legislative restrictions, traditional thinking of experts and politicians, but also with protests of local communities who have different preferences about the future of "their" landscape (Krzysztofik et al., 2020; Klusáček et al., 2025). Other dilemmas concern the extent to which post-mining legacies should be preserved (as cultural heritage and potentially tourist attraction) or the traces of the past should be erased, landscapes recreated, and local identities re-branded (Kaźmierczak et al., 2019; Bole et al., 2022).

The geographical prerequisites for and approaches to post-mining land use concepts considering both ecological and socioeconomic aspects vary across regions, thus the knowledge exchange and transfer of experiences are pivotal for the success of transformation process (Hattingh et al., 2019; Gerwin et al., 2023; Pagouni et al., 2024). In this paper, we discuss and illustrate – with examples from practice – the key issues and dilemmas associated with post-mining transformation, based on a comprehensive literature review and analysis of a sample of 28 case studies of the so-called good practice projects of reclamation, regeneration or recycling of coal mining landscapes from the Czech Republic. Previous international or national research projects, such as e.g., ReSource (Marot & Harfst, 2021), Tracer (Knoche et al., 2019), ReviRis (Ostrega et al., 2020) or START (Baker et al., 2021), offered examples of good practice projects or approaches to post-mining transformation, however, were limited to few case studies from specific regions or countries. In this respect, our study is distinctive in its comprehensive scope, analyzing a diverse range of recycling projects from surface mining landscapes to urban post-mining brownfields, with extensive analysis and findings.

2. Concepts, issues and dilemmas of post-mining transformation

2.1 Why so many "re"? On the terminological mismatch

Many different terms and often contradictory definitions are used in the context of post-mining transformation and land use planning, based on different conceptual approaches, scientific disciplines, regional traditions, language specifics and other factors. The different terms are commonly used interchangeably, they are vaguely defined, and expectations associated with them may differ significantly from one stakeholder to another (Lima et al., 2016). Inconsistent terminology hampers interdisciplinary communication, it results in uncertainty in the planning and decision making process, and reduces willingness of regulators, industry representatives and stakeholders to cooperate with the scientific community (Cross et al., 2018; Stevens & Dixon, 2017). Ambiguous terminology can disguise real aspirations and intentions of stakeholders and it hinders the setting of project objectives and the evaluation of their outcomes, i.e., the "success" of their implementation (Cross et al., 2018).

Table 1 shows the frequency of use of various terms in connection with coal mining in publications indexed in the Web of Science database. The four most frequently used terms are reclamation, restoration, remediation and rehabilitation, which are the key terms in the field of restoration ecology dealing mostly with the surface mining legacies, and they have been quite precisely defined (Lima et al., 2016; Cross et al., 2018). The term recultivation has been traditionally used in Germany, Czechoslovakia and some other countries of the Eastern Bloc in the same manner as a more widely used reclamation, denoting traditional forms of technical recovery of landscapes, including soil reconstruction, afforestation and agricultural restoration (Bauer, 1971; Strzyszcz, 1996; Meyer, 2021). The term reconstruction is used by both environmental scientists for the reconstruction of ecosystems (Tibbet, 2024) and engineering experts dealing with technical aspects of restoration (reconstruction

Term	No. of articles	Dominant disciplinary categories
Reclamation	1,321	Environmental Sciences (541), Soil Science (197), Geosciences Multidisciplinary (170), Engineering Environmental (166), Ecology (163)
Restoration	1,004	Environmental Sciences (454), Ecology (177), Soil Science (125), Engineering Environmental (113), Environmental Studies (113)
Remediation	408	Environmental Sciences (191), Engineering Environmental (68), Water Resources (51), Mining Mineral Processing (46), Geosciences Multidisciplinary (40)
Rehabilitation	317	Environmental Sciences (121), Ecology (41), Mining Mineral Processing (39), Engineering Environmental (38), Soil Science (37)
Reconstruction	296	Environmental Sciences (75), Geosciences Multidisciplinary (51), Water Resources (27), Mining Mineral Processing (26), Engineering Electrical Electronic (18)
Recycling	216	Environmental Sciences (72), Engineering Environmental (40), Engineering Chemical (24), Mining Mineral Processing (23), Energy Fuels (20)
Regeneration	110	Environmental Sciences (30), Engineering Environmental (13), Environmental Studies (13), Green Sustainable Science technology (11), Ecology (10)
Recultivation	50	Ecology (13), Environmental Sciences (12), Engineering Environmental (9), Soil Science (7), Geosciences Multidisciplinary (6)
Redevelopment	33	Environmental Sciences (14), Environmental Studies (7), Green Sustainable Science Technology (6), Geosciences Multidisciplinary (5), Mining Mineral Processing (4)
Revitalization	28	Energy and Fuels (5), Environmental Studies (4), Environmental Sciences (3), Geography (2), Architecture (2)

Tab. 1: Frequency of occurrence of the use of various terms in connection with coal mining
Note: Keywords used for search: TS = ("coal mining" OR "coal mine" OR "coal-mining") AND "specific term". If the search was not limited specifically to coal mining, then even more articles appear in connection with "mining" or "post-mining" in general
Source: Web of Science as of December 10, 2024; authors' research

[2] This applies primarily to Europe, while globally, coal production continued to rise and new mines are opening in many countries (IEA, 2024; Statista, 2024).

of terrain, soil composition, water resources) (Liu et al., 2021). As concerns the terms regeneration and revitalization, these were the most used by geographers, environmental economists and other experts dealing with the urban renewal and redevelopment of brownfields (Franz et al., 2006; Martinát et al., 2016, Mert, 2019). However, the term regeneration is also used in a wider context – in relation to the sociocultural and economic renewal of coal mining communities (Stephenson & Wray, 2005; Kim et al., 2015) or entire regions (Campbell & Coenen, 2017).

The term recycling appears in a relatively large number of articles dealing with coal mining, although it has not been usually associated directly with the transformation of landscape as such, but rather with the disposal or recycling of waste or residues after coal mining and combustion (tailings, waste rock, coal ash, slag) (Haibin & Zhenling, 2010; Pactwa et al., 2020). In recent years, however, a new path in academic research has appeared that is gaining visibility, adherents, and related research, one which uses the term recycling in relation to the transformation of traditional energy landscapes (Pasqualetti & Stremke, 2018; Pasqualetti et al., 2024; Pasqualetti & Smarden, 2025).

The use of different terms largely reflects the aspirations of scientists (as representatives of specific disciplines and approaches) and their priorities of what should be done with the landscape after mining. Ecologists advocate using standardized definitions and principles related to restoration process established by the Society for Ecological Restoration (SER, 2004; McDonald et al., 2016). However, people from mining industry, policymakers and experts from other disciplines often deviate from these standards, leading to persistent terminological inconsistency – see Cross et al. (2018) versus Kaźmierczak et al. (2017). The selection of terms can also significantly affect results of reviews and meta-analyses. For example, Alonzo et al. (2024) investigate approaches used for working with local communities in the post-mining transformation based on a review of literature selected by using a combination of terms mine/mining and rehabilitation, reconstruction, reclamation or remediation, however, omitting the restoration and regeneration.

From the perspective of restoration ecology, the primary goal of post-mining transformation is to "recover the ecosystem that has been degraded, damaged or destroyed" (SER, 2004). In this regard, Cross et al. (2018) suggest using strictly the term ecological restoration (and possibly rehabilitation where appropriate) and refuse to use the terms reclamation (as redundant or even erroneous since being applied predominantly to the recovery of productivity to landscapes) and revitalization (which primarily refers to socio-economic renewal) (Cross et al., 2018, p. 256). Gerwing et al. (2022), however, point out that the current definition of reclamation, and its anthropogenic focus, does not correspond well with how the term is used by practitioners and in some legal documents, and they posit a new term ecological reclamation, which does not make the discussion any easier.

A general problem with the term restoration is that it misleadingly suggests that landscapes should be restored to the state before mining started, implying a replication of the original site conditions (Kaźmierczak et al., 2017). Although the restoration to the original state is (or was) included in the legislative documents in some countries, in practice it is unnecessarily binding and does not make always sense considering the historical development, current conditions and future needs of the area. In the face of a rising level of commitment to do large-scale restoration internationally, a need to give ecological restoration reference to social values or greater flexibility has been emphasized (Cross et al., 2018).

In recent years, also the term resocialization appears in debates, which means a return of people to reclaimed and revitalized landscape (Vráblíková et al., 2016). This reflects a general shift in the approach to post-mining transformation, connecting ecological interests of disturbed landscapes with economic and social aspects, emphasizing the importance to consider needs and opinions of local communities (Unger et al., 2020; Alonzo et al., 2024; Worden et al., 2024). Considering the needs and preferences of local communities is important especially regarding the principle of just transition with its four aspects: procedural, distributive, recognition and restorative justice (Beckett & Keeling, 2019; Abram et al., 2022). The fourth mentioned aspect emphasizes the redressing of past harms (or reducing the likelihood of future harms), which is relevant particularly for coal mining areas and their communities that have been in the past constituted as "energy sacrifice zones" (Bell, 2016; Klusáček et al., 2025).

What we consider an important aspect in this terminological debate, is that the usage of terms reflects not only the different approaches and priorities of scientific disciplines, but reflects also specific issues concerning the type of coal of mining (surface or underground), the scale of landscape impacts and forms of mining residues, the spatial rural or urban context, and different phases of the mine lifecycle and the process of transformation (Lima et al., 2017; Keenan & Holcombe, 2021). In this regard, each term can have its place, meaning and justification. Nevertheless, we advocate using the term recycling, which encompasses all various options, because of its simplicity, evocative nature and newness that may attract wider public attention and interest. The recycling is applicable in relation to the landscape affected by surface mining, the infrastructure associated with underground mining as well as the post-mining brownfields in urban areas. It also implicitly emphasizes the responsibilities and active role of people in the process of post-mining transformation.

