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**Smart strategies for the transition in coal intensive regions**

**Project No: 836819**

TRACER
TRANSITION IN COAL INTENSIVE REGIONS

# *Decision Support Toolkit*

# *on substituting coal-fired generation with clean energy*

***WP 6 – Task 6.4 / D6.6***

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TRACER website: www.tracer-h2020.eu

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# Executive summary

The EU-funded TRACER project (www.tracer-h2020.eu) aimed to support, throughout its 3-year duration, nine coal-intensive regions[1], which are at different stages of their energy transition, to shape or fine-tune their Research and Innovation (R&I) Strategies and exchange previous experiences in order to facilitate transition towards sustainable energy systems.

The TRACER project, coordinated by WIP Renewable Energies – Germany, facilitated the mobilisation of a wide range of stakeholders in all nine European regions, to discuss and agree on a shared vision and priorities for coal transition. Several TRACER reports were delivered until now covering thorough analyses of the current situations, in terms of energy, environment and social aspects, and 2030-2050 transition projections in all 9 target coal intensive regions, together with best practices assessment globally. The R&I Strategies were based on the European Union's "Smart Specialisation Strategy" (S3) approach and the Entrepreneurial Discovery Process (EDP) focused on each of the 9 coal-intensive regions, while for the energy technologies were considered the R&I priorities of the EU's SET Plan.

This current document is mainly based on the prior deliverables in TRACER project, previous work performed by the Secretariat of the Initiative for coal regions in transition (CRIT) and the Just Transition Toolbox for coal developed by Wuppertal Institute.

It is part of a set of two Decision Making Toolkits (DSTs) that will serve as guidance for stakeholders in coal regions in transition for a better-informed decision-making process, on how to plan, set targets, choose optimal solution during implementation in compliance with legal and regulatory framework, and be prepared to secure finance for the transition to a sustainable energy system:

A. ***Decision support toolkit on substituting coal-fired generation with clean energy*** that will serve as a guideline for stakeholders in coal intensive regions on how to substitute energy production from coal with clean energy (demand of the energy production through alternative/clean energy resources, investment costs, estimated workplaces from the alternative energy resources/technologies, etc.), to get a feeling what it really means to substitute coal in an existing energy system;

B. ***Decision support toolkit on post mining landscape management*** (ecosystem services) which will help policy makers, local authorities and planners to take informed decisions, to set targets, access financial resources and attracted investors. This guidance will lead to choosing optimal solutions in compliance with the environmental legislation in force.

This toolkit (A) will highlight a logical sequence of a set of actions, for an effective transition process from coal, based on a step-by-step approach, and alternative options, if any.

Most often decision-support tools are applied with the help of purpose-designed software packages and drawing on specialised databases. The TRACER DSTs are guides aiming to present in a non-technical language all relevant aspects related to TRACER target regions transitioning from coal.

The online versions of both documents are interactive pdf formats easy to navigate and to access references.

[1] Lusatia Region (Brandenburg DE40 and Dresden DED2 - Germany), West Macedonia (EL53 - Greece), Wales (UKL1 and UKL2 - UK), Southeast Region (BG34 - Bulgaria), Jiu Valley, West Region (RO42 - Romania), Kolubara region (RS11 and RS21 - Serbia), Donetsk region (Ukraine), Upper Silesia (PL22 - Poland), North West Bohemia (CZ04 - Czech Republic)

# 1. 5 Ws and 1 H

The 5 Ws (What/Why/Where/Who/When) and 1 H (How), which this section focuses on, more specifically concern:

1. *What does this DST stand for?* ⇨ The aim of this toolkit is to provide guidance to the policy makers and stakeholders in coal intensive regions on how to substitute energy production from coal with clean energy in an existing energy system (in terms of covering the demand for energy, costs, new jobs, etc.).

2. *Why is needed?* ⇨ This toolkit will highlight a logical sequence of a set of actions for an effective and environmental oriented substitution of coal-fired power and heat generation with clean energy. Taking better-informed decisions means less resources (i.e. time, human and money) needed for planning.

3. *Where is useful?* ⇨ Coal intensive regions, already in transition or about to initiate the transition process towards a sustainable energy system must make the most of this guidance related to the substitution of the energy production from coal with clean energy in their attempt to retain their character as “energy centres” of their countries.

4. *Who is it aimed at?* ⇨ Policy makers, local and/or regional - national authorities, mining or energy companies, planners and civil society representatives from coal intensive regions, involved directly or indirectly in the substitution of the energy production from coal with clean energy in an existing energy system (either locally or in a wider, i.e. national, level).

5. *When to make use of it?* ⇨ Obviously, this toolkit has to be studied prior to starting the substitution of coal-fired power and heat generation with clean energy process, for defining an optimal and adaptive way to perform this substitution in order to respond to their unique contexts and opportunities.

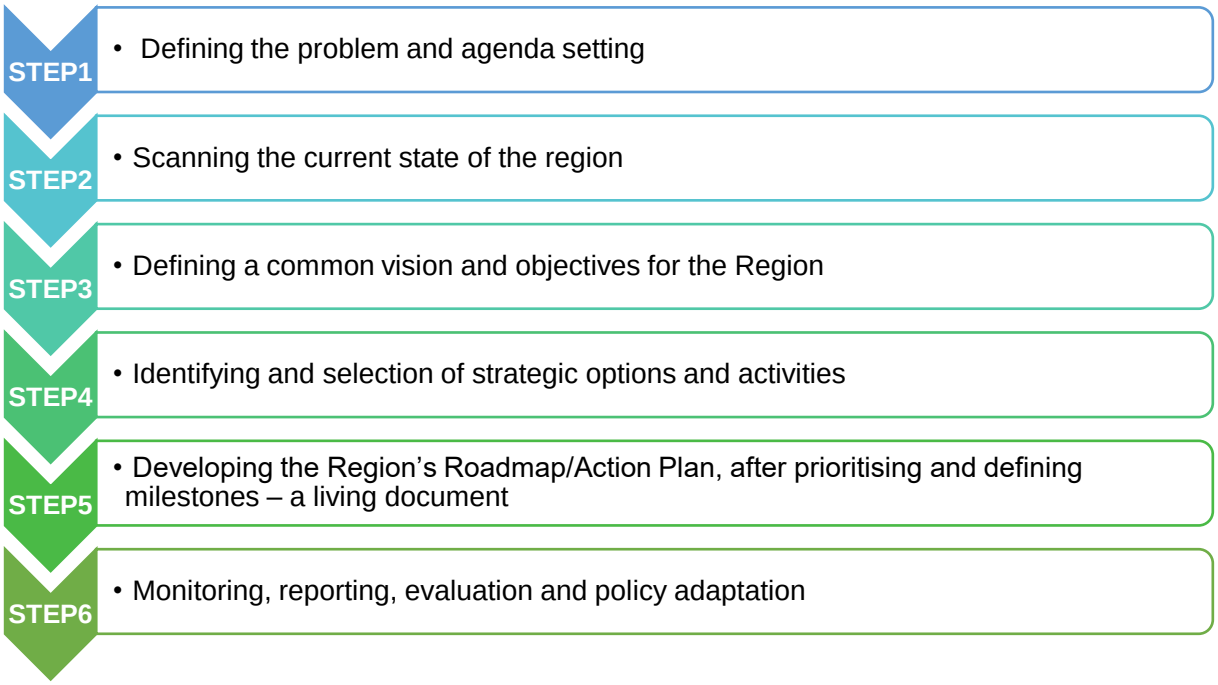
Finally,

6. *How to make the most of it?* ⇨ For its effectiveness, it is recommended to make use of this "tool" simultaneously with the existing (or being processed) development transition plans of the regions concerned, everything that is provided for in the corresponding National Energy and Climate Plan (NECP) of each country, as well as the planned programs for the promotion of RES and energy saving projects at the regional level.

# 2. Basic principles

As several regions in the world are facing a politically-initiated phasing-out of lignite mining and coal conversion, some main guiding principles in transformation processes of coal phase-out are provided in this Section, as key drivers for a technically feasible, cost-effective and socially acceptable transition from coal. Strategically planning a transition in coal intensive regions is like drawing a roadmap towards sustainable energy systems.

A well-planned transition from coal can be achieved by taking a step-by-step approach, from the current state to the desired state of the region, as follows:




**Step 1: Defining the problem and agenda setting**

Defining the problem is an important step in the agenda setting process and will largely define the next steps of the procedure, including what an appropriate strategy is, what suitable actions are, and which stakeholders need to be involved. Consulting with a wide range of stakeholders, from the start, can help define the problem more holistically and ensure that not only a sub-set of problems are addressed.

It is indeed crucial for the acceptance of the guiding principles to actively involve the regional population in the process by offering them the opportunity to contribute with ideas and thus to identify with the process. Participatory processes not only help to improve the quality of strategies, but also lay the foundation for ownership by actors needed for its implementation. The governance of the transition process must be set-up to correspond to the identified problems.

**Step 2: Scanning the current state of the region**

Strategic planning needs a sound knowledge base of the regional challenges, facts and figures. Gathering the necessary information, which normally is a long-term process requiring skills, institutional capacity, and cooperation between different stakeholders, is an iterative process with both a short term and a long-term perspective. Thus, a two-track approach should be followed:

a. quickly gather key facts for the first cycle of strategy development;

   and, in parallel,

b. build capacities in the region (skills, institutional capacity and cooperation between different stakeholders) to provide the knowledge for future adaptations of the strategy (gathering and assessing missing data as well as continuously updating most important data).

In principle, the current state / context should be analysed based on the following core information:

- the geographic characteristics about the size and extent of the region, but also about the type of mining and natural assets;

- social and demographic factors, including information about employment and the labour market;
- the economic characteristics, including technical and knowledge infrastructure;
- the institutional setting - including the existing and/or ongoing national / regional strategic documents (i.e. RIS3, Territorial Just Transition Plans, Regional Development Strategies, Integrated Development Plans, etc.) and initiatives / technical assistance (i.e. EC–DG Reform SRSS and SRSP, START; EIB; World Bank, etc.) - which frames the possibilities of development led by decision makers.

With this core information gathered and analysed, policymakers and the local stakeholders will have at hand a solid database to understand the strengths and weaknesses of the region. To make use of all the information, there are several analysis methods which can help to understand the status quo, including the coal value chains and economic interconnections, but also the region's future potential, such as the SWOT analysis, PESTLE analysis, market analysis, value-chain analysis, dynamic shift share analysis, and/or comparative advantages analysis.

**Step 3: Defining a common vision and objectives for the Region**

A transition strategy needs to specify its target with respect to the direction towards which it wants to develop. This should include:

- ***A long-term vision:*** Given that transition and structural change processes generally take several decades, the vision should have a long-term view and include an outlook with a 30-year time horizon. Such a vision is generally qualitative and describes a narrative.
- ***Development objectives:*** The general vision should be underpinned by clear concrete objectives. These objectives can address a shorter time frame (e.g. 5 to 10 years).

Visions and objectives need to respond to the specific conditions of the region, but they also need to be in line with national, EU, and international goals. For example, and as regards the energy sector, the **European Green Deal** is the new strategic priority of the European Union representing an all-encompassing strategy for achieving long-term, sustainable growth in Europe, creating wealth and jobs while significantly cutting emissions and pollution, with the ultimate objective of making the EU the first climate-neutral bloc by 2050.

In addition to that, the new **Fit-for-55** 'package' proposed legislation (presented in July 2021), designed to evolve the functioning of key sectors to reduce greenhouse gas emissions by 55% in 2030 compared to 1990, deemed critical to Paris commitments and 2050 carbon neutrality, needs to be mentioned, which in the meantime (in May 2022) was supplemented / recapped by **REPowerEU** plan, which in order to overcome dependencies from Russian fossil fuels requires swift implementation of Fit-for-55 but notes that gas consumption will now have to decrease more swiftly, limiting its role as a transitional fuel.

In this context, the Integrated National Energy and Climate Plans that have been developed in all EU Member States (plus in most of the countries of the "Energy Community") and are currently under reformation should be taken into serious consideration. This is also the case with the EU Cohesion Policy and the pilot actions that the European Commission launched for "regions in industrial transition", "coal regions in transition" and "creating new value chains through interregional investment in innovation".

**Step 4: Identifying and selection of strategic options and activities**

Once a long-term vision for the region is created and concrete objectives are defined, strategic actions to reach these objectives need to be identified. Practitioners often already

have concrete ideas for possible actions. This is a valuable knowledge base which should be explored. However, formalised approaches can help with “out of the box” thinking and can help ensure individual steps add up to a coherent portfolio of actions.

Scenarios are an approach of exploring future development options and for analysing the consequences or the impacts that certain actions might have. In order to identify potential pathways to reach the “desired” future for a region, scenarios are often combined with a back-casting process. First, a rough sketch of what a desired future for the region would look like must be made, and then work backwards must be done. The desired future can be described in general terms, using projections or analogies relating to the specific case. Then, through an iterative process, the pathways and steps involved in how this desired future can be achieved are identified.

There are simpler approaches of identifying options for action, such as the collection of options through interviews with stakeholders, consultation with experts, policymakers and market actors, or by transferring international good practices. Such approaches have their advantages in that the effort to identify options is generally less and, in many cases, there is a lot of local knowledge about what could be done or improved. They also enable immediate action on the ground when time pressure for implementation is high and can be used to achieve rapid convergence alongside the process of developing a robust and holistic strategy. However, special care must be taken so that these "quick decisions" do not conflict with long-term goals. Infrastructure investments in particular may set irreversible framework conditions for many years or even decades and risk setting the region on undesired paths on development paths that are not acceptable or cause stranded assets.

Other established approaches to identifying options in a strategic way are the “Logic Model” and the “Theory of Change”. Both approaches aim to describe possible processes from interventions to outcomes. This analytical process helps to better understand how certain goals can be achieved. As logic models and theories of change often appear as a chain of effects, they do not need to be linear, and if well implemented, they can also be used to identify correlations of different measures (synergies, gaps in strategies, etc.). Besides, both approaches can be combined with scenarios as well as with back-casting, while they can be used or developed in the context of participatory processes.

**Step 5: Developing the Region’s Roadmap / Action Plan, after prioritising and defining milestones**

Having identified and select the strategic options and key activities for the transition to a cleaner energy future in the targeted coal intensive region, as well as having at hand any other developed (and agreed) strategies, such as R&I strategies for smart specialisation and/or strategies for the re-skilling/re-training of the local workforce, the elaboration of concrete Roadmaps on how to finally implement the provisions of the these policy documents/strategies, gradually until 2030 at first and then until 2050, is the next logical step. This, again, needs to be supported (in the overall decision-making process) by the governance structures set up in the region for this purpose.

The elaboration of the Roadmap(s) aims at the formulation of the optimal planning and the identification of a series of measures and actions for the achievement of the targets set within the overall planning, but also in the frame of the R&I strategies for smart specialisation and the corresponding strategies for the re-skilling/re-training of the local workforce of the target region. Through the Roadmap, the appropriate guiding directions will be offered to the relevant policy makers, aiming at the enhancement of the legislative framework and the incorporation of the new energy technologies in the energy system and of the proposed (re)training, but also the stimulation of investments in the low-carbon energy sector.

