

**Knowledge Package**

# **Environmental rehabilitation of mining sites and infrastructure**

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**WORLD BANK GROUP**



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## Knowledge pack

# Environmental rehabilitation of mining sites and infrastructure

## Introduction

A comprehensive and holistic environmental rehabilitation of mining sites and related infrastructure is one of the key elements of a successful just transition in coal-dependent regions. The potential for value creation from post-mining sites and infrastructure is likely to be highest if planned in advance, well before scheduled mine closure.

This knowledge pack relates primarily to thematic Pillar 3 of the World Bank's 'Just Transition for All' three-by-three matrix: Environmental rehabilitation of mining sites and infrastructure. It is relevant to all three phases of support: Pre-closure Planning, Closure, and Regional Transition. This knowledge pack has a degree of overlap with the parallel knowledge pack on the repurposing of mining sites and infrastructure.

Just as all regions are characterised by a unique set of geographical and socioeconomic features there is no single optimal approach to environmental rehabilitation. However, as mine closure experience has accumulated worldwide, new lessons are continually being learned.

Coal transition experiences underline the value of early planning for environmental rehabilitation of mining sites and infrastructure. The selection of resources below includes those which address the mapping of land and infrastructure, baseline assessment for environmental rehabilitation requirements, the physical closure of mines, the monitoring of environmental regulation compliance, and the implementation of environmental rehabilitation actions including remediation, reclamation, restoration, and rehabilitation.

## Abstracts

| Asia-Pacific Economic Cooperation Secretariat. 2018. *Mine Closure—Checklist for Governments*. Singapore.

This checklist is designed to provide a logical, sequential series of steps to enable policymakers to identify gaps in their current mine closure framework and identify how to address them. The checklist is not specific to coal mines, but to mines in general. The document relates to Phases 1

and 2 in the World Bank's three-by-three matrix: Pre-closure Planning, and Closure.

Guidance for governments and governmental authorities are presented in four phases: getting started, developing policy for the closure plan, developing policy for managing closure, and implementing the closure policy. Key recommended sections relating to environmental rehabilitation include: 1.3 Understanding closure in the mining life cycle; 2.4 Promoting physical and chemical stability – the technology of closure, 2.8 Identify closure management and monitoring requirements; 4.1 Preparing to implement new closure policy; and 4.2 Evaluating the effectiveness of closure policy.

*Key terms: physical stability; chemical stability; monitoring; relinquishment; mine closure*

Australian Government. 2016. *Mine closure—Leading Practice Sustainable Development Program for the Mining Industry*. Canberra.

This handbook is primarily intended for use as a management tool to improve closure planning and execution on mine sites. The handbook has been written to be understood by a wide range of stakeholders associated with or potentially affected by mining operations, including representatives of NGOs, mining communities, and neighbouring communities. This handbook it relates to Phases 1, 2, and (to some extent) 3 in the World Bank's three-by-three matrix: Pre-closure Planning, Closure, and Regional Transition.

The handbook defines the overall objective of mine closure and relinquishment as the prevention or avoidance of adverse long-term environmental, physical, social and economic impacts. It introduces a number of aspects intrinsically linked to closure, including legal and regulatory requirements, cumulative impacts, impacts on local and regional biodiversity, climate change, post-mine land use opportunities, the physical, chemical and geochemical characterisation of soils and mine wastes, and engineered landform design. It also stresses essential elements in mine closure and relinquishment. These include developing a risk management approach to mine closure planning that applies from the concept stage to post-closure (i.e. integrated with whole life-of-mine planning), collecting quality baseline data and developing a high-quality knowledge base, and developing closure objectives and completion criteria in consultation with key stakeholders.

*Key terms: environmental baseline data; decommissioning plan; assets valuation and sale; decommissioning of infrastructure; remediation; legacy infrastructure*

*Australian Government. 2016. Mine rehabilitation—Leading Practice Sustainable Development Program for the Mining Industry. Canberra.*

This handbook addresses mine rehabilitation; in particular, it outlines the key principles and procedures now recognised as leading practice for planning, implementing and monitoring rehabilitation such as the importance of forward business plans for the mining sector, or the timely integration and implementation of rehabilitation plans during mine operations. The handbook relates predominantly to Phase 3 in the World Bank's three-by-three matrix: Closure and Regional Transition.

