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NEEDS ANALYSIS REPORT ON ENVIRONMENTAL RESTITUTION & LAND RESTORATION IN DECARB REGIONS

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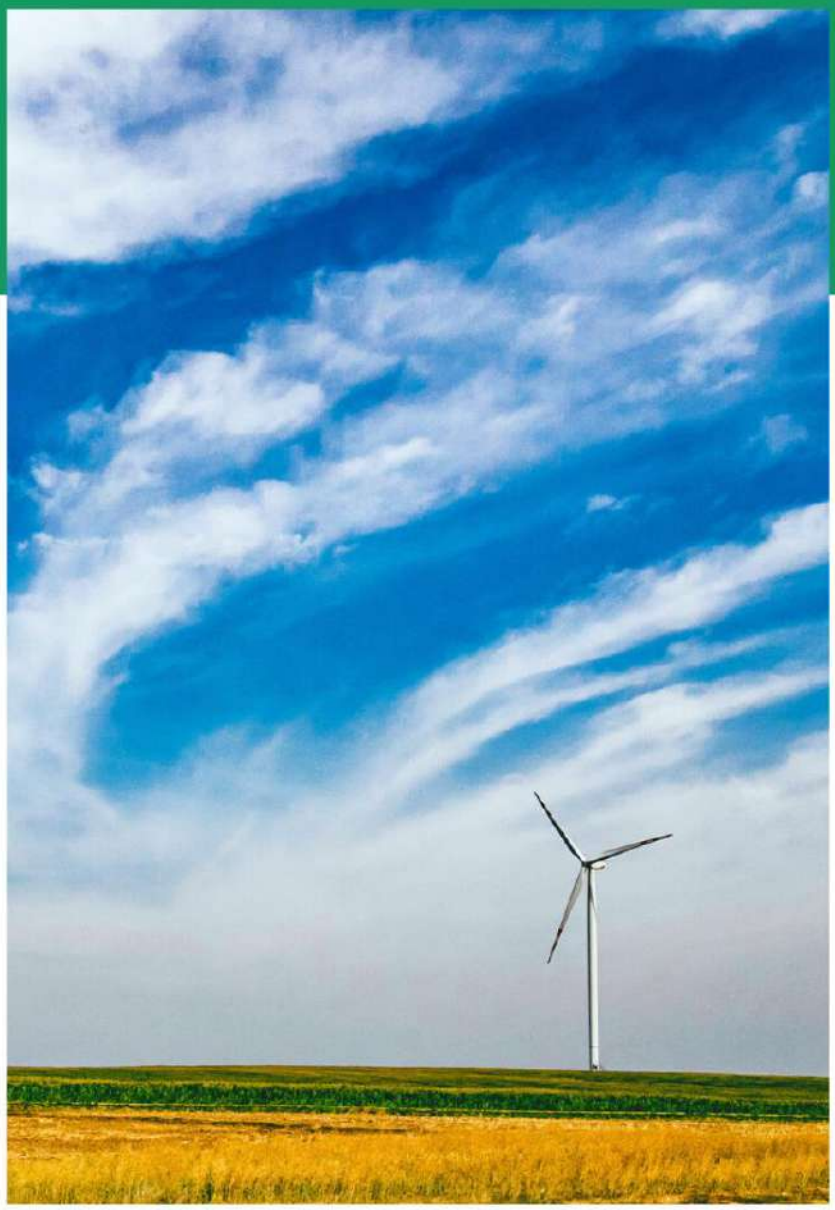

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TABLE OF CONTENTS

1 INTRODUCTION

Fossil fuels (solid fuels and natural gas) continue to supply most of energy demand in the EU-28. In 2018, the share of solid fossil fuels (coal and solid products derived from coal) in EU primary energy consumption (availability) was estimated at 14.5%. Coal is the third largest contributing source to energy production in the EU-28 (after renewables and nuclear power), accounting for almost a quarter of the total electricity generation [1]. However, the share of coal in the energy production mix varies considerably between Member States. For instance, the contribution of coal is particularly high in Poland (79%) and Greece (61%) while a number of countries such as Malta, Latvia and Cyprus do not produce any coal based energy.

Coal is currently mined in 41 regions across 12 EU countries. In the EU-28, there are currently 128 operating coal mines with combined annual production of over 500 million tonnes; and 207 coal stations (or coal-fired power plants) in 21 Member States with a total capacity of almost 150 GW [2]. In DeCarb territories, there are 19 operating coal mines with an annual production of 183.2 million tonnes (36.8% of the total EU production) and 17 coal fired power plants with a total capacity of 21 GW, which make up about 2.1% of the total European power generation capacity. It is estimated that the coal industry directly employs 48,450 people in DeCarb territories.

Recently, a series of factors such as restrictions on coal use, the new standards for industrial emissions, the decreasing profitability of coal mines, and most importantly the Union's commitment to phase out coal for electricity generation, has gradually led to the shutdown or limitation of coal driven activities in a number of regions across Europe. In 2014-2015, 58 mines were closed in Germany, Poland, Slovenia and Spain while a first massive wave of coal-fired power plant decommissioning is scheduled for the period 2020-2025.

Regions with economies largely fuelled by coal like most DeCarb territories need to act in light of this energy transformation as the shrinkage of the coal industry can push local communities towards stagnation and introspection unless just transition strategies are implemented. In this vein, particular emphasis should be devoted on the restoration and environmental restitution of the wounded landscape, as well as the selection of appropriate post mining land uses. Land restoration refers to the process of re-building ecological functionality and integrity across degraded landscapes (incl. enhancing local communities' well-being). Land restoration coupled with careful planning for the post coal era, will not only contribute to reverting or mitigating the environmental harm caused by decades of mining but can also aid to secure employment and social cohesion in the affected areas through the emergence of alternative, sustainable and diversified economic activities.

This report presents the findings of the analysis on environmental restitution and land restoration needs in DeCarb territories harshly suffered from intensive coal driven activities. The analysis focused on

territorial attributes and sketches the (coal) profile of DeCarb territories, discussing also post mining land uses that are physically feasible and exhibit the higher value for local communities.

The purpose of this needs analysis is to enable policy makers in DeCarb partnership areas to a) comprehend the socio-economic and institutional context that could best facilitate the shutdown of coal mining operations (either coal mining or coal fired power plants) and pave the way for environmental restitution and land restoration activities, b) pinpoint organisational and implementation needs, and formulate strategies to move forward, and c) determine what restoration activities provide the greatest ecological, social and economic benefits for local communities.

Study results reveal that renewables, tourism and agriculture are the post coal uses that are better suited to partners' territorial needs and attributes and can provide the highest environmental and socioeconomic benefits for local communities in coal intensive DeCarb territories. These uses combine substantial growth and employment potential and low environmental footprint, are not related to coal and are of sustainable nature, and can justify land restoration investments.

The report is outlined as follows:

- Section 2 presents the thematic background of the study and provides basic definitions to facilitate understanding.
- Section 3 outlines the methodological framework upon the needs analysis was carried out.
- Section 4 presents the socioeconomic profile of DeCarb territories, discussing drivers and barriers to land restoration and concluding to alternative, viable post mining land uses.
- Section 5 provides a comparative analysis of partners' territorial conditions to showcase similarities and differences.

2 THEMATIC BACKGROUND

Fossil fuels make the largest contribution to energy production as combustible fuels (coal, oil and natural gas) account for approximately 50% of total net electricity generated [3]. In this share, coal (hard coal and lignite), composed of carbon along with assorted other elements, provides one fourth of the production of primary energy in the EU. Coal activities represent a multibillion euro industry, which employs thousands of EU citizens and contributes millions of euros to public finance through taxation. The industry provides jobs to about 240,000 people: out of which 180,000 in the mining of coal and lignite and about 60,000 in coal- and lignite-fired power plants [4].

The coal industry, closely intertwined with the rise of industrial economy, involves all those companies constructing mine sites, extracting coal from surface and underground, preparing coal for use, and providing support activities for coal mining, processing and use to produce energy. Generally speaking, mining is a temporary activity with a finite life span, lasting from a few years to several decades. Its operational largely depends on the size, quality and quantity of the mineral deposit being extracted. Mine closure usually takes place once the supply of natural mineral resources comes to an end, or operations are no longer profitable (marginal cost is equal to marginal revenue). The shutdown of mining activities brings up a discussion on future post-mining uses in landscapes that have been severely degraded and (adversely) affected by extraction operations.

2.1 Land degradation and restoration

Regardless of the socioeconomic benefits associated with coal powered energy (e.g. employment & rural development), coal driven activities have been found to cause major disturbances to the natural environment (e.g. air pollution, soil erosion, water contamination, biodiversity loss) and exert a long lasting impact on landscape; known as land degradation.

Land degradation can be defined as the reduction or loss of a landscape's biological and production capacity to provide goods and services for its beneficiaries [5]. It covers all negative changes in land structure and properties such as scarcity of natural resources, soil fertility decline, natural habitats destruction and biodiversity loss, and deteriorated ecosystems services. Land degradation and desertification can be largely regarded as any change or disturbance to the landscape synthesis and properties, perceived to be deleterious or undesirable, and most importantly deteriorates the value of the biophysical environment.

It is a natural or human-induced process that adversely affects the land to function effectively within an ecosystem. Geo-climatic conditions and natural hazards (e.g. soil water erosion wind erosion and intrinsic characteristics of fragile soils) can make a natural environmental or landscape susceptible to degradation and desertification. Human activities that may cause land degradation include deforestation,

overgrazing, over-exploitation of vegetation for domestic use, excessive agricultural activity & inappropriate management of agricultural land, and intensive industrial activities such as coal mining. In addition, land degradation has serious economic and social implications affecting the stability of land-dependent communities. It may create a serious menace to food production and security as it reduces yields and crops, force farmers to use more harmful inputs (e.g. fertilisers) and may eventually lead to land abandonment. Land degradation results in biodiversity loss and problems on natural resource conservation, and in the wake of desertification may create economic downturn, instability and migration. The Economic and Land Degradation (ELD) Initiative estimates that economic losses from land degradation exceed 10 trillion dollars worldwide [6]. For all the above, halting degradation and restoring degraded land is highlighted as a key priority activity in many countries and regions.

Land restoration refers to the process of re-building ecological functionality and integrity across degraded landscapes (incl. enhancing local communities' well-being) such as those following the shutdown of mining activities. It is an emerging concept that refers to an approach involving stakeholders in all affected land-use sectors and applying participatory decision-making processes. It seeks a balance between restoring ecosystem services related to wildlife habitats and biodiversity, water regulation, carbon storage and more (**what is called environmental restitution**) and supporting the productive functions of land for agriculture and other related uses. Activities designed to restore or improve degraded ecosystems are described in the literature with different terms like "restoration," "rehabilitation," "remediation," "reclamation," and "regeneration". There terms, despite referring to the revival and renascence of adversely affected and degraded lands, apply in different circumstances and refer to distinct steps in land preparation for future use. Nevertheless, as they are closely linked, they are frequently used interchangeably in studies practice. Further clarifications are needed to better perceive their meaning, characteristics, and scope in a mining related perspective. The following provides definitions for the different terms used to describe mine closure activities in an attempt to make the distinction among them.

- **Restoration**: The process of returning the land and water resources to the previous ecological state by artificially accelerating the processes of natural succession. In simple words, restoration targets at the full recovery of the original ecosystem.
- **Rehabilitation**: The process of returning the land to some degree of its former state, as mining activity has impacted so dramatically the ecosystem that has made full recovery no longer possible. In all cases, rehabilitation entails the creation of a self-sustaining and functional ecosystem that requires repurposing.
- **Reclamation**: The process of recovering key ecosystem services and biogeochemical functions to convert a derelict land to a natural and economically usable state. The objective is to return the land and watercourses to an acceptable standard of productive use. Reclamation may involve engineering and ecological solutions such as planting native grasses and trees, removing

contaminants and any hazardous materials, stabilising the terrain (e.g. dams, waste rock piles), landscaping, and restoring topsoil.

- **Remediation**: Remediation focuses on the removal of pollutants & contaminants from a closed mining site intended for redevelopment. The aim is to clean up the contaminated land to safe levels, paving the way for returning the ecosystem to a productive and usable state. At mine sites, remediation often consists of isolating contaminated material in pre-existing tailings storage facilities, capping tailings and waste rock piles with clean topsoil, and collecting and treating any contaminated mine water if necessary.
- **Regeneration:** Efforts to create a productive and functional post-mining landscape that will generate substantial economic and ecological benefits to offset the negative impacts from the shutdown of mining activities. Regeneration aims to restore landscape functions and ecosystem services, and deliver outcomes that include sustainable production, an improved natural resource base, increased biodiversity and enhanced resilience. These outcomes will benefit not only primary producers and land owners, but also the community - environmentally, economically and socially.

For the needs of the DeCarb project and in an effort to avoid confusion, the definition for "land restoration" will remain deliberately as broad as possible so as to encompass a diverse range of improvement activities, scales, environments, and post mining land uses.

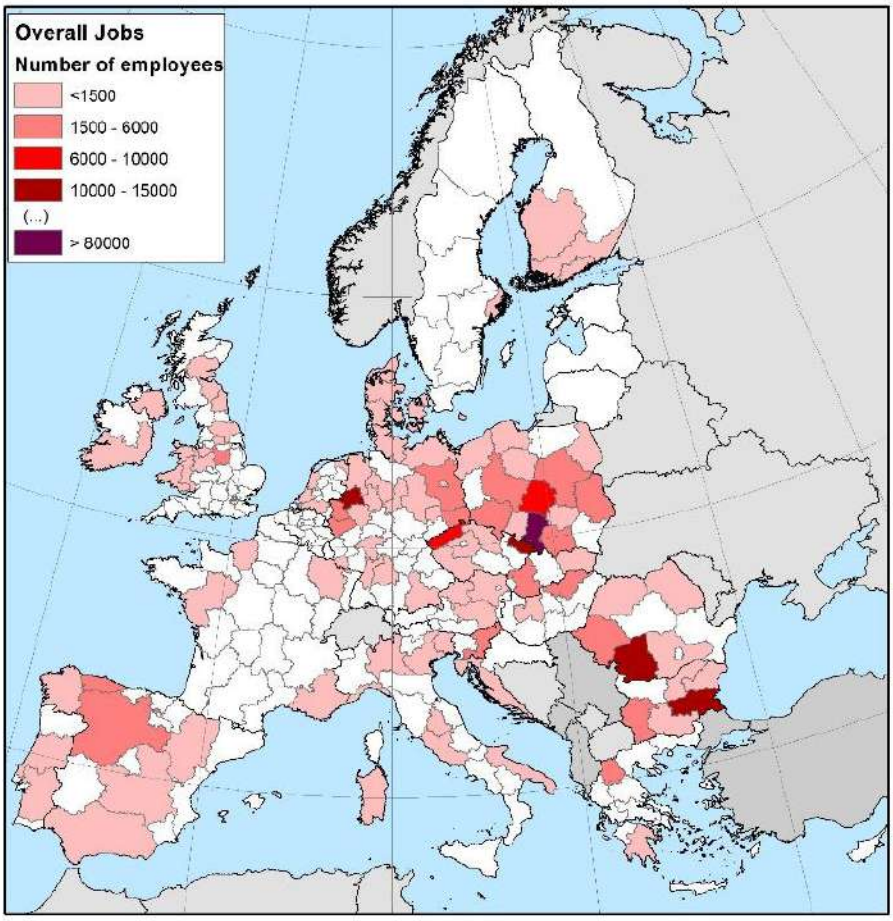
2.2 The current status of coal mining and coal fired power production in DeCarb territories

Coal extractions operations are currently taking place in all DeCarb territories, excluding Nordjylland (Denmark) and Extremadura (Spain). There are 19 operating coal mines in DeCarb territories and the total annual production amounts to 183.2 million tonnes, representing 36.8% of the total EU production. Western Macedonia (Greece) hosts the largest number of coal mines in the consortium with 8 extraction sites, followed by Yugoiztochen (Bulgaria) with 4 coal mines, and Észak-Magyarország (Hungary) and Brandenburg (Germany) with 2 coal mines each. Łódzkie (Poland) is the largest producer with 42.1 million tonnes annually, followed by Western Macedonia (37.5 million tonnes) and Brandenburg (34 million tonnes). Lignite is predominantly mined in DeCarb territories through mostly surface extraction operations in the form of open pits; underground mining operations are carried out only in Yugoiztochen (Bulgaria) and Savinjska (Slovenia). The average productivity of mines in DeCarb territories stands at 5,550 tonnes per employee, ranging from 9,994 in Brandenburg (Germany) and 8,849 in Western Macedonia (Greece) to 2,512 in Savinjska (Slovenia) and 2,264 in West Oltenia (Romania). The deeper coal mines are located in Łódzkie (Poland) and Yugoiztochen (Bulgaria) with 300 and 182 metres depth respectively.

Table 1: Information on coal mines in DeCarb territories

Partner	Region	No. of mines	Type of coal	Mine Type	Production (Mt)	Coal depth (m)	Coalfield
SZREDA	Yugoiztochen (BG)	4	Lignite	Open pit & underground mine	32.6	182	Maritsa lignite field
LODZKIE	Łódzkie (PL)	1	Lignite	Open pit & underground mine	42.1	300	Belchatów
ENEREA	Észak-Magyarország (HU)	2	Lignite	Open pit mine	9.3	n/a	Matra
SWORDA	Sud-Vest Oltenia (RO)	1	Lignite	Open pit mine	24	n/a	Oltenia Basin
MWE	Brandenburg (DE)	2	Lignite	Open pit mine	34	110	Lusatian Area
PEDDM	Dytiki Makedonia (EL)	8	Lignite	Open pit mine	37.9	175	West Macedonia Lignite Centre
KSSENA	Vzhodna Slovenija (SI)	1	Lignite	Underground mine	3.3	160	Premogovnik Velenje

Figure 1: Coal regions across the EU (source: European Commission)



All DeCarb territories host coal-fired power plants except for Extremadura (Spain), which has successfully managed to wean itself completely off coal-fired power generation. There are 17 coal fired power plants in operation in DeCarb territories with a total capacity of 21 GW, making up about 2.1% of the total European power generation capacity. With regards to the type of coal, lignite is used as primary fuel in almost all DeCarb territories except for Észak-Magyarország (Hungary) which uses hard coal. The DeCarb territory with the most installed capacity is Łódzkie (Poland) with around 5500 MW, followed by Brandenburg (Germany) and South-West Oltenia (Romania) with 4600 MW and 3900 MW respectively. The power plants with the lowest operational capacity among DeCarb territories are located in Nordjylland (Denmark) and Észak-Magyarország (Hungary) with 740 MW and 1130 MW respectively. The examined lignite fuelled power plants are located in close proximity to mine sites and are connected with them with rail networks/infrastructures to make the supply of raw materials easier and more convenient. The vast majority of coal-fired plants in DeCarb partnership area were commissioned over 30 years ago. These plants are, on average, 34 years old with an estimated efficiency of a mere 33.6%,

which is below the EU average (35%). Efficiency is a proxy to assess the performance of a power plant. It depicts the share of energy contained in the fuel that is converted into heat and electricity, and is calculated based on known plant parameters (age, type, fuel) and environmental conditions. The higher the efficiency of a coal fuelled power station, the less the production costs and carbon dioxide (CO2) emissions. The efficiency of coal-fired plants in DeCarb territories is within a range of 29% - 37%. The most efficient power plants, fitted with Best Available Technologies (BAT), are located in Savinjska (Slovenia), Łódzkie (Poland) and Nordjylland (Denmark) with rates greater than or equal to 37%.

Table 2: Information on coal fired power plants in DeCarb territories

Partner	Country	Region (NUTS2)	Capacity (MW)	Age (years)	Average efficiency (%)
SZREDA	Bulgaria	Yugoiztochen	3504	44	34%
LODZKIE	Poland	Łódzkie	5472	23	36%
ENEREA	Hungary	Észak-Magyarország & Közép-Dunántúl	1130	44	29%
SWORDA	Romania	Sud-Vest Oltenia	3900	37	33%
MWE	Germany	Brandenburg	4600	27	34%
HoE	Denmark	Nordjylland	740	27	36%
PEDDM	Greece	Dytiki Makedonia	3401	31	30%
KSSENA	Slovenia	Savinjska[1]	1029	22	37.5%

[1] Savinjska's thermal power station (TES) has 2 coal fired units in operation; unit 6 (commissioned in 2016) with an estimated average efficiency of 43% and unit 5 (commissioned in 1978) with an average efficiency of 32%. The table includes average figures.

2.3 Potential land uses following the shutdown of coal driven activities

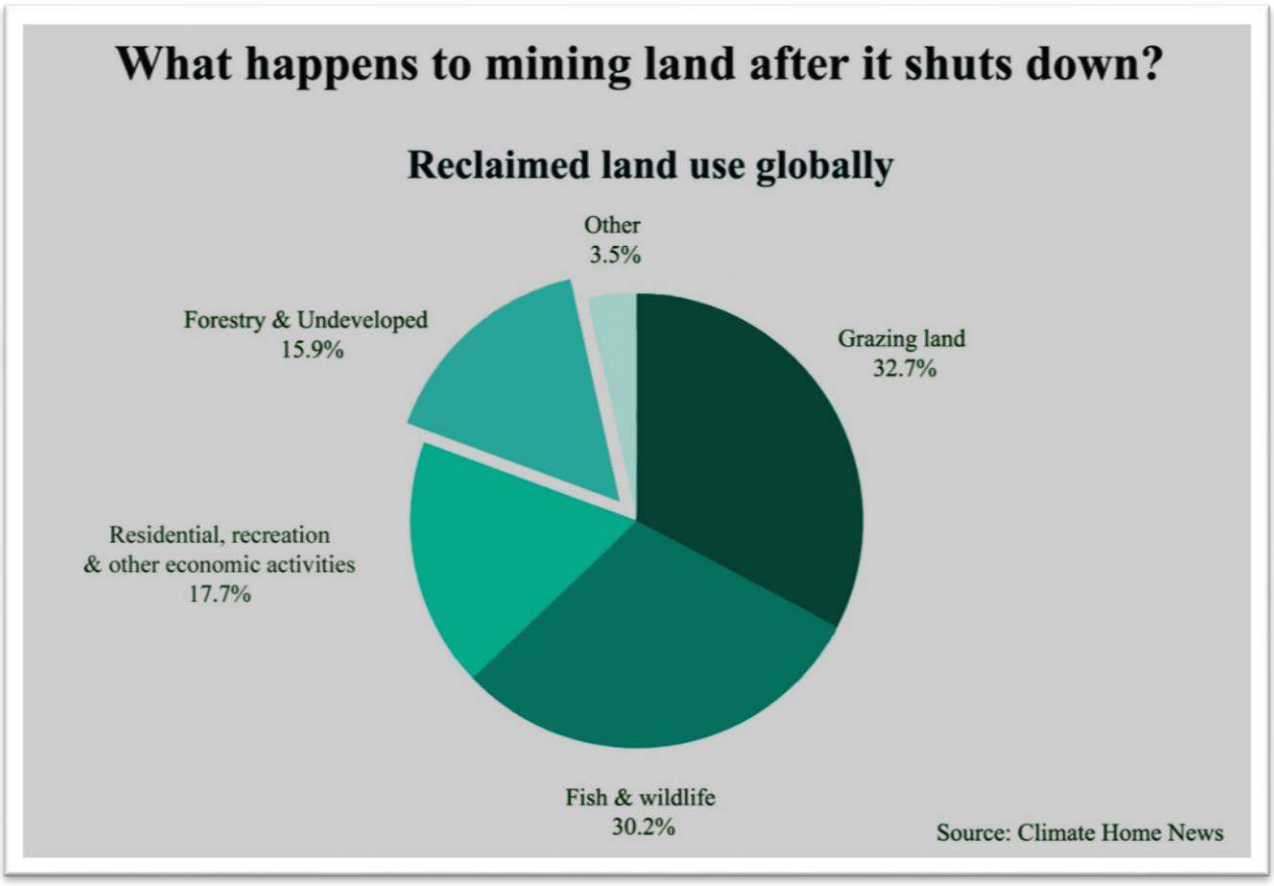
Land restoration projects are meant to address the adverse environmental impacts caused by coal driven activities and return the sites to a productive or usable state. Typical examples of post mining land uses include pastures, agricultural lands or croplands, forests and wildlife habitats, innovation centres, educational, sport and leisure facilities, residential use and other industrial activities. Many mined lands are restored as (native) grasslands, which are not used for any productive activity (e.g. food production and pasture) or recreational purpose; and hence they do not deliver any added value to the local community. It is also possible a restoration programme to include more than one land uses; for instance, to provide a combination of recreational facilities with natural parks or commercial activities. In a broad classification, post mining land uses can be categorised as follows (Table 3).

Table 3: Potential land uses following mine closure

Land use	Description
Forestry	Create foster lands for the long-term production of wood, wood fibre or wood-derived products.
Agriculture	Agricultural use in the form of croplands, pastures, hay production, fodder for livestock, and grazing land.
Recreation	Land used for leisure time and sports activities. This includes the creation of recreation facilities such as parks, camps, amusement areas, and sports centres, as well as structures for less intensive uses and activities such as hiking and canoeing. This type of restoration may include innovation and business support centres, theme paths, concert and conference halls, and laboratories.
Wildlife habitat	Land restored to increase habitat quality that will help to maintain biodiversity and safeguard wildlife. In situations where natural habitats have been destroyed completely from mining activities and coal extraction, restoration can be used to recreate them.
Water resources	Land used for storing water for beneficial uses, such as stock ponds, irrigation, fire protection, flood control and water supply.
Industrial	Land dedicated to industrial and commercial activities; either in the secondary sector (manufacturing, processing, and wholesaling) or in the service sector including hotels, restaurants, and other commercial facilities.
Residential	Land restored to provide housing opportunities to local community in the form of multiple family housing, mobile home parks or other residential lodgings.
Grassland	Previously mine lands restored as (native) grasslands without any productive activity (e.g. food production and pasture) or recreational purpose.

Figure 2 shows what happens to the land (post mining land uses) after coal mines shut down, as investigated and documented by the Institute for Journalism & Natural Resources (IJNR) and the European Climate Foundation. The majority of former mine areas are restored as grazing land, followed by interventions to safeguard wildlife, conserve natural resources and protect natural habitats.

Figure 2: Share of post mining land uses (source: Climate Home News)



2.4 Environmental restitution needs and land planning requirements

Environmental restitution needs

There are several compelling reasons for regions to promote restoration activities in areas affected by coal driven activities. Restoration needs contain not only environmental improvements and enhanced ecosystem services but also considerable economic potential and growth opportunities that can prompt regions to move away from an economy driven by fossil fuels and resource intensive activities. Land restoration can contribute to the transformation of degraded landscapes into resilient, multifunctional assets that boost economic activity and support local employment. From an environmental perspective, bringing degraded land back into a productive and usable state can essentially improve soil fertility and decrease erosion, strengthen food and water supplies, maintain biodiversity and preserve ecosystem services, foster carbon sequestration and improve the quality of life in post mining communities. To sum up, the environmental needs pursued to be covered through land restoration can be classified into 3 broad categories; a) carbon storage and sequestration, b) biodiversity and ecosystem services, and c) water quality and food supply.

- **Carbon storage and sequestration.** Mining activities cause changes in soil structure & properties and severely destroy vegetation, leading to large-scale carbon losses that affect landscape's environmental quality. Restoring former coal mines can help to capture carbon dioxide from atmosphere and store it in the soil and rehabilitated vegetation if appropriate reclamation techniques and post-reclamation management strategies are applied. This requires a thorough and detailed analysis of the different possible post-mining land uses (according to local specificities), to choose the one that will maximise carbon storage and sequestration. For instance, the establishment of vegetation (in the form of green spaces or recreational centres such as golf course), as natural reservoirs of carbon dioxide (by creating green spaces), will essentially increase the sequestration of CO2 below ground, thus mitigating the rising levels of atmospheric CO2, and associated impacts of global climate. Other options include to create opportunities for carbon farming, promote rock solutions and foster reforestation.
- **Biodiversity and ecosystem services**. Even though it is very difficult to return a closed coal mine into its previous ecological state by fully recovering the original ecosystem, reclaimed lands nevertheless may improve habitat quality to maintain biodiversity and safeguard wildlife or in situations where natural habitats have been destroyed completely, restoration can be used to recreate them. Furthermore, restoration can be used to re-establish connections between different habitats that were fragmented due to mining activities, by enhancing the linkage of existing natural landscapes or wildlife corridors. Potential environmental benefits also include enhanced ecological functioning and ecosystem services such as water supply, crops safety, pollination, carbon storage,

erosion control and less vulnerable ecosystems to climate change effects and other menaces (e.g. invasive species, habitat loss, and overexploitation).