The elaboration of the Roadmap(s) for each coal intensive region needs to be accomplished in three basic steps:

1. Selection of the priority energy technologies to be included in the Roadmap (with this selection the corresponding local workforce that will need to be reskilled or retrained will be also selected / identified);
2. Determination of the process to be used in the Roadmap's development, i.e. formulation of the major axes needed to accomplish the objectives of the Roadmap, proposition of a number of measures under each one of main axes to overcome specific barriers, and, finally, decomposition and analysis of the identified priority measures to specific actions;
3. Assessment of priority measures alternative scenarios (categorization of measures into High / Medium / Low priority).

Such Roadmaps have been developed in the frame of the TRACER Project for the target regions aiming to contribute to the formulation of an optimal planning, in order for the targets in view of the energy transition – in terms of having available the appropriately trained / skilled personnel that will work on the new, cleaner, energy production technologies - to be achieved, as well as the R&I strategies on energy to be appropriately and efficiently implemented in the regions. More about TRACER target regions' Roadmaps, together with the corresponding R&I Strategies online in TRACER Publications – National Policies and Challenges.

**Step 6: Monitoring, reporting, evaluation and policy adaptation**

This last step of the process aims to inform the next policy cycle, adapting the strategy based on what was learned in the first round. Indeed, as regions normally undergo a continuous process, the end of one policy cycle actually marks a new beginning, i.e., entering into the next cycle, adapting the strategy based on learning from the first round.

Some changes are immediately necessary, due to changes in the institutional or political context (e.g., new government and policy priorities at national level, new financing options, changes in international conditions in the energy sector, changes in markets, etc.), and others stem from practical application experience (i.e., a particular approach did not work as expected). But to make a strategy truly effective, it's important to take a closer look at what worked and what didn't. To do this, an appropriate monitoring and evaluation (M&E) system must be established.

Monitoring and evaluation (M&E) needs to be considered and implemented from the very beginning of the policy cycle. M&E systems:

- should include a mix of quantitative indicators (e.g., $CO_2$ emissions, money spent, jobs created), prioritising what is important over what is merely measurable, and qualitative ones;
- must reflect the various objectives of the strategy, and not only those that are easy to measure or which are the priority of the implementing agency (for just transition processes in coal regions, a balanced mix of economic, environmental and social assessment criteria is key);
- are helpful for future decision making, but they require a significant effort and regional authorities need institutional capacities of their own to ensure that results of M&E processes can be taken up in the revision of the strategy.

More about developing strategies for a Just Transition in coal intensive regions can be found in the Just Transition Toolbox for coal regions, Wuppertal Institute. Berlin.

In TRACER, the Strategy for Smart Specialisation (S3) approach was used (TRACER-D2.2, 2019), which involves a prioritisation exercise named the Entrepreneurial Discovery Process (EDP). The EDP aims to help stakeholders identify the domains and economic activities where regions or countries have the potential to generate competitive knowledge-driven growth, and to target investment and resources on these themes. This multi-actor development work is guided and shapes a shared vision for the region and is the epitome of

collective action within S3. It emerges from a process of knowledge-sharing and discussion of the existing and potential regional areas of strength, and as a result of entrepreneurial insight. The S3 approach seeks to respect the multitude of visions and values present in a region, and to potentially combine them in creative ways for the benefit of the region's development.

TRACER applied the EDP to help formulate and shape visions for the target coal regions in their transition to sustainable energy systems. Guidance developed for the TRACER target regions in June 2020 suggested that the regions' visions could be defined in response to the following question: *"What is the overarching developmental goal for the region, in relation to sustainable energy research and innovation, to support transition to a low carbon economy?"*

It was suggested that this could include some of the following dimensions:

- **A societal dimension**, e.g. shifting from coal production and use to more sustainable forms of energy, in order to contribute to the wider energy transition and a low carbon economy;
- **An economic dimension**, e.g. developing/expanding a particular sustainable energy industry, with a view to supporting overall prosperity or regional economic development;
- **An employment or skills dimension**, e.g. creating new jobs or transitioning workforce skills, in order to provide new employment opportunities for people in the region, or for particular groups of people (e.g. ex/current miners, young people, researchers);
- **A research/innovation/technological dimension**, e.g. enhancing specific kinds of R&I capacities, as a contribution to business development and economic growth, or new employment, or new opportunities for universities;
- **A collaborative/engagement dimension**, e.g. increasing opportunities for cooperation among regional stakeholders, in order to enhance social capital.

The guidance also suggested that the regional priorities could be defined in terms of concrete and achievable objectives and focused on the region's existing strengths, resources, and emerging opportunities, in an inter/national context.

**Box 1: Indicative themes for regional priorities in TRACER target regions**

The following themes were suggested as a focus for agreed priorities, related to the region's existing strengths/resources and potential:

- Natural resources or energy sources,
- Geographical location (e.g. proximity to resources or to markets),
- Infrastructure and physical capital (e.g. in relation to energy),
- Funding for investment in physical, human and knowledge capital, and for financing particular types of businesses or particular types of R&I activities,
- Key businesses and other economic actors,
- Human resources and skills,
- Research and innovation infrastructure and capacities, or funding for the diffusion and application of specific technologies
- Governance structures,
- Stakeholder engagement and social capital.

*Source: TRACER supplementary guidance: Developing a regional vision & priorities (including via online working) (June 2020)*

The regional shared vision and priorities were developed through a collaborative and iterative process with stakeholders. The TRACER target regions are all at different stages of their transition out of coal, and their transition into sustainable energy systems – this is reflected in the emerging visions and priorities. The visions and priorities were then carried forward into the next TRACER activities, to help inform the preparation of reports focused on the target regions on:

- projections for the transition to 2030/2050;
- research and innovation strategies relating to energy;
- the needs for workforce retraining;
- roadmaps for energy R&I and skills, related to energy transition;
- blueprints for energy transition.

**Box 2: Examples of visions developed by the TRACER target regions**

**Jiu Valley, Romania**: "Jiu Valley micro-region will become revitalised from a social point of view, with a sustainable development, interconnected with the major regional, national and European networks, and having a competitive economic environment. The integrated transition of Jiu Valley micro-region will be implemented by investing in human potential, education, spirituality and morality, thus creating the right environment and generating the necessary force for the human capital, able to develop the local economy by implementing innovative ideas."

**Kolubara, Serbia**: "Transition in Kolubara target region to coal phase-out should be planned well in advance. The transition should be gradual and supported by additional hydro pumped storage facilities with the aim to keep the electricity supply stable and minimise dependence on imports. Transition and reclamation activities should be well prepared before and developed immediately after each mine field closure. To support the transition process, new energy-related research and innovation (R&I) activities need to be developed, focused on the application of innovative technologies in line with the resources present in the Kolubara region."

**Western Macedonia, Greece**: "The region's production model must be rebooted, regenerated and be ready to be enriched with new activities that will create new jobs. The new production model should be non-dependent on coal, yet maintain its "energy" character and be based on the exploitation of new alternative and environmentally friendly resources and technologies (e.g., RES, hydrogen, energy storage). It should further expand to other sectors (e.g., agricultural, manufacturing, agri-food, mild forms of tourism exploiting the natural landscape and the cultural background). The regions' significant technological and research infrastructure could be upgraded and expanded to support new business activities – still energy based, but in innovative sectors and / or products. This, coupled with the highly trained technical staff, could constitute a very efficient and powerful tool for the new orientation of the production and economy of the area to alternative (energy and not only) paths."

# 3. Current state diagnosis

In order to assess, as correctly as possible, the current state of play in a coal region in transition, in terms of basic economic indicators (GDP, demography), policies and measures, legislative framework, energy technologies, energy production/consumption, environmental and social aspects, labour market status as regards employment / unemployment but also retraining / reskilling needs, etc., a lot of tools and methods exist. For example, some can use statistics analyses, others prefer to distribute questionnaires for data collecting, while others carry out face-to-face/online/phone interviews.

Apart from these methods, there are also some situational analysis tools, such as the SWOT and PESTLE analysis, that could be used for this purpose. SWOT (strengths, weaknesses, opportunities, and threats) analysis is a framework used to evaluate a company's competitive position and to develop strategic planning, assessing internal and external factors, as well as current and future potential. On the other hand, the PESTLE (Political, Economic, Sociological, Technological, Legal and Environmental) analysis is a concept in marketing principles mostly used as a tool by companies to track the environment they're operating in or are planning to launch a new project/product/service, etc.

Apparently, the best way of carrying out a rational current state diagnosis and assessment is the combination of all (or as much as possible of) the above. Considering this context, the following methods can be applied to carry out the current state diagnosis of a region:

1. **Collection of statistical data** – the main method to obtain quantitative information about the administrative structure, demographics, economy, national energy balances, employment, education, infrastructure, land use, and others.

2. **Literature review**, including:
    a. National, regional, and local policy;
    b. Annual reports of the national and/or regional energy holding, TPPs, and the mining companies – these provide information about the employees, produced energy carriers, financial results, and others;
    c. Energy, environmental, economic, and social analyses.

3. **Personal interviews** (face-to-face or online) with:
    a. Policy makers (anonymous or not) - to collect information about the planned policy change in the energy field;
    b. Representatives of the coal sector - to understand the situation of the enterprises, and the employees' skills, culture, and desires;
    c. Business associations and entrepreneurs – to get insight about the business environment in the region;
    d. Experts – to identify the energy, environment, and social needs, barriers, and opportunities for the region.
    e. Researchers – to collect information about the research capabilities, needs, and opportunities, as well as results from relevant studies.

4. **PESTLE analysis** of the region's transition away from coal, assuming that the transition starts immediately.

5. **SWOT analysis** of the social and re-skilling issues in the region to ensure smooth transition.

6. **Stakeholder workshops.** It is necessary to involve all stakeholders – public authorities, NGOs, energy and non-energy businesses, labour unions, civil society representatives, and consultants, in order to:
    a. improve the analyses; all stakeholders have the opportunity to contribute to the definition of the challenges faced by the region, SWOT analysis, PEST analysis, and conclusions;
    b. agree about the problems and opportunities and take ownership of the results;

These are important pre-conditions to ensure the involvement and collaboration of all stakeholders in the next steps of the process – establishment of a common vision, strategies, and roadmaps.

A type of report that includes an in-depth analysis of the existing situation in coal intensive regions, in different stages of transition to a sustainable energy system, being the main source of data could be the “Baseline Study”, including the following main sections:

- General description of the economic and demographic profile of the region including notable trends and projections;
- Overview and general characteristics of coal-related industry and locations;
- Socio-economic characteristics of coal-related industry;
- Characteristics, trends and challenges of coal-related locations and communities;
- Coal transition strategies, plans and projects;
- Current strategies and plans for economic diversification / development and decarbonisation.

Sectors to be assessed should be:

| | |
|---|---|
| General information of the region | ✓ Demographic data<br>✓ Number and characteristics of settlements (urban, rural)<br>✓ Geography, morphology, hydrology and land use in the region<br>✓ Economy characteristics: existing type of industrial activities, main sources of income<br>✓ Overall review on the quality of the environment in the region (air emissions and quality, water quality, land degradation) |
| Regional socio-economic profile | ✓ Total number of citizens<br>✓ Age and gender distribution<br>✓ Education status<br>✓ Employment by sectors (Agriculture, Forestry & Fishing, Industry, Mining and quarrying, Construction, Trades, Transport, Accommodation and food services, Information and communication, Professional, scientific, technical, administrative and support services, Public administration, Defence, Education, Human health and social work activities, Arts, entertainment and recreation; other services)<br>✓ Share of jobs in coal mining and coal fired power plants<br>✓ Share of jobs in the coal-related activities<br>✓ Jobs and skills in the mining and power generation sectors<br>✓ Jobs and skills in the coal-related activities<br>✓ Economic indicators (GDP per capita, energy consumption per capita) |
| Regional coal industry profile | ✓ Type of coal<br>✓ Type of mine<br>✓ Production rate of coal<br>✓ Number and structure of employees (by age and profile)<br>✓ Remaining operation period |
| Final energy consumption in the region | ✓ Electricity consumption by sectors (industry, residential, services)<br>✓ Heat consumption by sectors (industry, residential, services)<br>✓ Transport (optional) |
| Energy demand by sources | ✓ Solid: coal, biomass (wood, pellets)<br>✓ Liquid: fuel oil, bio-fuel<br>✓ Gas: natural gas, bio-gas, syngas |
| Energy generation plants in the region (capacity, no. of units, age, power generation per year, remaining life span) | ✓ Thermal power plants (fossil, nuclear)<br>✓ Hydro power plants<br>✓ Wind power plants<br>✓ Solar power plants<br>✓ Biomass power plants<br>✓ Others |

| | |
|---|---|
| Renewable energy resources in the region and potentials for energy generation | A theoretical wind and solar potential can be estimated using WB open-source platforms: Global Wind Atlas 3.0 and Global Solar Atlas 2.0 |
| Current or expected transition challenges facing the region | To be evaluated based on stakeholders' consultation methods (interviews, workshops, round tables, etc.) |

As far as renewable energy sources (RES) are, for the time being, the "cleanest" source of energy, there are a number of issues that need to be taken into account when diagnosing the situation regarding RES potential in regions under transitions. So, the best available renewable resource geospatial data should be used to estimate the achievable energy generation capacity and corresponding annual generation of specific RES technologies at specific sites within the region, depending on the technology, given system performance, topographic limitations, environmental, and land-use constraints. This results in a data set of locations across the region defined by resource characteristics and correspond to the evaluation of the **RES technical potential**.

Then, the Levelized Cost of Energy (LCOE) has to be estimated for each RE technology at these same locations, incorporating regional plant construction costs, technology cost, and performance and estimated intra-regional transmission costs. At each of these locations a Levelized Avoided Cost of Energy (LACE) should be further estimated by valuing the potential revenues available to a RE project at the location, which equals the amount the project would be paid for the electrical energy and capacity it can provide (else, what a utility would not have to purchase from other sources). For the full supply curve for each technology, the difference [LACE–LCOE] gives the net value for a location. A specific location is considered economically viable if its net value is positive, and the technical potential associated with locations with positive net value is summed and deemed the region's **RES economic potential**.

The TRACER assessment of the target regions' current situation took place in the second half of 2019 and first half of 2020. Some assessment issues of the current situation in TRACER target areas that deserve mention are listed in the next Box.

**Box 3: Issues in assessing the current state of play in the TRACER target regions**

In some of the target regions, like the South-East Region (BG34) in Bulgaria, Northwest Bohemia (CZ04) in Czech Republic, the Region of Western Macedonia (EL53) in Greece, the Upper Silesia (PL22) in Poland, and the Jiu Valley micro-region / West (RO42) in Romania, this procedure was followed more or less. In other cases, like e.g. the Lusatian Lignite District in Germany or Wales in the UK, work in this field was already done by the local authorities, so in the case of TRACER only some minor adaptations have been made.