Rehabilitation must be an integral component of a mining company's sustainable development strategies. Examples of key messages when planning for successful rehabilitation include early planning, the selection of objectives and targets that are specific, measurable, attainable, relevant, and time-based (SMART), and stakeholder involvement. It also addresses the implementation of rehabilitation, such as the selection of plant species, amelioration of soil characteristics and major rehabilitation management issues such as fire, erosion, and nutrient cycling. A chapter is then dedicated to monitoring rehabilitation, including the development of a monitoring programme, performance indicators, and monitoring techniques. The primary audience for this handbook is management at the operational level. It is also relevant to people with an interest in leading practice biodiversity management in the mining industry, including environmental officers, mining consultants, governments and regulators, non-government organisations, and neighbouring and mine communities.

*Key terms: rehabilitation planning; environmental baseline; rehabilitation implementation; physical amelioration; chemical amelioration; biological amelioration; fauna recolonisation; monitoring; reporting*

*Beuermann, Christiane. 2020. Toolkit: Environmental rehabilitation and repurposing—Guidance on the governance of environmental rehabilitation and repurposing in coal regions in transition. Brussels: European Commission.*

This toolkit was developed by the Initiative for Coal Regions in Transition (CRIiT), a European Commission-funded support platform. It shares knowledge and experiences that may be valuable to those regions that are now taking on transition and provides guidance on environmental rehabilitation and repurposing with an emphasis on governance processes. The toolkit relates to Phases 1, 2, and 3 in the World Bank's three-by-three matrix: Pre-closure Planning, Closure, and Regional Transition.

The toolkit contains seven key messages. Environmental rehabilitation and repurposing

have the potential to support efforts to attract new businesses and create new jobs; however, the financial risks associated with closure can sometimes make public sector intervention inevitable. The toolkit is designed for the use of national and regional authorities, and local governments, stakeholders (such as civil society organisations), and people engaged in political debate and local development processes.

*Key terms: mine closure; mine completion; mine rehabilitation; perpetual obligations; repurposing*

**| International Council on Mining and Metals. 2019. Financial concepts for mine closure. London.**

This document provides an understanding of key financial concepts as they relate to mine closure, enabling the consistent communication of these concepts within relevant disciplines both internally and externally across the mining industry. The handbook relates to Phases 1, 2, and 3 in the World Bank's three-by-three matrix: Pre-closure Planning, Closure, and Regional Transition.

There are several relevant methods for mine closure cost estimation; however, the understanding and application of these approaches varies within the mining industry. Consistent communication and engagement within the industry and with external stakeholders can be challenging, limiting the ability to benchmark performance. Mining companies should clearly differentiate between the different types of costs assessed, as they serve different end-goals. The document defines and contextualises the key concepts related to closure costing, accounting and reporting requirements, and is intended to provide general conceptual guidance across a range of factual circumstances.

*Key terms: life of asset closure cost; regulators closure cost; rehabilitation*

**| International Council on Mining and Metals. 2019. Integrated Mine Closure—Good Practice Guide, 2nd Edition. London.**

This document provides guidance for integrated mine closure. It aims to foster homogenous good practice across the sector; its concepts apply equally to large and small mining companies. It relates to Phases 1, 2, and 3 in the World Bank's three-by-three matrix: Pre-closure Planning, Closure, and Regional Transition.

Integrated mine closure is a dynamic and iterative process that should take into account environmental, social and economic factors from an early stage of mine development and throughout the life of assets. Fundamental to this process is the need to consider closure as

an integral part of the core of a mining operation. The structure of the guide reflects this process, providing good practice guidance on key elements of mine closure planning and implementation. It uses a risk and opportunity-based process to guide the practitioner through the iterative process of planning for final and progressive closure in a considered manner, as well as tactics for considering sudden or temporary closure. A key message is that effective closure planning results in more accurate closure cost estimates, the early identification of risks and mitigation strategies, and progressive reduction of liabilities.