2.2 And what next? On competing visions and dilemmas of post-mining transformation

The basic dilemma associated with post-mining transformation stems from different values, knowledges, and competing ideas and preferences about the future land use from the point of view of different stakeholders (Martinát et al., 2016; Kivinen et al., 2018; Baskerville et al., 2023; Poudyal et al., 2024). Several studies introduced various classifications of the ways of reclamation and types of post-mining land use (see the review by Kaźmierczak et al., 2017). Recently, Pagouni et al. (2024) documented 119 specific post-mining land uses implemented globally to date, which they categorized into 38 sub-classes and 11 general categories. In fact, it is obvious that when a mine site is recycled, there is often more than one land use (Keenan & Holcombe, 2021).

In recent years, probably the most discussed issue in the context of post-mining transformation is the long-term prioritization of technically and financially demanding reclamations at the expense of natural succession. Natural (spontaneous) or managed succession creates a "new wilderness", which becomes not only a refuge for endangered plant and animal species, but also a place with significant aesthetic, recreational and tourist potential (Wiegleb & Felinks, 2001; Sádlo & Gremlica, 2017; Braun Kohlová et al., 2021). A wider implementation of natural succession is, however, limited by existing legislative frameworks, a lack of experiences and traditional thinking of experts and the lay public. Although the natural succession is relatively cheap, it is a long-term process without direct economic benefits (Bradshaw, 2000). The reclamation options and possibility of leaving part of the areas for spontaneous succession must be assessed in relation to local natural and climatic conditions, regarding the extent of affected area, proximity of human settlements, the natural, cultural and economic potential, and related risks (Marot & Harfst, 2021; Pešout et al., 2022; Ronyastra et al., 2023). In this context, various multi-criteria decision making and land use suitability assessment methodologies, also integrating stakeholder expertise and regional knowledge, have been introduced to support decision-makers, mine operators and stakeholder decisions (Amaro et al., 2022; Arratia-Solar et al., 2022; Worden et al., 2024).

The traditional reclamations in the form of reforestation (somewhere still planting monoculture species), creating lakes or cultivation of land for agricultural production are facing local impacts of climate change (i.e., drought and greater water evaporation, lack of water sources, forest fires, landslides, etc.) and some turn out to be environmentally and economically unsustainable (Bell et al., 2017; Pešout et al., 2022). Natural hazards and potential risks associated with climate changes have not been always considered when deciding about the reclamation goals. The post-mining lakes, which have been highlighted so much in recent years, can be spectacular examples of recreation and renewal (Deshaies, 2018). However, these lakes may also suffer from lack of water resources or poor water quality, and they can pose risks to the environment and local communities, including serving as breeding grounds for disease-carrying insects, such as mosquitoes (Soni et al., 2014; Lund & Blanchette, 2023)

Other dilemma associated with post-mining transformation concerns the extent to which post-mining remnants should be preserved as cultural heritage or eliminated (and forgotten) with the aim of re-branding local and/or regional identity. Most authors emphasize the cultural, cognitive and didactive value of historic post-mining objects and their potential for tourism development (Wirth et al., 2012; Kaźmierczak et al., 2019; Lamparska, 2019). In many regions, the remains of mining (towers, plants, giant mining machines and others) have been integrated into the regenerated recreational lakelands as reminders of the industrial past, landmarks and tourist attractions (Deshaies, 2018) (Fig. 1). The open-air mining museums or thematic parks are among the most visited regional tourist destinations.

Important question is how big the potential of utilization of post-mining objects for industrial or energy tourism is and how long it can work (Frantál & Urbánková, 2017). According to Kuzior et al. (2022), 88% of respondents in Poland believed that post-industrial facilities may arouse the interest of tourists, whereas only 28% of respondents believed so in the US. Sinnett and Sardo (2020) report how local people differ in valuing their mining heritage and in opinion on the most effective way to manage these sites. They identified five groups according differing preferences for post-mining land use, including ‘preservationists’ (preferring to preserve mines as cultural heritage), ‘nature enthusiasts’, ‘environmentalists’ and ‘landscape lovers’ (putting different emphasis on restoring the sites for nature conservation, improving water quality or the visual appearance of the mines), and ‘industry supporters’ (highlighting the potential of mines for local economy) (Sinnett & Sardo, 2020).

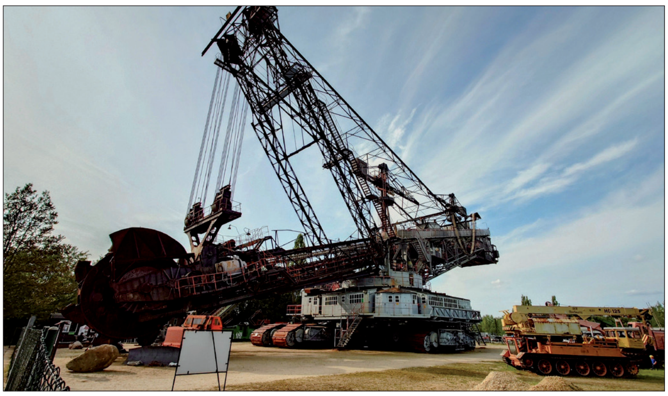

Fig. 1: Discarded wheel excavator as part of an open-air museum, Hagenwerder-Görlitz, Germany
Photo: B. Frantál

While some post-mining sites have been just slightly transformed and are used for sightseeing and experiencing of how it was (designed for tourists looking for authenticity in their experience), other objects have been completely rebuilt, providing new functions, in some cases being just symbolically connected to the past. In the latter case, the attractiveness for visitors seems to be related to the leisure activities and services located in a re-created place rather than its meaning and function in the past (Derek, 2013).

Halewood and Hannam (2001) pointed out that post-industrial tourism sites represent “landscapes of nostalgia”. A broader sociocultural or ideological dilemma is related to how coal mining is narrated and presented in the museum expositions, and marketing and educational materials. Coal mining history is often idealized, emphasizing its role for industrial and economic development, regional or national identities, and romanticized narratives of brave miners and their noble work. This idealistic view typically overlooks the negative environmental impacts, destruction of communities, and forced displacement of populations (see Price & Rhodes, 2022; Rhodes & Price, 2024).

A huge potential of using post-mining areas to produce renewable energy has recently been highlighted (Alves Dias et al., 2019; Pasqualetti & Smarden, 2025). It is not only about solar and wind parks, but also the production of biomass as a form of agricultural diversification, the use of geothermal energy, and opportunities in hydro power and pumped hydroelectric storage (Dražić et al., 2012; Alves Diaz et al., 2019; Marot & Harfst, 2021). Especially in Germany, extensive areas after surface coal mining have been used for renewable energy production. The transformation of post-mining landscape by installing solar panels and wind turbines resulted in some areas in the almost total disappearance of the legacies of mining, which some consider to be a certain “trivialization of the landscape” (Deshaies, 2018).

In this regard, one more great danger needs to be pointed out. The regions or localities that have been “sacrificed” for coal mining and energy production in the past can easily become new “green sacrifice zones”. As part of projects that are presented as urgent and necessary for a successful energy transition and economic transformation (i.e., large-scale solar parks, lithium extraction, energy storage industries, etc.), the extractive and infrastructural colonization of peripheral territories (often represented by coal mining areas) continues and past environmental injustices are reproduced (Canelas & Carvalho, 2023; Archer & Calvão, 2024). As emphasized by Brock et al. (2021), many of the same inequalities that characterized fossil fuels, such as undemocratic and unsustainable industrial processes, the concentration of corporate power and profits, and externalized waste and pollution are replicated by the green industrialization (or “green extractivism”). In this regard, the interests and preferences of both regional governments and local communities must be considered and the principle of just transition strictly applied in practice.

2.3 Successful, but sustainable? On the criteria for evaluating success of projects

A similar diversity to that in terminology related to landscape transformation also exists in relation to criteria for assessing the “success” of projects. According to some politicians and experts whatever completed reclamation or regeneration is a success (especially in regions with high concentration of post-mining areas and brownfields). The success, however, can be assessed from different perspectives (depending on a scientific discipline, geographical context, stakeholder group), according to different criteria, spatial scales (local, regional, national, global), and time horizons (Franz et al., 2006; Fischer & Stranz, 2011; Coppin, 2013). Some projects that were promoted in the media as successes or good practices have proven to be problematic over time and unsustainable (see section 4.3.2).

When talking about success, one should distinguish between success factors and criteria. The success factors are considered facts (conditions, circumstances, actors) that are determinants, drivers or contributors to successful regeneration (i.e., input variables). These factors determine which sites attract attention from investors, politicians, experts or other actors, and consequently receive priority as the most critical, urgent or profitable to recycle, while others remain neglected or being not completely (successfully) recycled (Frantál et al., 2012). The obligation of coal mining companies to restore the landscape after the end of mining is given by legislation in many countries, but the reality is often different (Toumbourou et al., 2020; Keenan & Holcombe, 2021). There are many areas affected by coal mining, including relics from the past[3], before the introduction of the legal liabilities of companies to pay a part of their profits to future reclamations, therefore the regeneration of landscapes often needs to be supported from public resources.

The success factors (determinants and drivers) are related to many aspects, including legislative (legal and regulatory requirements and constraints, land ownership relations), geographical (size of the area, specific localization within region, peripherality, transport links), technical (terrain conditions, extent of contamination and uncertainty on liability for clean-up, state of infrastructure and buildings), political-institutional (pressure from local community, support from regional/central government, public-private partnership), and socioeconomic (economic status of the locality and region, sociocultural capital, availability of financial incentives, funds, tax allowances) (Frantál et al., 2015; Mborah et al., 2016; Kantor-Pietraga et al., 2021; Marot & Harfst, 2021). The partial factors are usually related and affect each other.