- **Water quality and food supply.** As already mentioned, the full range of benefits from restoring post mining land depend on the circumstances of the land's use and its previous ecological state. Increased water quality and food supply/security can be seen as restoration's most common achievements. Mining, by its nature, consumes, diverts and can seriously pollute water resources. Mining activities affect negatively the quality and quantity of fresh water resources; on the one side through the excessive consumption of water in processing and coal treatment, and on the other side through groundwater contamination and pollution as drawn from discharged mine effluent and seepage from tailings and waste rock impoundments. Statistics show that water pollution caused during multiannual mining activities may need several years, even decades, to be managed and returned into a good environmental state. Land restoration in watersheds can effectively lead to water quality improvements, in the virtue of declining sulphate concentrations and chloride levels, and removal of any contaminant and waste residuals & impoundments polluting groundwater aquifers. Mining sites, depending on land suitability and driven by local community's economic interests, may be reclaimed to croplands or pastures, to enhance economic activity and food production. Nevertheless, such a restoration intervention requires appropriate engineering measures and reclamation techniques to remove the waste rocks and tailings that contain heavy metals and pose a serious threat to food security/safety and human health. Restored landscapes can also offer increased fodder for livestock, particularly in dry climates.

Land planning requirements

Successful post mining land restoration requires long-term planning and participatory decision-making processes that reflects local community's needs and emerging socioeconomic challenges and focuses on strengthening the resilience of landscapes, recovering ecosystem services, and creating future options for sustainable territorial growth. Regulatory authorities usually mandate mine closure and post mining land use plans before a mining permit is granted to a construction or coal mining company. These plans demonstrate how coal related activities will influence the natural environment, prescribe actions to minimise adverse environmental impact and eliminate threats to human health, and plan the next day following the closure of mine sites or the decommissioning of coal power plants by addressing contamination and post mining land uses. Certainly, restoration is a forward-looking and dynamic process that cannot be determined at a mining designation stage as many aspects will change over time. On the contrary, restoration strategies require multi-year vision of the ecological functions and benefits to human well-being, and proactive risk management to adapt to changing societal needs and address latest technological developments. To sum up, planning for restoration usually abides by the following guiding principles:

- **Focus on landscapes rather than individual sites.** Actions should be revolved around entire landscapes as opposed to individual sites. This entails connecting a diverse range of independent land uses in areas affected by coal driven activities, taking also into account the surrounding environment (e.g. settlements) and key production activities. Land restoration should be seen as part of a broader spatial planning process to promote sustainable development and social welfare, rather than a standalone activity.
- **Foster environmental restitution and reconvert land's functionality.** The primary focus should be on restoring the functionality and environmental status of the landscape in question by returning the land back to its previous form, or looking into possible options for other (post-mining) productive uses (what is called repurposing). This also includes efforts to establish a rich habitat environment, prevent erosion and flooding and withstand the impacts of climate change and other disturbances, caused by mining activities.
- **Allow for multiple societal and economic benefits.** Planning should aim at creating a suite of ecosystem goods/services that will sustain or enhance employment and growth potential, increase social welfare and quality of life, and keep a good environmental status. For instance, trees and plants can be added nearby agricultural sites to enhance food production and diminish erosion.
- **Leverage a suite of strategies and post-mining land uses.** The restoration plan should identify, on first analysis, a number of potential restoration options that comply with territorial specificities and adjacent to regional situation. Coming up with a shortlist of socially, technically, technologically and economically feasible interventions will require the results from environmental, economic and technical analyses as well as consultation with key stakeholders and civic society.
- **Justify further mining activities.** Moving on from the above principle, fostering environmental restitutions and addressing environmental damage entails a different growth pathway that abides by sustainability principles and leads to decarbonisation. This means that further mining activities in the site must be adequately justified and other options for the area need to be considered.
- **Fit to local conditions and growth priorities.** As noted above, restoration plans need to fit local social, economic and ecological contexts as there is no "one size fits all". Population, topography, structure of economy, employment, societal and cultural issues are all factors that needs to be assessed when developing a restoration strategy.
- **Manage adaptively.** Planners should be ready and prepared to adjust restoration planning over time as environmental conditions may change the geophysical state and properties of the site, new technologies may create new opportunities for restoration and policy developments may alter growth priorities, shifting focus from established economic activities to new and perhaps more innovative ones (e.g. from primary sector and agriculture to tourism). This requires continuous monitoring, learning, flexibility and readiness to make the necessary adjustments as the restoration process progresses.

3 METHODOLOGY OVERVIEW

3.1 Study objectives

This research activity pursued the following objectives:

1. Comprehend the socio-economic context that could best facilitate environmental restitution and land restoration in DeCarb territories.
2. Establish the picture of territorial reality (situation at hand) with regards to environmental restitution and land restoration needs for coal intensive DeCarb project.
3. Pinpoint drivers and barriers to the implementation of post mining land restoration interventions.
4. Identify post mining land uses that are technically feasible and can essentially contribute to setting forward an alternative, sustainable route for local economies.

3.2 Research details and study areas

The identity of this research activity can be summarised as follows:

- **Thematic focus**: Territorial needs on environmental restitution and land restoration in former mine sites
- **Contributors**: Participating organisations in the DeCarb consortium
- **Data collection method**: Secondary (desk) Research
- **Data collection instrument**: Input documentation forms

Data collection lasted 6 months, from 1 April to 31 September 2019, to secure a critical mass of evidence required for the needs analysis and facilitate the appropriate completion of input documentation forms from project partners. The Ministry for Economic Affairs, Labour and Energy of the State of Brandenburg (MWE) was the organisation in charge of coordinating data collection, informing about delays or shortcomings, and guiding partners on how to retrieve relevant territorial evidence. The needs analysis presented in this report was conducted for the geographical areas under the administration (or operation) of partners' organisations, as presented in the following table. The analysis covers 7 out of 9 territories represented in the DeCarb project. The Region of Extremadura (Spain) and the Municipality of Aalborg (Denmark) were excluded from the analysis. The former has managed to phase out coal generation and use covering its energy needs entirely with renewables, and the latter has no coal mines on its territory while the only operating coal fired power plant will be decommissioned by 2025 and the post coal plan is already in place.

Partner	Study area	Fields/Plants
Ministry for Economic Affairs, Labour and Energy, State of Brandenburg	Brandenburg	"Jänschwalde" and "Welzow-Süd" coalfields - "Jänschwalde" and "Schwarze Pump" Power Plants
South-West Oltenia Regional Development Agency	South West Oltenia	Oltenia Energy Complex
Regional Association of Local Governments of Western Macedonia	Western Macedonia	West Macedonia Lignite Centre
Stara Zagora Regional Economic Development Agency	Yugoiztochen	"Maritsa" East Mining and Energy Complex
Energy Agency of Savinjska, Šaleška and Koroska Region	Savinjska	"Velenje" Coalfield - "Šoštanj" Thermal Power Plant
Łódzkie Region	Łódzkie	"Bełchatów" Coal Field – "Bełchatów" Power Station
Eszak-Alfold Regional Energy Agency Non-profit	Eszak-Magyarorszag	Visonta" and "Bükkábrány" coalfields - "Mátra" and "Oroszlány" power plants

3.3 Needs analysis factors

For the needs analysis, factors pertaining to the socioeconomic structure, environmental quality, legal conditions, land planning requirements and funding availability, and which are inherently associated with coal driven activities, were examined.

1. Economy. Taking into account the economic implications of coal driven activities, this needs analysis area meant to outline DeCarb territories' current economic and development profile and guide the industrial restructuring process in the pathway towards decarbonisation. It allowed to evaluate the economic losses expected from stopping coal related activities, including the effects on other sectors of the economy. The following variables were considered:

- Role of coal in regional economy
- Regional economic strategy and growth priorities
- Key industries and economic activities

- Impact of stopping coal activities on other economic sectors

2. Employment. It is frequently overlooked that decarbonisation measures (such as the shutdown of mining activities) are usually associated with negative impacts on employment and socioeconomic conditions of the regions that host coal driven activities. This needs analysis area focused on direct employment in the coal industry (taking also into account additional parameters such as indirect employment; i.e. employment in sectors dependent or related with coal driven activities and the impact of mine closure or power plant decommissioning on local employment. For instance, the impact of a permanent interruption of coal driven activities is higher in regions and communities where the share of coal jobs amongst the economically active population is higher. Relevant information allowed to identify the magnitude/size of the industry and most importantly estimate the degree to which local economies are dependent on coal driven activities. The following variables were considered:

- Direct employment in the coal mine site or coal power plants in the site under examination
- Indirect employment in coal related activities
- Impact of power plant decommissioning on employment
- Impact of closing coal mines on employment
- Impact of job losses (coal phase out) on regional unemployment

3. Legal framework. This needs analysis area attempted to examine how the prevailing legal, policy and institutional arrangements in partnership territories can support or hinder the design and implementation of mine reclamation activities. The analysis looked at the extent to which existing legal conditions are conducive to scaling up restoration efforts or creating substantial barriers to relevant initiatives. It helped to answer the essential question of "which legal requirements must be attained by mining companies with regards to the termination of mining activities and restoration of degraded landscapes?" The following variables were considered.

- Mining laws
- Mine closure obligations
- Legal arrangements that support post-mining land restoration
- Legal arrangements that hinder post-mining land restoration
- Mine reclamation requirements set out in legislation
- Federal and local responsible institutions

4. Environmental restitution. Returning a degraded landscape into its previous ecological and natural state requires an assessment of the environmental pollution caused by coal driven activities in the region (e.g. air pollution, water contamination, biodiversity loss). Especially, with regards to large areas typically affected such as surface/underground coal mines, large scale intervention is needed upon mine closure to mitigate environmental damages and bring the landscape into a usable form. This needs analysis area aimed to a) outline regions' environmental profile, b) identify the different types of

environmental damages caused by coal driven activities in the site, c) assess the magnitude (severity) and geographical extent of impact, as well as the capability of the environment to return to a capacity or condition equivalent to the baseline after impact ceases. The following variables were considered:

- Types of environmental degradation from coal driven activities
- Magnitude of environmental damage caused by coal driven activities
- Geographic extent of environmental impact
- Reversibility
- Emissions of air pollutants related to coal driven activities
- Priorities for the environment

5. Funding. This involved the identification of the different types of finance and resourcing options that can be used to support restoration interventions. It is rational that the more a restoration programme will benefit key economic sectors, the more opportunities and more easily to attract private funds, and more an intervention provides societal benefits and employment opportunities for the local community, the better the chances to attract more public support, and share from the regional or even the national budget. Possible funding sources for restoration investments may be Regional Operation Programmes (ROPs), Special Development Programmes, European Energy Efficiency Fund, EU Bodies and Programmes (e.g. European Bank for Reconstruction and Development, European Investment Bank, Horizon 2020), PPPs and direct private investments. The necessary funds may also come from targeted fiscal interventions such as fossil fuel levy, auctioning of air pollutant emission allowances, and administration duty form large hydro power units. The following variables were considered:

- Regional budget
- Additional funding sources

6. Mine closure and reclamation companies. This needs analysis was devoted to mine closure and reclamation companies. Partners performed a SWOT analysis to pinpoint the needs of the sector, which are widely regarded as key factors for the design and successful implementation of land restoration projects. This was realised by identifying the strengths and weaknesses of reclamation companies and exploring the opportunities and threats that may exist in the wider environment. The "strengths" component examines the intrinsic assets and characteristics of a business, including the areas where a reclamation company performs particularly well, as well as the availability of resources (e.g. machinery/equipment, specialised staff, investment capital, previous experience) to support the initiation/implementation of land restoration projects. Weaknesses comprise attributes and resources that work against a successful outcome. These elements put up additional barriers to land restoration project. Weaknesses may include lack of specialised expertise and machinery, lack of geospatial data, insufficient financial resources and limited previous experience in reclamation projects. Opportunities include the external factors that a reclamation company can capitalise on to successfully implement a reclamation project in the area. Such factors may be the existence of a regional decarbonisation

strategy, open and transparent procurement methods, and funding programmes for reclamation projects. Threats refer to the unfavourable conditions and obstacles that may jeopardize companies work in post mining land reclamation. External threats may include market instability, unfavourable economic conditions discouraging large-scale investments, lack of political willingness towards decarbonisation and resistance from local communities which are largely dependent on coal driven activities. The following variables were considered:

- Availability of reclamation companies
- Strengths
- Weaknesses
- Opportunities
- Strengths

7. Land planning. Land planning refers to the process of managing the development of land to accommodate for the present and future needs of the community while preserving the natural environment. Land planning was a key element of the needs analysis process, involving the collection and documentation of site specific data for the area under examination as well as any other restoration-relevant information that would help determine post coal land uses such as previous land uses, land use constraints (e.g. geology, soil fertility, proximity to watersheds), and dominant land use surrounding coal related fields. This needs analysis area was critical to conclude with a number of post mining land uses that are physically possible and have the highest value for local communities in DeCarb territories, based on environmental conditions and priorities for economic development. The following variables were considered:

- Former land uses in mine sites & coal power plants
- Post coal land use constraints
- Dominant land use surrounding mine sites and coal power plants
- Potential for renewable energy generation
- Potential for tourism and recreation
- Possible post mining land uses

3.4 Key success factors for land restoration initiatives

The methodology also included a self-assessment exercise[2] (as part of the needs analysis) in which partners were asked to evaluate the extent to which a number of factors considered key enablers for land restoration, are in place in their territory.

This type of assessment was employed to assist DeCarb partners to identify whether their territories are adequately prepared to develop restoration strategies and highlight the areas/fields in need of targeted measures and improvements. The factors considered critical to the successful development of restoration activities are classified into three broad themes.

- **Motivation**. Policy makers, landowners, economic actors, stakeholders and citizens should be aware about the necessity to accelerate post mining land restoration, the benefits associated with decarbonisation, and motivated to support relevant interventions each from their side. This implies that the transition to clean energy and green growth pathways is as a key regional priority that has gained the support and approval of local community.
- **Enabling conditions**. A range of environmental, market, policy/regulatory, social and institutional conditions need to be in place to facilitate the establishment of a favourable, enabling environment for post mining land restoration.
- **Capacity and resources**. Land restoration is a resource intensive activity that does not require only significant financial resources but also intellectual capital, technological readiness and leadership, to implement post mining land restoration on a sustained basis.

The following table presents the different themes and factors evaluated in the context of the present needs analysis.

[2] This exercise is based on the Restoration Diagnostic Tool [7], created by the International Union for Conservation of Nature (IUCN) and World Resources Institute (WRI), and constitutes a major component of the Restoration Opportunities Assessment Methodology (ROAM). ROAM provides a flexible framework to promote and implement restoration programmes and landscape-level strategies.

Theme	Feature	Factor
Motivation	Benefits	- Land restoration creates economic benefits - Land restoration creates societal benefits - Land restoration creates environmental benefits - Land restoration provides opportunities for sustainable development
	Awareness	- Green economy awareness among companies - Public awareness on green economy and its potential benefits - The benefits associated with decarbonisation are widely known - Opportunities for restoration are identified
	Legal requirements	- Legal framework on post mining land restoration exists - Law regulating active coal mines and requiring land restoration exists - Restoration regulations are widely enforced
Enabling conditions	Environmental conditions	- The extent of environmental degradation makes land restoration feasible - Plants and animals that can impede restoration are absent - Native flora and fauna are readily available
	Market conditions	- There is increasing demand/interest for the degraded land - Market reforms to make smooth the transition to a post coal era are being implemented - Green market segmentation is developing
	Social conditions	- Local community can benefit from restoration opportunities - Local community participates in decision making concerning restoration
	Institutional conditions	- Integrated planning for land restoration exists - Roles and responsibilities are clearly defined - Effective cross-department coordination is in place
Capacity & resources	Leadership	- Political commitment towards decarbonisation exists - Transition plan to a post coal era exists
	Knowledge	- Geospatial data is available - Restoration know-how exists - Collaboration schemes with environmental agencies and knowledge institutes are in place - Collaboration schemes between mining companies and conservation bodies are in place
	Finance	- Incentives to shut down coal driven activities are provided - Investment capital for restoration interventions is readily available

4 NEEDS ANALYSIS RESULTS

4.1 Brandenburg (DE)

Geography

Brandenburg is one of the 16 federal states of Germany and one of the 5 new states created in 1990 after the reunification of the former West Germany and East Germany. It is situated in the east of the country, bordering with Poland, Saxony, Mecklenburg-West Pomerania, Saxony-Anhalt and Lower Saxony. Brandenburg covers 29,654 km^2 and is home to 2.500.000 inhabitants [8]. Its capital is Potsdam.

Economy

In 2017, Brandenburg's Gross Domestic Product (GDP) was estimated at 69.5 billion euros, representing approximately 2.2% of the national total [8]. The average annual growth rate of the region for the period between 2008 and 2017 was 2.9%, slightly above the national annual average growth (2.6%). Regional GDP per capita, expressed in purchasing power standards (PPS) reached €26,100 in 2017, significantly below the national average (€36,000).

The energy sector is major driver of economic development and one of the largest sources of income and employment in the region, accounting for almost 27% of the regional GDP [9]. Notably, the GDP of the Lusatian mining region (encompassing both Brandenburg and Saxony districts) was estimated at 31.4 billion euros [10]. Coal driven activities (i.e. mining, quarries, and electricity production) contributes a large share in the total product, accounting for approximately 13%. Real estate, financial and insurance services and construction combined represent approximately one fourth of Lusatia's GDP, followed by public services with a similar percentage. Wholesale and retail trade, transportation, accommodation, catering services and ICT account for 18%. The manufacturing sector follows with 17% while the primary sector (agriculture, forestry and fishery) account for less than 1%.

The regional strategy to boost economic growth and raise local income levels, foresees investments in Research and Development (R&D), creating competitive economic structures and integrating low-carbon technologies into existing value chains. To this end, the Regional Operational Programme includes actions in 4 priority areas:

1. PA1 - Strengthening applied research, development and innovation
2. PA2 - Strengthening SME competitiveness
3. PA3 - Reduction of CO2-emissions in all economic sectors
4. PA4 - Integrated development of urban and rural areas

Employment

In Brandenburg, the labour force is amounted to 1.2 million people, 3.0% of national total in 2017 [8]. Most residents are employed in the tertiary (service) sector (75.3%), 22.5% work in secondary sector (industry and construction) and less than 2.2% in the primary sector. Brandenburg has an unemployment rate of 4.5% in 2017, which is above the national average (3.8%). Over 4,500 people are employed in the coal mines and adjacent power plants in South East Brandenburg. Most of them work as mining and power plant engineers, specialists for soil, water and environmental protection and industrial mechanics. Throughout the coal value chain in Germany, the number of indirect jobs dependent on and supporting coal driven activities is estimated to 20,000 [2]. Notably, according to LEAG (mines and power plants operator), around 3,300 partner companies supply goods and services in the Lusatia's mining fields [11].

The coal industry

Brandenburg is one of the main energy producers and exporters in Germany. More than one tenth of the energy currently consumed in Germany is generated in the state of Brandenburg. With a mix of renewable and conventional energy, Brandenburg is now considered the most reliable supplier of affordable and environmentally friendly electricity in the country.

The region was once East Germany's coal mining centre, and communities strongly identified with their coal industry. Since the 19th century, Brandenburg emerged as an industrial region, with substantial production of lignite and electricity. The first mine was started in 1844, along with briquette factories that compacted the lignite into burnable bricks, and related manufacturing and metallurgy industries. Brandenburg, very soon, became one of the most coal intensive regions in Germany. The total mined area was approximately 85,000 hectares. Lignite was being extracted mostly through open pit mining operations (open cast mines of 100 meters depth), which had direct and visible impacts on land surface and ground composition and affected severely regional climate and water quality [12].

Despite the commitment and efforts made by the State to phase out lignite and coal fired power production in the area, Brandenburg remains one of the largest coal regions in the country, in terms of output (34 million tonnes) and power plant capacity (4500 MW). Notably, the Lusatian mining area in South East Brandenburg is one of the 4 most intensive coal mining areas in Germany. Brandenburg hosts two of the four opencast mines located in Lusatia; the "Jänschwalde" and "Welzow-Süd" mines. These two open cast mines, operated by the energy company LEAG, contain approximately 450 million tonnes of lignite. LEAG also operates 2 lignite-fired power plants; namely "Jänschwalde" and "Schwarze Pump" with a combined capacity of over 4500 MW at an annual basis that are connected with the adjacent mine sites through a 350-km rail network. The following table presents key facts for Brandenburg's active mine sites and power plants.

Mine site / Power plant	Key facts
"Jänschwalde" coalfield	• Mine Type: Open pit mine • Size: 80 km^2 • Type of coal: Lignite • Annual production (raw coal extracted): 9.1 Mt (2018) • Depth of coal deposits: Around 95m • Start of operations: 1974 • End of operations: expected in 2023
"Welzow-Süd" coalfield	• Mine Type: Open pit mine • Size: 108 km^2 • Type of coal: Lignite • Annual production (raw coal extracted): 21.8 Mt (2018) • Depth of coal deposits: Up to 120m • Start of operations: 1959 • End of operations: expected in 2030 (although a decision on further expansion is pending)
"Jänschwalde" power plant	• Installed capacity: 3,000 megawatts • Annual electricity production: 19.5 billion kWh • Net efficiency: approx. 35-36% • Years of operation: 27 years
"Schwarze Pump" power plant	• Installed capacity: 1,600 megawatts • Annual electricity production: 11.6 billion kWh • Net efficiency: approx. 34% • Years of operation: 27 years

Expected impacts on employment & economy

According to government's estimations, around half of the jobs directly or indirectly related to coal driven activities are expected to be lost, following the interruption of mine operations and the decommissioning of power plants in the area. Many of these jobs that require hard skills specific to coal related operations, may become redundant in the post coal era. The total number of job losses can reach 3500, leading to a 26.7% increase in the region's unemployment rate. It is estimated that the unemployment rate will eventually raise from 4.5% to 5.7%. In Lusatia, the economy is largely reliant on coal driven activities and the GDP per capita is 27% lower than the national average; indicating a relatively weak and undiversified economy. In addition, the shrinkage of the coal sector will inevitably

affect a group of other economic sectors related to coal driven activities. The sectors expected to be mostly affected are:

- The steel industry, which exhibits significant dependency on the competitive supply of electricity from local coal power plants; further to this coking coal is a vital ingredient in the steel making process.
- Mechanical engineering especially equipment manufacturers, who provide machinery and auxiliary systems essential for coal mining activities. In fact, equipment and machinery costs represent a large share of mining investments.
- Electrical and Electronic Engineering Industries, supplying electric devices, electronic and computing infrastructure to local coal mines and power plants.

Notwithstanding the above, Brandenburg is expected to experience a relatively low to moderate social impact with the possibility to absorb jobs at risk on medium to long term.

Legal and institutional framework

In Germany, lignite planning and post mining land uses are regulated (addressed) by spatial development and land planning policies, with responsibilities shared at 4 administrative levels (4 tiers spatial planning system); national (Bund), state (Lander), regional (Regionale) and local (Gemeinden). At the federal state, spatial development and land use planning is regulated by the Federal Regional Planning Act (ROG). The ROG outlines the framework principles and administrative procedures for spatial regional planning in the country.

The German Federal System follows a decentralised approach in spatial planning where legislative, administrative and executive competencies are largely delegated to the Federal States. Based on the ROG, the Federal States (Länder) have enacted their own planning laws for the areas that fall into their jurisdiction. In general, the State Planning Acts set the priorities for sustainable and inclusive regional development over a time period of 10-15 years and are meant to guide the development of corresponding land use plans. They also regulate spatial planning procedures and assign competencies at lower levels. The ROG provides States with the flexibility to decide whether spatial planning issues (incl. lignite plans) will be (exclusively) addressed by the State authorities or relevant functions/responsibilities can be also assumed by regional (counties) or local councils (decentralised level). Typically, States employ spatial plans at two levels; at state and county/regional (Landkreise) level. Regional plans are usually set aside to address the distinct characteristics and specificities of different regions/counties within the state, and must be compliant with the priorities defined in the State Planning Acts.

Lignite mining, as part of the spatial and land use planning system, is regulated by dedicated brown coal plans, which may be developed either at state or regional/local level by special lignite committees.

These committees are made up of those stakeholders that interact directly or indirectly with the management and/or use of the territory through their decisions and activity, and may be affected (positively or negatively) from lignite mining operations. These may be representatives from State authorities, regional authorities and municipalities, trade unions, chambers of commerce, professional associations, knowledge institutes, environmental organisations and civic society groups.

Brown coal plans are intended to determine the requirements and framework conditions for lignite extraction operations in designated mine sites. They cover all 3 phases of mining: exploration, extraction and reclamation. This means that post-mining land restoration is an integral part of the spatial planning procedure. The requirements for lignite extraction (e.g. demarcation of mining areas, type and depth of mining, displacement of communities, infrastructure and facilities deployment, relocation of traffic routes) and the restoration and environmental restitution of the wounded landscape (either once mining operations have been completed or while they are in progress) are specified in these plans, which are largely site-specific in order to reflect local environmental and development needs. As lignite plans have a long term scope – for instance extraction processes in an open cast mine may exceed 40 years – they are subject to updates and revisions so as to adjust to changing conditions and thus can effectively address the contemporary land restoration and environmental restitution needs.

The Federal Mining Act (Bundesberggesetz – BBergG), which is the primary legal basis for mineral extraction operations in the country, foresees that the granting of a mining concession permit shall meet the requirements foreseen by the State Planning Acts and be in accordance with regional/local lignite (brown coal) plans. In Germany, it is state authorities' jurisdiction to issue mining exploration and concession permits. State authorities may grant a permit only after the approval of the operator's mining (operation) plan and the environmental impact assessment report. This assessment is made on the basis of the BBergG, State Spatial Acts, lignite plans, and other applicable laws such as the Federal Water Act (WHG), the Environmental Impact Assessment Act (UVP-G) and the Federal Nature Conservation Act (BNatSchG).

The requirements for the rehabilitation/restoration of former mine sites are also addressed in the initial planning permit. Mine operators must designate and submit to competent authorities a mine closure plan. If the prescribed actions are deemed as not sufficient, the mining authority may not approve the extraction, potentially asking for additional remedial measures together with corresponding reservations/guarantees for effective land restoration. Post-mining land restoration requirements typically include the uptake (by mine operators) of precautionary measures on post mining land use, site rehabilitation and environmental restitution, site safety, decommissioning, waste dumps and tailings ponds, site water management, off-site infrastructure, and community socio-economic programmes.

In Brandenburg, the authority responsible for spatial planning and development is the Joint Planning Department Berlin-Brandenburg (GL BB) as per the agreement signed by the federal states of Berlin

and Brandenburg in 1996, forming the German capital region. Spatial structure plans (including brown coal and rehabilitation plans) for the entire region or certain locations within the federal states are prepared by the Joint Planning Department, in collaboration with relevant authorities and entities from both states [13]. The main instruments for spatial planning in the German capital region are the state development programme and state development plan (LEP B-B).

In Brandenburg, lignite and rehabilitation (or else redevelopment) plans lie within the responsibility of the Joint Planning Department, with the state lignite committee and interested regional planning communities to advise and contribute in their development and approval, as foreseen by the Brandenburg Act on Regional Planning and Lignite and Redevelopment Planning (RegBkPlG). The state's (lignite) rehabilitation plans prescribe all the necessary actions to be taken on the part of mining operators (e.g. site water management, restoration of off-site traffic routes, public and site safety measures) for returning the wounded land into an environmentally sustainable and productive state, thus paving the way for future sustainable land uses. Most importantly, the rehabilitation plans determine at an early stage (before the issuing of permit) the most appropriate and desirable post-mining land uses for coal mined in accordance with federal and state spatial planning priorities as well as the regional and communal land use plans in place. For Brandenburg, the most common post-mining land use purposes include agriculture, forestry, recreation, conservation and lakes.

Lusatia: A source of inspiration for post mining land restoration

Brandenburg is a region advanced and experienced in land restoration with developed and standardised procedures for spatial planning and decision-making processes related to environmental restitution and land restoration in former mine sites. The recultivation technologies and post-mining concepts that have been so far used for the rehabilitation of Lusatia's former mining areas in South East Brandenburg are widely praised for their technical and organisational excellence, and considered best practices in post mining land restoration. Lusatia's experience can essentially act as source of great inspiration for other EU coal intensive regions seeking an alternative and more sustainable path for their economies away from coal and fossil fuels. For Brandenburg, lucrative growth opportunities in former mine sites were erected in the field of renewables and especially in the installation of hybrid and energy storage facilities and technologies. The Joint brand of Lausitz Energie Bergbau AG and Lausitz Energie Kraftwerke AG (LEAG) have effectively worked on several recultivation projects in the Welzow-Süd region with remarkable environmental and economic results, thanks also to the contribution and exemplary collaboration with pioneer scientific institutions from the region such as the Brandenburg University of Technology (BTU) and the Research Institute for Post-Mining Landscapes Finsterwalde (FIB).

Lusatia's regeneration program[3]

The Lusatian Lake District is one of the most cited and renowned mine reclamation projects worldwide. For Lusatia, the plan was to convert the abandoned mine sites into a lake district surrounded by croplands, green spaces and forest. The objective was not to return the site into its previous form but to create a natural landscape that will restore area's natural functions and ecosystem services, and most importantly improve citizens' quality of life.