Especially as regards the Bulgaria's South-East Region (SER), it must be mentioned that this was the first study made to provide a basis for the region transition out of coal. At that time, although the EU policy and the huge financial losses in the coal sector clearly indicated that serious restructuring is inevitable, there was (almost) no national and regional policy related to coal phase out. Additionally, many stakeholders, such as most public authorities, coal and related businesses, and labour unions, strongly opposed the transition to low carbon energy.

In Jiu Valley micro-region, Romania, an unprecedented bottom-up stakeholder consultation process was performed, during 2 hard pandemic years, under different complementary EU initiatives (EC DG-Reform SRSS, SRSP and DG-Ener START) with TRACER project. All quadruple helix stakeholders' categories, i.e., industrial/business associations and individual businesses, research & education institutions, public sector bodies, and civil society (trade unions, NGOs, former miners, etc.), were informed, consulted/interviewed and engaged. It was long awaited and appreciated in Jiu Valley communities, but also overwhelming, the key stakeholders being practically the targeted for crossfires.

# 4. Planning – Forecasting – Prioritizing

After putting in practice the key principles and starting rolling-out the step-by-step approach recommended in Section 2, including an "in deep" current diagnosis (Section 3) and a "common vision" definition for the coal intensive region, it is time to assess the options for substituting coal-fired generation.

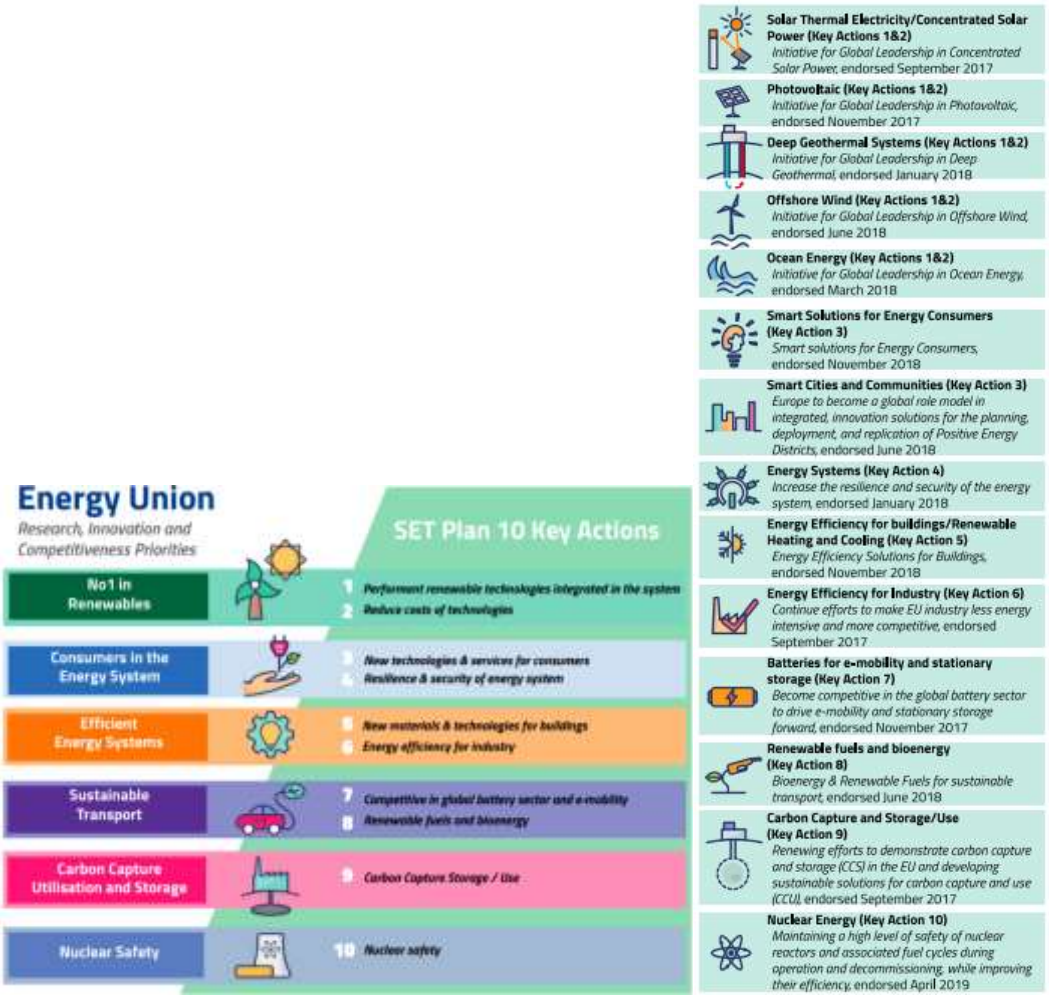
Each coal region in transition differs in terms of location (geography, rural or urban), existing infrastructure (including the coal-related one), economic specialisation and opportunities, geology, workforce, sectoral demands, former opened or underground mining, etc. And each coal-fired PP (power plant) has particular challenges like contaminated sites, economic viability of the energy companies, etc. – strongly influencing the timespan of assets repurposing or reuse.

To this end, the Technology Options Toolkit (EC-CRIT, 2021) is tackling the topic "re-use of coal power plants", recommending solutions for:

<table>
<tr><th>ENERGY STORAGE<br>system integration in existing PPs</th><th>CONVERSION</th><th>NON-ENERGY USE</th></tr>
<tr><td>Thermal energy storage, i.e. molten salt energy high-temperature storages or Carnot batteries or MGA (Miscibility Gap Alloys)</td><td>Conversion to gas, as transition fuel to 100% RES (short term option)</td><td>Data centres</td></tr>
<tr><td>Pumped hydro energy storage in former open casts/pits or underground mines</td><td>Conversion to sustainable biomass, via a secure and long-term efficient feedstock supply (short term option)</td><td>Logistical ports for off-shore wind</td></tr>
<tr><td>Chemical battery storage systems, i.e. li-ion and sodium sulphur</td><td rowspan="2">Conversion to other renewable energy as clean energy hubs with<br>- solar power and/or heating,<br>- wind power,<br>- deep geothermal energy<br>- mixed RES<br>for power and/or heat and/or hydrogen generation</td><td>Industrial parks</td></tr>
<tr><td>Gravity batteries in former underground mines</td><td>Offices, students' union centres</td></tr>
<tr><td colspan="2">Combined solutions as conversion to RES and storage (sector coupling)</td><td>Cultural sites</td></tr>
</table>

More about technological solutions for "re-use of coal power plants" are provided in TRACER Best Practice Platform and in the Just Transition Toolbox for coal regions, Wuppertal Institute.

It is important to notice that, in every phase of the region's "Planning-Forecasting-Prioritization" process, the mandates of the "Clean Energy Transition Technologies and Innovations Report" and of the National Energy and Climate Plans that set out the policies and financial measures that EU countries will take to reach the climate and energy targets, should be taken into consideration. At the same time, and as regards the energy technologies that are considered critical in order to achieve the EU's energy and climate goals and make Europe a global leader in clean energy and energy efficiency, the Strategic Energy Technology Plan (SET Plan) forms the European framework for boosting the transition towards a climate neutral energy system through the development of low-carbon technologies in a fast and cost-competitive way (TRACER-D6.1, 2021).




*Source: (Dufour, E., Lisi, V. and Robison, R., 2019)*

SET Plan (EC, 2021) has defined 10 key actions for research and innovation (to the left) and fourteen (14) technology areas (to the right) that have the highest innovation potential for delivering cost reductions and improvement of performance, thus contributing to the decarbonisation of the European energy system. In the right image, the 14 technology areas are further associated with the key actions and implementation plans (*italic*). Therefore, in the process of defining a regional development strategy in the field of energy based on smart specialisation, driven by Research, Technology and Innovation (RIS3), it is important to consider the implementation plans (IP) adopted by SET Plan, defining the R&I priorities and investment agendas. The above pool of SET Plan actions and technologies as well as the CRIT Technology Options Toolkit were the basis of the analysis carried out within the TRACER project for performing an optimum decision-making process, based on each target region specificity, looking at the options for substituting coal-fired generation with clean or alternative energy, and reuse some of the assets, or repurpose through total industrial transformation. As it turned out, the most promising technologies - which should be given further attention - in the majority of the TRACER project's target regions, are wind and PV systems, as well as the various bioenergy production technologies. In addition, the comparative advantage of "green Hydrogen" production should not be neglected, and indeed some of the TRACER target regions have started to take the first steps in this direction.

Wales in the UK is in a different coal phase-out stage, with the gradual but irreversible decline of the coal era and subsequent virtual disappearance in the 1990s. Since then, Wales has been undergoing a continuous process of industrial transformation. Several examples of initiatives which are helping Wales transition to more sustainable energies are briefly presented in the Box below.

**Box 4: Energy transition related case studies from Wales, UK**

*Developing the marine energy sector in Wales (*Link: https://www.marineenergywales.co.uk/)

Wales is in a good position to play a global leading role in marine energy, with 1,200km of coastline, up to 6GW of generating capacity potential for wave and tidal stream, the potential for four tidal lagoons and nearby accessible grid infrastructure. This is supported by an existing supply chain, seven strategically located ports (including the third largest in the UK at Milford Haven) and good road and rail links to other major cities and transport hubs.

Wave and tidal technologies are still in the pre-commercialisation stage, but around 20 emerging marine renewable energy developers are actively progressing projects in Wales. Four test and demonstration sites are under development with >€50 million being committed into the strategic development of Wales' test centre network to date, and there are testing opportunities across a wide range of scales.

*HYNET North West* (Link: https://hynet.co.uk/about/)

HyNet North West, a 'hydrogen' initiative, is an industrial decarbonisation cluster in the North West of England and North Wales, which aims to act as a catalyst for clean growth across the regions from the mid-2020s onwards. The project aims to lead the creation of a low carbon economy in the region, protecting and creating local jobs and attracting inward investment, establishing the region as a world leader in clean energy innovation.

HyNet involves both the upgrade to existing infrastructure, as well as the developing new infrastructure, including: underground pipelines, hydrogen production plants and storage facilities.

*Pembroke Net Zero Centre – PNZC*

Link: https://uk-ireland.rwe.com/innovation/pembroke-net-zero-centre-pnzc

The Pembroke Net Zero Centre is a new initiative in Wales led by RWE, the German multinational energy company. RWE's site at Pembroke Power Station in south-west Wales has undergone major transformations during the last 60 years - from hosting an oil-fired power station in the 1960s, to transitioning to a natural gas-fired power station in the 2010s. The PNZC initiative will see the site continuing its transformation as part of a decarbonisation hub (the South Wales Industrial Cluster), linking-up with new innovative technologies needed for a low carbon future, through three pillars:

- Decarbonisation of Pembroke Power Station, including CCS and initial Hydrogen feasibility studies;

- Green Hydrogen production, including feasibility studies for the development of an initial 100 - 250MW 'pathfinder' electrolyser on the Pembroke site but also looking at GW-scale opportunities in the longer-term;

- Floating Offshore Wind development in the Celtic Sea.

It is anticipated that the deployment of the PNZC, alongside the South Wales Industrial Cluster activities, will help unlock the route to Net Zero in South Wales, helping support the future of existing industries, businesses and jobs and attracting new industries and businesses, further developing the production and use of hydrogen for home heating, power generation and transport across the region.

*Biomass based District Heating*
Links: https://www.sustainable-energy.co.uk/projects/biomass-and-chp-district-heating/
https://www.sustainable-energy.co.uk/projects/2-5mw-biomass-district-heating-newport-city-homes/

Heat networks, including communal heat schemes and district heat networks, will have a role to play where the heat demand density is high. An interactive map published by the UK Government shows the progress of heat network projects through the planning system by region, status, energy type, capacity, heat network type, type of building and number of connections. Project pipelines provide an overview of upcoming procurement, encouraging new sources of finance to enter the sector. Wales has a range of completed heat network projects, including a 2.5 MW biomass district heating scheme for Newport and biomass and CHP district heating for Blaenau Gwent County Borough Council.

However, there are other problems that need to be solved before achieving a “just transition” to cleaner forms of energy. Indeed, the main characteristics of the labour market structure and social challenges in coal-intensive regions in transition, such as mono-industrial identity, depopulation, unemployment, poverty, migration, aging, brain drain, are common elements for all the mining and power generation from coal areas in Europe. According to the EU’s Joint Research Centre (JRC), by 2025, coal-intensive regions in the EU will face the loss of 77,000 direct jobs. The scenario is even worse on the long-term: 160,000 direct jobs are expected to be lost by 2030.

At the same time, an increase in jobs in the Renewable Energy Sources (RES) sector is already happening, which is expected to continue and perhaps grow further. This is of particular interest to carbon-intensive regions in transition, especially if this transition is to be in the direction of substituting coal-fired generation with clean energy (i.e., RES), as the existing labor force (as well as the new one that will soon enter the labor market) will have to be redirected to new jobs. In these regions, the vocational education and training (VET) system and the labour market are expected to be challenged by the rise of coal workers seeking re-employment in the near future and the surge in vacancies in RES.

As reskilling initiatives for the transition of coal workers to the RES sector are currently extremely limited, with only one EU country (Germany) offering relevant C-VET courses (RES-SKILL, 2020), a lot of effort should be put by the regions in the direction of developing novel curricula and tailored training contents to facilitate coal workers’ reorientation to the RES industry, as well as in supporting VET providers and academic institutes to integrate these curricula / materials into their VET and work-based learning (WBL) offerings. The procedure of an efficient retraining/reskilling planning requires a number of specific to each region preconditions, but this is the right time at which it will be done.

In conclusion, increased well-being is needed to secure social acceptance of the abandonment of mining projects and coal-fired power generation, and to maintain regional competitiveness and future prosperity. To this aim, in TRACER *Best practice report on labour markets, social issues and tourism* (TRACER-D2.4, 2020) the following key drivers for the regions have been identified

a. Support policies (industry, environment, social, education & labour market) and the inclusion of transition away from coal in state level energy and climate policies;
b. Strategic planning (structures, actions, documents);
c. Implementation resources (human capacity, competences, skills; secured financial support);
d. Formal dual education, training, retraining/reskilling and up-skilling, apprenticeship and life-long learning labour-market oriented programs for working people, their families, and their communities, including skills audit and matching;
e. Ability of a region to attract new investments;
f. Sustainable employments in RES industry, energy efficiency, digitalisation, circular economy;
g. Proactive stakeholders’ attitude and willingness to be engaged in the decision-making process;
h. Respect for, and protection of, human and labour rights (ACTU, 2016).

In order to implement a successful and socially acceptable transition process, it is considered as been essential to identify a personalized approach for each coal intensive region, having in view the specificity of the socio-cultural heritage, thus leading to sustainable employments, citizens regaining their self-esteem, identity, livelihood and stability.

More about success stories related to re-skilling and apprenticeship programs can be found in TRACER-D2.4 Best practice report on labour markets, social issues and tourism and TRACER Best Practice Platform; about renewable industry job creation potential and the needs for workforce retraining in TRACER-D6.3 Report on the needs for workforce retraining; about the Opportunities and challenges ahead for the EU coal regions and the Opportunities for jobs and growth in coal regions offered by clean energy technologies in two corresponding studies of JRC (JRC 2018 & 2020); and about employment opportunities in Just Transition Toolbox for coal regions, Wuppertal Institute. Berlin.