An appropriate evaluation of projects outputs might be a potential clue that will help to set up a transformation path for post-mining sites in the future and to prioritize projects to distribute and direct limited resources. However, setting up a uniform set of success criteria for every project is a similarly impossible task as looking for the guidelines that would meet the goals of all post-mining regeneration projects. As Fischer and Stranz (2011) emphasize, every mining or post-mining region has its own characteristics and thus different factors need to be considered. Coppin (2013) pointed out that success is often judged in the very short term, or is judged post-facto, with hindsight, and the criteria, where they are set, tend to be considered from a single aspect or narrow perspective, such as ecological conditions. It seems the key task in setting and defining success criteria or metrics is to find a balance between generality (and broader applicability) and excessive specificity.

Based on the literature review, Fischer and Stranz (2011) identified and present several criteria that good practices or successful projects of post-mining regeneration should meet. However, they mix together both the success factors as prerequisites and drivers (e.g., good location and transport links, leadership and visions, creative partnerships, involvement of community, etc.) and the success criteria or metrics (e.g., hybridity, exemplarity, creativity, transparency, responsibility, etc.). The paper of Fischer and Stranz (2011), as well as studies reviewed and cited by them, were inspiration for the experts involved in the international project ReSource[4] who created a set of seven success criteria and applied them to the assessment and analysis of good practice case studies from various European countries (Marot & Černič Mali, 2012; Marot & Harfst, 2021). This set of criteria includes:

- Efficiency: the project creates maximum benefits by using minimum resources, in regard to its effects on society and economy;
- Feasibility: the project takes account of the capacities of the system, namely location, financial and human resources, and administrative frameworks;
- Transparency and openness: the community has been sufficiently involved at all stages of preparation and implementation, and the process and solution have been communicated appropriately;
- Legitimacy: the solution represents a compromise amongst all stakeholders and actors potentially affected by the results, the local government and local residents are fully committed to restructuring the area;
- Innovativeness: the project concept is unique, has generated good design, has reinvented the image of the region, tells an interesting story, and is attractive in its originality;
- Transferability: an idea or a concept that can be re-used in similar conditions in different locations and under different governance frameworks;
- Sustainability: the project has produced solutions which promote the future use of these potentials and are adapted to local circumstances.

These criteria are specific enough, but at the same time general to be effectively applicable to various types of recycling projects, in different geographical conditions and political-institutional contexts (Marot & Harfst, 2021). Similarly as in the case of success factors, the success criteria are to a great extent inter-related and they influence each other. In the above overview, we deliberately put the criterion of sustainability to the bottom place, although the authors did not make it so. The reason is that we see the criterion of sustainability as a key for evaluating success. It must be kept in mind that the concept of regenerative sustainability is not static in time and does not imply a fixed spatial perspective (Franz et al., 2006). From the perspective of time, a balance between short term effects and long-term impacts is required, considering all environmental, economic, social, and institutional dimension of sustainability. As concerns the spatial perspective, the extent and scale of project impacts need to be defined and assessed at all spatial levels, from local and regional to national and global. The regional perspective allows for balancing out site specific problems and potentials within a wider spatial context (Franz et al., 2006).

3. Methods and data

3.1 Regional context

The Czech Republic is a country with a significant coal mining tradition dating back to the Middle Ages. The biggest mining boom, however, came in the second half of the 20th century. Czechoslovakia, as a member of the former East European COMECON group of countries, was designated the "forge of the socialist camp" with a dominance of metallurgical and energy-intensive heavy industries where coal was regarded as the "life blood of industry" (Glassheim, 2006). This planning orientation affected the overall national economy and resulted in the environmental devastation of several regions, particularly in the North-Bohemian and Ostrava-Karviná coal basins. Currently, the mining of brown coal (lignite) is still taking place in six open-cast mines in the northwest part of the country, while the last active hard coal mine in operation is in Karviná district (see Frantál et al., 2022).

[3] In post-socialist countries, the post-mining and industrial brownfields and many ecological burdens are results of processes of economic transformation, restructuring, privatization of the previously state-owned industries, so called tunneling and targeted bankruptcy of companies, etc. (see e.g., Pavlínek, 2005; Swain, 2013).

[4] ReSource – Utilization of post-mining potentials for sustainable re-development in Central European mining cities and regions (2009–2012)

The landscape reclamation has been carried out along with mining since the late 1950's. In the Czech practice, the term recultivation has been traditionally used, which is understood as a managed process of recovering the landscape, the goal of which is to restore the natural balance of the landscape and bring it to a state suitable for productive use. The recultivation is legislated in Act 44/1988 Coll. – the so-called Mining Act – which also imposes on organizations with mining rights the obligation to ensure the remediation and recultivation of areas affected by mining. It is estimated that reclamation works have been completed or are currently underway on more than 300 km^2 of post-mining areas, but there are other more than 400 km^2 affected by mining[5] which will need to be recycled (Europe in Data, 2022). In the socialist era, the restoration of soils and vegetation cover, afforestation or use for agricultural production were the most common forms of reclamation and overall they still occupy the largest share of reclaimed areas. Over the last decades, landscape reclamation has focused on enhancing natural features and socio-economic functions, resulting in the creation of several large lakes designed for recreation and sport.

The financing of reclamation activities is ensured both from the mandatory financial reserves of mining companies and from levies from mined minerals, which companies are obliged to pay according to the Mining Act. However, mining companies have had a legal obligation to create these financial reserves just since 1991. Due to the lack of reserve funds for carrying out reclamations from the time before the change of regime in 1989, the state also subsidizes reclamation activities as part of programs to repair ecological damages caused before the privatization of mining companies.

The current Operational Programme Just Transition aims to address the impacts of the shift away from coal in the most affected regions of the Czech Republic. A total of 42.7 billion CZK (approx. 1.7 billion EUR) is available for the period 2021–2027, which will be divided between three coal regions (Moravian-Silesian, Ústí nad Labem, and Karlovy Vary). The funds can be used to mitigate the impact of shifting away from coal mining. The Czech Government negotiated with the European Commission that about half of the funds will be used for so called "strategic projects" that are large and complex projects with significant transformational impact recommended by individual regions. Some of these strategic projects applying for financing include the recycling of post-mining landscapes. However, the just transition strategic plan and the system of funds distribution is criticized by NGOs and some experts. The main aspects criticized are the allocation of funds for landscape reclamation without proper application of the Polluter Pays Principle, excessive support for large enterprises and polluting industries (including coal mining companies), support of environmentally harmful activities, and the lack of transparent and inclusive processes (Bird & Cassier, 2023).

3.2 Research methods, data and its limitations

A mixed methods approach characterized by several stages of data collection, processing and analysis was deployed, including a qualitative phase of desk research supplemented with semi-structured interviews to identify relevant case studies (projects), expert elicitation of these case studies, coding and categorization of data, followed by a quantitative exploration of recurring characteristics of this collection of case studies.

We gathered a collection of projects which have been considered and medialized as successful examples or the so called good practices of reclamation, regeneration or recycling of post-mining landscapes (including post-mining brownfields). The case studies were identified and selected according to the review of available literature and media search (academic papers, project reports, national and regional newspapers, webpages of coal mining companies, regions and cities, etc.) and consultation with experts (researchers, representatives of companies dealing with coal mining and landscape reclamation, etc.)[6]. Good practice projects are often published by both the coal mining companies and regional governments to increase public awareness of the post-mining recycling and by presenting successful projects to encourage potential investors to follow the presented success stories. In total, we have selected 28 case studies for which we summarized basic information (name, location, original use, current use, costs, ownerships, timeline, etc.).

A kind of reconstructive analysis was performed (Frantál et al., 2018; Raška et al., 2023) to explore and retrospectively reconstruct the history, development and outcomes of projects, based on the analysis of available documents and semi-structured interviews with relevant stakeholders. For each case study the "passport" was created, including detailed information, narration of the project "story" and possibly photo-documentation (see Appendix 2). The narrations of all case studies were collectively reviewed by the group of researchers involved in the project and were analyzed to identify (i) factors for successful recycling, (ii) positive impacts or effects of recycling, and (iii) criteria of success (or good practice) in recycling. Each case study was then checked again to determine which of success factors, impacts and indicators does it meet – using a simple binary coding of 1 (project meets it) or 0 (project does not meet it). The data from case studies were coded, categorized and converted into a data matrix usable for statistical analysis (see Appendix 1).

Our purpose was not to create a list of all completed recycling projects. It was rather to form a selective database of those projects that attracted the interest from media for being some way original, innovative, interesting or technically demanding. In this regard, it cannot be considered a representative sample of all post-mining transformation projects. In addition to the included cases, many other forestry or agricultural reclamations of surface mines and dumps, as well as redevelopment of post-mining sites and buildings in urban areas have been implemented. Nevertheless, it still allows a comparison (if the structural characteristics of case studies are compared only) that provides valuable information for understanding the processes of post-mining transformation.

4. Results and discussion

4.1 The diversity of post-mining land uses

The basic characteristics of case studies are presented in Table 2. The good practice recycled areas include both the landscapes affected by surface mining (mines and dumps) and sites and industrial complexes associated with underground mining and processing of coal (i.e., mine towers, coal screening plants, coke plants, iron works, etc.). The area of recycling projects ranges from 2.5 hectares (devastated complex of the underground mine Jan Maria was recycled into hotel and restaurant) up to several hundred hectares (flooded quarries and reclaimed dumps). The costs of recycling ranged from units of millions of EUR to hundreds of millions of EUR. One of the spatially most extensive and financially demanding (about 300 mil. EUR) projects is a recent construction of so called Polygon and Future Mobility Development Centre for testing cars being implemented by the

[5] These are not only coal mining landscapes, but they represent the largest share of them.