A FLOATING HOUSE ON "GEIERSWALDER" LAKE, LUSATIA (SOURCE: THE GUARDIAN.COM)

LMBV, the Lausitz and Central German Mining Administration Company established by the Federal Government to handle restoration activities in former mine sites, worked in the mining region for more than 10 years implementing 30 reclamation and landscape development projects in total [14]. Through flooding, several decommissioned lignite opencast mines were transformed into recreational lakes, making what was previously a mined zone the largest artificial district of lakes in Europe. The district now covers an area of 80 kilometres across the states of Saxony and Brandenburg, and includes 26 artificial lakes of different size and use.

The majority of lakes are accessible and earmarked for several recreation activities such as water sports and cycling; some have been deliberately left undeveloped to protect wildlife and act as (protected) nature reserves. Around the two most developed lakes (Senftenberger and Geierswalder), it has been constructed a complex of facilities, geared to families and visitors, offering a virtue of accommodation and food and beverage services (e.g. restaurants, cafes, hotels, campsites, floating rental apartment) as well as leisure time and sports activities such as fishing and horse riding to quad-biking and diving. In addition, old power plants and briquette factories have been rehabilitated and are now open for the public. Visitors may opt for an organised tour in monumental facilities, where they can travel back to time and experience industrial culture.

Restoration interventions also included replanting forests, creating fishing communities in lakes, making agricultural land, and constructing marinas and other recreational facilities such as exhibition centres and towers for gazing over the former mines. The regeneration project process did not go without

[3] Retrieved from DeCarb A3.2 - Input Paper for the study visit on post mining land restoration in Brandenburg, Germany (prepared by the Ministry for Economic Affairs, Labour and Energy of the State of Brandenburg).

problems. The decades of mining activities have created severe environmental damages that requires many years to heal in the absolute level. The major concern was related to water quality, and more especially acidification resulting from mining-induced pyrite oxidation. The Company needed to take targeted interventions (engineering and mechanical processes) to remove iron hydroxide dislodged and harmful chemicals from the soil and phosphorus and other pathogens from lake water. Lusatia's regeneration programme is recognised as a success story and acts as an inspiration for other coal mine restoration projects. The total estimated cost, so far, exceeded 2.2 billion euros and new interventions and projects are planned for the area.

The results achieved are particularly impressive. The region has successfully recovered its previous ecological functions; fish have returned colonizing the artificial lakes by way of new canals that didn't previously exist or were too acidic to support life; new economic opportunities have been erected (e.g. sustainable tourism, agriculture, clean energy); more than 500,000 tourists stay overnight annually and visits have a constant growth rate of 10%; citizens enjoy a healthy natural environment and more employment opportunities [15]. What is more, the Lakeland carries a huge symbolic value as concerns the country's commitment to decommission all nuclear and coal power stations in an ambitious push towards clean energy (by 2038).

LMBV – The Lausitz and Central German Mining Administration Company

The Lausitz and Central German Mining Administration Company (LMBV, https://www.lmbv.de/) is a public owned company established in 1994 by the Federal Government with the mission to coordinate the decommissioning and reclamation of coal mine sites and support the re-structuring of mining operations in the Lusatian and Central German regions. LMBV is primarily concerned for the environmental restitution of degraded landscapes, the safety and welfare of local settlements/populations and ultimately the conversion of former lignite mining areas for new, constructive and environmentally sustainable uses. For over 25 years LMBV has successfully reclaimed over 100 worked out coal mines in Eastern Germany.

LMBV, as project executor legally responsible under the Federal Mining Law, is responsible for rehabilitation planning (in concert with decentralised brown coal committees) and oversees the execution of reclamation works by contractors. LMBV main competencies comprise the planning and solicitation of tenders, contract awarding, fund allocation, project control and coordination and the official turnover/acceptance of completed remediation work [16].

In addition to the above, LMBV draws up flooding and water-treatment concepts, with the objective of achieving sustainable enhancement of water quality in the newly formed mining lakes. LMBV also monitors environmental performance and adopt measures to mitigate the impacts and dangers associated with the raising of the groundwater level in the former mining areas (as a result of

groundwater resurgence). These include the safeguarding of endangered infrastructure facilities, the implementation of hydraulic engineering and construction measures for outlet channels (e.g. construction of wells), and compensatory measures (in the form of financial support) for those mostly affected from the restoration of former water levels. LMBV conducts additional measures to upgrade watercourse connections in the Lusatian and Central German Lake Districts and finances boat mooring facilities, bicycle paths, and other infrastructure to foster sustainable tourism development. To secure soil stability and fertility, the Potassium, Spar, and Ore Department of LMBV implements safety measures to safeguard the underground workings of potassium, spar, and ore mines.

In addition to the above, LMBV is charged with the management of over 30,000 hectares (other than those restored for nature conservation) of restored surface area and adjacent fields. This area is available for economic exploitation by public and private investors; however restricted for specific use(s) as those are defined in state and regional spatial and land use plans. This offering primarily includes newly created areas suitable for industrial and commercial parks, residential building, streets, paths, and highways, agriculture and forests, leisure and rehabilitation projects and nature reserves. In the marketing of such real estate, LMBV places priority on the settlement of industry and commerce activities, in an attempt to offset the negative impacts from the shutdown of coal driven activities on local employment and income.

Over this 25-year period, LMBV has achieved remarkable results. From the 18 open-cast mines, 23 Briquetting Plants and 23 Thermal Power Plants that were operating in Lusatia in 1989, only 4 mines and 4 plants are now still active. LMBV has demolished installations, equipment and buildings of over 18 million of tonnes, proceeding also with the compaction of 1.167 billion m^3 of masses to secure the stability of 1.200 km dump slopes. So far, the Mining Administration Company has restored over 17,000 hectares of previously mining land in Lusatia. Some 11,000 hectares of land were afforested with native deciduous and coniferous species helping to avert the biodiversity loss of previous years; and more than 1,600 hectares of land have been re-cultivated for agricultural and pasture purposes. To restore a balanced water supply in the region, LMBV has so far extracted and used over 7 billion m^3 of underground and surface water resources to flood old mines and refill aquifers, applying also advanced treatment methods to secure PH neutralization and decrease harmful substances into water bodies. Through the replenishment of groundwater aquifers and flooding from the outside, it has been possible to compensate for more than three-fourths of the groundwater deficit. What is more, new technologies and advanced water plants have been deployed for the treatment of iron-hydroxide contaminated waters, and for preventing the inflow of acid groundwater into rivers. Overall, most of the contaminated sites have returned into a good environmental status and are now utilised for other productive uses. Former open open-cast mines develop into attractive tourist destinations and post mining landscapes serve as public areas for nature conservation and recreation. Remarkably, the creation of a dynamically developing market for rehabilitation is also an ongoing success story.

Funding

As mentioned, mine operators are legally bound to fund with own capitals the restoration works prescribed in the mine closure operation plans to follow the termination of mining activities in the worked out sites. According to the German commercial law, mining companies must create reserves from the gains of extraction activities on an annual basis in order to secure the necessary funding for planned restoration works. For example, the cost for the regeneration program in the former "Cottbus-Nord" open cast mine will be fully covered by the mine operator "LEAG". The total cost is estimated at 250 million euros.

Beyond operators' contractual liabilities, the Federal Government has decided to allocate a respectable amount for post mining land restoration interventions in coal intensive regions. The Administrative Agreement (VAI) on Lignite Remediation (2018-2022) between the Federal Government and the states of Brandenburg, Saxony, Saxony-Anhalt and Thuringia outlines the (public) financial framework for the restoration of abandoned mine sites across the country. According to the Agreement, over 1.2 billion euros (out of which about 565 million in Brandenburg) will be allocated for lignite remediation the period 2018-2022. The Federal Government will contribute with 851 million euros while the rest will be covered by the states involved.

As regards Brandenburg, the State plans to allocate 212 million euros from the regional budget (for the period 2018-2022) for the rehabilitation of decommissioned lignite mines in the region; 162 million euros will be allocated for environmental restitution and public safety measures in 262 abandoned mine sites/facilities (where no restoration activities have been carried out by mine operators) and 50 million euros for infrastructure development. In total, 565 million euros (public funds) to be managed by LMBV will be used for restoration works in the State of Brandenburg between 2018 and 2022.

Mine reclamation companies

Currently, there are 2 mining companies in Brandenburg, which have established fully owned subsidiaries to undertake restoration works (as bounded by the Law) in the worked out mine sites; LEAG and LMBV. Other mining and reclamation companies operating in Germany are: DMT Group (www.dmt-group.com/), Wismut GmbH (www.wismut.de) and FAB Consulting (https://consulting-fab.de/). The following table presents the SWOT MATRIX for reclamation companies in the State of Brandenburg.

Table 4: SWOT MATRIX for mine reclamation companies in the State of Brandenburg (Germany)

STRENGTHS	**WEAKNESSES**
• Advanced machinery/equipment • Extensive mining reclamation experience • Diversified land restoration and environmental services • Skilful human resources • Investment capital for restoration interventions is readily available	• Difficult geospatial conditions • Schedule constraints • High cost investments
OPPORTUNITIES	**THREATS**
• Clean Energy strategy in place • Legal framework on post mining land restoration exists • Increasing demand for reclamation & environmental services in coal regions • New technology development • Funding programmes for land reclamation projects • Pressure from the public for phasing out coal and restoring degraded land	• Uncertainty over financial viability and market stability given the forward looking character of mine closure and reclamation plans • Bureaucracy (complex administrative procedures) concerning the initiation and implementation of land restoration projects

Former land uses and uses surrounding the mine sites/plants

The two coal fired power plants; namely "Jänschwalde" Power Station and "Schwarze Pumpe" Power Station were constructed in the immediate neighbourhoods of the towns of Peitz and Spremberg respectively. The Jänschwalde power station is located near the village of Jänschwalde (2 km away). The surrounding area is composed mostly by nature (forests, lakes), grassland, while several recreational activities take place in the broader surrounding area and closer to the city of Cottbus. The Cottbus-Drewitz Airport is very close to the power station in a distance of less than 4 km. The Brandenburg University of Technology and the football stadium "the stadium of friendship) are also located nearby, approximately 16 km away. The homonym adjacent open cast mine (very close to the power station) is surrounded by forests, grasslands and rocky surface.

Similarly, the Cottbus-Nord opencast mine is surrounded by forests, grassland and rocky surface. The surrounding area of "Schwarze Pumpe" power plant is made up of a unique combination of nature, recreation areas, culture, tourism and industry. The industrial park is not only situated in the heart of Europe but also in an attractive landscape providing a wide variety of recreational opportunities.

The former land uses in the sites where the power plants are now located cannot be precisely detected; however it is most likely that they were previously (economically) unexploited native grass lands. For open cast mines, there are more evidence that confirm the existence of settlements and local communities. Over the past century, 136 villages with over 30,000 residents in the Lusatia region have been partially or completely relocated to make way for open-cast lignite mines. The same happened in the communities/settlements and adjacent business facilities where Jänschwalde and Cottbus-Nord opencast mines are now operating. For instance, the village of Horno was demolished in 2007 and the Sorbian inhabitants were resettled from their community to a new location. In total, 5 villages were forced to resettle in Jänschwalde and 12 villages in Cottbus-Nord due to mining activities. New resettlements (affecting 1700 inhabitants) are also planned for the upcoming, projected extension of opencast mines in Jänschwalde.

Post mining land uses

Existing plans for land restoration

According to projections for post mining land uses in Jänschwalde and Cottbus-Nord opencast mines, a great expanse of these areas will be afforested with native/indigenous tree species such as pine, oak, maple, alder and beech. At the same time, new agricultural areas will be created to allow cultivation and pasture to flourish; thus providing new employment and income opportunities for locals. Further to these, in Jänschwalde, targeted interventions will be made to restore the Malxe River to its original river course. All these interventions are part of Lusatia's regeneration programme.

In fact, the opencast mine in Cottbus-Nord was permanently closed in 2015, according to the initial schedule. The mine operator, as forced by the Federal Mining Law, is currently working on reducing any interference with nature to the unavoidable minimum. Parallel to ongoing lignite mining activities, rehabilitation works have already begun on the areas already mined-out. According to rehabilitation plans[4], the proportion of land uses in the former mine site after restoration will be as follows:

- 53% woodlands
- 25% Water resources (biotopes and lakes)
- 10% agricultural land and pastures
- 12% other areas and infrastructures (e.g. roads, tracks and tourism/recreational areas)

In addition to the above projections, this section suggests a series of post mining land uses which can create alternative development routes for Brandenburg's economy. These uses are not associated with coal extraction and combustion, share substantial growth potential and low environmental impact, and

[4] https://www.leag.de/en/business-fields/mining/

can essentially contribute to offset the negative impact from coal phase out in terms of employment and local income.

Post mining land uses and activities with growth and employment potential

To start with, the potential for RES energy generation in Brandenburg's coal mine sites is extremely high. The average wind (14.41%) and solar (11.80%) availability factors for the Brandenburg State are above the EU average, favouring investments in RES developments [2]. Brandenburg is already a forerunner in RES generation. With an installed capacity of about 5,500 MW, Brandenburg is the second leading wind power state in Germany (as of 2014) [17]. Brandenburg also hosts the largest open-field solar parks in the country with up to 145 MW installed capacity. Overall nine of the ten largest solar power plants in Germany are located in the region. The potential for geothermal energy production is also identified at average 40 W/mK. In general, RES projects in former mine sites can aid with the re-employment of the skilled labour from the mining industry, contributing also to regional value creation and creating new job opportunities in trade and research.

The prospects for tourism growth in the State of Brandenburg are also good. The number of arrivals is increasing, the length of stay is satisfactory, the average daily spending is constant, and the number of significant tourist origins is going up. The number of nights spent at tourist accommodation facilities in the region will very soon exceed 4 million[5]. The demand for Brandenburg has been growing steadily despite the region has not yet an established reputation for its tourism offerings in the domestic and overseas marketplaces. Brandenburg has a combination of natural and cultural assets that render the region an attractive destination for families and thrill seekers. These include natural parks, aquatic ecosystems (e.g. lakes, rivers, and lagoons), historical structures, museums, local products and gastronomy, and wine routes.

Decarbonisation and land restoration recommended pathways

On 3rd July 2019, the German Ministry of Economics and Technology published its strategy to phase-out coal by 2038. This strategy includes development plans for affected regions, just transition measures for affected workers and local communities, and compensation payments to mines and power plants operators. As depicted above, Germany employs a decentralised approach in lignite planning and post mining land uses with responsibilities shared at different administrative levels. This means that states and regions will need to assume a vital role for the transition to a coal free era, setting the priorities for sustainable and inclusive regional development. The regions with coal related activities such as Brandenburg will receive financial support amounting to 26 billion euros in total so that they can proceed

[5] Ministerium fur Wirtschaft und Energie, Datenblatt zur wirtschaftlichen Entwicklung im brandenburger Teil der Lausitz, 2016

with the necessary structural changes to ensure that the transition to the post coal period will be as smooth as possible, and will have the minimum negative impact on local employment and income.

Brandenburg is a state advanced and experienced in land restoration, with developed and standardised procedures for spatial planning and decision-making processes related to environmental restitution and land restoration in former mine sites. To increase the rate of decarbonisation and further enable post mining land restoration, more emphasis could be placed on:

- Raising awareness on green economy and its potential benefits for local communities and private entities
- Providing incentives to mine operators to shut down coal driven activities. These can take the form of compensatory payments or a favourable tax regime for the transition period.
- Involving actors (e.g. environmental institutions, economic operators, citizens) who retain an interest in the area and will be directly or indirectly affected by future land use(s), in the discussions for the selection of post mining land uses.
- Pinpointing the major environmental problems caused by mining activities, and make targeted interventions to limit their extent.

4.2 South-West Oltenia (RO)

Geography

South-West (Sud-Vest) Oltenia is a development (administrative) region, located in Southwest Romania. The region has a surface of 29,212 km^2, covering 12.3% of the country's territory. South-West Oltenia is made up of 5 counties (Dolj, Gorj, Mehedinti, Olt and Valcea), and has a population of 1,973,140 inhabitants (Eurostat, 2018). The region is bordered by two natural "wonders", the Carpathian Mountain Range in the north and the Danube to the south, with fertile plateaus, rolling hills, forests and pastures in between.

Economy

South-West Oltenia is endowed with rich natural resources (lignite) and a hydrological network composed by the Danube and Olt and Jiu rivers, which have at a large extent shaped its economic identity as the main energy producer in the country. In 2017, the value of regional nominal GDP was €13.62bn, representing 7.3% of the national GDP [18]. Since 2013 when the regional economy has returned on a positive growth trajectory, the regional product has increased by almost 31% (cumulative growth) and the average annual growth rate for the period between 2012 and 2017 is 6.2%. South-West Oltenia, however, remains within the group of 20 regions with GDP per capita below 50% of the EU average. This is expressed as 13.600 PPS per capita (€6.500 per capita in euros); a figure which is 20% lower than the national average (17,000 PPS) and far below (55%) the EU average of 30.000 PPS.

The region is characterised by a large industry base and a highly diversified economy. The tertiary (service) sector accounts for the largest share (47.6%) of the regional output with wholesale, accommodation and catering services to generate €2.2bn, and public services to follow with almost €2bn [18]. The secondary sector, dominated by mining, energy production and automotive, represents 46.8% of the regional gross value added (€6.43bn). In 2017, agriculture contributed €751.58 million, accounting for 5.6% of the regional GDP.

The region's economic structure, mostly fuelled by agriculture, coal mining and the quarrying of granite and marble, varies significantly across the 5 counties [18]. More particularly, Dolj is strongly identified with traditional industries (e.g. automotive, tractors, cars, airplanes, agricultural and heavy machinery, oil and gas extraction, chemical industry, clothing, textiles, furs, leather, food and drinks), and is highly specialised in organic agriculture. Olt has a diverse industry where metallurgy (aluminium) stands out. Gorj's leading industry is mining and raw material processing but other industries such as electronics, electrical engineering, automotive, machine tools and food are also present and on the rise. Finally, Valcea has a strong chemical and food industry; other activities include coal, oil and salt exploitation, wood processing, footwear, textiles and clothing. In addition, Valcea enjoys the biggest potential for tourism development within the region.

The Regional Operational Programme (2014-2020) sketches the strategic directions for sustainable growth at regional level in Romania (incl. Sud-Vest Oltenia), placing particular emphasis on:

- Supporting the shift towards a low-carbon economy (Thematic Objective 4)
- Preserving and Protecting the Environment and Promoting Resource Efficiency (Thematic Objective 6)
- Taking actions to improve the regeneration and decontamination of brownfield sites (including conversion areas), reduction of air pollution and promotion of noise-reduction measures (Investment Priority 6e)

Employment

South-West Oltenia has an active labour force that amounts to 1.231.500 persons, which translates into an employment rate of 59.3%. According to the European Job Mobility Portal [19], the service sector accounts for 39.1% of the total employment, followed by agriculture, forestry and fisheries (30.7%) and secondary sector (industry and construction) with a share of 30.2%. The unemployment rate, as at 31 March 2019, was decreased compared to the previous year (when it was 7.7%) reaching 5.48%. The number of unemployed persons is now estimated at 46,800. This figure despite being above the national average (4.9%) is significantly lower than the EU average (7.6%). Notably, South-West Oltenia is the second ranked region (behind Śląskie, Poland) with regard to the number of coal related (direct) jobs. Over 13,000 people are employed in the coal industry in Sud-Vest Oltenia; 2600 in the 4 functioning coal fired power plants and 10,600 in the "Oltenia" coalfield. Further to this, the estimated number of indirect jobs related to coal driven activities at intra- and inter-regional level exceeds 13329.

The coal industry

South-West Oltenia is home to the largest lignite reserves in the country, around of which an energy complex of 10 mine sites (coal fields) and 4 power plants – all lignite based – has been deployed, delivering up to 80% of the country's coal based electricity and accommodating for around 30% of the total energy demand. The Oltenia Energy Complex (OEC), created in 2011 following the restructuring of the national power sector, features 4 coal fired power plants with a combined installed capacity of 3,900MW. The "Rovinari" Thermal Power Plant (TPP) consists of 4 units with an installed capacity of 330 MW each, the "Turceni" TPP has 4 units with 330MW each, the "Isalnita" TPP with 2 units and 630MW total capacity and the "Craiova" TPP with 2 units and 300MW total capacity. The coal fields in the complex can produce up to 34 million tonnes of lignite in 17 open cast perimeters and 2 underground operations. Most of this output is used by the adjacent power plants for the production of electricity and heat; the rest is provided to other energy providers such as COLTERM Timisoara, UATA Motru.

The "Turceni" thermal power plant, situated in Gorj County (South-West Oltenia) on the banks of the Jiu River, is the largest coal fired power plant in Romania, and one of the largest (still operating) in

Europe. The plant was designed to operate 8 units. The first unit was opened in 1978, and the last in 1987. From those, Units 1 (commissioned in 1978), 3 (1980), 4 (1981), 5 (1983), are still operational; Unit 2 was decommissioned in 1979 and Unit 8 was never completed. Unit 6 is to be overhauled while Units 4 and 5 have been already refurbished. Finally, Unit 7 shut down its operations in 2014, as failed to comply with legal operating conditions related to pollution limits. The plant became part of the Energy Complex in 2012. The following table presents key facts for the "Turceni" Thermal Power Plant.

Mine site / Power plant	Key facts
"Turceni" Thermal Power Plant	• Installed capacity: 1320 MW (as of 2019) • Annual electricity production: n/a • Net efficiency: 36% • Years of operation: 44

Expected impacts on employment & economy

Without a proper offset strategy, the region with GDP per capita almost 20% lower than the national average and ~13200 coal (direct) related jobs at risk might experience a high increase in the number of unemployed persons, which may reach 22%. This classifies South-West Oltenia among the EU regions to be most severely affected from the shutdown of coal driven activities, in absolute numbers. Nevertheless, the region given the low unemployment rate (5.48%) and the fact that the share of jobs at risk in economically active population is 1.1%, and despite the significant number of job losses, might experience a relatively low to moderate social impact with the possibility to absorb the decline in employment on medium to long term. The expected direct job losses in region's power plant operation based on the capacity projected to be decommissioned (and not replaced by new capacity) in the coming decade could reach 1981. This number, however, can be even higher in the incident of premature retirements, which may result either from operators' failure to comply with BAT emission requirements or as part of a national coal phase out strategy. According to Dias et al. (2018) [2], the capacity of power plants in the Oltenia Energy Complex likely to retire by 2025 is 450MW and by 2030 3065MW. This translates into 254 direct power plant jobs to be at risk in the first wave of decommissioning and other 1727 jobs to be impacted after the second and bigger wave of decommissioning in 2030.

The coal industry annual turnover is estimated at €600 million, representing 4.5% of the regional GDP and a vital source of income for rural communities, some of which are largely reliant on coal related activities and have a mono-industrial profile. The estimated net profits from coal driven activities in the region are over €42 million while a considerable share of revenues is attributed to the state in the form of environmental taxation (€800,000 annually) and another €130 million for the compensation of environmental damages and purchase of CO2 certificates. Inevitably, the closure of coal mines and

power plants will have a huge impact on the energy sector and subsequently to the country's security and self-sufficiency of energy supply. This is because the Oltenia Energy Complex is one of the major players in the energy sector, accounting for almost one third of the total electricity production in the country. In addition, the decarbonisation process may affect a number of other economic sectors and industrial activities, which are more or less dependent on the coal industry. These include the manufacturing sector, especially those businesses providing auxiliary equipment, machinery and spare parts critical for the operation of power plants, the tertiary (service) sector and utility companies, as well as the providers of transportation services (logistics and transportation of mineral extracts and mining equipment from coal field to the adjacent thermal power plants).

Legal framework

This section looks at the legal framework governing mining activities in Romania. The core legal mining provision is Law No 85/2003 (Mining Law) and its implementation guidelines. According to the Act, mining activities comprise the entire spectrum of activities before and after the execution of mineral extraction operations, starting from the reconnaissance, exploration and exploitation of mines to the trading of mining products, the termination of mining activities and environmental rehabilitation. Under Romanian law, mineral resources are exclusive property of the Romanian State regardless the status of land ownership. The exploitation of such resources requires the grant of permission by the National Agency for Mineral Resource (hereafter referred as mining authority) in accordance with the Mining Law. This includes concession rights for private operators and administration rights for public institutions. The following types of licences can be awarded for mining activities in a given designated areas ("block) under either concession or administration rights: a) prospect permit (for a maximum three years), b) exploration license (for a maximum five years), c) production license (for a maximum of 20 years), d) production permit (for a maximum term of one year).

The production license is awarded on an exclusive basis to national or foreign legal entities for the extraction of mineral resources in a specific block. The production licence may be either granted directly to the owner of an exploration licence (following bilateral negotiations) for the deposits of mineral resources discovered within the block, or to the winner of a public tender organised for this block by the National Agency for Mineral Resource. The difference between production license and production permit lies in that the permit is granted for the exploitation of a limited number of mineral resources. Typically, exploration and production licenses are granted via a competitive concession tendering procedure organised by NAMR during which bidders submit the proposed exploration schedule, technical operation plans (incl. land rehabilitation plan), and documents that demonstrates their technical and financial capacity. A production licence is awarded only after the relevant environmental impact assessment (EIA) is conducted and approved by mining authorities.

Under the National Law, contractors need to have in place comprehensive mine closure and recovery plans prior to the commencement of extraction activities. According to Article 52, titleholders need to submit an official request to NAMR for mine closure alongside with an updated closure and recovery plan that includes a) the reasons of closure based on technical and economic documentation, b) the detailed schedule of works for the restoration of degraded and contaminated land as well as a post-closure monitoring program, c) the social protection program to be employed for mitigating the negative impacts from the termination of extraction operations on employment, infrastructures and local income, d) environmental and water management authorisations for mine closure, and e) decommissioning and land vacating procedures. Notably, the Law foresees the establishment on the part of contractor of a financial guarantee, to ensure that all obligations in the environmental permit are financially secured and funds are available at any time for the rehabilitation of the site contaminated.

As already depicted, the competent authority for the application of the provisions of the National Mining Law is the National Agency for Mineral Resources. Its responsibilities include:

- Administration of mineral resources subject to public property.
- Negotiation and granting of licences and permits in the mining field.
- Enactment of secondary legislation.
- Supervision of compliance by beneficiaries of licences and permits and the applicable legislation.
- Establishment of royalties.
- Approval of exploration activities.
- Termination of mining activities.
- Professional certification.

To end with, a legislative proposal to replace the existing Mining Law was submitted for public consultation at the beginning of 2019. The draft legislation has raised significant debate and different concerns on mining activity in the country. On the one hand, the initiators and proponents of the new legislation claim that this reform will simplify the process of granting licences, enhance environmental protection aspects and impose the adoption of best available technologies in extraction processes. On the other hand, the legislative proposal has been criticised for providing significant powers to titleholders especially by simplifying the procedure by which a mining project may be declared of public utility.

Environmental restitution

The negative impacts of coal mining and lignite based electricity generation on the natural environment of the South-West Oltenia Region comprise the destruction of local ecosystems and agricultural land, extensive deforestation, biodiversity loss, underground and surface water pollution, soil degradation, ground contamination and dust pollution.

In 2018, the Oltenia Energy Complex generated 13.06 million tonnes of CO2 emissions, an amount which accounts for approximately 11.2% of the country's total emissions. In South-West Oltenia Region, coal pollution was responsible for 187 premature deaths [20]. In 2018, the "Turceni" Thermal Power Plant alone dumped around 700,000 tonnes of fly ash and produced 4.07 million tonnes of CO2 emissions, causing 87 premature deaths (ranked 39 among all European coal fired power plants). According to Beyond Coal Europe, coal driven activities in Romania was responsible for 520 cases of chronic bronchitis, 800 hospital admissions, 26,000 cases of asthma attacks in children, and 267,000 lost working days, amounting to an estimated €2 billion burden to the economy [20]. Notably, in May 2018, Romania was taken to the Court of Justice of the European Unions, for repeated failures to comply with air emission limits.

In addition to the environmental damages described above, the intensity and depth of excavation activities in the 10 coal fields of the Oltenia Energy Complex have led to the drainage and contamination of water resources, leaving entire villages without drinking and clean water. For instance, the wells in the village of Lupoaia have either dried out or are severely polluted; locals are dependent on tanks with clean water provided by the operator, as a form of compensation for the damage created. Further to this, landslides are regularly caused by improperly sealed-off mines happen whenever it rains, destroying people's properties and crops. In 2013, an accidental spillage of coal ash in Turceni destroyed 10 households and 15 hectares of agricultural land. Locals need also to stand the extended noise pollutions caused by mining operations (heavy machinery) and transportation of minerals and equipment.