*Key terms: integrated mine closure; knowledge base; closure activities; closure execution plan; monitoring; relinquishment*

Knoche, Dirk; Rademacher, Anne; Schlepphorst, Rainer. 2019. *Best practice report on environmental protection and post-mining land reclamation*. Finsterwalde: Forschungsinstitut für Bergbaufolgelandschaften.

The paper covers the aspect of environmental protection and post-mining land reclamation in the transformation process including a description of the respective regulatory framework, the geo-mechanical circumstances and soil preparation steps as preconditions for the land reclamation, as well as guidelines and best practices for agriculture and forest reclamation. It relates to Phases 1, 2, and 3 in the World Bank's three-by-three matrix: Pre-closure Planning, Closure, and Regional Transition.

This report offers key principles to consider when planning mine closure and implementing post-mining reclamation. Guidelines for ecological restoration should be embedded in mine resource management, tailored to the specificities of the region, and should take scientific information on both substrate quality and usability into account. Because of a degree of uncertainty when looking at the long-term ecosystem development, a risk-spreading precautionary principle is advisable, to compensate for any lack of conclusive information on long-term ecosystem development. This means that land management itself should be adaptive to react reasonably to changes in cropping situation. The report concludes that a mosaic of different land-use categories is promising the highest economic and ecological value but also stakeholder acceptance in its entirety.

*Key terms: soil survey; soil mapping; restoration; reclamation; agricultural reclamation; forest reclamation*

*Land Rehabilitation Society of Southern Africa, Coaltech, Minerals Council of South Africa. 2018. Land Rehabilitation Guidelines for Surface Coal Mines.*

This guide compiles aspects of good practice planning, implementation and ongoing management of surface coal mines from a land rehabilitation perspective. It relates to Phases 1, 2, and 3 in the World Bank's three-by-three matrix: Pre-closure Planning, Closure, and Regional Transition.

The guide is articulated in four sections covering the planning and implementation of surface mine closure as well as the subsequent monitoring and post-mining land management. These are further described in sub-sections, each proposing monitoring criteria that can be used to define and monitor rehabilitation success. Examples of topics addressed include developing post-mining surface landform design, soil stripping and handling, replacing soil types and improvement of physical, chemical, and biological soil characteristics, the identification of vegetation species that are well-adapted to local seasonal conditions, the control of invasive alien species, and the identification of infrastructure items that may have beneficial re-use potential to future land users. The guidelines cover all stages of mine closure.

*Key terms: rehabilitation; remediation; reclamation; regeneration; mine closure; relinquishment; monitoring; soil stripping; surface profiling; soil replacement; soil amelioration; revegetation; infrastructure; surface water.*

*World Bank. 2010. Towards Sustainable Decommissioning and Closure of Oil Fields and Mines. Washington, DC.*

This toolkit contributes to fostering awareness, understanding, and involvement in closure issues on the part of regulatory authorities in emerging economies with significant mineral and hydrocarbon resources. It relates to Phases 1 and 2, and 3 in the World Bank's three-by-three matrix: Pre-closure Planning, Closure, and Regional Transition.

The toolkit presents an assessment of key decommissioning and closure issues – at a level relevant to the interests of government authorities. Rather than being a prescriptive document, a process framework and strategies are presented, based on the existing knowledge of numerous organisations with practical experience and expertise. This resource may be used to support the development of flexible but systematic regulatory approaches to key components of sustainable decommissioning and closure planning. The main target audience is government actors; specifically technical and decision-making staff in regulatory authorities, institutions and ministries responsible for: administering resource extraction licenses and contracts; issuing environmental permits for exploration, exploitation, decommissioning and closure; and

ensuring that adequate legal, financial and technical measures are in place to address temporary shutdowns. The toolkit may also be used as a reference by companies, non-governmental organisations or other institutions.