**Lessons learned during the EDP process in TRACER regions**

As the Smart Specialisation Strategy (S3) approach is based on research that suggests innovation is a collaborative and dynamic process (through interaction between actors, knowledge is not just exchanged, but learning occurs, which can allow underused knowledge and innovation capacities to be identified and used more effectively) it foresees forms of inclusive and cooperative stakeholders' involvement (Foray, D., et. all, 2012), namely in the form of an Entrepreneurial Discovery Process (EDP). This generally consists of meetings, workshops or other interactions taking place within the region which bring stakeholders together to build trust and working relationships, share knowledge, and discuss and agree on a common vision and priorities based on regional strengths (or "specialisation").

Given regional strengths and capabilities will vary, the implementation of S3 as well as of any other strategy related to the transition and the EDP varies largely depending on the regional context. The TRACER target regions have taken different approaches to S3 to reflect the varied interests and needs of stakeholders, to take into account existing structures, and to promote synergies and complementarities where possible. The strategy processes have therefore been diverse across TRACER regions, allowing for a rich comparison and reflection on lessons learned from the process (TRACER-D5.2, 2022).

The TRACER project approach sought to involve a broad array of stakeholders from the quadruple helix i.e., public authorities, industry, research & education, and civil society. Several workshops were conducted across the target regions, promoting discussion. In addition, interviews carried out by the TRACER partners allowed for the collection of more detailed information. This work shifted stakeholders' attitudes by nurturing working relationships (e.g., Kolubara region, Serbia) and increasing understanding of the coal transition (e.g., Donetsk, Ukraine), narrowed the main interests and priorities for the coal transition (e.g., green energy tourism in North West Bohemia, Czech Republic), and established networks and/or strengthened existing bodies to coordinate efforts for the transition (e.g., Jiu Valley, Romania).

The interactive focus of S3 thus enabled TRACER's strong impact on community building and networking through these activities, with hundreds of relevant participants being involved in some instances (e.g., Southeast region, Bulgaria). Interest has also largely been maintained even after these first collaborative activities (e.g., Western Macedonia, Greece).

Challenges have nonetheless hindered the stakeholder engagement process, even beyond the impact of COVID, which necessitated a major change in working practices. The move to online communication tools during the pandemic had implications for stakeholder engagement, in particular where stakeholders were more comfortable with face-to-face interaction, or lacked the technology or IT skills to participate in online meetings. Other challenges included uncertainty regarding future funding programmes (e.g., Wales, United Kingdom), lack of skilled workers which can paralyse some R&I activities (e.g., Donetsk, Ukraine), the need for capacity-building for R&I (e.g., Western Macedonia, Greece) and for complex planning and needs assessments (e.g., Kolubara, Serbia), and a lack of clear and integrated legislation, which can hinder cooperation and hinder the transition process.

**Box 5: Key lessons learned under the TRACER stakeholders' engagement activities**

**R&D&I activities and workforce re-qualification needs to support the energy future of the region, and thus require constant enhancement.** The significant technological and research infrastructure and highly trained technical staff are important assets in the transition to "green energy" (Western Macedonia, Jiu Valley, Kolubara). Furthermore, it is necessary to come to an agreement on the need for innovation, business synergies and the circular economy. These may help with funding e.g., attracting foreign investments, where a well-developed R&D&I sector is seen as a key regional strength. Institutional and innovation capacity should be considered here. This can be a significant hindrance for less developed and peripheral regions that do not benefit from the infrastructure, skilled workforce, and institutional thickness or dynamics necessary for R&D&I activities to thrive.

It is essential to **develop a coherent vision for the region's specialisation and its role in the broader context.** This requires planning over the long term rather than corrective measures. Most of the TRACER regional teams reported that their target regions have already undertaken certain steps to define development strategies, including:

- Energy fields (e.g., in Bulgaria: large-scale solar PV, possibly later complemented by energy storage and/or hydrogen, small-scale projects - energy efficiency & RES in buildings, and replacement of some of the coal-fired capacities by combined-cycle gas turbines);
- Green energy as a leverage for regional tourism development (North West Bohemia, Czech Republic);
- Scale of future energy production (as in Lusatia, Germany – where it already is and will continue to be an export region for energy);
- Developing a shared view on need for collective effort at all levels to seize areas of opportunity (e.g., digitalization, reskilling in Wales, UK);
- Adaptation to domestic and international frameworks, including climate change mitigation (as observed in Poland, Romania, Serbia, and Ukraine).

**Awareness of politically sensitive topics plays an important role.** Some stakeholders were hesitant to express their position during meetings due to the specificity of the topic (e.g., Lusatia, Germany). Adaptation was needed in these cases, namely in-depth conversations in their own offices or through e-mail. For several target regions (Western Macedonia, Upper Silesia, Donetsk) the main concern of both the involved stakeholders and of the local community remains the replenishment of the current jobs related to lignite/coal activities. Social issues are extremely important; energy transformation must not deteriorate the living standards of local populations, and many people still see coal as a main energy source (Upper Silesia, Donetsk).

**The process should be as interactive as possible and not just informative.** To build consensus it is worth proceeding with a series of meetings to build relationships among stakeholders, especially in places where cooperation is not established yet at a satisfactory level. Also, the discussion should be stimulated where possible to encourage progress and not just an exchange of views. It is necessary to maximise knowledge exchange and optimise the cooperation between different stakeholders' groups, researchers, and practitioners.

**The mobilisation toll on stakeholders needs to be considered while planning further activities.** Consultation fatigue is real, and stakeholder engagement should be scheduled carefully, understanding their available time-capacity. It is important to keep in mind that stakeholders may already have many obligatory meetings related to energy transition, they may also be involved in other consultations, or they may not have the time to attend every upcoming event.

The governance structures to support the S3 implementation process and the TRACER activities have depended on the regional context and capabilities. The TRACER work sought to use the existing structures where possible to avoid duplication of efforts, only creating new bodies where necessary.

**Box 6: Examples of just transition from coal governance structures in TRACER target regions**

In the majority of TRACER regions, new networks or bodies had to be established (North West Bohemia (CZ); Upper Silesia (PL); West region/Jiu Valley (RO); Kolubara (RS); Wales (UK)). For example:

▪ In **Romania's Jiu Valley/West Region**, a new working group was established with 25-27 members from the quadruple helix, which after a series of transformations became officially the governance structure for a just transition "Jiu Valley Integrated Territorial Development Association" ADTIVJ. This allowed for an integrated approach at the micro-region level, aligned with the transformation planning at the regional level. Project ideas were also generated together and endorsed by local authorities and are expected to further develop;

▪ In **Wales, in the United Kingdom**, the *Net Zero Wales: Skills Economics Advisory Forum* was set up, with representatives from higher and further education, industry, regional skills partnership, local authorities and Welsh Government. The forum supports Welsh Government to progress the green skills agenda and to promote the just transition and decarbonisation.

The remaining TRACER regions joined existing committees or working groups (Southeast region (BG); Lusatia (DE); Western Macedonia (EL); Donetsk (UA)). For example:

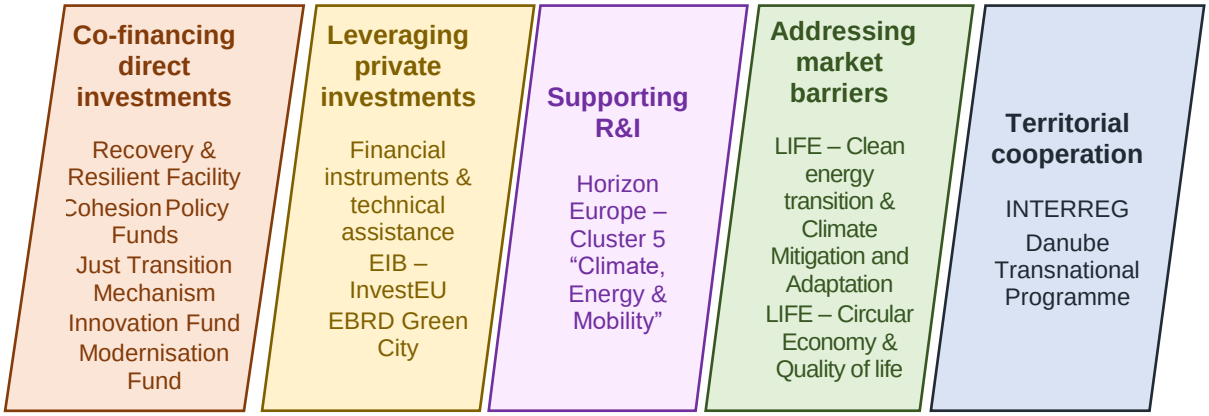
▪ In **Western Macedonia**, the TRACER partner (CRES) came in close contact with the group of the *Western Macedonia Region Working Team for Coal Platform*, with members representing research and higher education bodies, regional managing authorities, municipalities and the Ministry of Environment and Energy. The main goals in joining were mobilising stakeholders and disseminate TRACER findings as an additional tool in the energy transition phase;

▪ In the **German Lusatia region**, the TRACER partner joined the *Regional Lignite Mining Company* (LEAG) group which included Ministry staff, a recultivation company, nursery staff and farmers. The TRACER partner helped generate new value chains for LEAG and operating farmers, by developing a strategy for the future and starting the implementation of a field trial.

# 5. Securing financing

According to the Transition Financing Toolkit, developed by the European Commission Initiative for Coal Regions in Transition (EC-CRIT, 2021), the EU funding landscape, if properly managed and planned, offers a number of opportunities to support the implementation of sustainable energy systems, with a focus on transition strategies from coal. Comprehensive planning, including a good financing strategy, coordinating fund mobilisation efforts and capacity building at the regional and local level will support local actors, with limited capacity to access finance, to turn Transition and R&I Strategies into successful implemented projects.

Several funding programs are available (Dobrin M., et al., 2021) for:




First step, highlighted by the EC Initiative for Coal Regions in Transition (EC-CRIT, 2021) in finance mobilisation, is to ensure that a sufficient number of high-quality projects are ready to be financed. Once a project is identified and prioritised, the second step lies in preparing different documentation, such as:

- technical feasibility studies;
- risk assessments;
- financial planning;
- grant applications.

**Support for projects preparation** can be found in several initiatives like JASPERS, EIB - InvestEU initiatives Circular City Centre (C3), ADAPT, EC - TARGET, the European Investment Advisory Hub or the EEEF's technical assistance facility.

The European City Facility – EUCF provides grants to local authorities to develop investment concepts, as well as technical assistance and capacity building opportunities. Investment concepts translate a project idea into financial language in order to mobilise financing for its realisation. Also, the Covenant of Mayors has an interactive funding guide that gathers EU and national funding sources, as well as information about support services and innovative financing schemes.

**Strengthening the administrative capacity** for finance mobilisation among public authorities, SMEs, R&I entities, transition governance structures find support through LIFE and Horizon Europe programs. The LIFE programme offers training for setting up so-called 'Integrated Programmes' via own dedicated technical assistance calls (via the funding & tender platform). For Horizon Europe, the network of National Contact Points (NCP portal) is the main structure to provide guidance and training on all aspects of participation.

**Specific technical support for coal regions** refers to TARGET (Technical Assistance for Regions undergoing a Green Energy Transition) which is a new technical assistance programme co-developed by the EC and EIB for EU coal, peat and oil shale regions to support the pipeline development and implementation of projects. TARGET is focusing the following areas: clean energy and energy efficiency, in particular clean heating and energy-efficient renovations of buildings.

As presented above, EU financing opportunities are diverse and can be of three types:

- grants (non-repayable funding),
- loans (lend money in favourable conditions) and
- guarantees (whereby funding partners take over / a part of the obligation if the debt cannot be paid back).

An overview of the funding programs is presented in the table below.

| Type of funding | Focus on | Recipients | Application via |
|---|---|---|---|
| **The European Regional Development Fund - ERDF** | | | |
| Grants, loans and guarantees | - Innovation and research<br>- Digital transition<br>- Support for SMEs<br>- Low-Carbon Economy | Regional public and private entities, with special attention paid to disadvantaged regions and areas, notably rural areas and outermost regions | Operational Programs<br>URBACT<br>Urban Innovation Actions<br>INTERREG |
| **The European Social Fund Plus - ESF+** | | | |
| Grants | - Investments in youth, especially to support them finding a qualification and job<br>- Support to the most vulnerable suffering from job and income losses<br>- Promotion of social innovation, social entrepreneurship and cross-border labour mobility under the new Employment and Social Innovation (EaSI) strand | Public administrations, workers' and employers' organisations, NGOs, charities and companies. | Operational Programs<br>Funding & Tenders platform for EaSI strand and ESF+ technical assistance |
| **Cohesion Fund (CF)** | | | |
| Grants (the level of financing from the Cohesion Fund for a programme can amount to up to 85% of its cost) | - Trans-European transport networks, notably priority projects of European interest as identified by the EU.<br>- The Cohesion Fund will also support infrastructure projects under the Connecting Europe Facility.<br>- Environmental projects that are related to energy or transport, e.g. improving energy efficiency, use of RES, developing rail transport, supporting intermodality, and strengthening public transport, etc | Public and regional authorities in Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Greece, Hungary, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia and Slovenia. | Operational Programs |
| **HORIZON Europe** | | | |
| Grant funding and prizes | - Focus of pillar II: health; culture, creativity and inclusive society; civil security for society; digital, industry and space; climate, energy and mobility; food, bioeconomy, natural resources, agriculture and environment<br>- Focus of 'mission areas': adaptation to climate change including societal transformation; cancer; climate-neutral and smart cities; healthy oceans, seas, coastal and inland waters; soil health and food. | Scientists and academics, research organisations, universities, industry, SMEs, students, etc. | Funding & Tenders platform |
| **Just Transition Fund - JTF** | | | |
| Just Transition Fund / grants<br>Invest EU programme<br>EIB public sector loan | Support of investments in SMEs that target diversification; creation of new firms; research and innovation; environmental rehabilitation; clean energy, energy efficiency and district | National and local authorities, businesses and start-ups in the in the territories most negatively affected by the transition process (as identified in the | Member states |