Funding

Further to the financial guarantee required by contractors (i.e. mine operators) to assure that all obligations in the environmental permit are financially secured and funds are available at any time for the rehabilitation of the site contaminated, maintenance and restoration works in closed mine sites are also financed from the State budget. In 2012, the Romanian government, with the consent and approval of the European Commission, proceeded to the allocation of a €32 million state aid for the closure of 4 uncompetitive coal mine sites in the Jiu Valley, southwestern Romania. This amount, entirely covered from the state budget, was broken down into 4 priority areas; one of which was mine reclamation. Around €5.2 million were allocated for mine reclamation and landscape restoration works while the greatest amount (€19.8 million) was used to offset losses on current coal and energy production. Another source of funding for post mining land restoration initiatives could be the European Bank for Reconstruction and Development (EBRD). In 2013, the EBRD granted a €150 million loan for the rehabilitation and modernisation of the "Turceni" Thermal Power Plant, in an attempt to improve its net efficiency and reduce CO2 emissions by 300,000 tonnes per year. In 2019, the state budget foresees the allocation of around 7.5 million euros for the closure of non-competitive coal mines in the country, covering works for ecological revitalisation and environmental restitution. In addition, the Regional

Operational Programme 2014-2020 foresees funding for land restoration initiatives in former mine sites under Thematic Objectives 4 and 6; namely "TO4 - Supporting the shift towards a low-carbon economy in all sectors" & "TO6 - Preserving and Protecting the Environment and Promoting Resource Efficiency. In particular, the Investment Priority 6c supports actions to improve the regeneration and decontamination of permanently closed coalfields (including conversion areas), reduction of air pollution and promotion of noise-reduction measures. Beneficiaries of these types of activities are public authorities / other public bodies, including their subordinate structures, for historically contaminated sites owned or made available by the owner. To conclude, an estimation for the cost of mine reclamation and environmental restitution works in the Oltenia Energy Complex is not available. Further to this, Romania is continuing to prop up its ailing coal sector (coal is regarded as a sector of national interest and pillar of energy security), thus deferring the decision for region's decarbonisation in the long run.

Mine reclamation companies

There are 2 state owned companies that deal with the shutdown of coal driven activities in Romania, and hold substantial experience in mining and reclamation works; namely SC CONSERVIN, and The National Society for Coal Mines Closures Valea Jiului SA. These two companies operating under the jurisdiction of the Ministry of Economy are responsible for implementing the national mine closure policy. Their duties include managing state aid for mine closure, awarding public procurement contracts and overseeing land restoration and environmental rehabilitation works carried out by contractors to assess their compliance with contract provisions and land restoration requirements. The following table presents the SWOT MATRIX for mine closure and reclamation companies in Romania.

Table 5: SWOT MATRIX for mine reclamation companies in South-West Oltenia (Romania)

STRENGTHS	**WEAKNESSES**
• Extensive mining and reclamation experience • Diversified land restoration and environmental services • Skilful human resources	• Risk involved with government contracts
OPPORTUNITIES	**THREATS**
• Funding programmes for land reclamation projects	• Unfavourable economic conditions discouraging large-scale investments such as land restoration projects

Former land uses and uses surrounding the mine sites/plants

The remaining coal mining area in South-West Oltenia with associated power stations stretches over the northern outskirts of the Jiu valley. The Turceni Power Station is situated in Gorj County on the banks of the Jiu River and in the immediate vicinity of coalfields. Typical of the Jiu Valley is the agrarian environment, which is home to a rich flora and fauna biodiversity. The land surrounding coal sites are mostly covered by forests and meadows, agricultural land, green spaces and water bodies used for recreational activities, and settlement (urban) areas. Given the region's long coal mining tradition which goes back to the 19th century, the previous to coal era land uses cannot be easily identified; however it is most likely that they were previously forest and agricultural fields. The Jiu Valley suffers from extended environmental pollution as a results of industrialisation and intensive extraction activities that have been taking place in the area for over 150 years. Constraints to land restoration include intense wind or wind erosion, instability, acidity or alkalinity excessive nutrient deficiency, poor water regime, inhomogeneity accentuated, too large slopes, too big bumps. Miocene and Pliocene formations interlayers of fine sandy marls, sands, gravels, clay interspersed with packages layers of variable thicknesses, scrapped material and non-selective storage leads to a mineralogical and granulomere structure, which varies from one dumpster to another and especially in inside the same dump. Due to the friable, non-cohesive lithological substrate, the dumps are strongly exposed to surface and deep erosion; Soils on the dumps are not evolved, being formed on sterile landfills, devoid of distinct horizons. The humus layer is missing, but the presence of small amounts of clay and organic matter (scattered fossilized coal) makes the waste dumps totally devoid of features of fertility.

Possible land uses

Post mining land uses and activities with growth and employment potential

The Jiu Valley was once an economic powerhouse, producing millions of tons of coal and contributing several million to the regional economy. Now with most of the mines in the region to have ceased and decarbonisation process in progress, South-West Oltenia is in the quest of new growth opportunities to mark the post coal era. The post mining land uses that are physically feasible and exhibit the higher value for the local community include renewables, tourism and agriculture.

Renewables can be a viable and reliable alternative source of energy to contribute to region's energy security and supply whilst ensuring social and economic prosperity in the region. The potential for RES energy generation in South-West Oltenia coal sites is very high given the availability of substantial solar and water resources. The region has favourable sun exposure. It can benefit from an average annual energy flow of 1275 kWh/m^2. In South-West Oltenia, the average solar capacity factor is over 14%, much higher than the EU average. Therefore, the conversion of former mine sites and coal fired power plants for the production of solar energy can be a viable and particularly attractive alternative source of energy. Water resources are also abundant in South-West Oltenia. Thanks to its extended hydrological

network made up of the Danube, Olt and Jiu Rivers, South West Oltenia has emerged as the main energy producer in the country, accounting for more than 70% of total hydropower production. The examined coal areas (after closure) can also act as low-enthalpy geothermal resources, to be used for small to medium scale power generation and for heating and cooling purposes. They are located in areas with relatively high temperatures at depth, as demonstrated by the several thermal spas found in the region. Overall,

In South-West Oltenia, tourism is one of the fields with an attractive potential which can be further unleashed by utilising its strategic geographic location and the natural wealth of the Carpathians and the Danube River. The region has a rich diversity of natural features that include protected areas, natural parks, mountains, caves, non-polluted rural areas, mineral waters and spas. For instance, the Jiu Valley (the country's former largest coal mining area) is distinguished by wonderful landscapes, an exceptional river basin, and a very ancient history and culture. In the region, there are 6 declared health resorts: Baile Govora, Baile Olanesti, Calimanesti-Caciulata, Horezu, Voineasa and Sacelu; while more centres are currently undergoing the process of authorisation as health resorts. The presence of diverse and special historical, folkloric, religious and cultural elements (with coal related industrial heritage to hold a prominent place), creates also the premise for the development of diversified forms of tourism.

Agriculture is one of the main pillars of the regional economy with an annual turnover of over 750 million euros (5.6% of the regional GDP in 2017) and high growth potential. The sector also accounts for almost half (49.8% in 2017) of the total employment [18]. South-West Oltenia features large areas cultivated with energy plants, especially in the Dolj and Olt counties, which gives the region a competitive advantage and substantial potential to build on regional assets and resources to foster smart specialisation. Notably, South-West Oltenia is now ranked second in the country regarding the orchard and fruit tree nurseries cultivated areas.

Decarbonisation and land restoration recommended pathways

Though the EU has vowed to gradually phase out fossil fuels, Romania exhibits a stronger than ever pro coal stance with limited at the time being interest to change the current status quo in the country's mining regions such as South-West Oltenia. Coal currently covers about a third of domestic energy demand and while the national energy strategy foresees a diminishing role for coal, a coal phase out looks far from imminent. In contrast, the Romanian government has plans for the construction of a new 600 MW unit at Rovinari, Gorj County that will substitute the two recently decommissioned units. The situation is further exacerbated by the fact that the Romanian coal sector is one of the most polluting in Europe. None of the coal based power plants in the country comply with the Industrial Emissions Directive and most of them are operating without an environmental permit. Furthermore, even though over the last two decades a series of coal mines were closed in the country due to a lack of competitiveness, little has been made so far to utilise the restored land for other uses and create

sustainable economic alternatives that would help to sustain the socioeconomic fabric of local communities, affected by the termination of coal driven activities. Therefore, Romania is in a dire need to:

- Build country's commitment for a low carbon economy and elaborate on a phase out coal and just transition plan with targets and milestones for the permanent termination of coal driven activities in the country, including measures for environmental restitution and land restoration in worked out areas.
- Align the national mining legislation with the EU Industrial Emissions Directive, and include clauses for sustainable environmental management. These may take the form of a) requirement for the preparation of a waste management plan prior to the commencement of the extraction, b) permitting schemes for harmful activities, c) Environmental Impact Assessment (EIA), and d) the deposit of a financial guarantee by mine operators to act as an insurance for the funding of mine reclamation cost.
- Set forward a coordinated and integrated approach and procedures to assess possible and alternative land uses, which should not be constrained to cross sectoral collaboration of competent public administrations but involve all those actors (e.g. environmental institutions, economic operators, citizens) who retain an interest in the area and will be directly or indirectly affected by future land use(s).

4.3 Western Macedonia (GR)

Geography

The Region of Western Macedonia, situated in the North – Western part of Greece, is one of the 13 administrative regions of the country. Western Macedonia is a landlocked region, bordering with Albania to its west and with North Macedonia to its north. It occupies an area of 9,451 km^2 and its population is around 280,000 inhabitants (2017). With 30 inhabitants per km^2, Western Macedonia is one of the less populated regions in Greece. The region, distinguished by its mountainous surface, is endowed with rich natural resources such as fossil fuels (lignite) ores (asbestos, chromite, marble etc.) that have shaped its identity as the primary and most important energy production centre in Greece. Administratively, the region consists of 4 regional units (Kozani, Grevena, Kastoria and Florina) and 16 municipalities. The capital and largest city of the region is Kozani with 53,880 inhabitants.

Economy

In 2017, Western Macedonia's Gross Domestic Product (GDP) was estimated at 4 billion euros, representing 2.22% of the national total [21]. The average annual growth rate for the period between 2001 and 2009 was 5.1%, while during the years of economic recession, this rate was decreasing annually by 3.4%, rendering the region as one of the most affected by economic crisis. The regional GDP per capita, expressed in purchasing power standards (PPS), reached €17,200 in 2017, a figure below the national average (19,700) and the EU-28 average (29,200).

Energy production through lignite combustion constitutes the main pillar of regional economy with an annual turnover of around 1.5 billion euros. The energy sector accounts for almost 39.4% of the regional GDP and is the largest source of local income and employment in Western Macedonia. According to the Hellenic Statistical Authority (ELSTAT), in 2015, the secondary sector, which is primarily identified by lignite mining and electricity production, accounted for 47.9% of the regional output. The tertiary (service) sector followed with a share of 45.5% while the primary (agriculture) sector represented only 6.7% of the regional added value. The economic structure of Western Macedonia differs in terms of sectoral production and employment from the national model, which is largely dependent on services and trade. Remarkably, at national level, the economy is dominated by the service sector which accounts for almost 80% of the national GDP, followed by industry (16%) and the agricultural sector whose contribution to the national economic output is estimated at no more than 4%.

In Western Macedonia, industrial and manufacturing activities (apart from mining and power production) concern traditional sectors including renowned regional products such as marble, saffron, fruits, local wines, furs and leather manufacturing and specialised arts and crafts. In the services sector, retail and wholesale trade, tourism and public administration services are the most important sub-sectors in terms of value added while health and financial intermediation sectors are gradually growing in importance.

Western Macedonia is admittedly characterised by a weak and undiversified economy, low competitiveness and high unemployment. The recent economic crisis coupled with the absence of foreign direct investments, the declining manufacturing activities and the worsening environmental conditions (from decades of unsustainable mining and energy production activities) has amplified the structural pathogens of the regional economy, bringing to the fore the need for restructuring the economy towards higher value added and more sustainable economic activities. The industries that can play a driving role in the economic development of the region are agri-food, renewables, fur farming and tourism. To overcome the above challenges and boost economic development and employment in Western Macedonia, the Regional Operational Programme includes actions in the following key national development priorities.

- PA1 - Strengthening research, technological development and innovation
- PA2 - Improving the access, use and quality of information and communication technologies
- PA3 - Improving the competitiveness of small and medium-sized enterprises
- PA4 - Support the transition to a low-carbon economy in all sectors
- PA5 - Promoting adaptation to climate change, risk prevention and management
- PA6 - Preservation and protection of the environment and promotion of resource efficiency
- PA7 - Promoting sustainable transport and removing bottlenecks in core network infrastructures
- PA8 - Promoting sustainable and quality employment and supporting labour mobility
- PA9 - Promoting social inclusion and combating poverty and all forms of discrimination
- PA10 - Promoting social inclusion and combating poverty and all forms of discrimination
- PA11 - Investing in education, training and vocational training for skills acquisition and lifelong learning

Employment

In 2018, the unemployment rate is Western Macedonia was 27%; the highest rate among the Greek regions and the second largest in the EU-28, after the Autonomous city of Ceuta in Spain (29%). Western Macedonia is also ranked second in youth unemployment with a rate more than twice (62%) that of total unemployment in the region [22]. This rate can be attributed on the one hand to the effects of multi-year economic recession when over 20% of regional firms have been closed and economic activity has dropped by 40% and on the other hand to the de-industrialisation of the Greek economy over the past decades and the migration of labour intensive industries and firms to neighbouring low taxation countries (e.g. Bulgaria). The economically active population (sum of employed and unemployed people which form the region’s workforce) in Western Macedonia amounts to 110,000 people. The sectoral distribution of the regional employed workforce is as follows [21]. In absolute numbers, around 53,000 people are employed in the tertiary sector (59.6% of the total employment), 15,000 in the secondary sector (23.9%) and 12,500 in the primary sector (16.5%).

Mine-owners (The Public Power Company – PPC) is a major employer in the region. Mining and electricity generation activities account for 38.2% of the regional GDP and 6.3% of the total employment. Around 5700 persons are directly employed in the coal industry by the Public Power Company; 4283 in mine sites and 1398 in coal fired power plants. This figure represents 45.9% of job positions in the secondary sector, without taking into account the indirect employed created by coal driven activities. According to Dias et al. (2018), throughout the coal value chain, the number of indirect jobs in coal-related activities at intra- and inter-regional level may exceed 5,200 positions [2].

The coal industry

Greece is among the EU countries with high dependency on coal for its energy supply. Coal, despite its production and use is declining in Greece, retains a key position in the country's energy mix, accounting for over half of the total energy production. Western Macedonia, with eight of the nine remaining lignite mines on its territory, is recognised as Greece's energy centre. The region has a long standing tradition in lignite mining and coal based power production. The first excavations in Western Macedonia took place in 1939 following the publication of a study by German Professor F. Kegel, who confirmed the availability of rich lignite reserves in the region. The total sum of confirmed lignite reserves that can be exploited for energy generation in the country is estimated at 3.2 billion tonnes. The largest deposits (approx. 1.8 billion tonnes) are located in Western Macedonia. The mining area stretching over the Kozani - Ptolemaida - Amyntaio - Florina axis constitutes one of the largest lignite reserves in Europe.

The region features an energy complex (known as West Macedonia Lignite Centre) with 8 mine sites (coal fields) and 4 power plants (Agios Dimitrios TPS, Kardia TPS, Ptolemaida TPS and Amyntaion TPS); all lignite based. The mining area has coal reserves amounting to 1.82 billion tonnes of lignite and the annual production reaches 40 Mt. The lignite produced in the eight opencast mines is supplied to the adjacent coal fired power stations for the production of electricity. The 4 lignite fired power plants, made up of 12 units, have a combined capacity of 3,401 MW. They represent 40% of thermal units and 20% of the total installed capacity of the interconnected system in Greece. Overall, coal power plants are inefficient and old with an average plant age of 31 years.

In Greece, while the cost of extraction (2.12 euros per ton) is the lowest in Europe, lignite-fired power production is exceptionally costly estimated at 59.9 €/MWh when in Germany is 53.6 €/MWh, in the Czech Republic 39.0 €/MWh, in 38.6 €/MWh in Poland and 31.6 €/MWh in Bulgaria. This is mostly because of the extremely low calorific value of Greek lignite as well as other variable production cost variables.

Mine site / Power plant	Key facts
Lignite Centre of West Macedonia	• Mine Type: Open pit mine • Size: 160 km^2 • Type of coal: Lignite • Coal depth: 175 m • Annual production (raw coal extracted): 37.9 Mt (2017) • No. mines: 8
"Agios Dimitrios", "Kardia" , "Ptolemaida" and "Amyntaion" Power Plants	• Installed capacity: 3,401 megawatts • Annual electricity production: 7,700 GWh • Average Net efficiency: 30% • Years of operation: 31 years • End of operations: n/a

Expected impacts on employment & economy

The projected shrinkage of coal driven activities in the Region of Western Macedonia, which foresees the closure of coal fields and the retirement of approximately 3,500 MW of lignite capacity by 2030, will eventually cause a loss of 6,128 jobs and will deprive 1.14 billion euros from local economy. This will further deteriorate the poor socioeconomic conditions in the region that is already a champion in unemployment and have been harshly affected by the economic crisis. Western Macedonia with one of the largest unemployment rates in the country (27% in 2018) and a GDP/capita 25% lower than national average is expected to confront severe social impact, if an additional 3.5% of active population will be at risk of losing its employment status due to the closure of coal mines and coal fired power plants. According to a study conducted by the Technical Chamber of Greece (2013), for every one permanent job position provided by the Public Power Company in the mines and production stations, additional 2.6 jobs are created and preserved in the local economy. For every €1 spent on salaries and contract works, more than €3 are added to the local economy business cycle inductively. The gradual shutdown of coal phase out may affect a group of other interrelated activities and sectors that are vital for local communities' sustainability and prosperity. These mostly include distinct heating operation, which is based on lignite power plants supply, transportation and fuel market, companies providing auxiliary services to the Public Power Company and the Local Development Financial Source sustained by PPC and finances a wide range of local projects.

Legal framework

In Greece, mining operations are presently regulated mainly by the Mining Code (Legislative Decree 210/1973, as amended by several Laws) and the Regulation on Mining and Quarrying activities (Ministerial Decision 12050 of 2011), which cover issues regarding the safety and health of workers and local residents, the protection of the environment and the right way to perform mining activities. Additionally the forestry legislation as well as the EU legislation on the environmental impact assessment, the NATURA habitats, and the management of waste of the extractive industries, address a range of environmental issues, pertaining to the execution of mining exploration, extraction and reclamation operations.

According to the Law, the right of exploiting mineral resources is reserved to the Greek State. Still, private entities may acquire a mining permit after a license is granted by the State. The owner of the mineral rights has the exclusive right to explore, excavate the earth, extract and exploit any or all the minerals lying above or below the surface of the ground. Mineral rights can be obtained by concession from the State, by hereditary rights, by transfer or lease. To obtain a mining permit, one should submit to the Regional Authority a techno-economic analysis which defines the site of the mines, a geological study, the mineral deposits, the necessary constructions and all budget considerations. The application is transferred to the Ministry of Environment, which is the competent authority to issue the Presidential Decree granting the mineral rights.

Mining is valid for a limited period of time, strictly constrained to the designated site and is bound to the restoration of the site to its previous state. The State in concert with the mine operator is bound to adopt special preventive or repressive measures for the preservation of the environment taking into account sustainable development. On this note, candidate mine operators must submit an environmental impact study (together with an ecological assessment) in order for an environmental permit to be issues and then commence with exploration and extraction activities. The environmental permit is valid for 10 years or longer if the project has environmental management systems in place.

The Law foresees that the mine operator shall take during and beyond extraction operations all the necessary measures to prevent or reduce as far as possible any adverse effects on the natural environment and human health from mining activities. This includes the management of any waste facility, also after its closure. The operators must rely on best available techniques to minimise the risk of extended environmental pollution and proceed with protection measures, taking into account the technical characteristics of the waste facility, its geographical location and the local environmental conditions.

Apart from the Mining Code, land reclamation works and environmental restitution processes are also regulated by the Law 1650/89 (http://www.fdparnonas.gr/files/1650-1986.pdf), the Presidential Decree 148/2009 (https://www.e-nomothesia.gr/kat-periballon/pd-148-2009.html) and the Law 4042/2012

(www.e-nomothesia.gr/kat-periballon/apobleta/n-4042-2012.html). The institutions responsible for monitoring and maintaining the restoration of coal mining areas are:

- Public Power Corporation SA
- Ministry of Environment and Energy
- Environmental Department of the Region of Western Macedonia
- Environmental Department of decentralized administration of Epirus & Western Macedonia

Environmental restitution

The scenery in the mining area is kind of post-apocalyptic with a sprawling black landscape to span over 625 square miles, with a few deserted villages to break the monotony in Western Macedonia's mainland. Ash and dense clouds of smoke from burning lignite cover the sky over the 160 square kilometres Lignite Center.

Actually, Western Macedonia is among the regions with the higher emissions of air pollutants in the EU-28; PM10 emissions are above 3 kt per year (3.18 kt in 2017), NOx exceed 15 kt (17.1 kt in 2017) and SO2 are above 20 kt (26.5 kt in 2017). In Western Macedonia, recent measurements show that the European limit values for air pollutants are exceeded by more than 20%. The PM10 levels were exceeded by 3% in the settlement of K. Komi, 20% in Kozani, 31% in Ptolemaida, 42% in Florina and reached a peak of 43% in the village of Anargyroi.

Coal driven activities in Western Macedonia have also a negative impact on soil fertility and water resources. Soil quality and stability within and around coal mining areas have been substantially deteriorated, primarily due to the removal of vegetation and topsoil cover and the dumping of waste materials. To cover its water needs for the operation lignite units, the Public Power Company abstracts water from surface and underground freshwater resources such as the Polifitos Lake, the Aliakmonas River and the Sarigiol basin leading to the drainage and contamination of water resources (heavy metals), and in certain cases leaving entire villages without drinking and clean water.

According to regional records, 7 out of 10 deaths in the region come from cancer or thromboembolic diseases (stroke, stroke, pulmonary embolism), and which can be largely attributed to coal. Remarkably, cancer incidents in the region have been increased by 30.5% since 1960 when coal driven activities commenced; life expectancy is also declining in the region. A study conducted by Bodosakio Hospital found that the inhabitants of Ptolemaida were three times as likely to suffer from allergic rhinitis as the average Greek. According to Beyond Coal Europe [20], in 2018, the West Macedonia Lignite Centre generated over 22 million tonnes of CO2 emissions, accounting for 22.9% of Greece's total CO2 emissions. In Western Macedonia, coal pollution was responsible for 180 premature deaths.

Funding

The Region of Western Macedonia seeks to follow an alternative route for its economy, which for decades is being severely undermined to supply coal based electricity to the entire country. The regional strategy towards a coal free era in Western Macedonia places particular emphasis on:

- Decreasing fossil fuel dependence.
- Enriching region's productive baseline with innovative and competitive activities.
- Fostering capacity building and human resource skills development in areas directly linked to region's competitive advantages and smart specialisation areas.
- Enhancing environmental sustainability and improving daily living conditions for local population.

Two financial schemes are in place in Western Macedonia, to support the transition to a low carbon economy and foster land restoration and environmental restitution in areas severely affected by mining activities.

1. **Regional Development Fund of Western Macedonia**. Established in 2016 by the Western Macedonian Regional Council, the Fund reached its operational status in 2018. It is co-funded by the Public Power Corporation, through compensatory supporting actions, and the Hellenic Fund for Entrepreneurship and Development. The Fund aims to support local SMEs at regional level in the form of small low interest loans to expand their business activities in areas with substantial added value to the local economy. The Fund will allocate more than 10 million euros to support the implementation of at least 200 innovative business plans.
2. **National Just Transition Fund**. In January 2019, the Greek government established a National Just Transition Fund to support coal-affected communities in their efforts to wean off their dependency on fossil fuels and build strong, resilient, and diversified new energy economies. The Fund is planned to be financed using 6% of annual revenues from auctioning emissions allowances, and over a period of three years will support activities in six priority areas including renewables, energy efficiency, land restoration, circular economy, industrial heritage and re-skilling of workers.

Mine reclamation companies

The Public Power Company, controlled by the Greek government, is the biggest power company in Greece and the entity responsible for mine reclamation (in concert with its sub-contractors) in the West Macedonia Lignite Centre. Other construction companies providing environmental management, engineering and reclamation services in the country are MESOGIOS SA (https://mesogeos.gr/), TERNA SA (www.terna.gr/en/), GREEN PROJECTS SA (www.green-projects.gr) and KERGON SA. The following table presents the SWOT MATRIX for mine reclamation companies in Greece.

Table 6: SWOT MATRIX for the Greek reclamation companies

STRENGTHS	WEAKNESSES
• Extensive mining and reclamation experience • Skilful human resources	• Limited scope of reclamation and environmental services
OPPORTUNITIES	**THREATS**
• Legal framework on post mining land restoration exists • Increasing demand for reclamation and environmental services in coal intensive regions • Open and transparent procurement methods for reclamation services	• Market instability • Unfavourable economic conditions discouraging large-scale investments such as land restoration projects • Bureaucracy (complex administrative procedures) concerning the initiation and implementation of land restoration projects

Former land uses and uses surrounding the mine sites/plants

Before the mines were opened in Western Macedonia, the site was surrounded by forests, grassland and rocky surface, and people were mostly farming. Many settlements in the Western Macedonia Region were forced to relocate to make way for mining activities and the deployment of lignite based power stations. Kardia was the first village of the Region to be relocated. The relocation began in 1972 and was completed in 1976, involving 692 people. In 1979, 300 people were relocated from the Eksohi settlement and 1,228 people from the Haravgi village. The latest relocation concerned Klitos village while two relocations are now in process. The surrounding area is composed mostly by nature (forests, lakes), grassland, agricultural land and urban agglomerations established to support the operation of lignite extraction and electricity production processes in a distance of over 250 metres of mine sites and power stations.

Post mining land uses

Existing plans for land restoration

The Public Power Company, as forced by the Law, has already in place a land restoration programme for the mining area in Western Macedonia which is implemented concurrently with extraction and power production activities. According to the Environmental Impact Assessment (EIA), the restoration works are expected to be completed by 2053. The plan foresees the restoration of 81% of the total area while the proportion of land uses in the former mine sites will be as follows: 5,374 hectares of forests (46% of the total restored land), 5,015 hectares of cultivable areas (45%), and 1,167 hectares of lakes (9%). To date, more than 7 million trees have been planted at restored areas in the Lignite Centre of West

Macedonia while the currently restored areas amount to 27.3% of the total mining area. The budgeted cost of closing down and environmentally remediating the sites of the Ptolemaida Mines for the period between 2009- 2020 is estimated at 13.2 million euros.

Post mining land uses and activities with growth and employment potential

This section recommends possible post mining land uses, focusing on the development of economic activities that are not related to lignite extraction and combustion, are of a sustainable nature, share substantial growth potential and can contribute to offset the negative impact from coal phase out in terms of employment and local income.

The **primary sector** has traditionally been one of the main pillars of the Western Macedonia's economy. In 2016, agriculture accounted for 6.7% of the regional GDP, contributing 255 million euros to local economy. Over the next years, agriculture is expected to be one of the most dynamic and high-growth sectors thanks to the competitive advantages offered by the Greek natural ingredients and climate and hence can acquire a dominant position in the new post coal economic reality. Cultivated area in Western Macedonia currently amounts to 210,400 hectares while further 5,000 hectares will be made available for cultivation purposes after the projected by PPC restoration of mines sites. From saffron and aromatic plants to legumes, vineyards and apples, Western Macedonia is well-known for the production of unique and best quality agricultural products. The region is home to many certified products that hold a prominent place in domestic and international markets such as feta cheese, Kozani saffron, Amyntaio wines, beans of Prespes and Anevato Cheese. A recent study conducted by WWF [23] suggests that over 7,500 new agricultural related job positions will be created in Western Macedonia by 2021 while the processing potential of many of WMR's agricultural products can also contribute to job creation in the secondary sector (especially food manufacturing).

Forests that make up over half of Western Macedonia's territory can be a viable solution for the post coal era, in an attempt to enhance environmental sustainability in the region, which has been suffered from extended environmental pollution and degradation caused by decades of mining and coal fired electricity production. Forests can provide a series of valuable ecosystem services such as soil generation and protection, water resources protection and carbon storage, and halt biodiversity loss. Further to this, forestry can emerge as a new growth sector (wood trade) and forests become the driving force for secondary sectors such as tourism and manufacturing. According to PPC's restoration programme, 5.374 hectares of forests will be created in the place of former mine sites.