*Key terms: regulatory framework; sustainable decommissioning; closure planning; monitoring compliance*

**| World Bank 2021. Mine Closure: A Toolbox for Governments. Washington, DC.**

This document provides information needed to develop a broad governance framework that reduces the risks of an improperly managed mining industry and helps ensure successful mine closure. It relates to Phases 1, 2, and 3 in the World Bank's three-by-three matrix: Pre-closure Planning, Closure, and Regional Transition. Its purpose of this toolbox is to provide policymakers, governmental administrators, and legal actors with the information needed to develop a broad governance framework, reducing the risks associated with an improperly managed mining industry, and ensuring successful mine closure.

Examples of good international industry practice and basic legislative requirements, which facilitate closure, are provided. The toolbox also provides practical guidance and explanations for developing a governance framework specific to mine closure. Section five sets out the legal elements that should be in place to facilitate closure, while sections six and seven highlight the socioeconomic and technical requirements of closure respectively. Sections eight, nine, and eleven provide additional tools that are relevant for governments and other stakeholders in assessing and implementing closure practices. Section ten addresses some of the unique challenges arising from legacy mines that were not closed in accordance with good international industry practice.

*Keywords: mine closure framework; socioeconomic baseline; infrastructure repurposing; monitoring; closure technical requirements*

## Focussed bibliography

### Shortlisted documents (abstracts)

Asia-Pacific Economic Cooperation. 2018. Mine Closure Checklist for Governments. Singapore.

<https://www.apec.org/publications/2018/03/mine-closure---checklist-for-governments>

Australian Government 2016. Mine closure—Leading Practice Sustainable Development Program for the Mining Industry. Canberra.

<https://www.industry.gov.au/data-and-publications/leading-practice-handbook-mine-closure>

Australian Government 2016. Mine rehabilitation—Leading Practice Sustainable Development Program for the Mining Industry. Canberra.

<https://www.industry.gov.au/data-and-publications/leading-practice-handbook-mine-rehabilitation>

European Commission. 2020. Toolkit: Environmental rehabilitation and repurposing—Guidance on the governance of environmental rehabilitation and repurposing in coal regions in transition, by Christiane Beuermann. Brussels.

[https://ec.europa.eu/energy/topics/oil-gas-and-coal/EU-coal-regions/resources/environmental-rehabilitation-and-repurposing-toolkit\\_en](https://ec.europa.eu/energy/topics/oil-gas-and-coal/EU-coal-regions/resources/environmental-rehabilitation-and-repurposing-toolkit_en)

International Council on Mining and Metals. 2019. Financial concepts for mine closure. London.  
<http://www.icmm.com/en-gb/guidance/environmental-stewardship/financial-concepts-for-mine-closure>

International council on Mining and Metals. 2019. Integrated Mine Closure—Good Practice Guide, 2nd Edition. London.

<https://www.icmm.com/en-gb/guidance/environmental-stewardship/integrated-mine-closure-2019>

Knoche, Dirk; Rademacher, Anne; Schlepphorst, Rainer. 2019. Best practice report on environmental protection and post-mining land reclamation. Finsterwalde: Forschungsinstitut für Bergbaufolgelandschaften.

<https://coaltransitions.org/publications/best-practice-report-on-environmental-protection-and-post-mining-land-reclamation/>

Land Rehabilitation Society of Southern Africa, Coaltech, Minerals Council of South Africa. 2018. Land Rehabilitation Guidelines for Surface Coal Mines.

<https://www.larssa.co.za/sites/default/files/LarSSA-Rehab-Guideline-FINAL-v1-August-2019.pdf>

World Bank. 2010. Towards Sustainable Decommissioning and Closure of Oil fields and Mines. Washington, DC.

<https://openknowledge.worldbank.org/handle/10986/16964>

World Bank. 2021. Mine Closure: A Toolbox for Goversments. Washington, DC.

<https://openknowledge.worldbank.org/handle/10986/35504?locale-attribute=es>

### **Additional documents**

Krzemień, Alicja; Suárez Sánchez, Ana; Riesgo Fernández, Pedro; Zimmermann, Karsten; González Coto, Felipe. 2016. Towards sustainability in underground coal mine closure contexts: A methodology proposal for environmental risk management. *Journal of Cleaner Production* 139: 1044-1056.

<https://www.sciencedirect.com/science/article/pii/S0959652616313130>

Society for Ecological Restoration. 2016. International Standards for the practice of Ecological Restoration—1st edition.