| Type of funding | Focus on | Recipients | Application via |
|---|---|---|---|
| | heating projects; up- and reskilling of workers; job-search assistance and active inclusion of jobseekers' programmes; transformation of existing carbon-intensive installations. | Territorial Just Transition Plans). | |
| **JTF – Public sector loan facility** | | | |
| Grant funding and loans | Energy and transport infrastructure; district heating networks; public transport; energy efficiency measures; social infrastructure. | Exclusively for public entities | Member states EC published first calls for proposals JTM-2022-2025-PSLF-STANDALONE-PROJECTS JTM-2022-2025-PSLF-LOAN-SCHEMES |
| **LIFE Programme** | | | |
| Grant funding | - Focusing on the topics 'Environment' and 'Climate Action' under four sub-programmes: Nature and Biodiversity, Circular Economy and Quality of Life, Climate Change Mitigation and Adaptation and – most importantly for coal regions – Clean Energy Transition<br>- Contribute to the shift towards a clean, circular, energy efficient, low-carbon and climate-resilient economy, including through the transition to clean energy; protect and improve the quality of the environment; halt and reverse biodiversity loss, thereby contributing to sustainable development. | EU national or local authorities, private commercial organisations and private non-commercial organisations (e.g. non-governmental organisations). | LIFE website |
| **Connecting Europe Facility - CEF** | | | |
| Primarily grants, with different co-financing rates depending on the project type; blending calls | Energy; transport; digital. | The new CEF (2021-2027) will focus more on climate change, digital connectivity and renewable electricity. Industry, small and medium-sized enterprises, research organisations, other public and private entities established in a Member State or in a third country associated with the programme or created under EU law, and international organisations. | CEF website |
| **Research Fund for Coal and Steel - RFCS** | | | |
| Grant Funding | - For steel: clean steel production processes; optimised utilisation and conservation of resources, energy savings and industrial efficiency improvements; | Universities, research centres and private companies. | RFCS website |

| Type of funding | Focus on | Recipients | Application via |
|---|---|---|---|
| | emission reductions from steel production.<br>- For coal: health and safety at work; environmental protection; technologies supporting transition away from coal in coal regions. | | |
| **Modernisation Fund** | | | |
| Grants, guarantees, loans, capital injections (decided by Member States) | Generation and use of energy from renewable sources; energy efficiency; energy storage; modernisation of energy networks, including district heating, pipelines and grids; just transition in carbon-dependent regions: redeployment, re-skilling and upskilling of workers, education, job-seeking initiatives and start-ups. | Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania and Slovakia | Member States select the investments they wish to submit for Modernisation Fund support. |
| **Innovation Fund** | | | |
| Grants (up to 60% of additional capital and operational costs). | Innovative low-carbon technologies and processes in energy intensive industries, including products substituting carbon-intensive ones; innovative renewable energy; energy storage; carbon capture and storage (CCS); carbon capture and utilisation (CCU). | EU Member States | Funding and tender's platform |
| **European Globalisation Adjustment Fund for Displaced Workers - EGF** | | | |
| Grant funding (co-financing rate 60-85%) | The EGF can co-finance measures such as: help with looking for a job; career advice; education, training and re-training; mentoring and coaching; entrepreneurship and business creation. | EU Member States | Member states via contact person |
| **Recovery and Resilient Facility - RRF** | | | |
| Grants and loans | Clean technologies and renewables; energy efficiency buildings; sustainable transport and charging stations; rollout of rapid broadband services; digitalisation of public administration and services; data cloud capacities and sustainable processors; education and training to support digital skills. | EU Member States; and, indirectly, EU citizens, public or private organisations and businesses. | Member States (based on NECPs) |
| **REPowerEU** | | | |
| Grants and loans | Residential building sector: energy efficiency and heat pumps<br>Solar and wind energy | EU Member States by updating/amending the Regulation establishing the Recovery and Resilience Mechanism | Member States (based on updated NECPs) |
| **InvestEU** | | | |
| Grants, loans and guarantees | - Sustainable Infrastructure; research, innovation and digitalization; small and medium businesses; social investment | Public and private investors, project promoters, and SMEs. | Financial implementing partners (i.e. EIB) |

| Type of funding | Focus on | Recipients | Application via |
|---|---|---|---|
| | and skills.<br>- Coal regions may especially use this mechanism for strategic investments focusing on building stronger value chains as well as supporting activities in critical infrastructure and technologies | | |
| **INTERREG** | | | |
| Grants | - P1 – A smarter Europe<br>(i) developing and enhancing research and innovation capacities and the uptake of advanced technologies<br>(iv) developing skills for smart specialisation, industrial transition and entrepreneurs' hip<br>- P2 – A Greener, low carbon Europe<br>(ii) promoting renewable energy<br>(iv) promoting climate change adaptation, and disaster risk prevention, resilience, taking into account ecosystem-based approaches<br>(v) promoting access to water and sustainable water management<br>(vii) Enhancing protection and preservation of nature, biodiversity and green infrastructure including in urban areas, and reducing all forms of pollution<br>- P3 – A more social Europe<br>- P4 – A better cooperation governance | local, regional and national public authorities and organisations established and managed by public authorities responsible for research, innovation, technology transfer institutions, sectoral agencies and regional development agencies, networks, clusters and associations, research and development institutions, universities with research facilities, business support organisation (e.g. chamber of commerce, business innovations centres, technology information centres), higher education, education/training centre and school, NGOs, private enterprises including SME, or industrial and technological hubs and parks | Interreg Europe<br>Danube Transnational Programme |
| **Interregional Innovation Investments (I3) Instrument** | | | |
| Financial and advisory support as grant | - Investments in cross-regional innovation projects under the common priorities of smart specialization (S3), targeting mature partnerships to help them accelerate market uptake and scale-up<br>- increasing the capacity of regional innovation ecosystems from less developed regions to participate in global value chains, as well as the capacity to participate in partnerships with other regions | Legal entities (public or private bodies), established in one of the eligible countries | EIASME Platform (European Innovation Council and SME Executive Agency) |

The TRACER target regions from the EU Member States have prepared for launching their Operational Programs (OP), according to the Partnership Agreement 2021-2027 with the EC. Additional bilateral or multilateral assistance through grant-based technical support is available via UNDP, USAID, CIDA, JICA, EEA and Norway grants, etc. for developing and implementing just transition plans, policies and implementation strategies through knowledge transfers, co-creation of policy pathways, trainings, demonstration projects etc.

And last, but not least, facilitating the access of local SMEs to private financing is of great importance. Local financial institutions in EU countries can access EU funds to provide loans, micro-finance or equity financing through venture capital funds or social investors. For more information, visit the European Investment Fund (EIF).

# 6. Recommendations

From a wide literature review on how the concept has been used and framed by labour organizations, business organizations, researchers, civil society organizations and several country governments, seven basic principles that – taken together – underlie the "justness" of transition can be selected. These principles highlight that supporting just transitions means not only dealing with compensation and employment measures for affected workers, but also looking for ways to ensure environmental protection and restoration, diversify industry and other economic activities, and tackle socio-economic inequity and gender inequality.

These principles provide a framework for making a reality out of the concept of just transition as economies decarbonize. Importantly, the principles should be pursued in parallel, not selectively. That means, for instance, that the absence of adequate support for workers is not in itself a reason for delaying the low-carbon transition, since such a delay would magnify inequalities associated with the impacts of climate change.

A just transition means actively encouraging decarbonization at the same time as putting in place programmes and measures to ensure those affected are supported. As such, the recommended principles for a just, low-carbon transition are (SEI, 2020):

1) **Actively encourage decarbonization**: The prospect of negative impacts in carbon-intensive regions is not a reason to avoid or delay decarbonization. Delay is fundamentally unjust. A just transition is one in line with achieving globally agreed climate goals – that is, one that accomplishes a very swift decline in emissions towards a near-zero carbon economy.
2) **Avoid the creation of carbon lock-in and more "losers" in these sectors**: Ensure that transition is not undermined by ongoing investment or other forms of support to carbon-intensive industry (where alternatives are available) or fossil fuel production, or to reinforce the dependence of other businesses on these activities.
3) **Support affected regions**: Generate opportunities to nurture and maintain economic vitality and stability. Prioritize support to regions with lower financial capacity to invest in diversification, and those who bear lower historical responsibility for global emissions.
4) **Support workers, their families and the wider community affected by closures or downscaling**: Provide assistance to find new livelihood opportunities. When re-employment is not possible, ensure that adequate social protections are available. The economic, social and personal impacts of transition should not exacerbate the vulnerability of the most marginalized or weakest people. The transition must not compromise basic rights of workers, or threaten broader human rights.
5) **Clean up environmental damage, and ensure that related costs are not transferred from the private to the public sector**: The "polluter pays" principle should be respected.
6) **Address existing economic and social inequalities**: Response measures need to include a social equity perspective. Social equity and the empowerment of vulnerable social groups must be an explicit goal in designing support measures, evaluating economic opportunities, assessing impacts, and prioritizing transition support outcomes.
7) **Ensure an inclusive and transparent planning process**: This process should be based on wide social dialogue. Economic development paths and priorities should be

determined locally. International cooperation and solidarity are needed for financial and technological support.

# 7. References and key resources

## *Key resources*

- ✓ EC-CRIT platform toolkits to support EU coal regions in transition
- ✓ IEA Roadmap for the global energy sector – Net zero by 2050
- ✓ Wuppertal Institute for Climate, Environment, Energy – A Just Transition Toolbox for coal regions | Coal Transitions
- ✓ TRACER deliverables

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**Smart strategies for the transition in coal intensive regions**

**Project No: 836819**

TRACER
TRANSITION IN COAL INTENSIVE REGIONS

# *Decision Support Toolkit on post mining landscape management*

***WP 6 – Task 6.4 / D6.6***

**August 2022**

ΚΑΠΕ CRES | CENTRE FOR RENEWABLE ENERGY SOURCES AND SAVING

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TRACER website: www.tracer-h2020.eu

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***Definitions*** *as presented in* (ICMM, 2019), (WB, 2021)

***Mining life cycle****: This is the full period of the mining process. Typically includes exploration, development, operations, closure and post-closure.*

***Closure****: Processes and actions planned for and implemented when a mine ceases operation or a portion of a mine (or mine facility) is permanently removed from use for mining purposes. It includes rehabilitation or reclamation, remediation, decommissioning, demolition and/or dismantling.*

***Post-closure****: General term referring to the period after the completion of all works needed to implement the closure of the mine site. Sometimes used to refer only to a period of monitoring and maintenance leading up to relinquishment, but may include a period in which ongoing activity (such as the operation of a water treatment plant) is needed.*

***Post-mining land use****: Refers to the use of mined lands once active mining is complete. This may include land use during the period when the site is undergoing closure activities, particularly when closure activities stretch over many years or decades (such as during water treatment).*

***Reclamation****: Actions performed during or after an exploration project or 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.*

***Rehabilitation****: Return of land to a stable, productive, and self-sustaining condition after considering beneficial uses of the site and land. Reinstatement of degrees of ecosystems and function where restoration is not the objective.*

***Relinquishment****: The end of site ownership by the mining company and of their responsibility for the site, with transition of ownership and residual liability to the jurisdictional authority or a third party. Implies that the mining company has completed all obligations outlined in the closure plan to the satisfaction of the authorities (and possibly other stakeholders).*

***Remediation****: The 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.*

***Repurposing****: Beneficial reuse of a closed mining operation, whether through value-added reuse of the land (i.e. energy generation or residential), reuse of infrastructure at another site or derivative business opportunities to create positive economic activity. This may facilitate transfer of the site to a third party for relinquishment or provide an offset for ongoing post-closure operating and maintenance costs.*

***Restoration****: Re-establishment of ecosystem structure and function to an image of its prior near-natural state or replication of a desired reference ecosystem.*

# Executive summary

The EU-funded TRACER project (www.tracer-h2020.eu) aimed to support, throughout its 3-year duration, nine coal-intensive and former coal-intensive regions[1], which are at different stages of their energy transition, to shape or fine-tune their Research and Innovation (R&I) Strategies and exchange previous experiences in order to facilitate transition towards sustainable energy systems.

The TRACER project, coordinated by WIP Renewable Energies – Germany, facilitated the mobilisation of a wide range of stakeholders in all nine European regions, to discuss and agree on a shared vision and priorities for coal transition. Several TRACER reports were delivered until now covering thorough analyses of the current situations, in terms of energy, environment and social aspects, and 2030-2050 transition projections in all 9 coal intensive regions, together with best practices assessment globally. The R&I Strategies were based on the European Union's "Smart Specialisation Strategy" (S3) approach and the Entrepreneurial Discovery Process (EDP) focused on each of the 9 coal-intensive regions, while for the energy technologies were considered the R&I priorities of the EU's SET Plan.

This current document is mainly based on the prior deliverables in TRACER project (TRACER-D2.5, 2019) and (TRACER-D3.3, 2020), previous work performed by CRIT - the Secretariat of the Initiative for coal regions in transition (EC-CRIT, 2020), World Bank Document "MINE CLOSURE: A Toolbox for Governments" (WB, 2021) and the 2nd edition of the Good Practice Guide of the International Council on Mining & Metals (ICMM) on Integrated mine closure (ICMM, 2019).

It is part of a set of two Decision Making Toolkits (DSTs) that will serve as guidance for stakeholders in coal regions in transition for a better-informed decision-making process, on how to plan, set targets, choose optimal solution during implementation in compliance with legal and regulatory framework, and be prepared to secure finance for the transition to a sustainable energy system:

A. ***Decision support toolkit on substituting coal-fired generation with clean energy*** that will serve as a guideline for stakeholders in coal intensive regions on how to substitute energy production from coal with clean energy (demand of the energy production through alternative/clean energy resources, investment costs, estimated work places from the alternative energy resources/technologies, etc.), to get a feeling what it really means to substitute coal in an existing energy system;

B. ***Decision support toolkit on post mining landscape management*** (ecosystem services) which will help policy makers, local authorities and planners to take informed decisions, to set targets, access financial resources and attract investors. This guidance will lead to choosing optimal solutions in compliance with the environmental legislation in force.

This current document (B) will highlight a logical sequence of a set of actions, for an effective and environmental oriented remediation, reclamation and repurposing of former mining perimeters, whether it is about underground mines or open casts, including all assets and resources (land, buildings/constructions, other infrastructure, oversized mining equipment and machinery, mine waters, syngas, etc.).

The online versions of both documents are interactive pdf formats easy to navigate and to access references.

[1] Lusatia Region (Brandenburg DE40 and Dresden DED2 - Germany), West Macedonia (EL53 - Greece), Wales (UKL1 and UKL2 - UK), Southeast Region (BG34 - Bulgaria), Jiu Valley, West Region (RO42 - Romania), Kolubara region (RS11 and RS21 - Serbia), Donetsk region (Ukraine), Upper Silesia (PL22 - Poland), North West Bohemia (CZ04 - Czech Republic)

Most often decision-support tools are applied with the help of purpose-designed software packages and drawing on specialised databases. TRACER DSTs are guides aiming to present in a non-technical language all relevant aspects related to TRACER target regions transitioning from coal.

# 1 5 Ws and 1 H

### *What does this DST stand for?*

The aim of this toolkit is to provide guidance on how to plan, to set targets, access financial resources and monitor-evaluate in order to implement optimal solutions for the remediation, reclamation and repurposing of former coal mining perimeters.

### *Why is needed?*

This toolkit will highlight a logical sequence of a set of actions for an effective and environmental oriented post mining landscape management. Taking better-informed decisions are less resources (i.e. time, human and money) consuming.

### *Where is useful?*

Coal intensive regions, already in transition or about to initiate the transition process towards a sustainable energy system, must make the most of this guidance related to former mining perimeters, including existing mines (active, under conservation or under closure and post-closure) and legacy sites, including coal tailing dumps, whether it is about underground mines or open casts/pits, including all assets and resources (land, buildings/constructions, other infrastructure, oversized mining equipment and machinery, mine waters, syngas, etc.).