Western Macedonia can benefit from the development of **Renewable Energy Resources**, rendering the conversion of former mine sites and coal fired power plants to produce clean energy a possible and attractive solution. Besides, the positive social attitude towards renewables means that this reconversion option is likely to be met without strong opposition especially by trade unions and workers whose employment status will remain unchanged. In Western Macedonia, there is high solar availability; the

solar energy capacity exceeds 1500 kWh per kWp. The region has a favourable solar exposure that make currently operating mine sites the ideal location for solar power generation. The wind power potential, however, is rather limited, having also a narrow frame of application in the locations of mine sites. The average wind speed is only 2.45 m/s. Though geothermal potential in Western Macedonia cannot be easily detected, it is estimated that a solution involving geothermal heat pumps can bring a magnitude of 202 GWh energy production annually. Apart from the construction, operation and management of renewable energy production units, employment opportunities can also arise in the manufacturing of RES equipment. Remarkably, the recent proposal by PPC for the construction of a 200 MW PV park in the areas of the closed mines also included plans for the deployment of an industrial unit dedicated to the manufacturing of equipment and machinery for PV systems.

Western Macedonia is home to sites of spectacular beauty. On its territory there are NATURA protected areas, two National Parks, eight lakes, rivers, valleys and a number of significant archaeological and geological sites. Nonetheless, the **tourism** sector in Western Macedonia is underdeveloped in comparison with the rest of the country where tourism is a key driver of regional growth. In 2016, the number of tourist arrivals was 118,766 when in Greece as a whole the number of tourists exceeded 18 million. What is more, the region has low carrying capacity with less than 3,200 accommodation units (hotels and rooms). Despite its poor performance to date, Western Macedonia can take advantage of its rich natural and cultural assets and unleash its tourism potential. New growth opportunities, of a sustainable nature, for the post lignite era can emerge in therapeutic tourism, eco-tourism, agrotourism, and wine and religious tourism. In this context, the valorisation of the industrial heritage of former mining period should be a priority and hold a prominent place in region's tourism offering.

Decarbonisation and land restoration recommended pathways

Greece demonstrates a low degree of willingness towards the green energy transition, as the country continues to subsidise coal based electricity generation and the Public Power Corporation, in which the state holds 51% of shares, seems determined to prolong Greece's lignite-based model for electricity production with the construction of two new lignite fired units in Western Macedonia. In Greece, there is a lack of institutional initiatives for the transition to a post-lignite era, let alone a concrete plan for the closure of mine site and subsequent restoration of mined landscape in Western Macedonia. The establishment of the National Just Transition Fund for lignite areas by the former government in January 2019 can be regarded as a sign that something has started to change in the country. Further to this, the new Prime Minister stated during the UN Climate Action Summit 2019 that the country will adopt a new national energy and climate strategy by the end of 2019, which will prioritise the need to phase out from coal. The new government has vowed to close all lignite fired power plants by 2028 and expand the share of renewables to 35% by 2030. Still, uncertainty remains over the construction of a new coal power unit "Ptolemaida V" which has already soaked 950 million euros in investment and its delivery is

projected for 2022. In contrast, at local level in Western Macedonia, planning and discussions on Just Transition are more advanced. Local mayors, supported by trade unions and environmental organisation (e.g. WWF, Greenpeace) have reiterated the necessity for a more sustainable growth pattern for the regional economy. While environmental restitution and land restoration are an integral part of these discussions, Western Macedonia has a long distance to cover in order to establish a stimulating environment for post mining land restoration. The region is in dire need to:

- Better enforce restoration regulations and carry out environmental analyses to precisely detect the type and extent of environmental pollution caused by coal driven activities in the area.
- Raise public awareness on the environmental and socioeconomic benefits associated with decarbonisation and post mining land restoration.
- Set forward a coordinated and integrated approach to plan environmental restitution and land restoration in mine sites and assess possible and alternative land uses. This should not be constrained to cross sectoral collaboration of all involved public administrations (vertical and horizontal integration) but involve all those actors (e.g. environmental institutions, higher education institutes, economic operators, civic society) who retain an interest in the area and will be directly or indirectly affected by future land use(s).
- Raise public awareness on green economy and its potential benefits for local communities and economic entities.
- Provide incentives to local and foreign investors to join synergetic schemes for post mining land restoration.
- Increase investment capital for environmental restitution and land restoration interventions. This can be done through the formation of a dedicated fund, which will be based on the state revenues from environmental taxes imposed on coal driven (and associated) activities.

4.4 Yugoiztochen (BG)

Geography

Yugoiztochen (South Planning Region) is a NUTS2 administrative region, located in South-eastern Bulgaria. The region consists of 4 provinces (Burgas Province, Sliven Province, Yambol Province and Stara Zagora Province) and its capital is Burgas. It has a surface of 19,798.7 km^2, covering approximately 18% of the country's territory. Its population stands at 1,039,549 inhabitants [24]. The region is characterised by significant intra-regional inequalities with the cities of Burgas and Stara Zagora forming the major axis of urbanisation.

Economy

In 2017, the value of regional GDP was 6.68 billion euros, representing 12.9% of the national GDP [24]. The GDP per capita is 6,400 euros, slightly below the national average. Coal driven activities contribute approximately 2.3 billion euros to regional GDP, and is considered the main pillar of the regional economy. In 2018, the value added generated by activities in the service sector amounted to 3.23 billion euros, representing 48.3% of the regional GVA. Industry provided 3.1 billion euros accounting for 46.5% of the regional product. The relative share of the agricultural sector stands at 5.2%, contributing over 500 million euros annually.

The Regional Development Strategy (2014 – 2020) lays down region's growth priorities to achieve a sustainable and balanced development. The strategy places emphasis on:

1. Improving the business environment to attract competitive investments in the manufacturing sector and support small and medium-sized businesses.
2. Harnessing the area's research potential to more actively integrate innovation in manufacturing, fostering collaboration between educational institutes, R&D units and businesses.
3. Achieving energy efficiency in the manufacturing, domestic and transportation sectors, introducing renewable energy sources and stimulating a low carbon local economy.
4. Improving public e-services and e-markets, as well as providing broadband access for people and businesses.
5. Improving the labour market of the territory by stimulating labour mobility, youth employment, vocational education systems, forms of qualification and retraining and lifelong learning.
6. Supporting social integration, poverty reduction and promoting the social inclusion of disadvantaged groups.
7. Providing support for the optimisation and quality improvement of the health and social services system, improving the education system and preserving and developing the culture, cultural heritage and cultural institutions.

8. Taking into account global environmental objectives in the strategic planning process and incorporating measures to preserve and maintain the natural balance, as well as measures aimed at adapting the regional territory to climate changes.
9. Recognising the role of cities as centres of development and implementing approaches for integrated urban development and for solving problems in the development of adjacent rural areas.
10. Improving territorial cohesion and cooperation for social, economic and spatial cohesion between the municipalities in the district.

Employment

According to the European Job Mobility Portal [25], the region ranked third in Bulgaria in terms of employment growth in the fourth quarter of 2018 compared to the same period of 2017. This growth was generated by two provinces, Burgas and Stara Zagora, while for the other two provinces, the number of persons employed decreased in comparison to the fourth quarter of 2017. The region's employment reached 52.4% (59.6% for men and 45.7% for women) during the fourth quarter of 2018, compared to the national rate of 52.5%. In 2018, the number of unemployed persons registered with job centres in Yugoiztochen Region was 26,923 and the unemployment rate reached 5.7%; a figure which is lower than then national average (6.2%). Yet discrepancies can be observed between the provinces. Specifically, the unemployment rates of Burgas and Stara Zagora were 4.6% and 4.5% correspondingly, while the unemployment rates of the remaining two provinces were higher than the national average. With regards to employment positions linked to coal driven activities, approximately 12,300 people are directly employed in the coal industry; 10773 in the mining zone and 1885 in adjacent power stations. However, it is estimated that another 19,558 employment positions are related to coal driven activities.

The coal industry

The biggest mining activities in Bulgaria are situated in the Maritsa East Mining and Energy Complex situated in South Central Bulgaria in the region of Stara Zagora. The mining complex itself is situated on an area of 240 km^2. The average annual coal production in is over 30 million tonnes, representing nearly 97% of total production in the country. The lignite produced in Yugoiztochen mining complex is completely supplied to the adjacent coal fired power stations at for electricity production. The region's Coal Power Plants produce up to 60% of the electricity used in Bulgaria on an annual basis. They have a combined capacity of 3271 MW and the average efficiency rate is 34%. Maritsa Iztok 1 (AES Galabovo Power Plant) first opened in 1962 with an initial capacity of 200 MW. The Power Plant closed in 2010 and reopened in 2011 as a private company with added capacity to reach 670 MW. Maritsa Iztok 3 (Contour Global) became a partially private company in 1999. In 2011 the company was

bought by US Contour Global consortium and major investments in NO and SO2 emissions reductions were undertaken.

Mine site / Power plant	Key facts
Maritsa Iztok Coal Mine	• Type of coal: Lignite • Mine type: Open-pit mining • Production (Mt): 30,34 • Years of operation:68
Maritsa Iztok 1 (AES Galabovo Power Plant)	• Type of coal: lignite • Capacity (MW): Initially 200, increased to 670 (2011) • Years of operation: 57
Maritsa Iztok 2	• Type of coal: lignite • Capacity (MW): 1586 • Efficiency (%): 90 • Years of operation: 53
Maritsa Iztok 3 (Contour Global)	• Type of coal: lignite • Capacity (MW): 908 • Efficiency (%) 90 • Years of operation: 41
Brikel Jsc.	• Type of coal: lignite • Capacity (MW): 120 • Efficiency (%) 90 • Years of operation: 59
Maritsa 3 CFPP	• Type of coal: lignite • Capacity (MW): 120 • Efficiency (%) 90 • Years of operation: 48

Expected impacts on employment & economy

Yugoiztochen is one of the regions in the EU-28 which is expected to experience the highest socioeconomic impact from the coal phase out. The total number of job losses (directly from the coal industry) can exceed 12,000, leading to a 70% increase in the region's unemployment rate. Yugoiztochen with GDP/capita almost 20% lower than national average and a 2.3% of jobs at risk in economically active population, might experience an unemployment rate at the level of 9%, which is close to maximal value in Bulgaria. The social impact from the shrinkage of the coal industry might be

even higher if we take into account the number of indirect jobs in coal related activities; an estimated 19,558 jobs. For every one permanent job position in region's coal fields and power stations, additional 1.5 jobs are created and preserved in the local economy. The region is economically, heavily dependent on producing coal and burning it for power. The coal industry accounts for 34.4% of the regional GDP and provides livelihoods for more than 100,000 people (workers and their families). Discussions over a coal phase out plan has triggered serious concerns and uncertainty for the future of coal workers. In November 2018, coal miners and workers at the "Maritsa" coal-fired power plant marched in Sofia against government's decarbonisation plans, supporting the continuation of coal-fired energy production in the country. Furthermore, given that in 2017 the largest share (43%) of Bulgaria's electricity was produced by Coal Power Plants[6], the shrinkage of the coal industry in Yugoiztochen Region will pose a serious danger over the country's energy security and supply, unless alternative sources of energy are prioritised.

Legal framework

The law of underground property sets out the specific requirements and procedures for the management of mining waste from the exploration, extraction and primary processing of underground resources in order to prevent, reduce or limit their harmful effects on the components of the environment, safety and human health.

Specifically, the **Law of the Underground Property** as lastly amended in March 2009 regulates the terms and conditions for:

- Prospecting, exploration and extraction of the underground resources on the territory of the Republic of Bulgaria, in the continental shelf and in the exclusive economic zone in the Black Sea.
- Protection of the earth's interior and the rational use of underground resources in the exploration, extraction and primary processing.
- Mining of waste from exploration, extraction and primary processing of underground resources.

Furthermore, the **Ordinance on Specific Requirements for Mining Waste Management** (promulgated SG 10 February 6, 2009) sets out the specific requirements and procedures for the management of mining waste from the exploration, extraction and primary processing of underground resources in order to prevent, reduce or limit their harmful effects on the components of the environment, safety and human health.

As regards legal arrangements supporting post-mining land restoration, in compliance with the Soil Law, the state policy on conservation, sustainable use and soil restoration at national level is carried out by

[6] https://www.globallegalinsights.com/practice-areas/energy-laws-and-regulations/bulgaria

the Minister of Environment and Water, the Minister of Agriculture and Food, the Minister of Health and the Minister of Regional Development. At the Regional level, the policy on soil conservation, sustainable use and restoration is implemented by the regional governors and at the local level by the mayors of municipalities.

The **Soil Law** (Promulgated SG No. 66 of July 26, 2013) regulates public relations related to soil conservation and their functions, as well as their sustainable use and sustainable restoration as a component of the environment.

Other regulatory documents setting mine reclamation requirements include:

- **Ordinance No. 3 on Standards on the Permissible Content of Harmful Substances in Soils** (promulgated SG 71/08, August 2008) which defines the standards for the permissible content of harmful substances in soils and the requirements for taking and testing soil samples for determining the content of harmful substances.
- **Ordinance on Inventory and Surveys of Contaminated Soil Areas, Required Restoration Measures, and Maintenance of Rehabilitation Measures Implemented** (Official Gazette, issue 15 of 16 February 2007) which defines the order and manner of carrying out the inventory and surveys of contaminated areas, the necessary restorative measures, as well as the maintenance of the implemented restoration measures.
- **Ordinance No. 4 on Soil Monitoring** (promulgated SG No. 19 of 13 March 2009) regulating the procedure for conducting soil monitoring by establishing a National Soil Monitoring System (NMSP).
- **Order No. RD-564 / 13.10.2016 of the Minister of Environment and Water** which confirms the Methodology for preliminary and detailed studies and the establishment of a public register for inventory of contaminated soil.
- **Order No. RD-619 / 15.09.2009 of the Minister of Environment and Water**, confirming the soil monitoring schemes and indicators for the assessed soil condition according to Art. 10, para. 1 and Art. 11, para. 1 of the Soil Monitoring Regulation.
- **Ordinance No. 26 on the reclamation of disturbed terrains, improvement of poorly productive lands, seizure and utilization of the humus layer**.

Environmental restitution

The negative impacts of coal mining and lignite based energy production on the natural environment of the region of Yugoiztochen include destruction of native flora, biodiversity loss, soil contamination and fertility decline, soil erosion, groundwater contamination, surface water pollution, acid mine drainage as well as air pollution and to a lesser degree deforestation. According to Beyond Coal Europe [20], in 2018, coal fuelled power plants generated over 24 million tonnes of CO2 emissions, accounting for 44% of Bulgaria's total CO2 emissions. In Yugoiztochen, coal pollution was responsible for 660 premature

deaths. Remarkably, Bulgaria has been referred to the EU Court of Justice for failing to comply with air quality standards, and upper limits on air pollutants. The reported environmental damages are contained to a local level, with the exception of biodiversity loss and air pollution which extend to a regional level. All the damages are considered reversible on the long ran, with the exception of air pollution witch can be reserved in a shorter period of time. Yugoiztochen have set the following environmental priorities to secure ecological functionality and integrity in areas severely affected by coal driven activities. These include:

- Expansion of green areas and forestation
- Mitigation of climate change
- Sustainment of biodiversity
- Protection of natural habitats
- Improvement of air and water quality
- Promotion of sustainable waste management

Funding

According to ZaZemiata [26], there is no information publically available regarding the legal obligations of the power plant owners towards the elimination of negative consequences of their activities after the termination of their operations. On the other hand, Maritsa Iztok Mines EAD have the obligation to re-cultivate the territories, degraded during the period of its activity and to develop a "final detailed exit project" determining the state to which the land must be restored upon decommissioning. The funding sources that could be used to support post mining land restoration interventions in the region of Yugoiztochen may include the state and regional budget, EU funding through various funding programmes, funding by mining companies as contractual liability, as well as funding through Public Private Partnerships.

Mine reclamation companies

The most significant reclamation companies operating in Bulgaria are Melioratsii Ltd, Romb Ltd, Svemar Ltd and Pro Drone System Ltd. The following table presents the SWOT MATRIX for mine closure and reclamation companies in the region of Yugoiztochen.

Table 7: SWOT MATRIX for mine reclamation companies in Yugoiztochen (Bulgaria)

STRENGTHS	WEAKNESSES
• Extensive mining and reclamation experience` • Diversified land restoration and environmental services • Skilful human resources	• Risk involved with government contracts • Lack of geospatial data
OPPORTUNITIES	**THREATS**
• Increasing demand for reclamation & environmental services in coal regions • Open and transparent procurement methods for reclamation services • Funding programmes for land reclamation projects	• Bureaucracy (complex administrative procedures) concerning the implementation of land restoration projects • Resistance from local communities which are largely dependent on coal driven activities

Former land uses and uses surrounding the mine sites/plants

The Yugoiztochen region's mining and plant sites, namely the Maritsa Iztok Energy Complex, and their surrounding areas were formerly forests as well as agricultural areas and rural settlements. The current uses of the site's surrounding areas include rural settlements and agricultural activities. Some of the main constraints to the restoration of the land include soil fertility and land disturbance, caused by decades of coal extraction and combustion.

Post mining land uses

Post mining land uses and activities with growth and employment potential

This section suggests possible post mining land uses in Yugoiztochen Region, based on the needs analysis findings and in accordance with region's growth and environmental priorities. In all cases, priority should be given to address the extent of air pollution caused by old coal fired power plants still operating in the region. The aim should be to recover previous ecological functions and establish a sustainable and functional ecosystem; at the same time it is of particular importance to identify alternative, sustainable routes for the regional economy that will essentially contribute to sustaining local social-economic structures to be inevitably affected by the shutdown of coal driven activities.

The fields identified as regional economic drivers for the region of Yugoiztochen include a) renewables, b) pastures and cultivation, c) tourism and recreation, and d) forestry. Yugoiztochen exhibits high solar availability (15.39%), making the conversion of former mine sites for the production of solar energy an attractive and viable option. Yugoiztochen can also benefit from high temperatures geothermal

resources in mine sites and abundant water resources (where relevant) to engage in geothermal and hydro power production. Tourism is considered as one of Yugoiztochen's main opportunities for development as the region offers various attractive features in terms of both natural and cultural resources. The region's natural resources include fossil sites, aquatic ecosystems as well as coastal areas of great aesthetic value while its cultural resources include archaeological sites, historical structures and museums and sites of ethnographic interest as well as wine routes. Thus, the withdrawal from coal driven activities and the consequent reclamation and restoration efforts will contribute to unleashing the region's full potential in the sector of tourism.

According to the National Statistical Institute [27], agriculture accounts for 5.2% of the regional gross value added (GVA), with the services sector (48.3%) and industry (46.5%) being the main contributors. Yet, the land used for agriculture has decreased over 800 square kilometres (from 10.217 to 9.379) between 2012 and 2015, Forestation can be also a viable solution towards enhancing environmental sustainability in the region. Forestry can also have an important added value for the regional economy through the trade of forestry products and the further development of the wood industry. It can also provide diversified recreation opportunities, and push the emergence of new, sustainable tourism segments.

Decarbonisation and land restoration recommended pathways

Bulgaria still does not have a long-term energy strategy and a coal phase-out is currently not being discussed, as coal provides roughly half of the electricity in the country. Bulgaria seems determined to keep generating coal fuelled electricity beyond 2030. Remarkably, Bulgaria continues to dole out subsidies to high polluting coal plants and back coal extraction activities, while during its presidency, the Bulgarian government campaigned to overturn the new, tighter industrial pollution laws. The vast majority of Bulgarian coal power plants are not compliant with the new standards of the EU Industrial Emissions Directive and most of them have submitted a request for a derogation.

Given the above, there are several steps to be taken at regional level so that Yugoiztochen can at first stage speed up the procedures for the permanent closure of mine sites, and secondarily proceed with restoration programs. To begin with, there appears to be a complete lack of awareness concerning a) green economy and its potential benefits, b) the benefits associated with decarbonisation and c) the existence of opportunities for restoration. The region needs also to impose market reforms to smooth the transition to a post coal era, and provide incentives to local and foreign investors to join synergetic schemes for post mining land restoration. Further steps need to be taken in the fields of social and institutional conditions as there are no provisions for the participation of the local community in decision making concerning the restoration process, the roles and responsibilities are not clearly defined and there is a need for an effective cross-department coordination. Finally, there is a pressing need for the

development of funding schemes in the form of the provision of incentives to shut down coal driven activities as well as investment capital for restoration interventions.

4.5 Savinjska (SI)

Geography

Slovenia is divided into two NUTS 2 regions, Vzhodna and Zahodna Slovenija and then divided further into twelve NUTS 3 regions. Savinjska is one of the eight NUTS 3 regions of Vzhodna Slovenija, and one of the biggest regions in Slovenia. It is situated at the heart of the country and spans from the Austrian to the Croatian borders. The neighbouring regions are Koroška on the north, Podravska on the east, Spodnjeposavska on the south, Zasavska and Osrednjeslovenska on the west. The region is named after the alpine river "Savinja", which runs through the region, forming a biodiversity hotspot with enormous contribution to ecosystem services, and region's resilience to climate change effects. Savinjska covers 2,301 km^2, and its population exceeds 254.000. There are 31 municipalities in the region, and the largest city (and metropolitan centre) is Celje.

Economy

Savinjska has an export oriented economy, with a long industrial tradition and high concentration of businesses. The regional gross domestic product is 4.85 billion euros (2017), accounting for 11.3% of the national total. The regional GDP per capita, expressed in purchasing power standards (PPS) reached €19,045 in 2017, slightly below the national average (€20,815). The above figures position Savinjska in the fifth place among the 12 NUTS 3 regions in the country, but still far from the EU-28 average (€29,200).

Suprisingly, the economic development of the region can mostly be attributed to the big, successful companies, which have emerged as the backbone of the regional economy, creating more than 40% of added value. Overall, the service sector dominates the regional economy, accounting for 52.7% of the regional gross valued added (GVA), which totalled 2.22 billion euros. Manufacturing adds 1.63 billion euros to the region's product and the primary sector 91 million euros. Their shares in the region's total are 32% and 2.2% respectively. Notably, agricultural land covers about 30% of the regional territory. In this breakdown, the coal industry is a major source of income and employment. The gross added value of coal driven activities (coal mining, quarrying and other industry) is around 280 million euros; representing almost 6% of the regional GDP.

The Regional Development Programme for Savinjska Region outlines region's priorities for economic development for the period 2014-2020. The industries that can play a driving role in the economic development of the region by enhancing entrepreneurship and supplying quality and high paying jobs are metal processing, food industry, tourism and energy. The region is committed to promoting a socially integrated and territorially balanced sustainable development. To this end, particular emphasis has been placed on the following development areas: sustainable tourism and destination management, energy

security and self-supply, natural resources management, inclusive and balanced territorial development, infrastructure upgrading and green transportation.

Employment

In 2018, the active population in Savinjska was 119.830 persons and the unemployment rate was 5.5% [28]. Approximately 90% of residents are employed in the tertiary (service) and manufacturing sectors; while more than 11.540 persons work in agricultural activities. Over 1500 persons are directly employed in the coal industry; 1255 in the Velenje coal mine site and 311 in the Šoštanj Thermal Power Plant. Throughout the coal value chain, however, the number of indirect jobs largely dependent on the coal industry is bigger. In Slovenia, it is estimated that another 2500 job positions are related to coal driven activities. Notably, Premogovnik Velenje Group (mine operator) employs additionally 1000 persons in companies that the group consist of (HTZ, RGP, SIPOTEH, PLP).

The coal industry

Savinjska has a long mining tradition, which goes back to the 18th century. First drilling was held in 1875 and the first mines started to operate in 1887. The first thermal power plant, lignite-based, was built near the coal mine, a few years later in 1905. The region is still a coal intensive region. It hosts the only active coal mine site ("Velenje Coal Mine") and the biggest coal fired plant ("Šoštanj Thermal Power Plant") in Slovenia.

The "Velenje Coal Mine" is an associated company of HSE Group, controlled by the Holding Slovenske elektrarne d. o. o., a state owned mining enterprise. The coalfield (1104 hectares) is located in Šaleška Valley in the north part of Slovenia, within the boundaries of the Municipality of Velenje (532 hectares) and on the territory of the Municipality of Šoštanj. In the site, there are the largest coal deposits ever discovered in the country and one of the thickest known coal seams in the world. The coal seam is 8.3 km long and up to 2.5 km wide at a depth between 200m and 500m. Its average thickness is 60 m, with maximum values reaching up to 170m. The annual output of Velenje Coal Mine is approximately 3.3 million tons of lignite coal (2018). This output is entirely used by the Šoštanj Thermal Power Plant (TEŠ) for the production of electricity and heat. Overall, the area has provided over 220 million tonnes of lignite so far.

The "Šoštanj Thermal Power Plant", owned by HSE company as well, was constructed in 1956 in the city of Šoštanj, as a response to the increasing demand for electrical energy and the great amount of coal extracted in the Šaleška valley. The Šoštanj Thermal Power Plant, with an installed capacity of 1029 MW, generates approximately one third of the total electricity produced in Slovenia, with a potential to accommodate for more than one half of the national energy demand. The average annual electricity production ranges from 3,500 and 4,000 GWh. The average annual production of thermal energy used for district heating in the Šaleška valley amounts to 400-450 GWh. To achieve the above-mentioned

annual production of electricity and thermal energy, the power plant uses between 3.5 and 4.2 million tonnes of coal and approximately 60 million Sm3 of natural gas.

Slovenia bases its energy sector on three pillars – nuclear power, solid fuels and hydro. Electrical energy is predominantly sourced by nuclear power (36.6%). Fossil fuels (primarily lignite) generate 28.9% of the country's electrical energy while hydropower provides approximately 32% of the national electricity generation. The remaining 2.6% comes from biomass, solar and wind. From the above, it becomes clear that solid fuels play a key role for Slovenia's energy security. From the energy supply generated by fossil fuels, the big majority (89%) draws from lignite, followed by brown coal (10%). The following table presents key facts for Savinjska's coal driven activities.

Mine site / Power plant	Key facts
"Velenje" coalfield	• Mine Type: Underground • Size: 21 km^2 • Type of coal: Lignite • Annual production (raw coal extracted): 3.2 Mt (2018) • Depth of coal deposits: Up to 500m • Start of operations: 1875 • End of operations: expected in 2054
"Šoštanj" Thermal Power Plant	• Installed capacity: 1029 megawatts • Annual electricity production: 3753 GWh (2018) • Net efficiency (Unit 5): 32% • Net efficiency (Unit 6): 43% • End of operations (Unit 5): expected in 2030 • End of operations (Unit 6): expected in 2054

Expected impacts on employment & economy

The potential decline in regional employment due to mine closure and coal fired power plant decommissioning may reach 1,500 job losses. This puts an additional 1.2% of active population being already at risk of losing its job status. With a current unemployment rate at 5.5% (10,823 registered unemployed persons), the permanent interruption of coal-driven activities without a proper offset strategy could lead to a 22.7% increase in the unemployment rate. Therefore, the latter will eventually increase from 5.5% to 6.7%. However, as the unemployment rate is relatively low (5.5%) and the coal industry represents a relatively small share of the total GDP produced in Savinjska, the region will most probably be able to absorb lost jobs and re-employ these people in other more competitive industries. Yet, the number of job losses expected to be lost from the decommissioning of the coal fired plant may

be significantly lower than expected, as the energy company (Termoelektrarna Šoštanj") already looks into different alternatives to prolong the operation of the plant, which is responsible for approximately one third of Slovenia's electricity production. The initial plan is to substitute lignite and other fossil fuels with cleaner sources of energy.

Decarbonisation will inevitably have adverse consequences on the local and national economy (to be reflected on residents' income as well), with the most severe and greatest ones to be anticipated on the energy sector, unless the shutdown of coal driven activities go along with parallel investments in renewables and cleaner sources of energy. In addition, the coal phase out may affect a group of other economic sectors related to coal driven activities. The impacts will be more felt by the businesses that hold commercial relations with the "Velenje" Coal Mine. Briefly, the sectors expected to be affected the most from the shutdown of coal driven activities in Savinjska are:

- **Energy sector**. The thermal power plant is largely dependent on local coal production. The Velenje lignite mine is a strategic partner supplying around 90% of the raw materials used to generate heat and electricity. Further to this, the mining company provides auxiliary equipment, support services and other material critical for the operation of the plant. In general, the role of lignite in the country's energy mix (safeguarding also energy security and resilience) and the importance of the thermal power plant as one of the larger producer of electricity are at the epicentre of the public discussion on the country's energy future away from fossil fuels.
- **Maintenance of machinery and technological equipment**. Services of maintenance of machinery and equipment have an important role in the regional and national coal value chain, both from the perspective of possible economical and employment changes due to the decarbonisation and from the perspective of ensuring occupational safety, health of employees and reliable operation of machinery/equipment.
- **Manufacture of machinery and equipment**. A great share of equipment and machinery used in regional coal value chain is manufactured by foreign producers or suppliers. This is mostly due to the limited number of specialised companies in the domestic market. A share of the equipment, however, is manufactured or supplied by local, regional and national companies that have reach an advanced technological development level. It is expected that regional and national energy transition would to a certain extent affect indirect jobs as well as amount of produced/distributed outputs of equipment industry.
- **Food services**. In the past, catering services were provided in the mine site by a subsidiary of HSE Group; however, due to the internal business restructuring that took place in 2016, these services were externalised, and now they are being provided by a local operator. During this process, all employees in HSE subsidiary were absorbed in other business departments and functions. However, there is a possibility as the decarbonisation process progresses, these jobs to be at risk in the future.