[6] As part of the research project, we conducted interviews with 15 people, during which we discussed various topics, including the problems of post-mining transformation and landscape regeneration (for a detailed description see Klusáček et al., 2025).

BMW Group company on one of the largest surface mine dumps in the country (see Fig. 2). In terms of the amount of investment, the most economically demanding project was a gradual recycling of the Dolní Vítkovice industrial complex, which has been implementing in several phases since 2009 (see section 4.2.2).

The two most common types of recycling and post-mining land use in our sample are lakes created by flooding of open-pit mines and the open-air museums of coal mining created from former mining/industrial complexes. The areas surrounding new lakes offer various recreational facilities, from walking trails and cycling paths to beaches and playgrounds, complemented by food services and equipment rentals (see Fig. 3 and Fig. 12). The size of lakes created by the flooding of mines ranges from 28 hectares (Lake Michal) to 493 hectares (Lake Medard, which is the largest lake in the country).

Mining museums are located in several regions in the Czech Republic. They include preserved original buildings (mining towers, coal sorting plants and other facilities) that differ in the degree of conservation, renovation or reconstruction, in the spectrum of functions and services provided, and in the degree of authenticity (see section 4.2.3). Other specific types of post-mining land use include forest parks and vineyards realized on reclaimed surface mine dumps, golf courses, amusement parks (see Fig. 4), a racing circuit for cars and trucks (Autodrom Most), and a horse racing track (see Fig. 5).

An example of re-industrialization is the complex of the former František mine in Horní Suchá municipality, which was recycled and redeveloped into a new industrial and logistics zone with the aim of supporting local economic development. As part of one project, the post-mining brownfield (the former Alexandr mine) in Ostrava city was recycled, being now used as a center for charitable accommodation and social services.

It may be surprising that our collection of good practices does not include any example of the transformation of post-mining landscapes into "new energy landscapes" exploiting renewable energy sources. This is caused by both the legislative

Former land use	Number	New land use	Number
Type of mining		Lake and adjacent recreation area	7
Underground	15	Open-air mining museum	5
Surface	13	Forest park (arboretum)	4
Type of landscape		Golf course	3
Underground mine industrial complex	11	Thematic amusement park	2
Surface mine waste dump	8	Vineyards	2
Surface (open-cast) mine	6	Business center and shopping mall	1
Underground mine site (ruined, dump)	2	Historical, educational and cultural center	1
Slag heap	1	Horse racing track	1
Area (ha)		Racing circuit for cars and trucks	1
Less than 10	4	Car test polygon and development center	1
10–49	12	Industrial and logistics zone	1
50–100	4	Hotel and restaurant	1
More than 100	7	Charitable social services center	1

Tab. 2: Basic characteristics of the sample of recycling projects
Source: Authors' research

Fig. 2: The Polygon and Future Mobility Development Centre constructed by the BMW Group on a large surface mine dump near the city of Sokolov. Source: Kinkor (2023)

Fig. 3: Lake Matylda and Autodrom Most (left of the lake) created by flooding of the open-cast mine Vrbenský and reclamation of its internal dump in the city of Most. Photo: B. Frantál

Fig. 4: Dinopark Ostrava – an amusement park for families with children built on a reclaimed underground mine dump
Source: DinoPark Ostrava

Fig. 5: Most Hippodrome – a horse racecourse with tracks for in-line skating, which was built on a reclaimed surface mine dump, city of Most
Photo: B. Frantál

restrictions for using the post-mining land and by the fact that the Czech Republic has been lagging in the development of renewable energies compared to neighbouring countries, due to various political-institutional and other barriers (see e.g., Frantál & Nováková, 2019; Osička et al., 2022). However, few rather smaller photovoltaic power plants have been implemented on post-mining areas (see Fig. 6). Some of the current regional strategic projects seeking funding from the Just Transition Operational Programme include plans for using post-mining land for renewable energy production (e.g., the controversial Green Mine project – see Klusáček et al., 2025). This year (2024), the authorities of the Ústecký Region approved the delimitation of 2,000 hectares of post-mining land for the construction of large solar parks as part of the regional territorial development plan update. However, the announced projects of large solar parks are already met with protests from the concerned municipalities, which are afraid of the creation of a closed and impassable landscape that will not be usable for local people or have economic benefits for communities (Turek & Rambousková, 2024).

Fig. 6: PV power plant constructed on a former coal ash dump in the town of Oslavany. The landscape is dominated by the heap of boiler slag from an already demolished coal-fired power plant (the slag is gradually processed as an ingredient in building materials)
Photo: B. Frantál

4.2 Challenges and dilemmas of post-mining transformation

4.2.1 Technical reclamation versus natural succession

The Czech practice distinguishes four basic types of reclamation according to the post-mining land use: agricultural, forestry, hydrological and other. The majority of our case studies represent the 'other' forms of reclamation, i.e., areas recycled for recreational, tourism, cultural and business activities, including various forms of public greenery and parks, sport facilities, public amenities, areas for industrial or commercial use. However, most of the post-mining landscapes in terms of area have been reclaimed for forestry and agriculture, with an increasing share of water bodies in recent decades. It is like the situation in German lignite regions (Deshaies, 2017).

The Czech recultivation practice (Štýs, 2009) has been primarily focused on preparing the land for final use for productive purposes, and the legislative framework has not allowed natural succession areas to be recognized as a completed full-fledged reclamation. Natural succession thus took place rather unintentionally – in areas, which had not yet been subject to planned reclamation (either on dumps of active mines or on temporary sites where future extraction was expected), or on abandoned dumps, heaps or other brownfields. In some of these localities, spontaneous succession, usually in combination with managed local plantings, created naturally and biologically valuable landscapes (Hendrychová et al., 2008, Stalmachová & Sierka, 2016, Hendrychová & Kabrna, 2016).

A case, which is probably not a typical example of natural succession, but which is often highlighted in the media (that is why we included it in the sample), is the Ema heap (see Fig. 7). It is the widest and highest slag-heap in the city of Ostrava, the origins of which date back to late 1910's[7]. It started spontaneously burning inside in 1952 and has been active until recently. When the mining in the surrounding mines and the piling up of the heap ended, the reclamation works started. Flattening of slopes has been carried out, arable land was brought and some trees and bushes were partially planted. However, the high temperature of the surface complicated the growth of vegetation and a considerable part of the planting died. However, a large number of plants that got here through natural invasions have grown (Rutová, 2021). Since 1960´s, remediation measures were carried out to eliminate existing thermal processes, but these were not fully effective. Thanks to the high temperatures inside, thermophilic steppe flora and fauna can be found on the heap. The top of the heap provides unique views of the industrial city and the surrounding area with Beskydy Mountains, and it has become a popular hiking destination for both locals and tourists. It is also interesting spot for researchers of rocks, vegetation and fauna. The Ema heap has been classified as a cultural monument, and last year the plots of land were acquired by the city, which plans to improve the site for better tourist use in the future.

Fig. 7: The Ema heap in the city of Ostrava
Photo: B. Renner (The City Authority of Ostrava)

Disputes regarding the pros and cons of technical reclamations and natural succession often rest just on the different interpretations of what the processes and outputs of reclamation and succession are. Among the main benefits of reclamation emphasized is the speed of landscape recovery for a new use by people, which is in the order of several years, depending on the extent of the area, degree of landscape damage and availability of funds. Critics emphasize that extremely expensive reclamation measures based on extensive technical modifications of the terrain destroy the natural components of the landscape, impoverish the variety of species, habitats and the entire structure of landscapes (Stejskal, 2009, Sádlo & Gremlica, 2016). Proponents of reclamations counter that the so called "technical" reclamation has never been realized and that reclamation has always been an interplay of technology and ecology, preferring greenery and water as the main elements of landscape. For them the reclaimed landscape is not an artificially created, and the reclamation is just more intensive form of historically ongoing cultural transformation of landscape (Štýs, 2009).

[7] Historically it was called Trojice after the nearby mine from which the piled material (waste rock consisting mostly of sandstone, claystone, volcanic rock, and silt) comes, however, the name Ema was popularized by the public. It has an area of 82 hectares and originally reached a height of 325 m a. s. l., however it has decreased due to burning, settling and mining activities in the area (Rutová, 2021).

A major bone of contention seems to be the possible extent of leaving the landscape to natural succession. While proponents of reclamation do not consider natural succession an alternative to reclamation, since for them it essentially means leaving the devastated area fallow, which is possible only to a minimal extent, for example in the case of small quarries or sandpits. On the contrary, ecologists would like to leave about twenty percent of post-mining areas for the natural succession. However, this plan is likely to face protests from representatives of municipalities and local communities (Klusáček et al., 2025). Nevertheless, taking into account ongoing climate change, the huge economic costs of traditional reclamation projects and the challenges associated with their sustainability (see section 4.3.2), natural succession is gaining wider attention and support from experts, decision makers and mining companies.

This trend has recently been reflected also in the Czech legislation, whereby the amendment to the Mining Act included the obligation of mining companies to consider an option of landscape recultivation by "restoration close to nature". Moreover, the natural succession of post-mining areas could help the Czech Republic to meet the EU goals in the Biodiversity Protection Strategy to increase the share of natural protected areas by 2030 (Europe in Data, 2022).

4.2.2 Preserving heritage versus erasing the past and rebranding

This dilemma can be well illustrated by the case of two large-scale projects of recycling post-mining industrial complexes in the city of Ostrava. The former industrial complexes of Karolina (Fig. 8) and Dolní Vítkovice (Fig. 9) are located very close to each other in the city center, they have a common history, but a very different present.