### *Who is addressing?*

Policy makers, local and/or regional - national authorities, mining or energy companies, planners and civil society representatives from coal intensive regions, involved directly or indirectly in the mine closure processes.

### *When to make use of it?*

It is recommended to be studied prior to mine closure and post-closure planning process, for defining an optimal and adaptive post-mining landscape management.

### *How to make the most of it?*

For its effectiveness, it is recommended to make use of this "tool" simultaneously with the legally regulated mine closure and post-closure process implementation, for an efficient and successful post-mining landscape management, which in TRACER project focused on the 3Rs remediation-reclamation-repurposing steps/stages.

# 2 Challenges

The coal mining industry is essential for industrial and societal development. However, coal exploitation carries significant risks of long-lasting negative impacts on the environment, particularly on water resources and landscapes, as well as on local communities, to which coal use, mainly for energy purposes, is adding the air quality degradation.

According to the European Commission, coal, still one of the main fuels in the European energy mix, ensures in 2020 approx. 230 thousand jobs in the mining and energy production industry for 31 development regions (NUTS2) in 11 EU countries.

In the context of climate change, cost-inefficient mining and/or depleted resources, the transition to cleaner sources of energy and innovative technologies is happening and accelerates as coal is replaced by more sustainable and competitive alternatives.

Coal mine decommissioning takes several years and should be preceded by a one- to three-year planning stage. However, the effects of mine decommissioning are much more long-lasting than the decommissioning itself and can linger for decades. Such a chain reaction of the coal industry collapsing has substantial impacts of a collective nature, such as a decline in the income of local governments, major jobs loss, lack of support for local social and cultural initiatives, the progressive pauperization of local society. Another adverse effect of mine decommissioning may be the disorganization of social relations in the area covered by the mine (Jonek-Kowalska I., 2014).

**Impacts** summary (F. Pavloudakis, 2009):

| Environment | Social and economic |
|---|---|
| - Alteration of morphology<br>- Changes in hydrological pattern<br>- Loss of wild animal habitat<br>- Degradation of landscape value<br>- Reduction of property value<br>- Loss of topsoil<br>- Loss of agricultural land | - Changes in economic activities<br>- Occupation of land for a long period (usually many decades)<br>- Limited access to public utilities |

The decline of the coal era also has a number of specific impacts, either on the environment or the socio-economic aspects, each coal intensive region having its particularities, as was observed during the TRACER project, depending on the site hydro-geological profile and size, the local community level of development in terms of institutional capacity, technology, innovation, economy, labour market (up- and re-skilling needs), education infrastructure, cultural heritage, demography (aging, migration, brain drain, depopulation, shrinking communities), the psycho-social and behavioural characteristics and, not least, the political context.

**Box.1 Post-mining challenges**

In Poland, closing an unprofitable mine is considered a social and political rather than technical problem. This is due to the loss of jobs for miners. The direct cause of the liquidation of coal mines is usually the exhaustion of the mined deposits. The process can also result from the lack of technological possibilities to continue mining, unprofitable production or political decisions. Less frequently, mines are liquidated for social or environmental reasons (Uberman R, 2010).

For Kolubara coal region in the Republic of Serbia, important challenges are related to socioeconomic issues, as: reorientation and upgrading in a sustainable way of other coal dependent industries (steel industry, mining equipment manufacturing, coal terminals, etc.); the mono-industrial feature of local communities generating massive layoffs, both directly in the mining and energy industry and indirectly in other related industries and services, substantially reducing families income; youth migration in search for carrier development opportunities; worsening of health problems related to heart, respiratory, mental, bones and joints diseases according to the official regional “Occupational Health Reports”.

The major social impact generated by the increase in unemployment in coal regions in transition raised a major **challenge** for local communities, namely the labour market reconfiguration with a substantial need for workers’re- and up-skilling, according to the

analysis performed in TRACER-D2.4 “Best practice report on labour markets, social issues and tourism”, including examples from the TRACER Best Practices Platform.

Challenges and risks vary depending on the type of region (rural or urban), the type of mining (open cast mines or underground) and the predominant assets for which repurposing is sought (land, buildings, other infrastructure, etc.) (Wuppertal Institute, 2022).

Considering the challenges and impacts generated by mine closure and post-closure activities, the following **risks** need to be considered (WB, 2021):

- Economic;
- Environmental;
- Financial;
- Health and safety; and
- Social.

One of the main risks, when planning the rehabilitation of former mining perimeters, including coal tailing dumps and ponds, can be prevented or mitigated by securing:

- Human capacities, new competences & skills, and sustainable employment via social cohesion and civic engagement; investments with high added value; skills matching and long-life-learning programs; respect for, and protection of human and labour rights;
- Site safety in terms of geomechanical stability (slope’s landslides / at open casts and tailing dumps, waste dumps slumping or liquefaction, mine subsidence / at underground mines) and geochemical characteristics (existence of hazardous substances, mine wastes acidification, surface & underground water and air quality, soil fertility);
- Financing, in order to ensure the ability of mining/energy companies to fully covering the mine closure and post-closure costs;
- Ownership conditions of the former mining sites and assets, in order to avoid overspending and delaying deadlines.

When referring to the environmental impact, one of the main risks is the hydrogeological imbalance associated with the cessation of dewatering of the rock mass. It results from an increase in the level of the underground water table, which leads to the occurrence of local flooding, as many times areas drained by long-term drainage of the rock mass during mining operations. In addition, changes in the chemical composition of groundwater in the zone of influence of the mine drainage system can threaten the quality of clean drinking water and surface water bodies and watercourses.

The ecological risks assessment should be carried out with the participation of objective, interdisciplinary external experts whose expertise should reflect the ecological, social, technological and legal aspects of such a comprehensive risk assessment analysis. (Jonek-Kowalska I., 2014).

In view of the significant and diverse costs of coal mine decommissioning, there is a need to develop and apply comprehensive environmental and social risk management systems at mining companies. Responsible management of environmental and social risks requires dialogue and mutual respect for all stakeholders and, at some point, a refocusing of perspective from short-term benefits to long-term value creation, through positive relations with all parties involved. It is necessary to develop detailed procedures to help manage these risks. The identification of risks should be carried out as early as possible in the optimal situation, already at the design stage of the mining exploitation/perimeter (Jonek-Kowalska I., 2014), (Ostręga A., 2005). In the preparation of these risk management procedures, all potentially affected stakeholders (mining companies’ employees, academia - researchers

(environmentalists), representatives of local, regional - national authorities, NGOs) should participate.

Several risks regarding post-mining landscape management can be reduced by the correct and timely application of the legislation in force related to mine closure and post-closure, whether it is law enforcement rules or instructions / orders of the governmental entities involved. However, the legislation is sometimes too rigid, not enough R&I oriented, re-use or repurposing opportunities often being lost due to the absence of specific regulations regarding the 3R remediation-reclamation-repurposing of post-mining landscapes and lack of communication and cooperation between the mining or energy companies and the academic & research environment in the coal regions in transition.

**Box.2 Risks and barriers in post-mining landscape management**

In Upper Silesia, Poland, a factor that significantly reduces the value of sites and objects requiring revitalization are unregulated ownership issues and the accompanying difficulties in finding common ground between different owners' categories (public local administration, individuals, and mining companies). The revitalization of sites that often have great opportunities to give them new functions that take advantage of their features, and at the same time are desired by society, cannot take place due to unregulated ownership issues (Ostręga A., 2005).

In Jiu Valley, Romania, inappropriate post mining land & buildings re-use management, legal disagreements, unclear and bureaucratic regulations and no formally temporary exemption from taxes at ownership transfer, have led to long delays and the loss of financing opportunities, at that time (2012-2017). To this aim, in TRACER project reports was highlighted the need to simplify and update mine-closure procedure to be efficient, less time-consuming in terms of ownership transfer and R&I oriented, opened to safely make-use of the existing potential (i.e. MMC, UCG, heat storage, mine waters heat pilot projects tec.), from early stage of the closure process (TRACER-D3.1, 2019), (TRACER-D3.2, 2020).

More about risk assessment and management are provided in ICMM Tool 8 from Integrated Mine Closure – Good Practice Guide, 2nd Edition (ICMM, 2019).

Despite the major challenges coal regions in transition are facing, an effective, research-based and flexible post-mining landscape management can offer a vast potential for future **opportunities** and for positive impacts on several fields, such as: agriculture, silviculture, bioenergy crops; tourism (industrial, leisure, adventure, cultural, etc.); other sustainable innovative industries (renewable energy, energy storage, high & medium technology manufacturing, ITC, robotics, etc.); circular economy; residential areas regeneration, etc.

According to Wuppertal Institute the mining land should be treated as assets to attract new businesses and create new jobs in the region. Coal-related infrastructure often has assets (like railway lines, strong electricity grids, access to rivers, and so on), which could offer interesting potential for future uses (such as industry, renewables, etc.) (Wuppertal Institute, 2022).

In order to avoid time-costs overlaps and public non-acceptance, the whole process of post-mining landscape management must roll-out a transparent, trustworthy and constant communication, aiming stakeholders' awareness and freewill engagement, from the early stages of mine-closure planning. Within TRACER project, each target coal intensive regions mobilised a wide range of quadruple helix stakeholders (the business environment – industrial/business associations, mining/energy companies, SMEs; research & education institutions; public authorities; and the civil society – trade unions, NGOs, mass-media, the general public representatives) to participate in the process of developing a shared vision and priorities for 'life after coal'. As TRACER project has incorporated a Smart Specialisation (S3) approach into the heart of the project design, the **stakeholders' involvement** was

based on an inclusive – bottom-up approach, centred on the “entrepreneurial discovery” process (EDP).

As already mentioned, for a successful overall just transition from coal, in particular a post-mining landscape management, a high level of continued stakeholder involvement and empowerment is necessary during mine closure & post-closure planning and implementation stages. It is very important to have an open, transparent and collaborative relationship mainly between the mining/energy company and the regional and/or neighbouring local authorities - a partnership prepared to engage with the rest of 4 helix stakeholders, prior to post-mining stage and ownership transfer, from the planning stage of post-mining assets use.

To this aim, it is essential to develop collective or collaborative leadership, so that all quadruple helix stakeholders’ representatives are included in flexible decision-making structures. S3 **governance structure** should be able to prevent policy capture by specific interest groups, powerful lobbies, or major regional stakeholders.

More about stakeholders’ engagement – approach, tools and tactics and governance structures in the Analytical report on the outcomes of the mobilisation process in TRACER target regions (TRACER-D5.2, 2022).

# 3 Remediation – Reclamation – Repurposing solutions (options)

According to the Science Policy Report on a new vision of sustainable management in mining and post-mining landscapes (Leopoldina, 2019), elaborated by several international research institutions, mining landscapes should be understood as spaces of multifunctionality rather than mono-functionality. To this aim, the post-mining landscape management must be of multipurpose and flexible enough to be adaptive in real time.

The scientific literature does not provide a clear dedicated definition for "post-mining landscape management", referring in particular to "post-mining land use", but within the TRACER project the analysis of the nine targeted coal intensive regions was carried out from the larger perspective of the 3R aspects remediation -reclamation-repurposing.

Two international guidelines – the International Council on Mining & Metals (ICMM, 2019) and the World Bank (WB, 2021) define **basic principles** and objectives of good closure planning practice that can be used as a basis. If the good mine closure practice principles exemplified below are applied starting from earliest stages of mine closure planning, then the post-mining landscape management process will be a time & cost-effective one, accepted by stakeholders involved in the decision-making.

| ICMM | WB |
|---|---|
| - Safety<br>- Physical stability<br>- Chemical stability<br>- Socioeconomic transition<br>- Ecological stability<br>- Risk limitation<br>- Cost effectiveness<br>- Long-term care mitigation/elimination | - Preparation of a closure plan at the beginning of a project<br>- Definition of productive, sustainable post-closure land use<br>- Definition of key technical assessments that must be included in closure plans<br>- Preparation of a closure cost estimate based on the closure plan<br>- Placement of a financial assurance based on the closure cost estimate<br>- Regular updates of the closure plan and cost estimate<br>- Involvement of diverse stakeholders<br>- Management of socioeconomic transitioning |

- Collection of relevant data
- Preparation of a final closure plan/design near the end of the operational phase of the project

The status quo of the mining situation in the nine TRACER target regions was described in comprehensive reports, including the ecological situation with regard to coal mining and the phase-out of coal. The most specific environmental issues/questions are answered in the reports TRACER-D 2.5 (2019) and TRACER-D 3.3 (2020). According to TRACER-D 2.5 (2019), there are few **key principles** to consider when planning mine closure and implementing post-mining remediation-reclamation-repurposing works.

First of all, any concrete guidelines for ecological remediation & restoration should be an integrated part of the mine resource management through the life of a mine, always regional specific, situative and considering the available scientific information on both substrate quality and usability, best as possible. However, and besides key milestones that have to be achieved in mine closure, there still remains a degree of uncertainty when looking at the long-term ecosystem development on new ground − even more as nowadays the climatic conditions in Europe are changing rapidly thus overlapping endogenous, soil and ecosystem forming processes. In addition, the economic framework conditions and production targets in agriculture and forestry continue to develop, one example are the innovative biomass processing chains. It makes sense to apply the risk-spreading precautionary principle when conclusive information on long-term ecosystem development is missing in detail.

For reclamation performance and quality control there must be detailed conceptual descriptions and assessments of all reclamation activities including target criteria that have to be achieved in definite time, like soil target values in agriculture or biomass growth and biodiversity indicators for afforestation. It must be ensured that the reclamation objectives have been met once operations cease. Otherwise, additional maintenance measures are necessary. However, the land management itself should be adaptive to react reasonably if the cropping situation changes, e.g. by integrating natural succession processes in restoration or site adapted native species and cultivation methods developed for the revitalisation and valorisation of fallow land.

A mosaic of different land use categories is promising the highest economic and ecological added value, including also stakeholder acceptance across the full process of post-mining landscape management. Basically, post-mining land use can be divided into three main fields of action, with their special requirements for reclamation, aftercare and maintenance:

### *Agricultural reclamation*

- Agricultural reclamation of suitable arable mine spoils may contribute significantly to assure the continued existence of agricultural enterprises affected by mining activities, especially in times of an increasing shortage of fertile agricultural land worldwide;
- As compensation for the minus of production area, an agronomic upgrade should de intended − in particular, through the provision of high-yielding substrates and a proper topsoil preparation;
- The application of organic materials (composts, solid and liquid manure, digestates, etc.) with a balanced ratio between carbon and plant available macronutrients is stimulating soil development. But equally important is a soil fertilising and structuring crop rotation with nitrogen-fixing legumes in a key position;
- Scientific preliminary studies and a monitoring of the soil and yield development are necessary for the elaboration and adaption of all restoration procedures and land management activities, under the special site conditions on dumps and tips;
- Guideline (target) values for soil properties and a monitoring of the yield development provide an evaluation or control of the reclamation progress and success. The key

criteria for the topsoil evaluation are: pH-value, humus and carbon content, plant available macronutrients, water storage capacity and bulk density;

- On humus and nutrient poor raw soils, the first yields do not reflect the real cropping potential. Improving soil fertility is a long-term, biological driven process taking 60 to 80 years until the site-adapted and sustainable yield production potential is achieved.