Legal framework

The Mining Act (ZRud-1), as introduced in July 2010 and last amended in 2013, is the primary legal basis for mining and extraction operations in the Republic of Slovenia. It sets the legal requirements affecting minerals and mining in the country. It consists of 157 articles, which lay down the conditions for the prospection, exploration and extraction of energy and mineral resources (e.g. coal, geothermic resources, oil and gas, bauxite, nickel, sea salt), regulating also concession, ownership, environmental and health & safety issues. More particularly, the Mining Act defines:

- Managing authorities and competent bodies for the management of minerals, mining design, supervision of mining operations, and audit procedures.
- Procedures to obtain prospection/exploration rights.
- Procedures for the grant, refusal and revocation of mining permits (incl. public procurement).
- Financial liabilities of the holders of mining permit incl. guarantee funds for environmental restitution.
- Contractual obligations and Key Performance Indicators (KPIs) in terms of service delivery and production.
- Mining inspection and penalties for low environmental performance, and health and safety incidents.
- Obligations for mine closure and reclamation.
- Technical documentation in mining.

According to the Act, the designation of a mining area at a municipality level must comply with local land use and spatial plans. This is key to securing a good environmental status and high standards of living for local populations, and most importantly ascertaining the appropriate and balanced distribution of land for different uses and economic activities (e.g. residential, farming, forestry, tourism, industry, nature), in accordance with territorial priorities and geospatial characteristics. The process for granting a mining concession permit in Slovenia is as follows. Once a certain area has been approved as suitable and eligible for mining extraction, the Concession Act is published by the competent national or local authority (most probably by the Ministry of Infrastructure and Spatial Planning), and the Mining Right is typically awarded to the Most Economically Advantageous Tender (MEAT) through an open public procurement process. The Concession Act (i.e. tender) defines a) the scope and nature of the procured services (e.g. size of the mining area, duration of mining permit, quantity of the permitted extraction, the type of mineral resource), b) operator's contractual obligations (e.g. environmental protection and health & safety measures, compensatory measures to offset environmental damage) and c) the requirements that bidders need to fulfil to award the contract (e.g. minimum financial guarantees and technical documentation). In this vein, bidders (i.e. candidate operators) must submit a comprehensive mine plan detailing all the preparation works and operation activities to take place in the area in question over the contract duration. Integral part of this plan is the description of restoration works when mining

ends. According to the Mining Act, the mining right holder is obliged to undertake all the restoration works in the former mine sites, for returning the degraded land into a good environmental and usable state.

Typically and pursuant to the Mining Act, the mine right holder must submit to the Ministry of Infrastructure a request for the interruption of mining operations, coupled with an updated mine reclamation plan. This marks the initiation of post mining land restoration and rehabilitation works. All restoration works to be carried out must be in accordance with the approved plan and applicable spatial plans, and are to be monitored and audited by competent local authorities. Once all scheduled restoration works have been completed and the requirements set by the Act are successfully met by the operator (Article 95 and Article 96), the Ministry issues the final permit for the closure of the mine site.

For the "Velenje" Coal Mine and the "Šoštanj" Thermal Power Plant, as sites with multiannual coal related activity; critical for the country's energy security, the national government has formed a working team to prepare a detailed programme and roadmap for the gradual shutdown of coal driven activities in the region (by the end of 2020), land restoration and post mining land uses and its economic restructuring. Legal aspects of mine reclamation and land restoration are covered by several laws and regulations, including:

- National Mineral Resource Management Programme
- Regulation on the management of waste from extractive industries
- National Mining Strategy
- Spatial Planning Act
- Environmental Protection Act
- Water Act
- Nature Conservation Act
- Building Act

Different levels of government and types of entities are involved in the designation, planning, implementation and monitoring of post mining land restoration activities. These include:

- National public authorities such as the following ministries: Ministry of Infrastructure, Ministry of the Environment and Spatial Planning, Ministry of Economic Development and Technology. Their duties include the preparation of acts, monitoring of land degradation, assignment of roles and responsibilities throughout the restoration process, issuing of permissions, etc.
- Coal mine operators legally bound to complete all mine closure and environmental reclamation activities.
- Municipalities as competent authorities for the revitalization of municipality-owned areas
- Regional development councils engaged with the monitoring of the implementation of regional development restructuring programmes

- External organisations advising on mine closure programmes and assisting with post mining environmental assessments.

Environmental restitution

The consequences of multiyear mining and energy related activities in the Šaleška valley of the Savinjska have been severe. In 70s and 80s, the levels of air pollutant concentrations exceeded national limit values. The accumulated deposition of ash from the coal fired plant in lake sediments and ombrotrophic peats, resulted in minimising the self-cleaning capacity of water resources, and hence led to surface and underground water contamination. In addition, during the period of highest alkaline levels, there were no living organisms in Lake Velenje as a result of natural habitat destructions. The increased emissions of pollutants from Šoštanj Thermal Power Plant also affected the forests, which reflected in defoliation of the trees and reduction of increment, which was noticeable primarily in the mature spruce stands in Zavodnje and Sleme. Similarly, the extensive underground excavation of lignite had an adverse effect on soil quality. Beside gaseous pollutants, the Šoštanj Thermal Power Plant used to emit large quantities of heavy metals that accumulated in the ground and are circulating in the ecosystems of the Šaleška Valley. Another problem of the emission area of the Šoštanj Thermal Power Plant is soil acidification. Overall, mining activities transformed dramatically the landscape within and around the mine site. Further to the environmental damages, coal driven activities caused over 800 building collapses and forced more than 2,000 residents to resettle.

In 1987, the deterioration of environmental conditions in the Šaleška valley (as depicted above) provoked community marches and demonstrations against mine operators and their practices that were proved to spoil the natural environment and pose serious threats to public health. As a result of the public outrage, both the Velenje Coal Mine and the Šoštanj Thermal Power Plant set forward an ecological rehabilitation programme for the recovery of the wounded land and the protection of valuable natural resources. Since then, the operators have invested a vast amount of resources in environmental and social responsibility projects alongside with new environmental technologies to maintain ecological integrity and achieve the ambitious goals for lowering NOx, CO2, and SO2 and dust particle emissions, contributing also to the rehabilitation of degraded land and the safeguarding of water resources. According to Beyond Coal Europe [20], in 2018, the Šoštanj Thermal Power Plant generated 3.93 million tonnes of CO2 emissions, accounting for 22% of Slovenia total CO2 emissions. In Savinjska, coal pollution was responsible for an estimated 44 premature deaths.

It wouldn’t be risky to go so far as to say that the situation is now quite sustainable, even though the aforementioned effects have not been completely diminished. The most visible impact from lignite mining in the area of Šaleška valley has been the sinking of the ground’s surface and the subsequent formation of 3 lakes due to acidification (namely Velenjsko jezero, Škalsko jezero, Družmirsko jezero). This had direct impact on populations based and agrarian settlements and consequently caused the

displacement and resettlement of communities as well as destruction and deforestation of area above and near the mine. In Savinjska, carbon emissions remain at a low level (higher but comparable to those reported in other areas of the country) despite the intensive production of electricity from lignite. In numbers, the annual particulate matter (PM10) emissions are 0.1kt; the nitrogen dioxide (NOx) emissions is 3.3kt; and the sulphur dioxide (SO2) emissions are between 1.3kt.

To conclude, the environmental impact of mining in the area can be summarised as follows:

- Subsidence of the area and creation of lakes in previous open cast mines.
- Sunken area in the Šaleška Valley
- Destruction of settlements (Druţmirje, Preloge)
- Destruction of infrastructure: roads, sewers, waterworks, electrical transmission lines
- Deforestation, shrinking of arable surface, intensification of agriculture
- Soil erosion and negative effects on vegetation (the refraction of surface has caused mixing of disintegrated rock cover)
- Changes on waterway flow direction (the right side tributaries of the Paka River are not flowing directly into the river anymore, but through the emerged lakes).

Underground excavation of lignite in the Velenje and energy production in the nearby thermal power plant without a doubt resulted in a significant transformation of a landscape in Šaleška valley (Velenje and Šoštanj); however much efforts have been put into an ecological rehabilitation of the valley and a lot has been achieved in the field of environmental protection and improvement of living conditions in the past years. Velenje Coal Mine and TEŠ aimed to prevent and eliminate any negative environmental impacts of its operations and has played an active role in land rehabilitation and air/water protection programmes in the Šaleška valley as well as regularly monitor its environmental impacts. The clearest proof of sustainable development of the Šaleška valley is the tourist and recreational area that has been developed around the man-made lakes above the mine and in broader surroundings. The Lake Velenje is furthermore suitable for bathing, which has encouraged a construction of the beach on the lakeshore, used by thousands of swimmers each year. As the result of common efforts and a major environmental rehabilitation in the past three decades, one of the most environmentally burdened landscapes in Slovenia has changed to a post-industrial landscape with quality natural, social and economic environment.

Funding

The funding scheme for mine reclamation is quite nonspecific, with funding responsibilities to be shared between mine operators, municipalities, and the state. According to the National Mining Law, the mine right holder should invest a share of its asset for mitigating the environmental impacts from extraction activities (during mining operations) as well as the rehabilitation of the worked-out site once mining operations end. These include the reconstruction of public infrastructures, roads and facilities, the

recultivation of degraded land and the protection of forests and native flora and fauna. Yet, previous experience shows that mine operators only partially compensate local communities for the damage they caused in the natural environment. For instance, the Municipality of Velenje has spent a respected amount to regenerate the municipality-owned areas exposed to degradation caused by coal mining within or surrounding the designated mine areas. The most recent example of mine reclamation was the "Trbovlje-Hrastnik" mine site. In this case, the cost for land restoration was entirely covered by the mine operator while regional development activities were covered by public funds. For the Velenje Coal Mine (the only active mine site in the country), public authorities plan to pass a law for the gradual interruption of mining activities, which will specify all budget considerations (incl. funding sources) concerning the rehabilitation of the mined land. It is expected that the funds for the implementation of the mine closure program will be provided in conjunction by the state budget and mine operator's own resources (a state owned company). The cost for environmental restitution and land rehabilitation in Savinjska is yet to estimate. Generally, post mining land restoration initiatives can be also financed by municipal authorities. These funds may be channelled directly from coal driven operations through (green) taxation, and strictly gathered for this use. Other sources of co-financing, especially for coordination and support projects dealing with capacity development, education/training and reskilling and stakeholder engagement, could be the Horizon 2020 framework programme for coal intensive regions or the European Bank for Reconstruction and Development. Innovative financial mechanisms such as crowd funding could also provide an interesting alternative for financing landscape regeneration.

Mine reclamation companies

Both the "Velenje" Coal Mine and the "Šoštanj" Thermal Power Plant are operated by HSE d.o.o. through its subsidiaries "Premogovnik Velenje, doo" and "Termoelektrarna Šoštanj d.o.o." respectively. HSE doo is a state owned company, technologically advanced and with substantial experience in mining and reclamation works. HSE d.o.o. is the he controlling company in the HSE Group, one of the largest producers and sellers of electricity from domestic sources on the wholesale market in Slovenia and the largest Slovenian producer of electricity from renewable sources. Its headquarters are located in Ljubljana. There are also 3 business units in Maribor, Šoštanj and Nova Gorica. The company's operations are mostly based on the sales and trade in electricity and thermal energy, CO2 emission coupons, certificates of origin and other renewable energy certificates, the provision of ancillary services needed for the functioning of the electricity system and on the management and implementation of energy projects. The following table presents the SWOT MATRIX analysis for the energy colosseum of the Republic of Slovenia.

Table 8: SWOT MATRIX for mine reclamation companies in Savinjska (Slovenia)

STRENGTHS	**WEAKNESSES**
• Advanced machinery/equipment • Extensive mining and reclamation experience • Skilful human resources • Geospatial data is available	• Limited experience in specialized fields related to reclamation processes
OPPORTUNITIES	**THREATS**
• Open and transparent procurement methods for reclamation services • Funding programmes for land reclamation projects • New legislations and strategies such as the national decarbonisation strategy, the national coal phase-out program and the Slovenia Energy Concept	• Land use constraints

Former land uses and uses surrounding the mine sites/plants

The area of lignite seam and the adjacent coal fired plant extends over almost the entire Šaleška valley, creating a large industrial zone that stretches along the Paka River from Velenje to Šoštanj. The mining area is approximately 8.3 km long, 1.5–2.5 km wide and 160 m thick. The TEŠ (Thermal power plant Šoštanj) complex lies on the southern outskirts of the valley and in the immediate vicinity of the Velenje coalfield. Typical of the Šaleška Valley (except for urban centres) is the agrarian (at the flatland and the south expositions of the hilly area) and wooded landscape, which is home to a rich flora and fauna biodiversity. The land surrounding the mining site under examination is mostly covered by forests and meadows, settlement (urban) areas (Pesje, Šoštanj, Škale, Gaberke, Velenje), lakes used for recreational activities (swimming, surfing, SUPing, cycling, hiking, horse riding, sport fishing, etc.) and in a smaller share by agricultural fields. The area surrounding the TEŠ complex is dominated by typical urbanized (industrial) landscape. The former land uses in the sites where the mine site and the thermal power plant are now located were previously forest, agricultural field and rural settlements.

Possible land uses

Post mining land uses and activities with growth and employment potential

This section suggests possible land uses for the post coal era in Savinjska, based on the needs analysis findings and in accordance with region's growth and environmental priorities. In all cases, the ultimate aim is to recover previous ecological functions and establish a sustainable and functional ecosystem

whilst sustaining local social-economic structures to be inevitably affected by the shutdown of coal driven activities. In Savinjska, post mining land uses should be selected in a manner to counterbalance the expected decline in employment and income, and most importantly to support areas with growth potential. The fields identified as regional economic drivers for the Savinjska Region are in order of priority a) tourism and recreation, b) renewable energy and c) cultivation.

Tourism is one of the region's major developmental opportunities. The evidence for tourism development are particularly encouraging. In recent years, the number of arrivals has been constantly increasing and the daily spending as well. These have rendered tourism a valuable source of income for local population. The number of nights spent at tourist accommodation facilities in the region will very soon exceed 2 million (1.8 million in 2018). The demand for Savinjska is growing steadily despite the fact that the region does not have an established identity in domestic and overseas marketplaces. Velenje, mostly due to its industrial character, is still largely undiscovered by tourists (34,310 nights spent in 2018), even though it is particularly rich in natural heritage (e.g. national parks, lakes, rivers, hills) and offers a great variety of leisure and cultural opportunities: from exploring cultural attractions, hiking and biking by the lakes to unique underground adventure in Coal Mining museum. The shutdown of coal driven activities and the revitalisation of the mined and degraded landscape (lakeshore stabilisation, appealing destinations) will aid to further unleash the growth potential of the industry. According to Velenje municipality's projections, the revitalisation programme already in place for the Šaleška valley and the Lake Velenje will continue with more targeted interventions to restore degraded landscape and valorise natural heritage assets therein (mostly man-made lakes). The aim is to increase the availability of leisure opportunities in the area by constructing suitable infrastructures for new recreational activities (swimming, surfing, cycling, hiking, horse riding, sport fishing), and showcasing area's distinguished characteristics and identity. The latest project in the area involves the restoration of a landscape of 46,090 m^2 around and close to the Velenje Lake, alongside with the construction of a big stage for events and concerts. Previous restoration activities were key to increasing visitor inflows in the region. In 2018, the number of both domestic and foreign visitors exceeded 100,000; further to this, the Velenje beach received an award for the best natural bathing place in the country.

The potential for RES energy generation in Savinjska is very high. The region has high sun exposure levels especially from solar resource; the average solar availability factor is 12%-14% (significantly above the EU average). That favours investments in solar panels, which could potentially be connected with the Šoštanj thermal power plant. Energy production from solar power may be both a strategic possibility and opportunity for the region. Given the recent expansion of the plant with a new 600 MW unit (to remain operational until 2054), the development of RES projects can help to avoid locking the country into a carbon-intensive future whilst accelerating decarbonisation efforts, and secure country's energy security and supply. It can also aid to counterbalance losses in employment from the coal phase out, boosting at the same regional sustainable economic development. Some of the examined regional

areas can also act as low-enthalpy geothermal resources, to be used for small to medium scale power generation and for heating and cooling purposes. They are located in areas with relatively high temperatures at depth, as demonstrated by the several thermal spas found in the region. In contrast, in Savinjska's coal mining areas, there is little potential for wind energy projects given the low attitude and low average wind speeds. The wind availability factor in Savinjska is significantly below 10%.

Finally, new agricultural areas could be created to allow cultivation and pasture to flourish; thus providing new employment and income opportunities for locals. In Savinjska, there are over 11,000 farms; 90% of which are run by an individual or a family and rely primarily on family labour. The region is endowed with favourable natural conditions for farming and agriculture, which position Savinjska among the most productive agricultural regions at national level. Agricultural land covers about 30% of the region's territory and in 2017, agriculture accounted for 2.7% of the regional GDP.

Decarbonisation and land restoration recommended pathways

Slovenia may have not yet announced an official phase-out date for coal but the need for a transition to a low carbon economy is increasingly recognised and embraced by local communities even in the country's coal intensive regions such as Savinjska. The national energy strategy (as of 2015), which transposed at national level all relevant EU regulations, foresees a decreased role for fossil fuels in the country's energy mix. The use of coal for energy generation is expected to gradually decrease in relation to cleaner forms of energy such as RES. According to the Slovenian Energy Concept, the use of coal is currently allowed solely for existing installations and until the end of their operations lifetime. Nonetheless, based on current technologies and capacity, the use of coal will end no later than 2054 as the New Thermal Power Plant Unit 6 has been commissioned to operate until that time. To speed up decarbonisation, a national coal phase-out program based on just transition principles, including all the necessary legislation and actions regarding the gradual closure of Velenje coal mine, environmental restitution and land restoration, and the restructuring of the region is currently in the making and is expected to enter into force by 2022. In addition, Slovenia needs to resolve a series of issues/shortcomings towards the efficient environmental restitution and post mining land restoration. These include to:

- Set forward a coordinated and integrated approach and procedures to assess possible and alternative land uses, which should not be constrained to cross sectoral collaboration of competent public administrations but involve all those actors (e.g. environmental institutions, economic operators, citizens) who retain an interest in the area and will be directly or indirectly affected by future land use(s). Furthermore, policy making, planning and decision making on post mining environmental restitution and land restoration should be coordinated across different disciplines (horizontal integration) and between different levels of government (vertical integration).

- Raise public awareness on the environmental and socioeconomic benefits associated with decarbonisation and post mining land restoration.
- Devise ways to stimulate the demand for the restored land and attract investors' interest; for example through taxation.
- Increase investment capital for environmental restitution and land restoration interventions. This can be done through the formation of a dedicated fund, which will be based on the state revenues from environmental taxes imposed on coal driven (and associated) activities.

4.6 Łódzkie (PL)

Geography

The Łódzkie Region is a Polish province located at the heart of the country next to Mazowieckie and covers an area of 18,219 km^2. Łódzkie has a total population of 2.47 million residents and the population density stands at 135 persons per km^2 [29]. The two-thirds of the population lives in urban centres. The capital and main centre of economic activity is Łódź; the 3rd largest city in Poland with around 700,000 inhabitants. Administratively, the Łódzkie region is divided into 24 districts and 177 municipalities. The largest cities are Bełchatów, Kutno, Pabianice, Piotrków Trybunalski, Radomsko, Tomaszów Mazowiecki and Zgierz.

Economy

In 2018, the regional GDP was estimated at 28.2 billion euros and a 4.26% growth is expected for 2019 [29]. The GDP per capita was 18,600 (PPS) in 2016, slightly below the national average (19,900). Łódzkie has a long industrial tradition, which goes back to the 19th century during which the region and especially its capital Łódź was famous for its (now declined) textile industry. The region's economy is dominated by the service sector which accounts for 58.7% of the regional GDP. After services, industry is second most important pillar of the regional economy. Industrial activities, with an annual turnover of almost 9.9 billion euros, account for 38.4% of the region's GDP (higher than the national average), representing a vital source of income and growth for urban agglomerations. The majority of the province's industrial and manufacturing plants are concentrated within the Łódź Industrial District. The most developed branches of industry are the production of textiles and clothing, mining of lignite, generation and distribution of electricity, production of chemicals, production of foodstuffs, production of machines and equipment, production of electrical equipment and building materials. The primary sector accounts for 2.9% of the regional GDP, generating around 750 million euros every year. The share of coal driven activities in the regional GDP is 1.27%; coal mining and electricity production contribute around 360 million euros to regional economy.

Employment

At the end of March 2019, there were 67.700 registered unemployed persons and the unemployment rate stood at 6.2% (minus 0.4% as compared to April 2018), significantly higher than the national rate (4.6%). Łódzkie has a similar to the national one employment distribution. The largest portion of the active labour force is employed in the service sector (55-60%), industry accounts for 38-42% while agriculture employs around 10-12% [30]. Poland employs about half of the European coal workforce. In Łódzkie region, the coal industry employs about 8930 workers; 6388 in extraction sites and 2538 in

the Bełchatów Power Station. Throughout the intra and inter regional coal value chain, the number of jobs indirectly related to the coal industry is estimated at 30,305 [2].

The coal industry

Poland hosts the largest reserves of coal in Europe (behind Germany) with approximately 80% of its energy production to derive from the burning of coal. 35 coal mines are currently operating in the country with a combined capacity that can reach up to 135 million tonnes annually. Łódzkie is home to the world's largest lignite fired power plant with a nominal power of 5,472 MW. The Bełchatów Power Station, situated near Bełchatów city in Łódź Voivodeship, is the largest thermal power station in Europe, producing 27–28 TWh of electricity per year; a volume that represents approximately 20% of the total power generation in Poland. The power station is owned and operated by PGE GIEK Oddział Elektrownia Bełchatów, a subsidiary of Polska Grupa Energetyczna. The plant was commissioned in 1982 and currently operates 13 units (12 x 370/380 MW and 1 x 858 MW), with an average efficiency of 36%. The plant is fed by two huge open-pit coal mines: in Belchatow and in Szczercow. The Bełchatów mining zone represents one of the largest coal reserves in Poland with confirmed reserves of 1.93 billion tonnes of lignite coal. It zone covers an area of over 10.350 hectares; 7.210 hectares in the Bełchatów Field and 2.608 hectares in the Szczerców field.

Mine site / Power plant	Key facts
Bełchatów Coal Mine	• Mine Type: Open pit mine • Size: 10369.3 ha • Type of coal: Lignite • Coal depth: 166.4 m • Annual production (raw coal extracted): 42Mt • No. mines: 2
Bełchatów Power Station	• Installed capacity: 5,472 megawatts • Annual electricity production: 27–28 TWh • Average Net efficiency: 36% • Years of operation: 23 years • End of operations: n/a

Expected impact on employment and economy

Łódzkie is expected to experience a low social impact from the shutdown of coal driven activities, given its highly diversified economy and the limited role of coal in the region’s economic structure; the share of coal driven activities in the regional GDP is 1.27%. From the coal phase out, Łódzkie may lose up to

8,500 jobs provided directly by the coal industry. With current unemployment rate at the level of 6.2% and almost 8,500 jobs at risk (0.65% from economically active population), Łódzkie will experience a slight increase in its unemployment rate that could eventually reach 7%. This means that the region will most probably be able to absorb lost jobs and re-employ these people in other more competitive industries. Nevertheless, the social impact from the shrinkage of the coal industry might be worse, taking into account an estimated 30,000 jobs in sectors/companies with connection and tights with coal. The companies that will be mostly affected will be those providing mining support services and are involved in the production of mining machinery and equipment as well as other metal finished products. Lower impact is foreseen for construction and engineering companies, as well as R&D centres and the transportation industry.

Legal framework

The legal basis that governs mining operations and drives permitting procedures is made up of the Geological and Mining Law (2015), the Act on the Liberty of Economic Activity (2014), the Nature Conservation Law (2015), the Environmental Protection Law (2013), the Water Law (2015) and the Act on Land Use Planning and Space Management (2015). The Geological and Mining Law constitutes the most updated legal scheme to regulate mining in Poland as of April 2019. According to this Act, an entrepreneur undertaking mining activities is obliged after the completion of extraction activities to proceed with the planned reclamation works in the wounded landscape. Mine operators' obligations include to secure or safely remove remaining equipment, installations and facilities from the site, and restore basic ecological functions. Permitted extraction activities shall be carried out under an approved technical operation plan. This means that candidate mine operators, in order to obtain the final permission, must have in place a detailed technical operation plan that sets out the intended mining activity, including plans for land, forest and water use, and schedule of technical works/operations in the area concerned.

Regarding post-mining land restoration, a number of important provisions are also identified in the following acts:

- The Act on the Protection of Arable and Forest Land of 3 February 1995 (Journal of Laws 2015, item 909, as amended)
- The Act on Mining Waste (Journal of Laws 2013, item 1136, as amended)
- The Act of 13 April 2007 on preventing the damages to nature and their compensation (Journal of Laws of 2014, item 1789, as amended)
- The Act of 27 April 2001. The Environmental Protection Law (Journal of Laws of 2016, item 672, as amended)

The Act on Mining Waste stated that the mined area should be properly cleared from waste and overburden in order for reclamation works to commence. The primary purpose is to restore the land to its previous use and natural state; while particular emphasis should be placed on enhancing soil quality, and safeguarding wild fauna and flora, natural habitats and freshwater ecosystems. The provision for monitoring of the mining waste disposal facility is also specified under the Article 27. The waste holder operating a mining waste disposal facility is legally bound to monitor and assess environmental impact on the site during and after the completion of extraction operations, and submit regular environmental impact reports to competent authorities. The Environmental Protection Law defines the concept of "remediation", ways of conducting it and criteria for choosing the most appropriate method.

Environmental restitution

The Bełchatów power plant is the most polluting thermal power station in Europe. The plant burns about 45 million tonnes of coal each year, has emitted approximately 1 billion tonnes of carbon dioxide throughout its lifetime and is responsible for the largest releases of carbon dioxide (CO2), sulphur dioxide (SO2) and nitrogen oxides (NOx) to the environment. In 2016, the Bełchatów power plant generated 38.35 million tonnes of CO2 emissions (ranked 1st of all coal power plants in Europe) [20]. The plant was also responsible for an estimated 489 premature deaths (ranked 4th in Europe), 140,000 lost working days and 205 cases of chronic bronchitis in adults, which culminated in over a billion Euros in health costs. While plans for old units retrofitting with carbon capture and storage technologies are in place, the Bełchatów power plant has seen a substantial rise in CO2 emissions and air pollution for a third year in a row. The plant increased its emissions from 34.9 million tonnes of CO2 in 2016, to 38.3 million tonnes in 2018, a rise of 10 percent. Along with rising emissions, air pollution levels from the plant have also risen in the last two years, with an estimated 54 percent increase in particulate matter, 50 percent rise in Sulphur (SO2) and 8 percent rise in nitrogen dioxide (NO2) levels, as well as increased heavy metal concentrations such as lead and arsenic released by the plant. It is not only the Bełchatów power plant to blame for the extended environmental pollution in Łódzkie Region; the two neighboring open cast mines in Bełchatów and Szczerców have caused severe disturbance on the hydrological cycle (e.g. lowering of water table pollution), dust pollution, and have contaminated soil and water bodies with high releases of toxic heavy metals (mercury, cadmium and lead).

Funding

Apart from mine operators' obligation to cover the costs of mine reclamation in worked out sites with own capitals, the national funding mix for environmental restitution and land restoration causes consists of state aid (directly drawn from state budget) at a rate of 50%, domestic loans and credit from financial institutions (33%), environmental funds (7%), EU funding (5%) and other funds (5%, non-financed outlays). Alternative funding sources are identified within:

- The Regional Operational Programme of the Łódzkie Region for 2014-2020 under the Priority Axis "Preservation and protection of the natural environment, supporting the efficient management of resources" (280 million euros).
- The National Fund for Environmental Protection and Water Management (Earth Surface Protection Programme).
- The Operational Programme Infrastructure and Environment 2014-2020, Version 11.2, Warsaw, 1 August 2019, Action 2.5 Improving the quality of the urban environment (budget of Action 2.5 - 251.5 million EUR).
- The LIFE Programme (the budget for 2014-2020 is 3,456 million EUR, including 2.592 million EUR for environmental protection).
- Commune's Reclamation Programmes.
- Loan Programmes from Development Banks such as "GOSPODARSTWA KRAJOWEGO".

Mine reclamation companies

There are eight important companies actively engaging with mine closure and reclamation in Poland. These are ALDEX SA, MENARD POLSKA, DEKONTA POLSKA, SUEZ POLSKA, GEOTRADE, SEGI-AT, EKOLOGUS and PROTE. The following table presents the SWOT MATRIX for mine closure and reclamation companies in the region of Łódzkie.