The area of Karolina (named after the coal mine) originally included underground mine, coke oven, briquette plant, and power plant. After the end of operation of these facilities and their demolition in the late 1980's, a vast derelict and contaminated brownfield was left here, which was fallow until 2005, when the city announced an urban planning competition for projects of the redevelopment of the area. The business center called Forum New Karolina with shopping mall and apartment houses was opened in 2012, and the office spaces in 2013. In the following years, additional apartment and administrative buildings were built. Within the area, two historic buildings of the former power plant (protected as monuments of industrial architecture) have been preserved and reconstructed into spaces for cultural and social events and sport activities (so called Triple-hall multifunctional center).

Industrial production in the huge complex of Dolní Vítkovice (consisting of a mine, coke plant and iron works) ended in 1998. The opinion to demolish the complex was outweighed by the idea of preserving it as a technical monument. The idea of intensive use of the entire area prevailed over the option of preserving it as a managed technical ruin or an open-air museum in the model of the "last working day" (see section 4.2.3). In 2002, the complex was declared a national cultural monument by the Government, and a large subsidy from the EU and national funds was agreed for the renewal and redevelopment project. In the course of several years, the area was transformed into a cultural, social and educational center, offering various sightseeing tours, an interactive museum the "World of technology", observation tower with a café (made from the blast furnace), multifunctional hall for cultural events and conferences, restaurants, galleries, art studios, and sport amenities. Music festivals with a capacity of over 40,000 visitors are regularly held in the area in the summer. Currently, it is the most visited place in the region and among the five most visited cultural monuments in the country, attracting both domestic and international tourists.

Fig. 8: Forum New Karolina – the shopping mall, residential houses and office spaces constructed after demolition of a former coal industrial complex
Photo: L. Kaboň (Deník.cz)

Fig. 9: Industrial complex Dolní Vítkovice – former mine, coke plant and iron works recycled into cultural and educational center
Photo: B. Frantál

The Karolina project faced criticism for demolishing almost the entire industrial complex, notably the fifty-meter-high functionalist coal processing plant that had dominated the area's skyline. The selection of the developer and contracting of the final version of the project for brownfield regeneration by the city was not transparent and it was accompanied by protest petition from several architects and urban planners. The concept (i.e., construction of a shopping mall in the urban core), a genesis of the project and the final architectural form have been criticized and the building was called "New Fukushima" by the locals for its resemblance to the Japanese nuclear power plant (see Fig. 8). However, the project turned out to be an economic and urban renewal success, it has caused an influx of new investments, accelerated the development of the surrounding infrastructure and a new residential area in the neighbourhood.

Dolní Vítkovice faced shifting criticism – initially for preserving such a vast industrial complex, and later for its extensive reconstruction and expansion. The project was accompanied by disputes between investors, the city, the region and the National Institute for the Protection and Conservation of Monuments and Sites stemming from different ideas about the future form of the area. After all, this project of recycling is considered a good practice example of the cooperation of a conscious investor, inventive architects and conservationists accepting a modern adaptation of historical industrial relicts (Pavliňák, 2012). While most experts evaluate the project positively as a flagship of urban renewal, which strengthened the city's image and identity and contributed to the development of tourism, there are also critical voices. Considering it not only from the perspective of industrial heritage and tourism, but from the point of view of complex urban development, critics suggested "better ways" of land use, such as urban greenery, recreation zones, housing development and public services, or construction of scientific and research centers dealing with emerging technologies (Blažejová, 2024). According to some, the city should fully distance itself from its industrial past. In this context, a provocative opinion suggested the complex could have been demolished, as it reminds of the coal mining past and still symbolizes the city (Blažejová, 2024). Another question concerns the economic and technical sustainability of the complex, considering conservation and maintenance costs, and a possible drop in interest in industrial tourism attractions in the future.

4.2.3 The authenticity and a danger of Disneyfication

Most museums of coal mining in the Czech Republic try to preserve the authenticity of the past and design their exhibitions on the model of "miners' last working day", where the buildings, facilities, and equipment (including miners' clothes, tools, etc.), have been conserved in the condition when mining ended (Fig. 10). Most of the preserved and accessible mines have the status of cultural monuments or even national cultural monuments (i.e., the most important parts of the nation's cultural wealth). These preserved mining sites often employ former miners as tour guides, offering visitors authentic insights from those who once worked there.

Fig. 10: Podkrusnohorské museum of mining in the former underground lignite mine Julius III (city of Litvínov) builds on authenticity and operates on the model of "miners' last working day"
Photo: B. Frantál

While maintaining their historical significance, some mining complexes have been modernized with new facilities and services. This transformation aims to attract not only mining history experts and enthusiasts but also adventure-seeking tourists, especially families and younger visitors (see Frantál & Urbánková, 2017). The Landek Park in Ostrava city, the largest open-air museum complex in the country (occupying an area of 10 hectares), includes, in addition to preserved mining objects, machinery and exhibits related to the mining history, also restaurants, mini zoo, courts for tennis and beach volleyball, gym, and site for camping.

Some projects, even though preserving mining heritage, have been designed primarily to offer adventure-oriented tourism attractions, such as the Permonium Park in Oslavany town (Fig. 11). In this case, a former coal mining complex has been recycled into the entertainment park, offering adventure attractions combining sport activities and educational programs linked to the mining history. The complex includes a former mining tower reconstructed into an observation tower with a cafe-restaurant, museum exhibition, and venue for conferences. The complex also serves as a training and team-building center for firms from the region, which brings significant financial income to the owner (an engineering company), which helps to keep the project economically sustainable, despite the challenges of seasonal operation and high maintenance costs.

Fig. 11: Permonium Park – former complex of the Kukla mine in Oslavany town recycled into amusement park
Photo: B. Frantál

The recycling of post-mining sites into the tourist attractions is associated with the problem of "Disneyfication", which means the process of transforming places into stereotypical, tourist-friendly attractive forms, where reality may turn into hyper-reality and simulation (Kennedy & Kingcome, 1998; Kaya, 2018). In this regard, it is necessary to find a balance between the goal of attracting as many tourists as possible and having economic profits and maintaining a certain degree of authenticity respecting the history of the place (Berger, 2019). It is also necessary to be careful regarding the degree of stereotyping, romanticization or idealization of coal mining (Price & Rhodes, 2022) and to point out the problematic aspects and negative environmental impacts, such as climate change, destruction of landscape and human settlements and forced displacement. The critical interpretation of regional histories of coal involving negative aspects of coal mining is present in only a minority of current exhibits in the Czech Republic.

It is not realistic to assume that most post-mining relics will become tourist attractions. The attractiveness of objects, the potential and costs for tourism development depend on the scale (concentration in specific regions or cities, their size, extent of devastation, costs of recycling or conservation of the authentic form, etc.). As Marot and Černič Mali (2012) pointed out, the mining heritage does not attract mass tourism, so that it is unrealistic to expect the use of austere cultural potentials can generate added value equal to that produced by major economic activities. In many cases it would be economically more advantageous to demolish the old buildings and use the site for a new development. The maintenance and operation of most post-mining objects in the Czech Republic, which are designated cultural monuments, must be financially subsidized. In this regard, it is necessary to search for a balance between the uniqueness of objects and their cultural-historical value and the economic sustainability of their preservation.

4.3 Factors and criteria of successful recycling

4.3.1 Factors of success

Table 3 summarizes the most important determinants or drivers (i.e., success factors) of recycling post-mining areas, respectively factors that occurred most frequently in the sample of our case studies. Specific localization of the area appears to be the key factor of successful recycling of post-mining landscapes. All projects are located in relatively close proximity to urbanized areas (a third of the projects are even located close to city centers), and most of the sites are well accessible by public transport, so there was a potential for their utilization by local residents and

Success factors	Occurrence within the sample	
	Abs.	Rel. [%]
Proximity to urbanized area	28	100
Clear ownership relations	26	93
Public transport accessibility	25	89
Tourism potential	24	86
Support of local/regional government	23	82
Public-private partnership	22	79
Economic potential	18	64
Natural (landscape) potential	17	61
Proximity to highway	16	57
Financing by the EU funds*	12	43

*Tab. 3: The most important success factors (i.e., determinants or drivers) of post-mining recycling (Note: *If counting only the projects implemented after the Czech Republic joined the EU in 2004, two thirds of them were co-financed from the EU funds)*
Source: Authors' research

tourists. The second most common characteristic of projects was clarified ownership relations. As also the previous research has shown, in post-socialistic countries ownership issues have been among larger problems encountered in the process of recycling of post-mining sites or brownfields (Osman et al., 2015; Marot & Harfst, 2021). The problem is, on the one hand, that land has often several owners as a result of the processes of restitution and privatization of properties, with a typical scenario being the separate ownership of land and the buildings and infrastructures situated on it. Another problem is that the state with official rights to excavate on post-mining land may not transfer ownership rights to local communities (Marot & Harfst, 2021).

An important success factor is also the support of projects by local or regional governments, in the case of the largest projects also support from the central government (whether in the form of funds, tax reliefs, etc.). The majority of projects were implemented in so called public-private partnership using both private and public resources, including contributions from the EU funds. In a similar number of cases, an important factor was economic potential (for commercial utilization) or, conversely, natural (landscape) potential (Wirth et al., 2012). On the other hand, the size of the area did not prove to barier of recycling since both small sites and mega-sites have been successfully recycled. Different sizes of areas are suitable for different types of land use and vice versa. For example, the key success factors for the project of BMW Polygon (see Fig. 2) were a large contiguous land area with clear, single-owner property rights, good transport links, and proximity to Germany (the city of Munich, where is the company's headquarters). Also, the previous use and mining type do not seem to be determinants of whether the site will be recycled or not.