***Forest reclamation***

- In the temperate climate zone afforestation and natural reforestation of stripped land are the most obvious and promising solution for revegetation. Forests are the climax vegetation form providing basic ecosystem functions and services in the long term;
- In principle, the biological self-organisation of forests can follow technical reclamation and natural succession, depending on the landscape planning objectives, i.e. the requirements of the society and subsequent users of the reclaimed land. Leaving behind or creating a suitable rooting medium is an essential precondition for ecosystem development − especially, if forest management orientates primarily at economic targets;
- The overall challenge is to establish diverse, low-risk, forward-looking and sustainable forest ecosystems for multifunctional use options. Scheduled afforestation by planting or seeding and natural succession should complement each other, with different nuances and emphases in detail;
- Implementing natural succession can expedite the artificial establishment of forest habitats. Even though successional tree species cannot replace commercially valuable crop trees in an economic sense, they are most important for wildlife and early soil revitalisation;
- The of artificial forest ecosystems with productive functions but close to nature is promoting a self-supporting development. On the other hand, natural forest succession can be accelerated by introducing late and final successional, heavy-seeded species such as oak trees or beech;
- It is well known that deciduous trees support humus quality, soil life, soil forming processes, ecosystem nutrient turnover and mineral nutrition − all aspects considered having positive effects on timber growth a reclamation progress;
- As for all long-living and complex ecosystems it makes sense to assess the reclamation quality by a combined growth evaluation and biodiversity check. In contrast to agriculture, soil target values which have to be achieved in a short management period are questionable, since after initial revegetation there is no more regular soil cultivation;
- Forest ecosystem and soil development are long-term processes, although mature forests on reclaimed land show quite similar functional features as forest stands of the surrounding area regarding biomass growth, mineral nutrition, water turnover, nutrient cycling.

***Nature conservation***

- Technical agriculture and forest reclamation implies a landscape design and soil preparation adequate to the management demands of the land users. By this the structural diversity and small-scale patchwork of the ground surface resulting from spoil heaping gets levelled out to some extent;
- Moreover, strictly reclaimed land is developing much faster from the starting point. Notably basic soil amelioration and regular fertilisation speeds up ecosystem development in the early stage;

- A dilemma from the ecological point of view: Intensification of mining operation and standardised good reclamation practice are in general leading to a more productive but also uniform, artificially smoothed post-mining landscape;
- Especially, when looking at a higher landscape scale, better-yielding cropping systems correspond with a loss of biodiversity as compared to human-undisturbed sites. In contrast, many comprehensive studies reveal, that both natural self-development and guided succession lead to better ecological values as compared to one-way technical reclaimed areas;
- As a counterpoint to production targets the different plans in the active mining and mine closure should always take into account the management requirements to ensure biodiversity values and ecological variety in the developing post-mining landscapes. In particular, habitats with extreme substrate and specific microclimatic conditions are a good refuge for endangered species;
- Various management strategies are available and exercised to support the formation and conservation of scarce habitats in post-mining landscapes suitable for the re-colonisation of indigenous and threatened species;
- Therefore, the establishment and conservation of sparsely vegetated, nutrient poor and dry bare substrates, dunes and wetlands play a key role. Another option relates to agro-environmental measures for conserving the open landscape and early successional stages, e.g. by extensive grazing and cutting regimes;
- Summing up, nature conservation measures should contribute to improve biodiversity upon the pre-mining conditions, even if there is no concrete legal obligation. However, even in designed nature reserves landscaping cannot stand against overruling and legally-binding reclamation targets, notably considering long-term erosion control and safeguarding of ground stability.

It is known that **post-mining landscape repurposing options** depend on the site-specific characteristics, ranging from agriculture to civil and industrial infrastructure in open casts or underground mines, including coal tailing dumps and ponds, and ash & slag dumps.

Repurposing options are summarized and schematically structured in the table below.

| | | |
|---|---|---|
| agriculture and forestry | agriculture | - nitrogen-fixing plant species can be used to condition soil different crops;<br>- medicinal herbs;<br>- pasture grasses;<br>- viticulture (wine growing); |
| | silviculture | - agroforestry;<br>- forests; |
| ecology | nature conservation | - restoring ecosystems and preserving biodiversity; |
| circular economy | industrial waste re-use | - ash & slag re-use |
| Industrial and civil infrastructure | clean energy | - renewable energy – solar & wind; mix of small medicinal plants with ground PV;<br>- mine waters – closed and flooded underground mines have good potential as low-enthalpy geothermal resources;<br>- energy storage – pumped hydropower;<br>- bioenergy – energy crops; |
| | water bodies | - pit lakes for fish-farming;<br>- pit lakes as reservoirs for livestock watering, crop irrigation; |
| | wastes management | - solid (and hazardous) waste storage, transport, disposal;<br>- hazardous - low-level radiological waste storage; |

| | | |
|---|---|---|
| | urban regeneration | - former industrial buildings renovation and repurposing; architectural aesthetics;<br>- regional planning and residential growth; |
| | tourism | - industrial;<br>- leisure;<br>- adventure;<br>- cultural, etc. |
| | Other industries | industrial parks including SMEs active in<br>- high & medium technology manufacturing;<br>- ICT;<br>- robotics, etc. |
| R&I in all above fields of action (agriculture, civil & industrial infrastructure, circular economy, ecology, etc.) and others | | - carbon sequestration;<br>- MMC (Mine Methane Capture);<br>- thermal energy storage tanks, etc. |

Implementing these projects need close cooperation between key stakeholders - mining companies, regulators, land-use planners, investors, the regional/local government and citizens, aiming to identify the most sustainable solutions and to maximize social-economic development.

More information on implemented solutions for post-mining landscape repurposing in: ▪ TRACER Best Practice Platform; ▪ Wuppertal Institute for Climate, Environment, Energy: A Just Transition Toolbox for coal regions; ▪ ICMM Integrated mine closure: good practice guide – Tool 4; .▪ World Bank MINE CLOSURE: A Toolbox for Governments.

According TRACER-D 3.3 (2020), a brief summary of the main findings on *Coal mine reclamation planning, Implementation rules and best practice* and *Agricultural and forest reclamation* is given below.

### *Coal mine reclamation planning*

There is a good agreement within the TRACER consortium that a suitable and effective post-mining land use is crucial for the acceptance of mining in the societal discourse. **Post-mining conditions should provide ecosystem services and produce lands capable of supporting the future needs.** Good environmental conditions and life perspectives are counteracting partially the ongoing economic-driven depopulation of European mining regions in transition. Nevertheless, **in many regions there is missing an overall publicly discussed guiding principle (*landscape vision*) for the long-term development of post-mining landscapes − beyond the implementation of technical and biological land reclamation.**

Coal mining follows complex and multilevel planning and approval procedures. Due to the legislative harmonisation within the EU, there are similar environmental standards and legal approval procedures in running coal mining − for example, regarding the implementation of EIA (Environmental Impact Assessment) or ESIA (Environmental and Social Impact Assessment) − but also embedding land reclamation into the planning and approval process.

Thus, in active coal mining, the companies are obliged to conduct pre-mining analyses of the site, prepare a mining plan, and designate a land use that could be achieved during and after mining operation. In addition, they are responsible to carry out all measures which are necessary to restore soil, water and vegetation cover. Therefore, they have to build up adequate financial reserves under government control and access − in the case of insolvency or an improper reclamation not compliant with the minimum legal requirements as laid down in the approved operating and restoration plans. In fact, the expenses for land reclamation are only a small part of the total costs (and profits) of mining operation.

In the case of closed, abandoned or former state-owned and not privatised older mines the competent national authorities or state-run mining companies take over safeguarding and reclamation. **In some TRACER regions this task is obviously underfinanced due to the overall economic situation − that`s a crucial factor why there are still considerable land reclamation deficits.**

### *Implementation rules and best practice*

Practical coal mine reclamation includes a number of technological tasks e.g. movement and deposit of overburden material, surface layer modelling and relief shaping, but also the determination and construction of the final land use system. Therefore, it must have detailed conceptual descriptions and assessments of all reclamation activities including target criteria that have to be achieved in definite time.

Land reclamation follows the approved mining operation and closure plans. In no case landscaping can stand against overruling and legally-binding restoration targets, notably considering long-term erosion control and safeguarding of ground stability. Therefore, reclamation implementation rules and technical guidelines (rulebooks) are provided on national level to ensure land consolidation and preparation for a proper follow-up land use as designated in the mine closure and reclamation plans. **However, in some TRACER regions the procedure and responsibilities of the license holder do not comply. In such cases neither local authorities nor citizen representatives have a proactive attitude − a general lack of civic engagement.**

Land reclamation methods in the TRACER target regions are tailored to particular locations, geological conditions and site/soil properties but also an outcome of mining history and applied technologies. It is common sense in CRP that a reconstruction of the pre-mining (original) landscape is almost impossible due to the very specific relief and site conditions after mining. In addition, landscapes are dynamic systems and permanently changing. It is hard to define a generally accepted reference/baseline situation.

There are some sounding examples for sustainable reclamation strategies and post-mining landscaping. However, **in most cases there are no ecological criteria to define and evaluate the restoration success as intended in mine closure planning. In addition, long-term investigations on ecosystem development are lacking.**

### *Agricultural and forest reclamation*

By far, the less demanding forest reclamation is dominating the land use distribution in post-mining landscapes. It is the natural climax vegetation, and thereby, natural ecological processes are stimulated and used to achieve rehabilitation cost-efficient. However, the experience and knowledge in practical reclamation and also the available financial resources for a proper soil preparation vary widely.

Nowadays the desired time lag between mining impact and scheduled reclamation is between 10 and 20 years, whereas in the past barren land remained untouched for decades with all negative effects on the surrounding landscape, e.g. surface erosion, AMD, metal leaching. But due to historic land overexploitation, technological reclamation deficits, ecological limitations or insufficient regulations on impact control and restoration in the past but also available funds there is a different progress in land reclamation today.

In each of the TRACER regions there is practical knowledge in agricultural and forest reclamation with some recommendations on promising plants and/or cropping systems, although at a different level - with or without scientific support. However, **the practical experience with energy cropping, special crops or other renewables on reclaimed land is very low, with only view promising examples, especially regarding SRC with poplar and black locust, although the processing chains are underdeveloped. In some**

**regions post-mining landscapes are already activated for wind energy and solar power.**

The cropping potential of mine sites depends from a proper land preparation and is often underestimated. Therefore, the exploitation of biomass resources from reclaimed is low and insufficient − effective post-mining management plans and recommendations on land use considering the very special site conditions are missing. In other regions the reclamation and cropping experiences is poor. The major focus lies on revegetation/greening and early plant growth. However, **from the ecological point of view restoring biological systems is a long-range process taking several decades. It remains unclear whether the applied reclamation solutions are sustainable in the long term.**

Unfortunately, **in most cases the later land users are not involved into practical reclamation. Basic failures in land reclamation − like the dumping of unfertile spoil materials, an insufficient amelioration or not site-adapted choice of tree species − are difficult to rectify afterwards.** The course of reclamation is determined already with substrate dumping and land preparation and the choice of site-adapted land use forms. Even more, **it is important to make use of the regional cropping experience to ensure a sustainable land management.**

Despite all the difficulties, the recultivated areas and also the old industrial sites offer enormous economic potential.

**Box.3 Success stories in post-mining landscape repurposing**

In all TRACER regions, there are initiatives for the further valorisation of these areas. A selection of particularly successful post-mining landscapes repurposing with regard to tourism concepts (Ecotourism, Industrial tourism, Petrila Planet, Recreation and sports areas), alternative energy generation concepts (Photovoltaics and Wind Power, Power-to-X, Solar park Senftenberg, Decentralised electricity production), energy storage (Heat storage, BigBattery Lausitz) and new economic settlements (Conversion to industrial parks in the German Lusatian Lignite District and a chemistry park, and in the Czech North Bohemian coal region) can be found on the TRACER Best Practice Platform and publications, including also a spontaneous succession in North Bohemian post-mining landscape.

In Wales, UK a region that is in a different coal phase-out stage, gathering experience since the 1970s with repurposing of coal mining/industrial land, there are many success stories in former underground mining sites, including Blaenavon UNESCO Site and Big Pit Mining Museum, Rhondda Heritage Park, Cefn Coed Colliery Museum, Cwm Cynon Business Park, Gatewen Colliery, Wrexham (redeveloped to housing and public open space), Maesteg Comprehensive School, Oakdale Business Park, Bargoed Woodland Park and Ebbw Vale Garden Festival Park. Surface mining sites have also been reclaimed for landfill/recycling, schools, leisure centres, golf courses, horse racing tracks, sports pitches, water treatment/sewage works, electricity facilities, campsites and visitor centres.

The Welsh Government, when referring to alternative thermal energy generation concepts in former mining regions, is making considerable progress with research and demonstration/pilot projects regarding heat supply, using water from disused mines. New funding was announced in July 2022 for producing a map showing the potential for mine water heat across Wales' coalfield areas. Feasibility studies will be carried out on those which look promising and which deliver social benefits to the local community. Warm water from Wales' only thermal spring is currently providing heating to a primary school and park pavilion in Taff's Well, using technology similar to that which could be used for mine water.

Effective post-mining landscape management will involve resources from many disciplines across key stakeholders engaged (mining/energy company, local public authorities, business environment (SMEs), research & education, civil society) and will affect directly the financial

performance of the mining/energy company and the third party (usually the local budget of the public authority), after ownership transfer.

A well-documented and collectively governed **decision making process** will generate an optimal cost-effective post-mining land use planning and implementation. The decision-making process, during the whole post-mining land use planning, implementation and monitoring, needs to be based on sound multidisciplinary knowledge incorporating natural, physical and social sciences, medicine, politics and ethics (F. Pavloudakis, 2009).

Several **tools** can be utilised in formulating an appropriate decision when choosing post-mining landscape use solutions according to site-specific characteristics, such as:

- Quantitative and qualitative data gathering assessing site quality and state of play of the neighbouring communities (literature review – guidelines, toolkits, policies, researches, legal framework; large existing database, checklists; SWOT and PESTLE analysis; on site visual screening and measurements/laboratory analysis – water and soils analysis, laser and remote sensing with satellite, drone or aircraft; multi-stakeholders dialogue - EDP, surveys, interviews, public consultations and debates, etc.);
- Standard or predictive modelling tools to predict site physical and chemical stability;
- Establishing KPI (Key Performance Indicators) and ranking of criteria;
- Cost estimations (i.e. Standardized Reclamation Cost Estimator), CBA (Cost-Benefit Analysis) and sensitivity analysis;
- IDM – Initial Decision Matrix and MCDA – Multi-Criteria Decision Analysis, including ranking of criteria;
- Formal risk assessment;
- GIS – Geographical Information System and spatial data analysis;

and more advanced and combined methods for a more realistic, less subjective and time-consuming approach, as:

- MC-SDSS – Multi-Criteria Spatial Decision Support Systems, a field of research which aims at the combination of MCDA with GIS techniques (Amaro S., 2020);
- GIS-MCD-SDSS – a geographical information system and multi-criteria decision-making methods, based on binary integer linear programming models (LP), integrated into a SDSS (Spatial Decision Support System) to select the appropriate post-mining land use solution taking into account social, technical, economic, environmental and safety criteria (F. Pavloudakis, 2009);
- Integrated Information Modelling System based upon a high-resolution spatiotemporal database, utilizing state-of-the-art multi-scale and multi-sensor monitoring technologies, combined with desktop applications and Augmented Reality (AR) for visualization purposes (Benndorf, J.; Restrepo, D.A.; Merkel, N.; John, A., 2022).