Table 9: SWOT MATRIX for mine reclamation companies in Łódzkie (Poland)

STRENGTHS	**WEAKNESSES**
• Diversified land restoration and environmental services • Skilful human resources • Collaboration with foreign companies (a pioneer in land reclamation) • Geospatial data is available	• Lack of modern machinery/equipment • Risk involved with government contracts • Difficult geospatial conditions
OPPORTUNITIES	**THREATS**
• Legal framework on post mining land restoration exists • Increasing demand for reclamation and environmental services in coal intensive regions • New technology development • Funding programmes for land reclamation projects	• Market instability • Unfavourable economic conditions discouraging large-scale investments such as land restoration projects • Bureaucracy (complex administrative procedures) concerning the initiation/implementation of land restoration projects

• Pressure from the public for phasing out coal driven activities and restoring degraded landFunding programmes for land reclamation projects	• Resistance from local communities which are largely dependent on coal driven activities

Former land uses and uses surrounding the mine site/plants

The Belchatów coal field, since its establishment, has acquired land equivalent to 10.350 hectares. The former land uses include 6,900 hectares of agricultural land expropriated by the state to make way for mining activities, 2,876 hectare of forests cut down and 922 hectares of other land uses such as settlements, roads and public infrastructures. As the reserves in the two coal mines (Belchatów and Szczerców) are rapidly depleted, the operators are constructing a new extraction site in Zloczew that is anticipated to displace 3,000 people from 33 villages. This would cause the destruction of entire rural settlements, including highly specialised modern farms, homes, schools, shops, chapels and fire stations. The Bełchatów coal mine is situated 150 km west of the capital (Warsaw) and 43 km north of Lodz. The land surrounding the mining site is mostly covered by forests and meadows, rocky hills, settlement areas (Bełchatów), and in a smaller share by agricultural fields.

Possible land uses

Existing plans for land restoration

Mine operators, as legally bound, have already in place a land restoration programme for two mining fields in Łódzkie Region, which is implemented concurrently with ongoing coal extraction and combustion operations. The plan foresees the further reclamation of an area of 6,247 hectares; 3,887 hectares which are currently mined in Bełchatów Field and 2,360 hectares in Szczerców Field. The major share will be afforested with selected species of trees and bushes (14,000 items per hectare); one fifth of the reclaimed area will be made available for cultivation and farming and another part will be used as a dumping site for ashes and accompanying minerals. Two water bodies, interconnected by a canal, will be created in a previously mining area of 32.5 km^2, to be used for recreational purposes but also for biodiversity conservation.

At present, mine operators in concert with regional authorities are drawing up a more ambitious plan for post mining areas, which once completed will transform the previously mining area into Poland's largest sport and recreation centre. This plan foresees the construction of indoor ski runs, hippodromes, racetracks, artificial water courses with beaches as well as sailing and motor boating harbours, and finally, a technological park which could house a dedicated museum on mining heritage. A ski run over 850 m long on the slope of an external dump in Góra Kamieńsk has been already made available to

local and incoming visitors together with modern infrastructure including ski lifts and a catering-accommodation base.

Post mining land uses and activities with growth and employment potential

This section suggests also possible post mining land uses that could be part of a regional just transition plan that needs to support a coal phase out decision. These comprise economic activities that are not related to lignite extraction and combustion, are of a sustainable nature, share substantial growth potential and can contribute to offset the negative impact from coal phase out in terms of employment and local income.

To start with, Łódzkie is well suited for investing in tourism and recreation. Tourism can provide an alternative viable route for Łódzkie's economy, succeeding coal driven activities in the post coal era, as it offers several attractive features in terms of both natural and cultural resources. Having historically been an industrial city and despite an influx of over 500,000 foreign tourists annually, the Region is mostly shunned by tourists in favour of the more popular Polish cities such as Krakow, Warsaw or Wroclaw. However, this situation can be reversed, with the region claiming its position as an attractive tourist destination for visitors primarily concerned for environmental sustainability and cultural heritage. As indicated below, former coal mines could provide venues for conferences, concerts and other special events, and host modern sport facilities such as indoor ski runs, hippodromes and racetracks. Other touristic and recreational activities might include mining themed holidays in former mine areas or/and the organization of concerts.

In addition, Łódzkie Region can benefit from the development of Renewable Energy Resources, rendering the conversion of former mine sites and coal fired power plants to produce clean energy a possible and attractive solution. Łódzkie higher suitability for wind power generation with an average wind speed of 12.2 miles per hour and a high availability factor (41.85%). The solar resource is lower (12% availability factor), but the conversion can still be considered feasible. Finally, due to the intensive excavation of land in former mine sites that has deteriorated soil quality and stability, housing projects seem a technically difficult option to consider.

Decarbonisation and land restoration recommended pathways

Poland is the largest coal producer in Europe and is extremely dependent on domestic coal for its energy supply. Coal accounts for almost 80% of energy production and 51% of total primary energy supply. Poland, in spite of having the most polluting coal industry in the EU, demonstrates a low willingness to decrease its emissions let alone to completely wean itself off fossil fuels. In contrast, the Polish government plans the extension of coal driven activities in the country with the commissioning of new lignite fuelled power stations and the construction of two coal extraction sites in Zloczew and Silesia. The draft national energy explicitly states that coal will continue to have a key role in the country's

energy mix for the next decade; Poland will produce 60% of its energy from coal. As the country seems deeply stuck on coal, there is no currently a stated coal phase plan but only a soft commitment to rule out state aid for coal related activities. Even though the government seems committed to the prolongation of carbon based economy (as backed by mining companies and workers union), local support for ending coal activities is growing and leads to more vocal demands for planning a transition.

In addition to strengthening efforts to convince for the need to decarbonise economy, Poland and coal intensive regions including Łódzkie need to actively address a series of issues/inadequacies towards the efficient environmental restitution and land restoration in (former) mine sites. These include to:

- Raise public awareness on the benefits of economy's decarbonisation and post mining land restoration opportunities that can be identified.
- Discover new alternative ways and methods to encourage the demand for the restored land and attract investors' interest. It has been observed that taxation often is an adequate incentive.
- Increase investment capital for environmental restitution and land restoration interventions. The latter can be implemented via the establishment of a fund, based on state revenues deriving from environmental taxes enacted for coal related activities.
- Initiate a harmonised and integrated approach and procedures to evaluate potential and alternative land uses, which could comprise among others, cross sectoral collaboration of competent public administrations, involving actors such as environmental institutions, economic operators and citizens interested in the area, affected directly or indirectly from possible future land use(s).

4.7 Eszak-Magyarorszag (HU)

Geography

Eszak-Magyarorszag (North Hungary) is one of the seven administrative (NUT2) regions of Hungary. As its name suggests, Eszak-Magyarorszag is located in the north-eastern part of the country. The region borders with Slovakia in the North and with Ukraine in the East. Eszak-Magyarorszag has a surface area of 13,433 km^2, covering 14.4% of the country's territory. Its population stands at 1.47 million inhabitants. The region is sparsely populated with 88 inhabitants per km^2, when the national average is 131 inhabitants. Administratively, Eszak-Magyarorszag is divided into 3 counties (Borsod-Abaúj-Zemplén, Heves and Nógrád) and 29 districts. The capital and main centre of economic activity is Miskolc.

Economy

Despite the rapid growth in the 2010s during which the GDP per capita in Eszak-Magyarorszag has been steadily growing by 5% annually (since 2013), Eszak-Magyarorszag remains one of the least developed regions in the country and in the EU-28. Its gross domestic product amounted to €8.8bn in 2016, corresponding to a GDP per capita in purchasing power standards (PPS) of 13,000 PPS per inhabitant [31]. Eszak-Magyarorszag is the Hungarian region with the lowest GDP per capita; 21% lower than the national average (16,400 PPS). Notably, Central Hungary's (the top-ranking region in the country) GDP per capita was almost 2.5 times higher than those of Eszak-Magyarorszag. Industry and manufacturing (the chemical, engineering, automotive and electronics industries) are the main pillars of the regional economy, followed by agriculture and tourism. Tourism importance as a driver of regional growth has increased recently as the number of tourist arrivals is on the rise and new tourism facilities are deployed, owing to the outstanding natural and cultural heritage of the region. The regional economy is entirely open, and depends on the EU for over 80% of its foreign trade. Still, region's stock of foreign direct investment (FDI) is far below the national average: 4.6% of total in 2016.

The Territorial and Settlement Development Operational Programme outlines country's priorities for sustainable regional development. This is a centralised operational programme which covers the budgetary period 2014-2020 and incorporates the territorial development objectives of all regions incl. Eszak-Magyarorszag. The main priorities of the Operational Programme include: 1) economic development and job creation; 2) improvement of the framework conditions of entrepreneurship (e.g. through improvement of public services, for example health and transport services; development of settlements' infrastructure; elimination of segregation and human resources development); 3) transition to a low-carbon economy; and 4) development of cities' and settlements' identity, cohesion and satisfaction. Policy measures related to innovation-specific objectives include support to the development of industrial parks and incubators, SMEs' market-oriented innovation and to their

investment in technology upgrading. Prioritised industries include tourism and food industry and to a certain extent also eco-industries. To end with, the main policy priority in Eszak-Magyarorszag is to enhance business innovation through technology upgrading, corporate and university-based knowledge generation, and R&D infrastructure improvement.

Employment

In 2016, the region's unemployment rate was 5.8%, the lowest in recent years (in 2008 the unemployment rate was 13.2%); still above the national average but lower than the EU-28 average (7.6% in 2017). The youth unemployment rate in the region is the highest among Hungarian regions; it stood at 17% in 2017. Around 66 thousand people living in Eszak-Magyarorszag are currently unemployed and actively seeking for a paid job. Most regions in Hungary have a similar employment structure. The largest portion of the active labour force is employed in the service sector (60-65%), industry accounts for 25-30% while agriculture employs around 4-8%. In Eszak-Magyarorszag, around 2,200 persons are directly employed in coal driven activities; 1655 in "Mátra" coalfield and 632 in the adjacent power station. Another 222 people are employed in the "Oroszlány" Power Plant in Central Transdanubia. Throughout the coal value chain, the number of jobs sustained by the coal industry is even higher. In Hungary, the number of jobs indirectly related to coal is estimated at 5697.

The coal industry

Hungary is a country relatively rich in energy resources. Total conventional energy resources in Hungary comprise approximately 10.5 billion tonnes of coal, 2.4 billion cubic metres of natural gas (including unconventional) and 24 million tonnes of oil (including unconventional). Lignite and brown coal reserves account for about half of Hungary's total coal resources. The country's major lignite and brown coal resources are concentrated in the regions of Transdanubia and in northern and north-eastern Hungary. Over 90% of this volume is utilised for heat and power generation purposes.

In 2015, national electricity generation amounted to 30.2 TWh, with an installed capacity of around 8.6 GW of which 7.3 GW are constantly available; a net 13.7 TWh of electricity was imported. In 2015, Hungary's domestic electricity production mix was as follows: nuclear energy had a share of 52.5%, electricity produced from coal and lignite 19.5%, gas fired generation 16.8%, and renewable energy about 9.9%.

Coal mining has a long tradition in Hungary, with dozens of underground and open-cast coal mines operating throughout the last two centuries. Twenty years ago, coal mining was one of the mainstays of the national economy, employing over 80,000 peoples, of which 52,000 in coal extraction sites. Nowadays, the industry is on the decline. Nevertheless, the country remains largely reliant on fossil fuels, and primarily on coal to address their growing energy needs. Notably, almost 60% of the coal

used in Hungary is produced indigenously (the rest is imported), though coal accounts for only 19.5% of the country's total primary energy supply.

In Hungary, there are now 2 active opencast lignite extraction sites (Visonta and Bükkábrány) with about 0.5 billion tonnes lignite reserves in total. The coal mines are operated by the energy company Opus Global. The lignite produced in the two opencast mines is supplied to the adjacent coal fired power station at Visonta for electricity production. The Mátra Power Plant, made up of five lignite-fired units and two topping gas turbines, is the second largest power plant in Hungary (and the largest one using coal as fuel), with an installed capacity of 966 MW (2 x 100 MW units, 1 x 220 MW, 2 x 232 MW, two gas turbines of 2 x 33 MW and a 16 MW solar park). The Mátra Power Plant is fully supplied with local resources and provides about 15% of the country's electricity and over 80% of the coal based electricity. The average annual production is estimated at 6,200 GW. In addition, the country hosts a series of smaller power units fuelled with coal with the "Oroszlány" Power Plant to be the largest one. The "Oroszlány" Power Plant, consists of 4 commissioned units with a total installed capacity of 240 MW. "Oroszlány" Power Plant is the second largest coal fired plant in the country, accounting for 3.7% of the total electricity generated and around 17% of the share of power generated by coal plants. Until 2014, the power plant was supplied with lignite from the associated "Márkushegy" underground mine. Following the shutdown of extraction operations in "Márkushegy", the power plant continued to operate using stockpiles from previous years, as well as lignite imported from other EU regions.

The two coal fired power plants has a combined annual capacity of 1130 MW and their average efficiency power is estimated below 30%. This rate is not a surprise as all units in Hungary were commissioned during sixties and seventies. The low efficiency rate suggests that the continued use of coal as an energy source will require the refurbishment or replacement of old, inefficient power plants, to cut down high operation costs and CO2 emissions. The "Mátra" Power Plant is licensed to produce energy by 2025 – the government plans to extend the licensing period - while "Oroszlány" is scheduled to be decommissioned by the end of 2020.

In the energy field, the national target is to increase the renewable energy share in gross final energy consumption to 14.65% by 2020. Unless further investing on the clean energy sector, Hungary may increase its dependency on imported fossil-fuels to cover its energy needs and fall behind environmental targets. Domestic gas and oil production is already peaked, and increasing the use of lignite will result in failing to achieve CO2 targets. As a result, national goals on the share of renewables need to be revised, notwithstanding that Hungary will retain nuclear power generation, approving the construction of two nuclear reactors to replace phased out generation capacity and address the need for new capacity.

Mine site / Power plant	Key facts
"Visonta" and "Bükkábrány" coalfields	• Mine Type: Open pit mine • Size: 80 km^2 • Type of coal: Lignite • Annual production (raw coal extracted): 9.6 Mt (2018) • No. mines: 2
"Mátra" and "Oroszlány" power plants	• Installed capacity: 1,130 megawatts • Annual electricity production: 7,700 GWh • Net efficiency: 29% • Years of operation: 44 years • End of operations: For "Mátra" expected in 2025 (although a decision on further expansion is pending); for "Oroszlány" expected in 2020

Expected impacts on employment & economy

The anticipated direct job losses in power plant operation from the decommissioning of the "Mátra" and "Oroszlány" coal fired power plants in the coming decade could reach around 855 jobs, which is 35.6 % of the estimated current employment in the coal industry. Around one fourth of these jobs may be lost in the early 20's, as the end of operations in the "Oroszlány" plant has been scheduled for 2020. Evidently, coal mining extractions have a tight linkage with the operation of coal fired power plants. As mentioned earlier, over 90% of the coal produced in the country is used for power generation in these two power stations. As a result, the phase-out of coal fired-power plants will render unnecessary most lignite mines, leading eventually in the short-to-medium term to their closure. This means that the number of jobs at risk is even higher. The number of direct job expected to be lost in coal extraction processes may reach 1655 jobs in Eszak-Magyarorszag. The positions that may face a higher risk are those in coal extraction processes. This is because the vast majority of former coal-fuelled units were not permanently closed but switched their input fuel to natural gas or biomass (specifically firewood); thus maintaining the previous employment status.

On the whole, as the unemployment rate is relatively low and the coal industry represents only a small share of the total GDP produced in Eszak-Magyarorszag, the region will most probably be able to absorb lost jobs and re-employ these people in other more competitive industries. The planned coal phase out will inevitably put pressure on the local economy with the most severe and greatest impacts to be anticipated on the energy sector, unless the shutdown of coal driven activities go along with parallel investments in renewables and cleaner sources of energy. In addition, the coal phase out may affect a group of other economic sectors related to coal driven activities. Hungary hosts a considerable number

of enterprises active or dependent on coal mining (15-20 large enterprises and SMEs), most of which providing supporting services and equipment. For instance, the segment of mining equipment manufacturers, which provides machinery essential for coal extraction activities might confront serious challenges to continue to grow in a sustainable way, taking into account the changes expected ahead in the coal sector. Hungary is a net exporter of mining equipment while the industry has a total annual turnover of around 300 million euros, and about 1,000 employees.

Legal framework

The national Mining Law, as introduced in 1993 and amended in 2000, lays down the conditions for the prospection, exploration, extraction and exploitation of energy and mineral resources in Hungary. The Law addresses issues related to concession procedures, security zones and protective pillars, mine plans, safety of mining; landscape rehabilitation; mine damages, right to use water, fines for environmental damage, and state supervision of mining activities.

Until April 2015, the authority responsible for mining permitting was the MBFH (under the Ministry of National Development) and its regional departments of mines. Since April 2015 regional mining authorities and several other authorities representing the various mining, environment, nature conservation, soil protection, and cultural heritage inspectorates, have merged to form "Government Offices" (20 in total including Budapest) as a one-stop-shop in charge of licensing mineral extraction processes.

For ore minerals (incl. hydrocarbons, coal, geothermal energy), the Mining Law foresees a concession tendering procedure for granting an extraction right. The Minister shall designate concession areas (in accordance with spatial plans) and then publish the call on ore minerals exploration and extraction in the Official Journal on hydrocarbons and geothermal energy. The exploration and extraction right is typically awarded to the Most Economically Advantageous Tender (MEAT) through an open public procurement process.

To acquire a mineral extraction right, the beneficiary of exploration permission, shall process with the establishment of a mining plot after the final exploration report, which presents the results of exploration activities including information on available mineral reserves, environmental status and feasibility analysis, has been approved by the mining authority. The applicant needs to submit an official request no later than 5 moths from the approval of the final evaluation report. According to the Mining Act, extraction of mineral raw materials shall only be permitted on the section of the surface and depth separated for this sole purpose (i.e. mining plot).

According to Article 27 of the Mining Act, extraction activities shall be carried out under an approved technical operation plan. This means that the candidate, in order to obtain the final permission, must prepare a detailed technical operation plan that sets out the intended mining activity, including plans

for land, forest and water use, and schedule of technical works/operations in the area concerned. The plan needs to demonstrate that all extraction procedures will be carried out in full compliance with technical safety, health, mineral reserve management, water management and environmental natural and land remediation requirements.

According to the Mining Act, the mining right holder holds the obligation to undertake all the restoration works required in the former mine sites, to restore the degraded land. Alongside with the technical operation plan, the beneficiary shall prepare and submit to mining authorities a preliminary land remediation plan on how to return the mined land into a good environmental state that can be exploited for other productive uses. The preliminary land remediation plan shall contain the textual description and map of the natural features to be affected throughout the intended mining activity as well as of the new installations/facilities to be constructed. The textual part of the preliminary land remediation plan shall embrace the purpose of re-utilization and detail the tasks required for the restoration of land mine contaminated sites. The preliminary land remediation plan shall take into account the environmental protection permit, the regional spatial planning or regulation plans in force and the time schedule of the use of the designated area.

Environmental restitution

In 2016 [20], the "Mátra" Power Plant generated 5.25 million tonnes of CO2 emissions, and was responsible for 83 premature deaths (ranked 42nd among all European coal fired power plants). On average, regions with significant coal activity exhibit 2 times more emission of PM10, 2.5 times more NOx and almost 10 times more SO2 emissions compared to regions with no coal activity. The level of air pollutant emissions is higher for outdated and inefficient coal fired power plants; which is the case for Eszak-Magyarorszag. In Eszak-Magyarorszag, coal driven activities are responsible for 25% - 50% of total PM10 and NOx emissions, and over 50% of total SO2 emissions, while air pollution levels in the region regularly exceed the EU's daily and annual limits. In addition to the above, coal extraction activities have caused damage to the groundwater system (at least within the boundaries of the mining zone) through the reduction of water resources and the decline of aquifer levels. Similarly, the "Matra" coal power plant has contaminated groundwater with elevated levels of arsenic, lithium and other pollutants. Coal driven activities are traditionally associated with habitat destruction and noise pollution that directly impact local biodiversity. In Eszak-Magyarorszag, however, the extent of biodiversity loss is limited as the land that was converted for coal extraction was previously used for agricultural purposes, and the adjacent "Békás" Lake that is home to large number of native (endangered) species and despite the pessimistic initial expectations, has remained largely unaffected by coal driven activities. Further to this, the continuous replenishment of the harvested barrels that follows the end of mining operations, has resulted in the complete re-introduction of affected species. Overall, the extent of

environmental pollution in Eszak-Magyarorszag from coal can be generally characterised as low and the effects can be detected mainly within or close proximity to the mine sites and power plants in question.

Funding

The mining right holder is legally bound to cover the entire cost of restoration works in worked out mine sites, and return the land into its previous ecological state. The state has not budgeted any specific amount for land restoration in former mine sites; still social protection and environmental restitution programs can be approved on a case by case basis. For the coal mines located in Eszak-Magyarorszag, there is no approved state grant; all restoration works are to be undertaken by the mining right holder, in accordance with the approved preliminary land remediation plan and local spatial plans.

Mine reclamation companies

Currently, there are 3 environmental and construction/engineering companies in Hungary that can undertake environmental restitution and land restoration works in former mine sites. These are ENVIROTIS (https://envirotis.hu/), BÁNYAVAGYON-HASZNOSÍTÓ (http://www.bvh.hu/) and ENVECON (http://www.envecon.hu/). The following table presents the SWOT MATRIX for mine closure and reclamation companies in Hungary.

Table 10: SWOT MATRIX for mine reclamation companies in Eszak-Magyarorszag (Hungary)

STRENGTHS	**WEAKNESSES**
• Diversified land restoration and environmental services • Skilful human resources	• Lack of modern machinery/equipment • Limited experience in reclamation projects
OPPORTUNITIES	**THREATS**
• Regional decarbonisation strategy in place • Legal framework on post mining land restoration exists • Public Private Partnerships (PPPs) for land reclamation projects	• Uncertainty over the closure date of mine sites

Former land uses and uses surrounding the mine site/plants

The "Matra" power plant and the "Visonta" coal field are located in the valley of the Matra Mountains in close vicinity to the town of Gyöngyös in Heves County. The land that was cleared to make way for extraction purposes was previously covered by agricultural land and meadows, utilised by local communities for crop farming and animal husbandry. The examined sites are now surrounded with grassland, meadows, ditches, creeks, artificial mine lakes and road infrastructures while the major

economic activity taking place in the area other than coal related operations is farming. Proximity to watersheds, nature protected areas rich in biodiversity (Békás Lake) and archaeological sites can be regarded as the only (geospatial) constraints to post mining land exploitation.

Possible land uses

Post mining land uses and activities with growth and employment potential

The fast rising prices in the EU's emissions trading system (ETS) coupled with falling costs for solar and wind energy production has rendered lignite based electricity production a no more economically viable activity in Europe, thus paving the way for the transformation of the economy structure in coal intensive region. Eszak-Magyarorszag, with high potential for energy production from renewables, can claim a brighter and more sustainable future away from fossil fuels. Eszak-Magyarorszag has a reliable supply of solar energy even in winter. The average annual solar radiation in the region is estimated at 1,349.84 kWh/m^2. The owners of the "Matra" plant have already installed a 16 MW photovoltaic plant on an abandoned slurry deposit to take advantage of solar availability, and have plans to add two 20 MW solar plants nearby, to boost station's solar power capacity. The examined coal areas (after closure) can also act as low-enthalpy geothermal resources, to be used for small to medium scale power generation and for heating and cooling purposes. In contrast, wind power potential in region's mine sites is rather limited as the average wind speed is about 2.50 m/s; a figure that falls at 1.6 m/s for territories with up to 50 metres altitude.

Eszak-Magyarorszag can also benefit from the enhancement of the agricultural sector, which has traditionally been one of the main pillars of the regional economy. In the surrounding of "Mátra" Power Plant and adjacent coal fields, there is a tremendous potential for the cultivation and commercial exploitation of vine cane, fruit-tree cuttings, other tree cuttings, mushroom compost and straw. Tourism potential in mine sites, despite the overall number of tourist arrivals is on the rise and new tourism facilities are deployed in the region, is quite limited and can be only seen in relation with the exploitation and environmental enhancement of mine lakes that could provide opportunities for fishing, water sports, bathing, and wetland development. To make this happen, a water permit is required alongside with restoration works on raising the level of water quantity in lakes, removing contaminants from soil and ensuring lakes' self-cleaning capacity.

Decarbonisation and land restoration recommended pathways

Hungary may be the first country in Eastern Europe to end coal fired power generation. Though a coal exit date has yet to be officially announced (and thus no just transition plans are in place), Hungary appears particularly committed to follow a different and more sustainable route in electricity production by replacing coal with biomass, gas, solar energy and battery. This move is motivated by a) the fact that Hungary is less dependent on coal than other countries in Central and Eastern Europe such as

Poland, Czech Republic and Bulgaria - the country's coal fired electricity production rate (15%) is among the lowest in the EU and much of this energy is imported from abroad – b) the rising costs of EU carbon prices, c) "Matra" station owners' intention to maintain the operation of the plant by converting into low carbon solutions and d) the low social pressure and political risk from losing jobs. At the UN Climate Action Summit in New York, the Hungarian President unveiled that the country is planning to wean itself from coal-fired electricity generation by 2030, in an attempt to help reduce emissions and tackle climate change. When it comes to land restoration, alternative options for post mining land use are already available in Eszak-Magyarorszag and the region appears adequately prepared to proceed with restoration programmes in former mine sites should the political will exist. Still, more efforts should be made to:

- Set forward a coordinated and integrated approach and procedures to assess possible and alternative land uses, which should not be constrained to cross sectoral collaboration of competent public administrations but involve all those actors (e.g. environmental institutions, economic operators, citizens) who retain an interest in the area and will be directly or indirectly affected by future land use(s).
- Raise public awareness on the environmental and socioeconomic benefits associated with decarbonisation and post mining land restoration.
- Devise ways to stimulate the demand for the restored land and attract investors' interest; for example through taxation.
- Increase investment capital for environmental restitution and land restoration interventions. This can be done through the formation of a dedicated fund, which will be based on the state revenues from environmental taxes imposed on coal driven (and associated) activities.

5 COMPARATIVE ANALYSIS AND CONCLUSIONS

There are certain patterns emerging in DeCarb territories' coal profiles, after careful analysis. These patterns reflect both common socioeconomic and political realities and therefore problems, obstacles and opportunities associated with the decarbonisation of local economies, and the environmental restitution and restoration of degraded landscapes due to mining. This section summarises the key findings from case by case analysis on examined territories, attempting to identify common misconceptions, weaknesses and needs for the design and implementation of land restoration programmes.

Employment

In the early 1960s, coal mining, closely intertwined with the rise of industrial economy in Europe, created millions of jobs in coal intensive regions and secured a good standard of living for rural communities. In Germany alone the coal industry provided permanent employment to over 600,000 people. Nevertheless, over the past few decades the number of coal related jobs in Europe is steadily decreasing as the production and consumption of coal in the EU has been in steady decline due to the closure of uncompetitive coal mines and the growing role of renewables in the EU countries' energy mix. Still, the coal industry remains a major employer in regions with substantial mining and coal based power generation activity. It is estimated that the coal industry directly employs 49,027 people in DeCarb territories; 38,306 (78.1%) in coal mines and 10,721 (21.9%) in coal fuelled power plants. The territories with the highest overall employment in the coal industry are South-West Oltenia (Romania) and Yugoiztochen (Bulgaria). Coal related employment in DeCarb territories ranges from 12,300 jobs in Yugoiztochen (Bulgaria) and 13,000 jobs in South-West Oltenia (Romania) to 250 jobs in Nordjylland (Denmark) and 1,500 jobs in Savinjska (Slovenia).

Yugoiztochen (Bulgaria) and South-West Oltenia (Romania) are on the top of the list regarding employment in coal extraction activities, each hosting more than 10,500 direct jobs in coal mine sites. Łódzkie (Poland) and Western Macedonia (Greece) follow with around 6,400 and 4,300 employees respectively while Savinjska (Slovenia) and Észak-Magyarország (Hungary) account for less than 1,600 employees. When it comes to coal power stations, South-West Oltenia (Romania) and Łódzkie (Poland) account for the largest number of job positions among DeCarb territories with over 2,500 employees. On the other side, Nordjylland (Denmark) and Savinjska (Slovenia) provides 250 and 311 jobs respectively in coal based energy production.

Alves Dias et al. [2] provide an estimation of indirect jobs linked to coal. These have mostly to do with equipment and machinery manufacturing and supply, supporting services and R&D. Throughout the coal value chain in DeCarb territories, the number of indirect jobs is estimated at 94,781. For DeCarb territories, the ratio between indirect and direct jobs is 1.93. This implies that for every direct job created

in the coal industry, almost two additional jobs are created and preserved in the local economy in support of coal driven operations. The highest ratio between indirect and direct jobs is observed in Brandenburg (Germany) and Łódzkie (Poland) with 4.44 and 3.33 respectively.