4.3.2 Criteria of success

In terms of meeting the criteria of success or good practice in recycling (see Tab. 4), all projects presumably meet the criterion of transferability. However, the nature of projects, and uniqueness

Success criteria	Occurrence within the sample	
	Abs.	Rel. [%]
Transferability	28	100
Feasibility	26	93
Legitimacy	26	93
Transparency and openness	25	89
Efficiency	18	64
Sustainability	17	61
Innovativeness	10	36

Tab. 4: The degree of fulfilment of the success criteria by recycling projects
Source: The set of criteria adopted from Marot and Černič Mali (2012), calculations by authors

of local geographical, political and economic conditions, challenge the transferability potential. In other words, concrete examples of national good practice cannot be transferred across national borders without caution and critical thinking for reasons of context and scale (Frantál et al, 2018). On the other hand, only about a third of the projects meet the criterion of innovativeness. Being innovative is quite difficult, as the recycling of landscapes has been going on for decades, and the ways of reclamation and types of post-mining land use are limited. In this regard, just projects that were the first to introduce some original use of post-mining landscapes, or with some innovative technological or architectural solution, were evaluated as innovative. A majority of projects more or less have met the criteria of feasibility, legitimacy and transparency. To maintain transparency and openness in the communication and planning and to reach a compromise amongst all stakeholders and actors potentially affected by the results is important particularly in terms of compliance with the principle of environmental justice.

Only more than half of the projects meet the criterion of efficiency – creating maximum benefits by using minimum resources regarding the effects on society and economy. Similarly, only more than half of the projects meet the sustainability criterion. In this regard, it is necessary to emphasize that the binary scale we used for the evaluation of case studies (whether the project meets the given criterion or not) is not ideal and it would be more appropriate to evaluate them on a multi-valued scale to distinguish between the projects. Nevertheless, the criteria of efficiency and sustainability proved to be the key measures of success according to which the differences between recycling projects appear in the longer term (i.e., evaluating long-term impacts over time).

Besides the seven criteria introduced by Marot and Černič Mali (2012), we identified through analysis some other criteria, which seem to be highly relevant in evaluating the success of projects. The multi-purposeness or multifunctionality of land use proved to be an important factor in terms of project efficiency, sustainability, but also acceptance by local communities (projects that have a wider use in terms of both the variety of functions and the spectrum of end users are preferred). Examples of such multifunctional places are both recreational landscapes enabling diverse sport and leisure activities as well as multi-purpose complexes in an urban environment. The multifunctionality is usually related to the issue of seasonality – whether the place can be used throughout the year or just seasonally. The seasonality of operation combined with higher maintenance costs (for equipment, labour or energies) critically threatens economic sustainability. This represents a problem for some golf courses, amusement parks or museums with a limited visiting season or significant fluctuations in attendance.

In addition to more general criteria, the success can be also measured by the degree of positive impacts or effects that projects generate, whereby the local or regional specifics can be considered (see Tab. 5). A project's success can be measured by the diversity of its positive impacts, although different stakeholders may value these impacts with varying degrees of importance.

An example of project that had been medialized as innovative good practice, but which turned out to be problematic and unsustainable over time is the Golf Resort Karviná-Lipiny (Fig. 12). According to original plans, the derelict area between two active underground mines supposed to be reclaimed for arable land or forestry. Local politicians, however, pushed for a project of terraced landscape with use for either motocross or golf. In 2007, the final decision was made to build a golf course, which was put into operation in 2012. Part of the area is a restaurant with non-authentic mining tower, which should remind of the coal mining past. Although the resort includes also a public course accessible for beginners, and summer camps with golf lessons for children have been regularly organized here, overall, the project is perceived controversially.

Local people perceived it as a place for the upper class, which was also caused by the fact that the place served in the past for behind-the-scenes negotiations between regional politicians and businessmen. Plans to connect the resort located outside the city by a cycle path with the nearby recreation area of Darkov Lake were not implemented due to the economic collapse of the coal mining company (the original owner) and its takeover by the state. The costs of maintenance and operation significantly exceed profits in the long term and make the golf course economically unprofitable. Complicated ownership relations, where the owner of the land is different from the operator of the resort and demands high rents, increase the loss rate. The resort is currently for sale and in danger of falling into decay. Overall, this project can be considered as innovative and transferable, however, it was not legitimate, and it is inefficient and unsustainable under current conditions.

An example of project which turned out to be environmentally difficult to sustain is the one of Lake Most (Fig. 13). The lake is located on the territory of the historical town of Most, which was demolished during 1970's (see Glassheim, 2007), and where the Ležáky open-cast mine was operated until 1999. It is a lake with no natural inflow and outflow of water, the flooding was realized through industrial water pipes from the distant Ohře river. The water level has been set at 199 m.a.s.l., which, based on historical climatological data, was supposed to guarantee a balance between water inflows and evaporation. However, due to warming and drought, the evaporation and water loss is significantly higher than expert studies estimated. The water must be continuously replenished through pipes, which costs about 400 thousand EUR annually, and the water is lacking for other uses. A further development of the lake's surroundings (the city plans to build a luxury camp, facilities for tourists, but also new residential area) is hindered by unresolved ownership relations. The city would like to acquire the land from the state free of charge (as a reparation for the demolished old town) and does not accept the purchase at the market price.

The case of Lake Most and the described problems have led to a re-consideration of the long-term plans to create lakes from other large quarries in the region (there were even plans to create a large hydrological system of interconnected lakes with pumping storage power plants), and negotiations about alternative ways of landscape transformation and future land use, including natural succession, construction of solar parks and others (see Pešout et al., 2022, Klusáček et al., 2025).

Positive impacts	Occurrence within the sample	
	Abs.	Rel. [%]
Improving the image of the area	26	93
Tourism development	22	79
New local jobs	22	79
Re-greening of the area	20	71
Economic benefits for local communities	19	68
Increase in vegetation or water areas	17	61
New meeting place for locals	13	46
Preservation of historical/cultural heritage	11	39
Educational activities	10	36
Research and development	5	18
Other (industrial production, agriculture, housing development)	4	14

Tab. 5: The positive impacts of recycling projects
Source: Authors' research

5. Conclusions

Coal mining has been transforming our landscapes for centuries and remains ongoing in many regions of the world. In this paper, we have tried to offer alternative answers to the question of what the future use of coal energy landscapes should or could be. Post-mining recycling and re-use will be a long-term dynamic process involving countless uncertainties, starts and stops, many related to social conflicts. As we have shown in concrete examples of good practice projects from the Czech Republic, the key dilemmas rarely have straightforward solutions. It is important to determine an appropriate scale of landscape reclamation and natural succession, of preserving unique and valuable relics of mining as cultural heritage or transforming places to new forms and giving them new functions, to find a balance between maintaining the authenticity of places and their attractiveness for tourists, taking into account the scale of affected landscapes, the natural and economic potential areas, needs of the local communities, but also risks related to climate changes and economic fluctuations.

Our analysis identified several factors that represent determinants and drivers of successful recycling. The location of sites near urbanized areas and good transport accessibility (which provide potential for their utilization by local residents and for tourism development), clear ownership relations, support of the project idea by local and regional governments, the public-private partnership, and availability of funds from different sources are among the most important. Evaluating the success of projects in the sense of their outputs is a complex task, since every post-mining region and locality have their own characteristics, and thus different factors need to be considered. Moreover, not just short-term effects but long-term impacts should be taken into account, considering different perspectives, such as ecological, economic, social or cultural-historical. While the criteria of transparency and legitimacy of recycling projects are essential for applying the principles of just transition, the criteria of efficiency and sustainability prove to be key measures of success according to which differences between projects appear in the longer term.

Fig. 12: Golf Resort Lipiny – built on a derelict area between two active mines near the city of Karviná
Photo: B. Frantál

Fig. 13: Lake Most created by flooding of the former open-cast mine Ležáky (on the territory of demolished historical town of Most) serves as a place for recreation and sport. Photo: B. Frantál

The efficiency and sustainability are significantly associated with the multi-functionality of landscapes and places and seasonality of their use.

Efficient process of landscape recycling requires communication and cooperation of experts from different scientific disciplines, regional and local politicians, companies, NGO´s, and other stakeholders, and an understanding of how local communities perceive their post-mining identities and future forms of landscapes. In the context of persistent inconsistencies in the terminology used within post-mining transformation, we advocate using the term recycling, because of its simplicity, evocative nature and newness that could attract wider public attention and interest to be involved in planning and decision-making processes.

As emphasized by Beckett and Keeling (2019), the projects of post-mining restoration present a unique opportunity for the negotiation and articulation of morals, values, histories, and physical experiences associated with the mining landscapes, harms and injustices, and they can represent a "creative process of landscape and community healing". We can observe a paradigmatic shift in the post-mining land use planning from mine sites to a regional scale (see also Hattingh et al., 2019; Worden et al., 2023). In this context, an emphasis is put on creating coordinated post-coal transformation strategies at the regional level reflecting collective visions of what the post-mining landscape should look like, what the new regional identity should be built on and what the priorities of (regional) socioeconomic development should be.

Post-mining landscapes have a huge potential to be transformed into new energy landscapes exploiting renewable energy resources and developing related industries, such as energy storage or green hydrogen production. Some coal mining regions possess also sources of critical raw materials necessary for the energy transition, such as lithium. In this context, it is necessary to guarantee that the energy transition will be truly "just" and that coal mining regions will not now become "green sacrifice zones" (Brock et al., 2021). It is needed to find the right scale of landscape change, to exploit its potential to transform the image of the region and stimulate its socioeconomic renewal, while maintaining its identity elements and adhere to the principles of environmental and landscape justice. In this context, it is important to evaluate responsibly and comprehensively (considering the criteria of feasibility, legitimacy, efficacy, sustainability, etc.) the projects that apply for financing from the Just Transition Funds and to ensure that supported recycling and redevelopment activities do not reproduce old or create new injustices, or social and spatial inequalities.