[https://seraustralasia.com/wheel/image/SER\\_International\\_Standards.pdf](https://seraustralasia.com/wheel/image/SER_International_Standards.pdf)

Aboriginal Affairs and Northern Development Canada; Land and Water Boards of the Mackenzie Valley. 2013. Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest.

[https://www.lands.gov.nt.ca/sites/lands/files/resources/2013\\_mvlwb-aandc\\_guidelines\\_for\\_closure\\_and\\_reclamariation.pdf](https://www.lands.gov.nt.ca/sites/lands/files/resources/2013_mvlwb-aandc_guidelines_for_closure_and_reclamariation.pdf)

World Bank. 2018. Managing Coal Mine Closure: Achieving a Just Transition for All.

<https://documents1.worldbank.org/curated/en/484541544643269894/pdf/130659-REVISED-PUBLIC-Managing-Coal-Mine-Closure-Achieving-a-Just-Transition-for-All-November-2018-final.pdf>

Corbett, M. H. 1999. Revegetation of mined land in the wet-dry tropics of northern Australia: A review. Supervising Scientist.

<https://www.environment.gov.au/science/supervising-scientist/publications/ssr/revegetation-mined-land-wet-dry-tropics-northern-australia-review>

Society for Ecological Restoration Australasia. 2018. National standards for the practice of ecological restoration in Australia—Second edition.

<https://seraustralasia.com/standards/National%20Restoration%20Standards%202nd%20Edition.pdf>

United Nations Environment Programme; World Health Organization. 1998. Mine Rehabilitation for Environment and Health Protection: A Training Manual.

[https://wedocs.unep.org/bitstream/handle/20.500.11822/30173/Mine\\_RehabManual.pdf?sequence=1&isAllowed=y](https://wedocs.unep.org/bitstream/handle/20.500.11822/30173/Mine_RehabManual.pdf?sequence=1&isAllowed=y)

Australian and New Zealand Minerals and Energy Council; Minerals Council of Australia. 2000. Strategic Framework for Mine Closure.

<https://www.sernageomin.cl/wp-content/uploads/2017/11/Strategic-Framework-Mine-Closure.pdf>

Environmental Protection Authority Western Australia. 2015. Guidelines for preparing mine

closure.

[https://www.epa.wa.gov.au/sites/default/files/Policies\\_and\\_Guidance/DMP-EPA-Guidelines-Mine-Closure-Plans-080515.pdf](https://www.epa.wa.gov.au/sites/default/files/Policies_and_Guidance/DMP-EPA-Guidelines-Mine-Closure-Plans-080515.pdf)

Duda, Adam; Valverde, Gregorio Fidalgo. 2020. Environmental and Safety Risks Related to Methane Emissions in Underground Coal Mine Closure Processes. *Energies* 13 (23), 6312.

<https://www.mdpi.com/1996-1073/13/23/6312>

Valverde, Gregorio Fidalgo; Duda, Adam; Iglesias Rodríguez, Francisco Javier; Frejowski, Aleksander; Todorov, Ivan. 2021. Groundwater Risk Assessment in the Context of an Underground Coal Mine Closure and an Economic Evaluation of Proposed Treatments: A Case Study. *Energies* 14, 1671.

<https://ideas.repec.org/a/gam/jeners/v14y2021i6p1671-d519167.html>

Technische Hochschule Georg Agricola. 2020. Evaluation of mine water rebound processes, by Christian Melchers, Sebastian Westermann, and Bastia Reker.

[https://fzn.thga.de/wp-content/uploads/sites/4/2021/02/Berichte-zum-Nachbergbau\\_Heft1\\_Evaluation-Mine-Water-Rebound\\_encoded.pdf](https://fzn.thga.de/wp-content/uploads/sites/4/2021/02/Berichte-zum-Nachbergbau_Heft1_Evaluation-Mine-Water-Rebound_encoded.pdf)

14th International Conference on Mine Closure. 2021. Abstract list.