For some DeCarb territories, the coal industry represents a major source of employment for local populations. For instance, in Western Macedonia (Greece), coal mining and power generation activities account for 6.3% of the regional employment. Remarkably, the coal industry is responsible for 45.9% of job positions in the secondary sector, without taking into account the indirect employed created by coal driven activities.

Table 11: Coal related employment in DeCarb territories

Territory	Employment in coal mines	Employment in coal fired power plants	Indirect employment	Total employment
Brandenburg (DE)	3,402	1,107	20,000	24,509
South West Oltenia (RO)	10,600	2,600	8,000	21,200
Western Macedonia (GR)	4,283	1,398	5,200	10,881
Yugoiztochen (BG)	10,773	1,885	19,558	32,216
Savinjska (SI)	1,255	311	2,500[7]	4,066
Łódzkie (PL)	6,338	2,538	30,305	39,181
Eszak-Magyarorszag (HU)	1,655	632	5,697	7,984
Nordjylland (DK)	-	250	1,021	1,271
DeCarb territories	**38,306**	**10,721**	**94,781**	**143,808**

Expected impact from the shutdown of coal driven activities

The EU has embarked on an energy transition to decrease its carbon emissions by 40% below 1990 levels until 2030. This entails the decarbonisation of the EU economy, which requires a switch from fossil fuels (especially coal) to cleaner and more sustainable sources of energy such as renewables. However, this transition will not come without challenges for territories strongly dependent on coal. The shrinkage of the coal industry, as anticipated with the closure of coal fields and the decommissioning of coal fuelled power plants over the next decade, will inevitably create a shockwave for coal intensive regions, to be experienced in the form of severe losses in local employment and income. Therefore, the future of these regions should be designed on the foundations of a just transition strategy that will exploit region's

[7] At national level.

competitive advantages and strengths, to diversify the economy and set forward an alternative route for sustainable and inclusive growth away from coal and mineral resources. This subsection presents the magnitude of socioeconomic impact from the shutdown of coal driven activities in DeCarb territories. The territories that will most probably confront the highest impact are those with high unemployment rates, lower regional GDP per capita, and undiversified economy.

Table 12: Socioeconomic conditions in DeCarb territories

Territory	Unemployment rate	Coal related jobs (both direct & indirect) as a share in economically active population	Regional GDP per capita versus the national average	Share of coal industry in the regional output
Brandenburg (DE)	4.5%	2%	27% lower	13%
South West Oltenia (RO)	5.5%	2.9%	20% lower	4.5%
Western Macedonia (GR)	27%	9.9%	25% lower	39.4%
Yugoiztochen (BG)	5.7%	6.1%	20% lower	34.4%
Savinjska (SI)	5.5%	3.4%	8.5% lower	6%
Łódzkie (PL)	6.2%	3%	6.5% lower	1.3%
Eszak-Magyarorszag (HU)	5.8%	0.7%	21% lower	Not available (but low)

From DeCarb territories, Western Macedonia (Greece) and Yugoiztochen (Bulgaria) are expected to witness the most severe socioeconomic impact from the coal phase out scenario. Western Macedonia (Greece) with a particularly high unemployment rate (27% in 2018) and GDP/capita 25% lower than national average will suffer a major hit, if an additional 3.5% of active population will be at risk of losing its employment status due to the closure of coal mines and coal fired power plants. Another territory that might be significantly affected is Yugoiztochen (Bulgaria). Yugoiztochen with GDP/capita almost 20% below than national average and 12,300 jobs at risk might reach an unemployment rate at the level of 10%.

Savinjska (Slovenia) is expected to experience a lower social impact (low to moderate), compared to Western Macedonia (Greece) and Yugoiztochen (Bulgaria), considering that the unemployment rate is relatively low (5.5%) and the coal industry represents only a small share of the total GDP produced in the region (5.7%). Yet, Slovenia is relatively small country and both within the context of the Savinjska region and the country as a whole, the lignite is one of the largest sources of electricity production and of great importance for currently well-balanced energy mix for security of supply reasons and therefore the biggest factor to consider in terms of wider impacts caused by a future phase out of coal on national level as well. In Brandenburg (Germany), the permanent shutdown of coal driven activities is expected to lead to the loss of around half of the jobs directly or indirectly sustained by the coal industry. The

total number of job losses can reach up to 3500, resulting in a 26.7% increase in the region's unemployment rate from 4.5% to 5.7%. With a low unemployment rate and despite the fact that the GDP per capita is 27% lower than the national average, Brandenburg (Germany) will most probably be able to absorb job losses by re-employing a significant portion of coal related workforce in RES energy production; Brandenburg (Germany) is a forerunner in the use of solar and wind energy, biomass, geothermal and hydroelectric power. Finally, South West Oltenia (Romania) region with GDP per capita almost 20% lower than the national average and ~13200 coal (direct) related jobs at risk might experience a high increase in the number of unemployed persons, which may reach 22%. South West Oltenia (Romania) will be one of the EU regions to experience the highest job losses from the shutdown of coal driven activities in absolute numbers. Nevertheless, the region thanks to its low unemployment rate (5.48%), and the fact that the share of jobs at risk in economically active population is 1.1%, and despite the significant number of job losses, might experience a low to moderate medium social impact with the possibility to absorb the decline in employment on medium to long term.

With 9,000 direct jobs and 30,000 indirect jobs at risk, Łódzkie (Poland) will be the most affected region in absolute numbers among DeCarb territories. Notwithstanding this, Łódzkie might experience a low social impact, as it is characterised by a low unemployment rate (4%) and a highly diversified economy. The same stands for Észak-Magyarország (Hungary), which features a small number of workers in coal driven activities (2,200), a low unemployment rate and the coal industry represents only a small share of the regional product. The positions that may face a higher risk are those in coal extraction processes as previous experience shows that the remaining coal-fuelled power stations will not permanently close but will most probably switch their input fuel to natural gas or biomass thus maintaining the previous employment status.

Table 13: Socio-economic impact from the coal phase out in DeCarb territories

Territory	Socioeconomic impact
Western Macedonia (GR)	**High**
Yugoiztochen (BG)	**High**
Brandenburg (DE)	**Medium**
South West Oltenia (RO)	**Medium**
Savinjska (SI)	**Medium**
Łódzkie (PL)	**Low**
Eszak-Magyarorszag (HU)	**Low**

Environmental pollution

Coal extraction and combustion for the production of electricity is one of the leading causes for the emission of harmful air pollutants such as PM10, NOx and SO2 particles, with detrimental effects on human health and the environment. At a time when the EU has stepped up its efforts to phase out from coal and meet its climate change targets, coal is responsible for almost 15% of total EU emissions (Agora Energiewende and Sandbag 2018).

In 2016, coal driven activities in DeCarb partnership countries generated 540.7 million tonnes of GHG emissions. This volume ranges from 265.6 million tonnes in Germany and 129.3 million tonnes in Poland to 6.8 million tonnes in Hungary and Denmark. In DeCarb territories, coal combustion accounts on average for 24.5% of total GHG emissions generated at country level. The highest shares are observed in Bulgaria (44%), Poland (36%), Greece (31%) and Germany (29%).

It is well known that coal is a high polluting industry; however the situation is exacerbated in DeCarb territories from the fact that the vast majority of active coal fuelled power plants have been commissioned over thirty years ago and most of them have not undergone the necessary retrofitting and technology upgrading to meet the new EU standards in accordance with the Industrial Emissions Directive. For instance, in Western Macedonia (Greece), air pollutants caused by Thermal Power Plants exceed the European limit values by more than 20%.

The negative environmental impacts from coal are not limited to air pollution but include the destruction of local ecosystems and agricultural land, extensive deforestation, biodiversity loss, underground and surface water pollution (e.g. acidification), soil degradation, ground contamination and dust pollution. In some cases (e.g. South West Oltenia) the intensity and depth of excavation activities in have led to the drainage and contamination of water resources, leaving entire villages without drinking and clean water.

Further to environmental damage, coal extraction and combustion release substances that are profoundly hazardous to human health. Exposure to these pollutants can damage people's cardiovascular, respiratory and nervous systems, increasing the risk of lung cancer, stroke, heart disease, chronic respiratory diseases and lethal respiratory infections. According to "Europe Beyond Coal", coal is responsible for over 9,000 premature deaths annually [20] while in coal intensive regions life expectancy is much lower compared to other parts of EU countries.

Possible post mining land uses

Though the primary purpose of land restoration is to re-build ecological functionality and integrity across worked out sites, and return the degraded land into a productive and usable state, the biggest challenge for DeCarb territories is to implement a just transition strategy (for the post-coal era) with alternative, sustainable economic activities that will aid to offset the losses from the shutdown of coal driven

activities providing new job opportunities and economic value to affected communities as well as contributing to a more secure energy supply. The post mining land uses that are physically feasible and exhibit the higher value for local communities include but not limited to renewables, tourism and agriculture. These uses combine intensive activity, substantial growth potential and low environmental footprint, are not related to coal and are of sustainable nature, and can justify land restoration investments.

Converting mine sites or coal plants into renewable energy generation facilities can be an attractive option for the post coal era. Renewables, as a viable and reliable source of energy, can contribute to regional energy security and supply, secure previous employment status, and ensure social and economic prosperity for affected populations. In coal intensive regions, RES development projects can also benefit from pre-existent infrastructures and land availability. The study revealed that All DeCarb territories are well suited to investing in renewable energy. Southern territories such as Western Macedonia (Greece), Yugoiztochen (Bulgaria), South-West Oltenia (Romania) and Savinjska (Slovenia) – including Brandenburg (Germany) at a lesser extent – exhibit high solar availability and hence are well placed for solar generation. In contrast, mine sites located in mine sites located in Central and Eastern EU countries (Brandenburg and Łódzkie) present higher suitability for wind power generation, as they share substantial wind resource availability because of high altitudes and strong wind speeds. DeCarb territories can also benefit from high temperatures geothermal resources in mine sites (especially Western Macedonia and Brandenburg) and abundant water resources (where relevant, especially South West Oltenia) to engage in geothermal and hydro power production. Successful examples of mine site redevelopment for solar and wind energy generation can be retrieved from Brandenburg (Germany) and Észak-Magyarország (Hungary).

Tourism and recreation uses exhibit also attractive growth potential in most DeCarb territories, which can be further unleashed by utilising the natural wealth and industrial heritage of mining sites and surrounding areas. In particular, DeCarb territories are characterised by rich diversity of natural features that include protected areas, natural parks, mountains, caves, non-polluted rural areas, mineral waters and spas. Therefore, land restoration and revitalisation programmes need to include targeted interventions to enhance environmental quality in former mine sites, valorise natural heritage assets therein (e.g. man-made lakes, green areas) and provide for attractive leisure opportunities. New sustainable growth opportunities can emerge in cultural, therapeutic, religious and eco-tourism. The territories that are better suited to investing in tourism are Brandenburg (Germany), South-West Oltenia (Romania), Savinjska (Slovenia) and Łódzkie (Poland).

Agriculture is traditionally one of the main pillars of rural economies, and as such can re-position itself as a key economic driver for DeCarb territories in the new post coal economic reality. Cultivated area already accounts for a considerable portion in the examined territories, and further area available for

farming can be made available after the closure of mine sites. The territories that demonstrate the higher potential for agricultural development thanks to favourable climate conditions and unique natural ingredients are South-West Oltenia, Western Macedonia, Yugoiztochen and Savinjska.

Table 14: Development potential in DeCarb territories

	Solar Energy Development	Wind Energy Development	Hydropower Development	Geothermal Energy Development	Agriculture	Tourism
Brandenburg	Medium	High	Low	Medium	Low	High
South West Oltenia	High	Low	High	Medium	High	High
Western Macedonia	High	Low	Low	High	High	Medium
Yugoiztochen	High	Low	Low	Medium	Medium	Medium
Savinjska	High	Low	Low	Medium	High	High
Łódzkie	Low	High	Low	Medium	Medium	High
Eszak-Magyarorszag	Medium	Low	Low	Medium	High	Low

Coal phase out commitment and common land restoration needs

The most critical step and a key prerequisite for successful land restoration and environmental restitution in DeCarb territories' mine sites, is the existence of a firm commitment from national governments to phase out coal powered electricity within a given time interval, which needs to be strongly backed by regional authorities and local communities as well.

Only a handful of EU countries have announced their intention to wean off dependency from coal by 2030 (or earlier), which is the milestone year under the UN Climate Agreement. France intends to phase out coal by 2022, Italy and Ireland by 2015, Denmark, Spain, Finland, Portugal and the Netherlands by 2030. On July 2019, Germany pledged to shut down all of its coal fired power plants by 2038 at the latest.

While Western and Northern DeCarb countries (Denmark, Spain, Germany) are committed to ceasing coal use by the next decade, Central and South-eastern countries (Poland, Romania, Greece, Slovenia, Bulgaria) – except for Hungary which has limited dependence on coal and therefore a realistic perspective of completely phasing out by 2030 – seem particularly reluctant to commit themselves. Notably, Romania exhibits a stronger than ever pro coal with limited at the time being interest to change the current status quo. In fact, the Romanian government is in negotiations with the Chinese investors for the construction of new coal fuelled unit at Rovinari coal plant while unfavourable economic

conditions delay the retrofitting of existing units. Greece, until recently, appeared determined to prolong its lignite based model for electricity production with the construction of a new lignite fired units in Western Macedonia to be on course. However, the new government announced the creation of a new national energy strategy that will prioritise the decommissioning of all coal fired plants by 2028. In Hungary, despite a phase-out plan has not been announced, competent authorities in concern with the operator of the only one power plant left, have been examining different scenarios for the next day, with the low carbon conversion scenario appearing to be the most viable and possible one for the moment. In Slovenia, discussions are currently being focused on the preparation of the legislation mandating the terms of a gradual closure of the Velenje lignite mine. Additionally, in April 2019, the National Assembly of the Republic of Slovenia already called on the Government of the Republic of Slovenia to establish a working group to prepare a timetable and a fair plan for the early closure of Velenje Coal Mine and the abandonment of fossil fuels at the Šoštanj Thermal Power Plant. Based on this call, the Ministry of Infrastructure prepared documentation on the establishment of a government working group, which will be responsible for determining the timetable and coordinating the activities related to the decarbonisation, fair energy transition and restructuring of coal regions. Bulgaria and Poland are stuck in their lignite based model for electricity production and no discussions for coal phase out have been initiated. Power plants commissioned over 30 years ago are still in operation and the countries largely rely on derogations from EU laws to keep the power plants active and avoid taking responsibility for just transition actions.

Following an announcement for coal phase out, competent authorities (either at national or regional level – it depends on whether decarbonisation and land planning issues are centralised or administrative and executive competencies are delegated to regions, just as in the case of Brandenburg) need to draw up and implement a just transition plan to set the ground for the necessary transformation and restructuring of affected economies. The primary goal is to address the needs of affected workers and communities (in terms of employment and income) and set the foundations for the succeeding post-coal period, with particular emphasis on alternative, sustainable routes for regional economies. To date, only Germany, Denmark, Spain have coal phase out plans.

When it comes to the legal framework for land restoration in mine sites, all DeCarb countries have in place legal acts that define mine operators' obligations on mine reclamation and environmental restitution in worked out sites. Notably, mine operators need to have in place mine closure and recovery plans prior to the commencement of extraction activities; further to this it is mandatory to provide a financial guarantee, to ensure that all obligations in the environmental permit are financially secured and funds are available at any time for the rehabilitation of the site contaminated. While in all countries mine operators are legally bound to fund with own capitals the restoration works prescribed in the mine closure operation plans, a series of countries such as Germany have decided to allocate a respectable amount for post mining land restoration interventions in coal intensive regions. These funds are mostly

directed to the rehabilitation of decommissioned/abandoned mines and social recovery programs (e.g. for re-skilling of coal workers).

This section presents with the common needs among DeCarb territories towards the efficient environmental restitution and post mining land restoration. All DeCarb territories are in a dire need to:

- Enhance the legal framework governing mining operations with stricter legal provisions concerning mine operators' liabilities for managing the consequences on the natural environment such as the long-term depletion of aquifers, the permanent loss of natural soil fertility even after completed renaturation, and the usability of water bodies, as well as the associated burden on the people living in the mining regions.
- Set forward a coordinated and integrated approach and procedures to assess possible and alternative land uses, which should not be constrained to cross sectoral collaboration of competent public administrations but involve all those actors (e.g. environmental institutions, economic operators, citizens) who retain an interest in the area and will be directly or indirectly affected by future land use(s). Furthermore, policy making, planning and decision making on post mining environmental restitution and land restoration should be coordinated across different disciplines (horizontal integration) and between different levels of government (vertical integration).
- Raise public awareness on the environmental and socioeconomic benefits associated with decarbonisation and post mining land restoration.
- Devise ways to stimulate the demand for the restored land and attract investors' interest; for example through taxation.
- Increase investment capital for environmental restitution and land restoration interventions. This can be done through the formation of a dedicated fund, which will be based on the state revenues from environmental taxes imposed on coal driven (and associated) activities.

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9 ANNEX A: SELF-ASSESSMENT FORMS

BRANDENBURG (DE)

Theme	Feature	Factor	Status
Motivation	Benefits	- Perception that land restoration creates economic benefits	
		- Perception that land restoration creates societal benefits	
		- Perception that land restoration creates environmental benefits	
		- Perception that land restoration provides opportunities for sustainable development	
	Awareness	- Green economy awareness among companies	
		- Public awareness on green economy and its potential benefits	
		- The benefits associated with decarbonisation are widely known	
		- Opportunities for restoration are identified	
	Legal requirements	- Legal framework on post mining land restoration exists	
		- Law regulating active coal mines and requiring land restoration exists	
		- Restoration regulations are widely enforced	
Enabling conditions	Environmental conditions	- The extent of environmental degradation makes land restoration feasible	
		- Plants and animals that can impede restoration are absent	
		- Native flora and fauna are readily available	
	Market conditions	- There is increasing demand/interest for the degraded land	
		- Market reforms to make smooth the transition to a post coal era are being implemented	
		- Green market segmentation is developing	
	Social conditions	- Local community can benefit from restoration opportunities	
		- Local community participates in decision making concerning restoration	
	Institutional conditions	- Integrated planning for land restoration exists	
		- Roles and responsibilities are clearly defined	
		- Effective cross-department coordination is in place	
Capacity and resources	Leadership	- Political commitment towards decarbonisation exists	
		- Transition plan to a post coal era exists	
	Knowledge	- Geospatial data is available	
		- Restoration know-how exists	
		- Collaboration schemes with environmental agencies and knowledge institutes are in place	
		- Collaboration schemes between mining companies and conservation bodies are in place	
	Finance	- Incentives to shut down coal driven activities are provided	
		- Investment capital for restoration interventions is readily available	

SOUTHWEST OLTENIA (RO)

Theme	Feature	Factor	Status
Motivation	Benefits	- Perception that land restoration creates economic benefits	
		- Perception that land restoration creates societal benefits	
		- Perception that land restoration creates environmental benefits	
		- Perception that land restoration provides opportunities for sustainable development	
	Awareness	- Green economy awareness among companies	
		- Public awareness on green economy and its potential benefits	
		- The benefits associated with decarbonisation are widely known	
		- Opportunities for restoration are identified	
	Legal requirements	- Legal framework on post mining land restoration exists	
		- Law regulating active coal mines and requiring land restoration exists	
		- Restoration regulations are widely enforced	
Enabling conditions	Environmental conditions	- The extent of environmental degradation makes land restoration feasible	
		- Plants and animals that can impede restoration are absent	
		- Native flora and fauna are readily available	
	Market conditions	- There is increasing demand/interest for the degraded land	
		- Market reforms to make smooth the transition to a post coal era are being implemented	
		- Green market segmentation is developing	
	Social conditions	- Local community can benefit from restoration opportunities	
		- Local community participates in decision making concerning restoration	
	Institutional conditions	- Integrated planning for land restoration exists	
		- Roles and responsibilities are clearly defined	
		- Effective cross-department coordination is in place	
Capacity and resources	Leadership	- Political commitment towards decarbonisation exists	
		- Transition plan to a post coal era exists	
	Knowledge	- Geospatial data is available	
		- Restoration know-how exists	
		- Collaboration schemes with environmental agencies and knowledge institutes are in place	
		- Collaboration schemes between mining companies and conservation bodies are in place	
	Finance	- Incentives to shut down coal driven activities are provided	
		- Investment capital for restoration interventions is readily available	

WESTERN MACEDONIA (GR)

Theme	Feature	Factor	Status
Motivation	Benefits	- Perception that land restoration creates economic benefits	
		- Perception that land restoration creates societal benefits	
		- Perception that land restoration creates environmental benefits	
		- Perception that land restoration provides opportunities for sustainable development	
	Awareness	- Green economy awareness among companies	
		- Public awareness on green economy and its potential benefits	
		- The benefits associated with decarbonisation are widely known	
		- Opportunities for restoration are identified	
	Legal requirements	- Legal framework on post mining land restoration exists	
		- Law regulating active coal mines and requiring land restoration exists	
		- Restoration regulations are widely enforced	
Enabling conditions	Environmental conditions	- The extent of environmental degradation makes land restoration feasible	
		- Plants and animals that can impede restoration are absent	
		- Native flora and fauna are readily available	
	Market conditions	- There is increasing demand/interest for the degraded land	
		- Market reforms to make smooth the transition to a post coal era are being implemented	
		- Green market segmentation is developing	
	Social conditions	- Local community can benefit from restoration opportunities	
		- Local community participates in decision making concerning restoration	
	Institutional conditions	- Integrated planning for land restoration exists	
		- Roles and responsibilities are clearly defined	
		- Effective cross-department coordination is in place	
Capacity and resources	Leadership	- Political commitment towards decarbonisation exists	
		- Transition plan to a post coal era exists	
	Knowledge	- Geospatial data is available	
		- Restoration know-how exists	
		- Collaboration schemes with environmental agencies and knowledge institutes are in place	
		- Collaboration schemes between mining companies and conservation bodies are in place	
	Finance	- Incentives to shut down coal driven activities are provided	
		- Investment capital for restoration interventions is readily available	

YUGOIZTOCHEN (BG)

Theme	Feature	Factor	Status
Motivation	Benefits	- Perception that land restoration creates economic benefits	
		- Perception that land restoration creates societal benefits	
		- Perception that land restoration creates environmental benefits	
		- Perception that land restoration provides opportunities for sustainable development	
	Awareness	- Green economy awareness among companies	
		- Public awareness on green economy and its potential benefits	
		- The benefits associated with decarbonisation are widely known	
		- Opportunities for restoration are identified	
	Legal requirements	- Legal framework on post mining land restoration exists	
		- Law regulating active coal mines and requiring land restoration exists	
		- Restoration regulations are widely enforced	
Enabling conditions	Environmental conditions	- The extent of environmental degradation makes land restoration feasible	
		- Plants and animals that can impede restoration are absent	
		- Native flora and fauna are readily available	
	Market conditions	- There is increasing demand/interest for the degraded land	
		- Market reforms to make smooth the transition to a post coal era are being implemented	
		- Green market segmentation is developing	
	Social conditions	- Local community can benefit from restoration opportunities	
		- Local community participates in decision making concerning restoration	
	Institutional conditions	- Integrated planning for land restoration exists	
		- Roles and responsibilities are clearly defined	
		- Effective cross-department coordination is in place	
Capacity and resources	Leadership	- Political commitment towards decarbonisation exists	
		- Transition plan to a post coal era exists	
	Knowledge	- Geospatial data is available	
		- Restoration know-how exists	
		- Collaboration schemes with environmental agencies and knowledge institutes are in place	
		- Collaboration schemes between mining companies and conservation bodies are in place	
	Finance	- Incentives to shut down coal driven activities are provided	
		- Investment capital for restoration interventions is readily available	

SAVINJSKA (SI)

Theme	Feature	Factor	Status
Motivation	Benefits	- Perception that land restoration creates economic benefits	
		- Perception that land restoration creates societal benefits	
		- Perception that land restoration creates environmental benefits	
		- Perception that land restoration provides opportunities for sustainable development	
	Awareness	- Green economy awareness among companies	
		- Public awareness on green economy and its potential benefits	
		- The benefits associated with decarbonisation are widely known	
		- Opportunities for restoration are identified	
	Legal requirements	- Legal framework on post mining land restoration exists	
		- Law regulating active coal mines and requiring land restoration exists	
		- Restoration regulations are widely enforced	
Enabling conditions	Environmental conditions	- The extent of environmental degradation makes land restoration feasible	
		- Plants and animals that can impede restoration are absent	
		- Native flora and fauna are readily available	
	Market conditions	- There is increasing demand/interest for the degraded land	
		- Market reforms to make smooth the transition to a post coal era are being implemented	
		- Green market segmentation is developing	
	Social conditions	- Local community can benefit from restoration opportunities	
		- Local community participates in decision making concerning restoration	
	Institutional conditions	- Integrated planning for land restoration exists	
		- Roles and responsibilities are clearly defined	
		- Effective cross-department coordination is in place	
Capacity and resources	Leadership	- Political commitment towards decarbonisation exists	
		- Transition plan to a post coal era exists	
	Knowledge	- Geospatial data is available	
		- Restoration know-how exists	
		- Collaboration schemes with environmental agencies and knowledge institutes are in place	
		- Collaboration schemes between mining companies and conservation bodies are in place	
	Finance	- Incentives to shut down coal driven activities are provided	
		- Investment capital for restoration interventions is readily available	

ŁÓDZKIE (PL)

Theme	Feature	Factor	Status
Motivation	Benefits	- Perception that land restoration creates economic benefits	
		- Perception that land restoration creates societal benefits	
		- Perception that land restoration creates environmental benefits	
		- Perception that land restoration provides opportunities for sustainable development	
	Awareness	- Green economy awareness among companies	
		- Public awareness on green economy and its potential benefits	
		- The benefits associated with decarbonisation are widely known	
		- Opportunities for restoration are identified	
	Legal requirements	- Legal framework on post-mining land restoration exists	
		- Law regulating active coal mines and requiring land restoration exists	
		- Restoration regulations are widely enforced	
Enabling conditions	Environmental conditions	- The extent of environmental degradation makes land restoration feasible	
		- Plants and animals that can impede restoration are absent	
		- Native flora and fauna are readily available	
	Market conditions	- There is increasing demand/interest for the degraded land	
		- Market reforms to make smooth the transition to a post coal era are being implemented	
		- Green market segmentation is developing	
	Social conditions	- Local community can benefit from restoration opportunities	
		- Local community participates in decision making concerning restoration	
	Institutional conditions	- Integrated planning for land restoration exists	
		- Roles and responsibilities are clearly defined	
		- Effective cross-department coordination is in place	
Capacity and resources	Leadership	- Political commitment towards decarbonisation exists	
		- Transition plan to a post coal era exists	
	Knowledge	- Geospatial data is available	
		- Restoration know-how exists	
		- Collaboration schemes with environmental agencies and knowledge institutes are in place	
		- Collaboration schemes between mining companies and conservation bodies are in place	
	Finance	- Incentives to shut down coal driven activities are provided	
		- Investment capital for restoration interventions is readily available	

ESZAK-MAGYARORSZAG (HU)

Theme	Feature	Factor	Status
Motivation	Benefits	- Perception that land restoration creates economic benefits	
		- Perception that land restoration creates societal benefits	
		- Perception that land restoration creates environmental benefits	
		- Perception that land restoration provides opportunities for sustainable development	
	Awareness	- Green economy awareness among companies	
		- Public awareness on green economy and its potential benefits	
		- The benefits associated with decarbonisation are widely known	
		- Opportunities for restoration are identified	
	Legal requirements	- Legal framework on post mining land restoration exists	
		- Law regulating active coal mines and requiring land restoration exists	
		- Restoration regulations are widely enforced	
Enabling conditions	Environmental conditions	- The extent of environmental degradation makes land restoration feasible	
		- Plants and animals that can impede restoration are absent	
		- Native flora and fauna are readily available	
	Market conditions	- There is increasing demand/interest for the degraded land	
		- Market reforms to make smooth the transition to a post coal era are being implemented	
		- Green market segmentation is developing	
	Social conditions	- Local community can benefit from restoration opportunities	
		- Local community participates in decision making concerning restoration	
	Institutional conditions	- Integrated planning for land restoration exists	
		- Roles and responsibilities are clearly defined	
		- Effective cross-department coordination is in place	
Capacity and resources	Leadership	- Political commitment towards decarbonisation exists	
		- Transition plan to a post coal era exists	
	Knowledge	- Geospatial data is available	
		- Restoration know-how exists	
		- Collaboration schemes with environmental agencies and knowledge institutes are in place	
		- Collaboration schemes between mining companies and conservation bodies are in place	
	Finance	- Incentives to shut down coal driven activities are provided	
		- Investment capital for restoration interventions is readily available	