It is recommended that the sophistication of the evaluation process, used to support the decision-making process, should be commensurate with the cost and complexity of the measures under consideration.

In order for these support tools, as part of the decision-making process, to be effective, it is vital to ensure transparency by translating the results of these complex analyses into an accessible language for key stakeholders, constantly engaged, regardless their level of education.

Additional guidance for decision-making support tools in: ICMM Integrated mine closure: Good practice guide (ICMM, 2019), A Just Transition Toolbox for coal regions (Wuppertal

Institute, 2022) and TRIM4Post-Mining is a H2020/RFCS-funded project (TRIM4Post-Mining, 2021).

# 4 Financing sources and how to attract investors

The decline of the coal era generated a domino effect in the economies of European regions affected by massive unemployment, energy poverty and economic decline following the closure of mines and related power plants.

The process of post-mining remediation-reclamation-repurposing is expensive and includes costs directly related to mine decommissioning and long-term costs related to the effects of mining operations, such as the cost of pumping out pit water and of reclamation of post-mining areas. Also included in the scope of mine closure are the costs of remediating mining damage associated with the refurbishment of residential buildings, public buildings, water and sewage networks, street surfaces, etc. (Jonek-Kowalska I., 2014). Securing the financing of the closure and post-closure phases is very important; hence the need for "hard" management tools for risk financing and appropriate legal solutions, such as mandatory decommissioning funds, insurance or agreements with local governments or state authorities. Given the significant financial impact of mine operations, these solutions should be compulsory (Ostręga A., 2005).

Securing financing is imperative in order to lower risks for mining/energy companies and regions/local authorities and cover full costs of the environmental and social rehabilitations measures, including long-term post-closure monitoring and maintenance. To this aim, different approaches are recommended (EC-CRIT, 2020), (Wuppertal Institute, 2022), as:

- pooling funds, like an insurance policy fund, for providing a financial guarantee that environmental rehabilitation measures will be implemented;
- covering long-term costs through financial assurance/closure bond that, even when the mining/energy company is closed, existing post-mining contracts/claims will be honoured;
- outsourcing closure planning and implementation, at an early stage of mine operation to create financial liabilities.

It has to be underlined that just the ‘planning & preparation’ part of the post-mining repurposing costs are included in the closure cost estimate, like costs to prepare the site or infrastructure for redevelopment or an alternative land use. Mining/energy company responsibility should be to leave the site in a condition that it could be redeveloped by other parties (usually regional or local authorities/public administration) for the selected post-mining land use (WB, 2021).

The distribution of legal responsibilities and those regarding the coverage of the costs generated by the works and activities performed during closure-post-closure and post-mining stages are schematically presented in the table below.

| **Actions \|Stages** | | **Scope of work** | **Legal responsibility and costs coverage** |
|---|---|---|---|
| planning<br>management<br>implementation<br>monitoring | mine closure & post-closure | rehabilitation<br>restoration<br>remediation<br>reclamation | mining/energy company<br>government |
| planning<br>preparation | post-mining | repurposing | |

| transfer of ownership / relinquishment | | | |
|---|---|---|---|
| management<br>implementation<br>monitoring | post-mining | repurposing<br>developing | third party / regional-local administration government |

**Box.4 Post-mining costs coverage**

In all TRACER target regions, except for Wales in the UK that is in a different coal phase-out stage, the mining/energy companies are state-owned, as sole or majority shareholder, each governments being involved in financing mines closure and post-closure, including the planning, management and monitoring of the post-mining landscapes, in the remediation and reclamation stages, until the transfer of assets ownership (lands, buildings, and infrastructure) to third parties – mainly regional or local authorities. For the next stage of post-mining repurposing, the legal responsibilities of mining/energy companies in covering also the costs for planning and landscape preparation are not usually included. It depends on how the ownership transfer was carried out, the quality of the decision-making process, securing financial resources and the efficiency of the management act are becoming extremely important related to "after coal life" solutions implementation, customised for each region in an optimal and sustainable (in terms of environment, economy and social fairness) way.

For example in the Czech Republic according to the Mining Act n$^{o}$.44/1988, mining companies must draw up a Remediation and Reclamation Plan before mining, and subsequently create financial reserves in order to finance these activities; the Ministry of the Environment controls and issues, together with the affected cities and municipalities, an opinion regarding the implementation of the Remediation and Reclamation Plan; finally, the District Mining Office approves the creation and use of the relevant financial resources. However, projects related to post-mining social revitalisation and assets (lands, buildings, infrastructure) repurposing are no more covered by the above mentioned financial reserves.

Different types of financial support are offered by International Financing Institutions, Foundations, the private sector (Wuppertal Institute, 2022) and the EC:

- Bilateral or multilateral assistance through grant-based technical support (i.e. UNDP, USAID, CIDA, JICA, EEA and Norway grants, EC, etc.) for developing and implementing just transition plans, policies and implementation strategies through knowledge transfers, co-creation of policy pathways, trainings, demonstration projects etc.;
- Lending facilities from development banks (i.e. WB, EBRD, EIB, KfW, etc.) for project, policy and programme financing for public sector; debt and guarantee facilities for private sector investors;
- Climate Mitigation Funds (i.e. GEF) through grants, equity or even debt funding of specific clean energy, energy efficiency, clean transport, ecological restoration projects;
- Research & Innovation programs co-financed by the EC, also with focus on 3Rs projects (remediation, reclamation-repurposing);
- Investments from the private sector (i.e. MNCs – multinational corporations) focused on the development of the former coal communities, on workers up- and re-skilling, etc.;
- Private Foundations & CSR Funds (i.e. CIFF – Children's' International Foundation Fund, IKEA, etc.) with dedicated programs for community outreach, identification of policy pathways, knowledge creation and capacity building, social infrastructure development.

A comprehensive guidance related to European financing opportunities for coal regions in transition (i.e. Just Transition Fund, Modernisation Fund, etc.) is presented in TRACER Decision support toolkit on substituting coal-fired generation with clean energy (TRACER-D6.6-DST.A, 2022).

Revitalization of post-industrial sites may not always be economically justified, so the possibility of using various types of financial instruments guaranteed by law would be a desirable form of **attracting investments** in areas and facilities degraded by industrial activity. Similarly, the use of various types of tax preferences or temporary exemption from taxes at ownership transfer or reductions in lease rates or fundraising issued by local authorities would greatly facilitate the management of post-mining landscapes. This is because municipalities have more opportunities to obtain funding, as well as to join the project in a **public-private partnership**. In a situation where many brownfield sites are owned by a municipality, which has no ideas on how to revitalize / repurpose, a public-private partnership could be a win-win for all parties: the municipality, the investor and the public, as beneficiaries of the future developed sites.

An important form of state aid for economically declining regions is the creation of so-called **free economic zones**. The assistance consists in exempting companies established in such a zone from paying taxes, which is supposed to encourage investors to establish business entities and create jobs. Spending money on social security and early retirement for miners from decommissioned mines may solve the livelihood problems of the departing generation of miners and temporarily soothe their political mood, but it does not create future job prospects for the region's younger generation.

Interestingly to mention that post-mining lands have some specific qualities which should be recognized, due to higher ability of several folds to store carbon than soil in surrounding landscapes. Also these landscapes may harbour rare and endangered species, thus a proper ecosystem restoration will make the area more attractive, which can be one of the clues for attracting potential investors to region.

**Box.5 Tips on how to attract foreign capital**

During the last TRACER event in Jiu Valley, the representatives of two important investors entities shared few tips on how to attract foreign capital:

**AmCham** - American Chamber of Commerce in Romania

**the human capital**

The Jiu Valley needs to identify proper solutions to increase the mobility of the human capital within the region and attract human capital from other regions (including from other countries).

**infrastructure development and maintenance**

It is crucial to connect the Jiu Valley to TEN-T Core and build a modern transport network within the region to allow the easy movement of people and goods.

**tailored incentives**

The local authorities should remain flexible and work with potential investors to direct local resources towards the support mechanisms that are essential to each investment.

**predictability and transparency**

Investors need a dialogue partner at the local level who can support them every step of the way.

**FIC** - Foreign Investments Council in Romania

One of the most important measures in attracting the investors is the **dialogue**.

Measures at national level that are considered fundamental in attracting investment in all areas of the economy, including the energy sector, are:

- coherent, stable and predictable legislative and administrative framework;

- implementation of a high value-added investment policy, with a multiplier effect on all sectors of the economy;
- establishing strategic sectors for investments;
- improving the administrative framework of investments (foreign and domestic in external markets).

Recommendations for regional/local authorities:

- the existence of **consolidated data** (available labour force, halls and buildings that can be used, existing providers for different sectors, infrastructure, but also access to education and healthcare services);
- the availability of these information for potential investors as soon as possible.

FIC underlined that economies can increase, if private and public investments are combined, together with measures aiming to: ▪ stimulate digitalization and innovation; ▪ improve the capacity of institutional and state-owned companies; ▪ protect human capital by facilitating access to jobs, education and health; ▪ transform the energy mix and develop the energy infrastructure.

# 5 Recommendations

The success of any transition strategy or economic transformation process requires continuous monitoring and tools for evaluation of its implementation effects.

A constant monitoring and evaluation process of the current state of play of the former mining site, starting prior to the mine closure & post-closure stages, is a must, in order to:

- Continuously documenting the planning and management of post-mining landscapes 3Rs (remediation-reclamation-repurposing), by gathering data upon process evolution;
- Not losing changes in management and ownership;
- Avoid costs & timing overlaps and help realistic revisions, thus adapting the overall transition strategy, in real time.

ICMM is defining in the Good Practice Guide on Integrated mine closure (2nd Edition) - Tool 2 the following categories of monitoring (ICMM, 2019):

- socioeconomic;
- water;
- terrain;
- ecological; and
- air quality.

According to TRACER-D 3.3 (2020), a brief summary of the main findings on *Environmental impact and monitoring* is given below.

As shown by the nine TRACER target regions, the environmental impact of coal mining is quite serious and over the long-term. Thereby, ecological problems are site/regional specific; but nevertheless, there are similar challenges, as: the restoration of soil functions on dumped raw soils, the waste water decontamination or securing adequate post-mining land stability.

It is obvious that notably abandoned mines provide unpredictable long-term security and ecological risks, like sinkholes, deactivated wells, soil and water contamination by solid waste and production residues, etc. Due to increasing national standards of environmental protection and safety within the EU member states, active coal mining is nowadays under

more or less strict governmental control − from the technical development of the coal deposit to the final land reclamation and release of mining supervision. However, in some regions there is a considerable lack of enforcement in environmental protection and land reclamation. Less than one fifth of the land taken by mining is restored and cleaned up, and in one case it is only 0.3 percent of the residues.

In every mining region there is an environmental monitoring with regard to the so-called *legal protections* (*objects of protection*), notably for human health, water, soil and air quality. The monitoring intensity, parameters and analytical methods, including also national threshold values applied, are very different and for some regions the effectiveness is unclear, especially regarding derived measures. **It is still missing a Europe-wide standardised and implemented ecological monitoring system after mine closure (mandatory and additional parameters, legally binding reference/intervention values).**

Mining companies have to meet many quality standards and to apply preventive mitigation measures, according to the national laws and European directives. Especially when the socio-economic development of a region is highly dependent on mining activities, environmental aspects are - historically viewed - rather subordinated although the need for action in this field is great. The interrelationships between mining industry and policy/authorities should be questioned.

In these cases, a deficit in information policy and public transparency can be noticed. It raises the suspicion that the **ecological effects of mining are widely underestimated and played down, especially regarding mechanical instable dumps/tailings, uncontrolled disposal of hazardous substances/industrial and municipal wastes** (soil and water contamination). Moreover, a **post-mining water and soil monitoring is missing in most countries**. Of course mining has a considerable impact also on the surrounding landscape, e.g. AMD, groundwater lowering, emissions. However, it is rather unclear whether environmental monitoring during active coal mining is necessary to continue after land rehabilitation.

It should be noticed that mine restoration in a wider sense is more than land preparation for a proper follow-up use or minimising the hazardous effects on nearby ecosystems in line with the regulatory requirements. It also addresses the restoration/conversion of industrial sites and damaged natural resources going beyond the mining operation area and facilities as defined by the operating plans.

The Science Policy Report on a new vision of sustainable management in mining and post-mining landscapes (Leopoldina, 2019), elaborated by several international research institutions, underline that all recommendations envisioning mining activities (i.e. planning, management, monitoring, prevention, revitalisation) involve all stakeholders. Thus, information and power should be shared with all relevant parties from the beginning to the end of mining operations.

These recommendations are designed with the following objectives:

- Encourage local involvement and capacity-building;
- Create opportunities for science to become an integral and open-access part of the overall mining process
- Create an international, law-abiding standard to guarantee due diligence and transparency, while simultaneously sharing generated data with stakeholders;
- Institutionalize effective participation of stakeholders during all phases of mining to mitigate the effects of mining and ensure socio-economic prosperity for all involved parties.

Both key resources ICMM (ICMM, 2019) and WB (WB, 2021) also emphasise the essential role of stakeholders engagement and cooperation along the entire mining process, from initiation to post-closure and repurposing, for the mutual benefit of the mining/energy company and its host communities.

The WB, in Mine Closure Toolbox for Governments (WB, 2021), makes a series of additional recommendations:

- the need to regulate the actions/measures taken during the post-mining landscape use stage, including other assets (buildings and infrastructure); the request to carry out the ESIA for impact assessment, with an emphasis on social aspects that should not be neglected during pre-closure, closure, post -closure and repurposing stages;
- the obligation of stakeholders (4helix) engagement from early stage of mine closure, post-closure and repurposing; with the aim of defining a common vision for post-mining assets use (land, buildings, infrastructure), taking into account legal constraints;
- the need for a transparent, efficient and participatory decision-making process, with the use of complex tools, comprehensive enough in terms of the volumes and categories of data processed, with a user friendly interface;
- the enforcement of a legal framework for the existence and financing of both the re-and up-skilling programs - correlated with the need of the post-mining labour market together with the envisaged investments and the regional/national development plans, as well as the retrenchment packages.

# 6 References and key resources

Applying tools and good practice guides can help strengthen knowledge and optimise post-mining landscape management, extensive professional guidance being available also here:

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