<https://mineclosure2021.com/abstracts/>

## GLOSSARY

**Brownfield redevelopment** refers the process of site development – remediation, reclamation, rehabilitation and repurposing – to restore the physical, environmental, economic, and social/community aspects of a brownfield site.

**Carbon neutrality** refers to a state in which the activities of an individual, an organisation, a city or a country result in net-zero CO<sub>2</sub> emissions. For a given set of activities to be carbon neutral, either the activities themselves must have zero CO<sub>2</sub> emissions, or the same amount of CO<sub>2</sub> released by the activities must be permanently sequestered (i.e. removed). Carbon sequestration can be achieved by making use of a so-called natural carbon sink, which are the natural ecosystems (e.g. forests, soil, oceans) which have the ability to absorb more carbon than they emit. To date, no artificial carbon sinks are able to remove carbon from the atmosphere on the necessary scale. Offsetting emissions made in one sector by reducing them somewhere else through investment in renewable energy or energy efficiency could contribute to carbon neutrality.

**Civil society** refers to the wide array of non-governmental and not for profit organizations that have a presence in public life, express the interests and values of their members and others, based on ethical, cultural, political, environmental, scientific, religious, or philanthropic considerations.

**Clean energy technologies** refer to any processes, products or services that reduce negative environmental impacts of energy production through emissions reduction, energy efficiency improvements and sustainable use of resources (use of renewable and clean sources of energy such as geothermal, hydropower, solar, wind, and sustainable biomass).

**Coal phase-out** is the cessation of coal extraction and related utilisation activities, as part of a broader fossil fuel phase-out and transition to carbon neutrality.

**Decommissioning of infrastructure** refers to the removal of redundant infrastructure (equipment, buildings, material) when a coal mine or a power generation facility has reached the end of its service life. The level of decommissioning work, together with site clean-up, will depend on potential future reuse options.

**Energy transition** refers to the (global) energy sector's shift from fossil-based systems of energy production and consumption — including oil, natural gas, and coal — to renewable energy sources like wind and solar. The need to reduce energy-related CO<sub>2</sub> emissions to limit climate change is at heart of energy transition. Adoption of renewable energy and energy efficiency

measures are needed to achieve the required carbon reductions.

**Future proofing** refers to processes for anticipating future developments and events and taking actions to prepare to minimise possible negative consequences and maximise possibilities to seize opportunities. In the context of energy transition, ‘future proofing’ often refers to making investments that are resilient towards the effects of climate change and/or aligned with and adaptable to expected trends and changes in energy production and consumption, including climate neutrality. Future proofing investments in emerging post-transition sectors provide, therefore, a safeguard for long term employment and productivity potential of the local or regional economy.

**Governance model** refers to the arrangement put in place by public authorities to deliver its coal transition strategy in a way that is effective within the broader prevailing governance context. Successful governance models rely on close cooperation among the various governance levels (local, regional, national) and the various actors (public, private, social) in the concerned coal region(s).

**Inclusion**, also known as social inclusion, is the process and outcome of improving the terms on which individuals and groups, who might otherwise be excluded or marginalized, take part in society. An inclusive approach to energy transition is one that recognises and addresses in a meaningful way the disproportionate effects of the transition on certain groups and individuals. It may also encompass an approach whereby transition is recognised as an opportunity to improve the well-being of those that are already excluded or marginalized.

**Industrial reconversion** refers to conversion of former industrial areas, including post mining areas, and related activities into alternate socio-economic uses. Regions with a historical legacy of mining and industrial heritage have an opportunity to use the industrial infrastructure as an asset for future economic activity (e.g., industrial zone, cultural centre, or business and technology park).

**Just transition** encapsulates the principle that the transition to a climate neutral economy should happen in a fair way, whereby the benefits and costs of transition are distributed equitably, and where those that stand to lose economically or socially from the transition are adequately supported to ensure that no one is left behind. Consequently, just transition focus on jobs and livelihoods, and on advancing social and economic justice. It also incorporates the principle that transition processes should be based on dialogue and cooperation between workers, employers, communities, and governments to draw-up and drive the concrete policies, plans, and investments to achieve transition.