Recycling coal mining landscapes and transforming them from derelict wasted space into forms that have renewed value seems a sensible extension of the fuel cycle. At a time of increasing human pressure on our limited land resources, it also provides one of the clearest examples of our growing attention to a sustainable energy future.

Acknowledgements

The paper has been created within the project "Accumulating Environmental Injustices and the Emergence of Climate Vulnerability in Central-European Coal Regions: Socio-Spatial Perspectives" financed by the Czech Science Foundation (No. 23-07382S). The authors thank Stanislav Martinát and Jindřich Frajer who participated in the selection of case studies and their assessment. The authors would like to dedicate this paper to Stanislav Martinat, a former leader of the project, who unexpectedly died in August 2023 (see Frantál et al., 2023).

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Please cite this article as:

Frantál, B., Pasqualetti, M., & Brisudová, L. (2024). Challenges, dilemmas and success criteria of recycling coal mining landscapes. Moravian Geographical Reports, 32(4), 216–232. https://doi.org/10.2478/mgr-2024-0018

Appendices

Appendix 1: Data matrix of good practice case studies

ID	Site/Name	Description	NUTS 3	LAU2	Former land use	Area (he)	Current land use	New use since	Costs
1	Arboretum Antonín	Arboretum and forest park	Karlovarský	Sokolov	Mine waste dump	168	Recreation, research	1974	21 mil.
2	Čepirohy vineyards	Vineyards	Ústecký	Most	Mine waste dump	35	Agriculture	1978	n/a
3	Lake Barbora	Lake and recreation area	Ústecký	Hrob	Open-cast mine	63	Recreation, sport, tourism	1982	n/a
4	Autodrom Most	Racing circuit for cars and trucks	Ústecký	Most	Mine waste dump	140	Motor sport, business, tourism	1983	n/a
5	Lake Matylda	Lake and recreation area	Ústecký	Most	Open-cast mine	39	Recreation, sport, tourism	1992	326 mil.
6	Mayrau Museum of mining	Open-air mining museum	Středočeský	Vinařice	UG mine complex	16	Tourism, education	1994	192 mil.
7	Hipodrom Most	Horce racing track (& golf course)	Ústecký	Most	Mine waste dump	82	Recreation, sport, tourism	1997	74 mil.
8	Landek Park	Open-air mining museum	Moravskoslezský	Ostrava	UG mine complex	40	Recreation, sport, tourism	1997	n/a
9	Michal Mine Michálkovice	Open air mining museum	Moravskoslezský	Ostrava	UG mine complex	5	Tourism, education	2000	n/a
10	Podkrušnohorské Museum of minin	Open air mining museum	Ústecký	Most	UG mine complex	5	Tourism, education	2003	n/a
11	Lake Michal	Lake and recreation area	Karlovarský	Sokolov	Open-cast mine	28	Recreation, sport, tourism	2004	150 mil.
12	Ema (Trojice) Heap	Tourist destination, scenic spot	Moravskoslezský	Ostrava	Slag heap	82	Recreation, tourism	2007	n/a
13	Hotel Jan Maria	Hotel and restaurant	Moravskoslezský	Ostrava	UG mine complex	2	Tourism, business	2008	n/a
14	Lake Darkov (Sea of Karviná)	Lake and recreation area	Moravskoslezský	Karviná	Collapsed UG mine	32	Recreation, sport, tourism	2009	630 mil.
15	Dinopark Ostrava	Amusement park	Moravskoslezský	Orlová	Mine waste dump	35	Recreation, tourism	2009	56 mil.
16	František Mine - Industrial zone	Industrial zone	Moravskoslezský	Horní Suchá	UG mine complex	20	Industry, logistics	2010	150 mil.
17	Silvestr Mine - Golf course & park	Golf course and forest park	Karlovarský	Dolní Rychnov	Mine waste dump	270	Recreation, sport, tourism	2010	262 mil
18	Alexander Mine	Charitable social services centre	Moravskoslezský	Ostrava	UG mine complex	2	Social services	2010	n/a
19	Kukla Mine - Permonium Park	Amusement park	Jihomoravský	Oslavany	UG mine complex	6	Tourism, education, industry	2012	150 mil.
20	Golf Resort Lipiny	Golf course	Moravskoslezský	Karviná	Underground mine area	70	Recreation, sport, tourism	2012	240 mil.
21	Dolní Vítkovice Industrial area	Historical, cultural & social center	Moravskoslezský	Ostrava	Mine, coke plant, iron works	11	Tourism, education, business	2012	60 mld.
22	Forum Nová Karolina	Business centre, shopping mall	Moravskoslezský	Ostrava	UG mine and coke plant	30	Business, housing, culture	2012	4 mld.
23	Žacléř Museum of mining	Open-air mining museum	Královehradecký	Lampertice	UG mine complex	40	Tourism, education	2012	134 mil.
24	Bohemia Forest park	Forest park with inline skating track	Karlovarský	Sokolov	Mine waste dump	18	Recreation, sport, tourism	2015	50 mil.
25	Lake Milada	Lake and recreation area	Ústecký	Ústí nad Laben	Open-cast mine	252	Recreation, sport, tourism	2015	5,5 mld.
26	Lake Medard	Lake and recreation area	Karlovarský	Habartov	Open-cast mine	493	Recreation, sport, tourism	2016	n/a
27	Lake Most	Lake and recreation area	Ústecký	Most	Open-cast mine	310	Recreation, sport, tourism	2020	1,7 mld.
28	BMW Future Mobility Centre	Car test polygon & development centr	Karlovarský	Dolní Nivy	Mine waste dump	600	Industry, research	2023	7 mld.

	Factors of success													
ID	Proximity to highway	Proximity to urbanized area	Location close to city centre	Availability of public transport	Support from local/regional government	Support from central government	Financed by EU funds	Natural/landscape potential	Economic potential	Sociocultural potential	Tourism potential	Historical/architectonic potential	Clear ownership relations	Public-private partnership
1	1	1	0	1	0	0	0	1	0	0	1	0	1	1
2	0	1	0	0	1	0	0	1	1	0	0	0	1	0
3	0	1	0	1	1	0	0	1	0	0	1	0	1	0
4	1	1	0	1	1	1	0	1	1	0	1	0	1	0
5	1	1	0	1	1	0	0	1	1	0	1	0	1	1
6	0	1	0	1	1	1	1	0	0	1	1	1	1	1
7	0	1	0	1	1	0	0	1	0	0	1	0	1	1
8	1	1	0	1	1	1	1	1	1	0	1	1	1	1
9	0	1	1	1	1	1	1	0	0	0	1	1	1	1
10	1	1	0	1	1	0	1	0	0	0	1	1	1	1
11	1	1	0	1	1	0	0	1	1	0	1	0	1	1
12	0	1	1	1	0	0	0	1	0	0	1	0	1	1
13	0	1	1	1	0	0	0	0	1	0	1	1	1	0
14	0	1	1	1	1	0	0	1	1	1	1	0	1	1
15	0	1	0	1	0	0	1	1	1	0	1	0	1	1
16	1	1	0	1	1	1	1	0	1	0	0	0	1	1
17	1	1	0	1	1	0	0	1	1	0	1	0	1	1
18	1	1	1	1	1	0	0	0	0	0	0	1	1	1
19	0	1	0	1	1	0	1	0	1	1	1	1	1	1
20	1	1	0	1	1	1	1	0	1	0	1	0	0	1
21	1	1	1	1	1	0	1	0	1	1	1	1	1	1
22	0	1	1	1	1	1	1	0	1	1	1	0	0	0
23	0	1	0	1	0	1	1	0	0	1	1	1	1	0
24	1	1	1	1	1	0	1	1	0	0	1	0	1	1
25	1	1	0	1	1	1	0	1	1	0	1	0	1	1
26	1	1	0	0	1	0	0	1	1	0	1	0	1	1
27	1	1	1	1	1	1	0	1	1	0	1	0	1	1
28	1	1	0	0	1	1	0	1	1	0	0	0	1	1

	Positive impacts													
ID	Re-greening of the area	Renewable energy development	Industrial activities	Agricultural activities	Public amenities (shops, services)	Housing development	Research and development	Educational activities	Tourism development	New jobs opportunities	Improving the image of the area	Preservation of historical heritage	Increase of vegetation or lakes areas	New meeting place for locals
1	1	0	0	0	0	0	1	1	0	0	1	0	1	1
2	1	0	0	1	0	0	1	0	0	1	1	0	1	0
3	1	0	0	0	0	0	0	0	1	0	1	0	1	1
4	0	0	0	0	0	0	0	0	1	1	1	0	0	1
5	1	0	0	0	0	0	0	0	1	1	1	0	1	1
6	1	0	0	0	0	0	0	1	1	1	1	1	1	0
7	1	0	0	0	0	0	0	0	1	0	1	0	1	1
8	1	0	0	0	0	0	0	1	1	1	1	1	0	0
9	0	0	0	0	0	0	0	1	1	1	1	1	0	0
10	0	0	0	0	0	0	0	1	1	1	0	1	0	0
11	1	0	0	0	0	0	0	0	1	1	1	0	1	1
12	1	0	0	0	0	0	0	1	1	0	1	0	1	0
13	0	0	0	0	0	0	0	0	1	1	1	1	0	0
14	1	0	0	0	0	0	0	0	1	1	1	0	1	1
15	1	0	0	0	0	0	0	1	1	1	1	0	1	0
16	0	0	1	0	0	0	0	0	0	1	0	1	0	0
17	1	0	0	0	0	0	0	0	1	1	1	0	1	0
18	0	0	0	0	0	0	0	0	0	1	1	1	0	0
19	0	0	1	0	0	0	1	1	1	1	1	1	0	0
20	1	0	0	0	0	0	0	0	1	0	1	0	1	0
21	0	0	0	0	1	0	0	1	1	1	1	1	0	1
22	1	0	0	0	1	1	0	0	0	1	1	1	0	1
23	1	0	0	0	0	0	0	1	1	1	1	1	1	0
24	1	0	0	0	0	0	0	0	1	1	1	0	1	1
25	1	0	0	0	0	0	0	0	1	0	1	0	1	1
26	1	0	0	0	0	0	0	0	1	1	1	0	1	1
27	1	0	0	0	0	0	0	0	1	1	1	0	1	1
28	1	0	0	0	0	0	1	0	0	1	1	0	0	0