**Legacy infrastructure** relates to physical structures, utilities and machinery that were previously used in the extraction, preparation and transportation of coal and which are no longer utilised due

to the cessation of mining activities. These can represent both assets and liabilities; their status being dependent on their condition, maintenance, investment, and future plans for a site or a locality.

**Mine closure** is the process undertaken when the operational stage of a mine is ending or has ended, and the final decommissioning and mine rehabilitation is due to commence or is underway.

**Mine closure liability** is the situation of being legally responsible for a mine closure, which usually falls on the mine operator who should prepare and execute a mine closure plan.

Government may face a risk of having to assume the liability for mine closure if an operator fails to or is incapable of closing the mine in a responsible manner.

**Mining communities** are communities, towns, or larger urban areas where miners and/or former miners and their families live. Mining communities are usually created around a mine or a quarry and are often characterised by a mono-industrial economy (an economy dominated by a single industry or company). They also often have strong local identity and display a place attachment to their community – a cultural and emotional bond between person and place.

**Mining heritage** relates to heritage values of former mining places, such as specific cultural and social values and meanings. Upon closure, the mining industry often leaves behind a large number of tangible and intangible assets which are a reminder of the past importance of mining and which contribute to regional identity. Physical mining heritage, such as buildings, machinery and equipment, are often transformed into cultural attractions of historical value that attract visitors to the region.

**Multi-level governance (MLG)** refers to models for both the decision making and implementation of policies and strategies that rely on interactions between different levels of government (i.e., local-regional-national). Effective multi-level governance models can enhance cooperation across levels of government, enabling synergies among different actions that can improve implementation of transition strategies and better achieve national and sub-national policy goals. Multi-level governance enables synergies between the priorities, powers, functions and regulations of differing levels of government.

**Participatory methods** refer to ways for active involvement of ‘the public’ in decision-making processes. The public can be citizens, stakeholders in a particular project or policy, experts, and other concerned parties. Participatory methods are considered to be integral to achieving a just transition in coal regions, as they can empower affected communities, enhance transparency, accountability, and responsiveness, and improve public policies and services. There are various participatory methods, including focus groups, consensus building conferences, thematic workshops and social dialogue activities. These methods can form the basis for partnership-

based planning and co-creation of a transition strategy.

**Perpetual obligations** are ongoing actions, such as pumping of mine water, that need to be continued indefinitely after cessation of mining activities. Such obligations depend on the type of coal mine and on specific regulatory requirements.

**Public-private partnerships (PPPs)** are long-term contractual agreements between a government entity and a private party for the provision of a public asset or service, in which the private party bears significant risk and management responsibility. This may relate to infrastructure assets (such as bridges, roads) or social assets (such as hospitals, utilities) and their associated services.

**Reclamation** are actions performed during or after a mining operation to shape, stabilize, revegetate or otherwise treat the land in order to return it to a safe, stable condition consistent with the establishment of a productive post-mining use of the land and the safe abandonment of a facility in a manner which ensures the public safety, as well as the encouragement of techniques which minimize the adverse visual effects.

**Regional mine closure planning** applies a regional land use approach to mine closure that goes beyond site-specific plans and aligns site-specific rehabilitation and repurposing targets to regional land use needs and capacities within an overarching planning context. Such an approach should lead to more focussed and co-ordinated efforts, as rehabilitation can be aligned to wider considerations of land productivity, ecosystem functionality, urban and rural development, or renewable energy drivers.

**Rehabilitation planning** is planning for restoration of land on which mining has taken place to prepare it for its intended post-closure land uses, which may be to restore the landscape to its pre-mining land uses (environmental rehabilitation). Rehabilitation planning may include measures relating to physical mine closure, environmental reclamation and rehabilitation (including the removal of mine equipment), securing the stability of remaining dumps and impoundments, water management and surface stability at closed underground mines, and monitoring and managing any post closure environmental and human health impacts.

**Remediation** is an action of remedying something, i.e. reversing or stopping environmental damage. Often used in context of contaminated soils or water. Remediation may include activities carried out to clean up or mitigate contaminated land or water.

**Renewable energy** is energy that is produced by natural resources—such as sunlight, wind, rain, waves, tides, and geothermal heat—that are not depleted or are naturally replenished within a short time span (i.e., within a few years or on a ‘human timescale’). Biomass (organic material from animal or plant matter) is also defined as a renewable energy source but for it to make an effective contribution to

reducing greenhouse gas emissions, it must be produced and managed in a sustainable way.

**Repurposing** refers to the beneficial reuse of a closed mining or other industrial operation, whether through value-added changes or reuse of the land (e.g., energy generation or residential use), reuse of infrastructure at its present location or at another site, or derivative business opportunities that create new economic activity.

**Revitalisation** refers to policies and processes implemented to return and sustain the economic, environmental and social dimensions/contribution of the former mining (or industrial) sites for the benefit of the local community. Conducting revitalisation is aimed at preserving the mining cultural heritage, while introducing new economic and social functions. Successful revitalisation can attract visitors and investors, increase attractiveness of the region and revitalise local communities.

**Social dialogue** refers to negotiations, consultations or simply exchange of information between, or among, representatives of government, employers, and workers, on issues of common interest typically relating to economic and social policy. It can exist as a tripartite process, with the government as an official party to the dialogue or it may consist of bipartite relations only between labour and management (or trade unions and employers' organisations), with or without indirect government involvement. Social dialogue processes can be informal or institutionalised, and often it is a combination of the two. It can take place at the national, regional or at enterprise level. It can be inter-professional, sectoral or a combination of these.

**Social impacts** refer to socio-economic and cultural aspects of mine closure. Some of the common social impacts of closure include changes to the affected community's economic structure (e.g., loss of employment and business opportunities) and dynamics (e.g., demographic changes, departure of employees). In the context of coal phase out, social impacts can also encompass gender dimension (e.g., gender-related economic and employment inequalities), health and well-being of miners.

**Smart specialisation** is an approach that combines industrial, educational and innovation policies to suggest that countries or regions identify and select a limited number of priority areas for knowledge-based investments, focusing on their strengths and comparative advantages. In the EU Member States, smart specialisation is a place-based innovation policy concept used to support regional prioritisation in innovative sectors, fields or technologies. Regions impacted by coal phase out are under pressure to identify and develop new areas of specialisation, and to support local economic actors to exploit latent economic specialisms and diversify their local and regional economies.

**Stakeholder engagement** refers to the process by which an organisation leading the

transition away from coal engages with and involves those who are concerned or affected by the decisions that are made. Stakeholder engagement goes together with partnership building, both of which allow stakeholders to pool their resources to solve common problems. Effective stakeholder engagement can enhance the quality of decisions and outcomes, strengthen public trust, and enhance broad acceptance. If implemented properly, stakeholder engagement fosters legitimacy, especially through improving transparency and inclusivity. The inclusion of a broad and diverse set of stakeholders, including citizens, is considered a key element to successful stakeholder engagement.

**Stranded assets** are now generally accepted to be those assets that at some time prior to the end of their economic life (as assumed at the investment decision point) are no longer able to earn an economic return (i.e. meet the company's internal rate of return), as a result of changes associated with the transition to a low-carbon economy (lower than anticipated demand / prices). Or, in simple terms, assets that turn out to be worth less than expected as a result of changes associated with the energy transition.

**Structural change** refers to a qualitative transformation and evolution of economic systems. It is represented by a change in the relative weight of significant components of the economy such as production, consumption, employment, and population, and is seen in a shift or change in the ways a market, industry or economy functions or operates. Structural change is often sparked by technological innovation, new economic developments, changes in resource availability, changes in supply and demand of resources, and changes in the political landscape. In coal regions, structural change is associated with a transition from a carbon-intensive economy, where coal-related activities play a major role in the local economy, to a carbon-neutral economy, which utilises clean technologies and processes.

**Welfare support** is a government intervention intended to ensure that members of a society can meet their basic needs. Welfare support is usually part of an integrated portfolio of interventions that constitute the broader social protection (social security) system. In the context of a coal phase out, welfare support measures will be typically needed for workers that have lost or are about to lose their jobs. Welfare support can come in various forms, including income replacement benefits, early retirement options, or assistance in seeking alternative employment.