	Criteria of success												
ID	Efficiancy	Feasibility	Transparency	Legitimacy	Innovativenss	Sustainability	Transferability	Multifunctionality	Seasonality	Environmental synergy	Heritage synergy	Infrastructure synergy	Local economic benefits
1	1	1	1	1	1	1	1	0	0	1	0	0	0
2	1	1	1	1	1	1	1	0	0	1	0	0	1
3	1	1	1	1	0	1	1	0	0	1	0	0	0
4	1	1	1	1	1	1	1	0	0	0	0	0	1
5	1	1	1	1	0	1	1	0	0	1	0	0	1
6	1	1	1	1	0	0	1	0	0	0	1	0	1
7	0	1	1	1	1	1	1	1	0	1	0	0	1
8	1	1	1	1	0	1	1	1	0	0	1	0	1
9	1	1	1	1	0	0	1	0	0	0	1	0	1
10	1	1	1	1	0	0	1	0	0	0	1	1	0
11	1	1	1	1	0	1	1	0	0	1	0	0	1
12	1	1	1	1	0	1	1	0	0	1	0	0	0
13	0	1	1	1	0	1	1	0	0	0	1	0	0
14	1	1	1	1	0	1	1	0	0	1	0	0	0
15	0	1	1	1	1	1	1	0	1	1	0	0	1
16	1	1	1	1	0	1	1	1	0	0	1	1	1
17	0	1	1	0	1	1	1	0	1	1	0	0	1
18	1	1	1	1	0	0	1	0	0	0	1	1	0
19	0	1	1	1	1	0	1	1	1	0	1	1	1
20	0	0	0	0	1	0	1	0	1	1	0	0	0
21	0	1	1	1	1	0	1	1	0	0	1	0	1
22	0	1	0	1	0	1	1	1	0	0	0	0	1
23	1	1	1	1	0	0	1	0	1	0	1	0	1
24	1	1	1	1	0	1	1	0	0	1	0	0	0
25	0	1	1	1	0	0	1	0	0	1	0	0	1
26	1	1	1	1	0	1	1	0	0	1	0	0	1
27	0	0	1	1	0	0	1	0	0	0	0	0	1
28	0	1	0	1	1	1	1	0	0	1	0	0	1

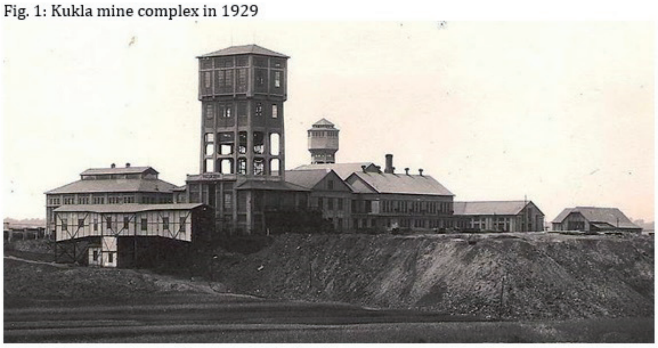
Appendix 2: Example of the "passport" of a good practice case study

Project # 19: Kukla mine – Permonium park

Location	
Country	Czech Republic
NUTS 2	South-East
NUTS 3	South-Moravian (Region)
LAU 1	Brno-countryside (District)
LAU 2	Oslavany
Site description	
Original use	Mining, Industrial
Type of coal mining	Underground (hard coal)
Size of the area	5,4 ha
Type of area	Industrial site on the outskirts of a small town
% of built-up area	Not available
Type of potential (Wirth et al., 2012)	Cultural
State of environment	After decontamination
Project description	
Project start / end	2010 / 2012
Type of project	Tourism, culture, education, business, industry
Owner of site	Oslavany Engineering Ltd.
Total costs	1.4 million EUR (the 1st phase)
Investors	Oslavany Engineering Ltd. The Regional Council of the South-East Cohesion Region (provider of EU funds)
Main aims / objectives	
- Preservation of historical-cultural heritage ("the social footprint in the region") - Restoration of local landscape landmark to be used as observation tower (accessible for wheel-chair users by a special lift) - Adventure tourism development (thematic amusement park)	
Relevant legislation, policies, programmes *(which directly made the project implementation possible)*	
- ERDF - Regional Operational Programme Southeast – Priority Axe No. 2: Development of sustainable tourism.	

Main factors of successful regeneration process			
- Private-public partnership - Availability of financial incentives (co-financed by local company and EU funds) - Specific location (local landscape dominant) - Transport links (close to highway D1, proximity to Brno city, free parking, accessible by public transport from Brno) - Multi-functionality (innovations + new developments, technical equipment, renting of place, the entertainment park)			
Some negative impacts / problems			
- Last years the complex is not economically profitable, it is subsidized from the company's profits. Some local people would like to use the facility for free.			
Lessons learned			
- Regeneration of existing infrastructure + heritage for reshaping a city's historical and future narrative (combining mining legacies with education and adventure). - Giving a mining site a specific theme or a vision helps to reduce complexity and can accelerate ideas and public engagement in the implementation process			
Criteria of good practice *(according to Marot and Harfst, 2021)*			
Efficiency: 1	Sustainability: 0	Legitimacy: 1	Transferability: 1
Feasibility: 1	Transparency: 1	Innovativeness: 1	

Fig. 1: Kukla mine complex in 1929



The story of the site
The Kukla mine was excavated in 1865 to draining Františka mine in Padochov. It was modernized in the years 1911-1913 and rebuilt into the central shaft of the mining district. It had task of supplying coal to the newly constructed thermal power plant in Oslavany town (to provide Brno city and the surrounding area with the electricity). The mining was finished in 1973. After the end of mining, the complex was used by the First Brno Machinery company and various construction modifications were made due to the transformation of the complex into an engineering plant. However, the mining towers were not affected by any reconstructions, so they gradually fell into disrepair. In 1993, the local Oslavany Engineering company gained the complex. In 2009, the Kukla mining tower was declared as a cultural monument by a decision of the Ministry of Culture of the Czech Republic. The reconstruction of the complex started in 2009. The main goal was to build the training centre with the technical equipment for their own company and for other companies in the micro-region. The next goal was to regenerate the distinctive place (landscape landmark) in Oslavany town. The project was financed by the company with support from the EU funds. The reconstruction was divided into four phases and ended in 2012. They preserved historical attributes as they could. The whole complex consists of educational entrepreneurial and technical centre, the manufacturing facility, thematic entertainment park for families with children called Permonium, and the observation tower with historical exhibition and coffee house. The Kukla complex has become an attractive place for families with children of all ages, and for companies from the region (as a training and team-building venue). The operation of the Oslavany coal-fired power plant stopped in 1993 as the coal mining was completely stopped in the region. In 2010, solar park (8 MW) has been constructed on a previously used coal mining dump. These projects are considered good practice examples of post-mining landscape. The forested hill by the solar park is made of coal slag and the surrounding buildings were part of the coal mining complex and coal-fired power plant. In 2021, the demolition of the power plant complex was carried out to be used for local development purposes.

Current use and project impacts	
Current use	Adventure tourism, cultural events, education, business
New economic activities	Museum, entertainment park, cafe-restaurant, venue for conferences, concerts, training centre for firms, etc.
New jobs created	n/a
Stakeholders who benefit from project	Employers of the company, local residents, local and regional companies, tourists, schools in the region, etc.
Local acceptance	Yes

Fig. 2: Kukla mine complex today – Permonium amusement park

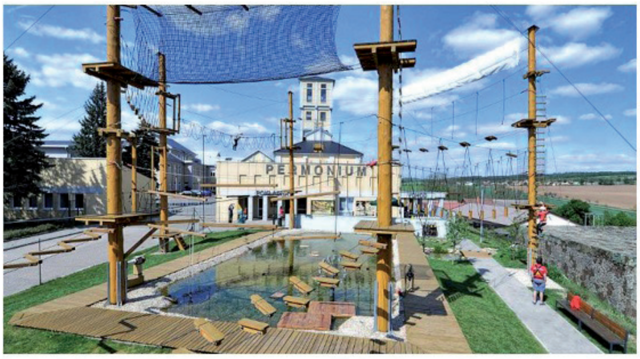
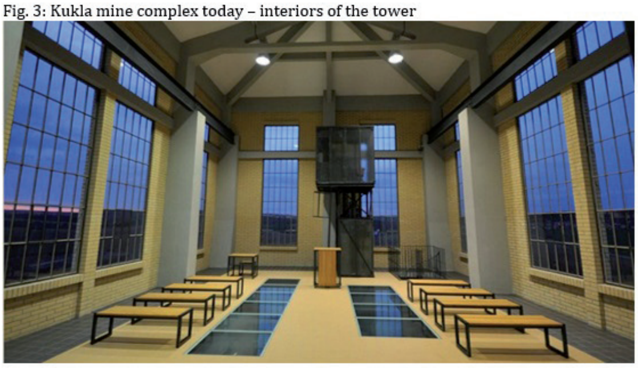


Fig. 3: Kukla mine complex today – interiors of the tower



Sources: http://www.vezkukla.cz/index.php