

POTENTIALS

RFCS AM PROJECT

Synergistic potentials of end-of-life coal mines and coal-fired power plants, along with closely related neighbouring industries: update and re-adoption of territorial just transition plans

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Deliverable 5.1

Roadmap for updating Territorial just transition plans

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Table of contents

EXECUTIVE SUMMARY	8
1 INTRODUCTION	9
2 SPANISH JUST TRANSITION TERRITORIAL PLAN	10
2.1 STRATEGIC FRAMEWORK FOR ENERGY AND CLIMATE	10
2.2 THE JUST TRANSITION STRATEGY	11
2.3 JUST TRANSITION TERRITORIAL PLAN FOR ASTURIAS	15
2.3.1 JUST ENERGY TRANSITION STRATEGY FOR ASTURIAS	17
2.3.2 ASTURIAS RAW MATERIALS STRATEGY	17
2.3.3 ENERGY REHABILITATION STRATEGY FOR BUILDINGS	17
2.3.4 RESEARCH AND INNOVATION STRATEGIES FOR SMART SPECIALISATION (RIS3)	17
2.4 TYPES OF OPERATIONS ENVISAGED IN ASTURIAS	17
2.4.1 GREEN INDUSTRY TRANSFORMATION, SUSTAINABLE MOBILITY, CIRCULAR ECONOMY AND ENERGY EFFICIENCY	18
2.4.2 BOOSTING THE VALUE CHAIN OF RENEWABLE ENERGIES, SELF-CONSUMPTION, ENERGY STORAGE AND RENEWABLE HYDROGEN	19
2.4.3 PROMOTING SMES AND BUSINESS PROJECTS THAT ARE KEY TO THE ECONOMIC DIVERSIFICATION OF THE TERRITORIES	19
2.4.4 FOSTERING RESEARCH, DEVELOPMENT AND INNOVATION (R&D&I), ICT INTEGRATION AND DIGITAL TRANSFORMATION	19
2.4.5 ENVIRONMENTAL REHABILITATION, NATURE CONSERVATION, BIODIVERSITY AND ECOSYSTEMS, PROMOTION OF HISTORICAL AND CULTURAL HERITAGE, AND PROMOTION OF SUSTAINABLE TOURISM	20
2.4.6 PROMOTING SOCIAL INFRASTRUCTURES, SOCIAL ECONOMY, TRAINING & QUALIFICATION INITIATIVES	21
2.5 UPDATING TERRITORIAL JUST TRANSITION PLANS: THE CASE OF ASTURIAS	21
3 SILESIA JUST TRANSITION TERRITORIAL PLAN	23
3.1 STATUS OF POLAND'S TRANSITION	23
3.2 JUST TRANSFORMATION IN THE SILESIAN VOIVODESHIP	26
3.3 PRIORITISATION OF BUSINESS MODELS FOR THE TJTP UPDATE	30
4 GREEK JUST TRANSITION DEVELOPMENT PLAN	37
4.1 CURRENT STATUS	37
4.2 POTENTIALS AND GREEK JTDP – SIMILARITIES	38
4.3 POTENTIALS AND GREEK JTDP – CONTRIBUTIONS	41
4.4 PRIORITISATION OF BUSINESS MODELS FOR THE GREEK JTDP	42
4.5 SUMMARY	46
5 GERMAN TERRITORIAL JUST TRANSITION PLAN	47
5.1 INTRODUCTION	47
5.1.1 NORTH RHINE-WESTPHALIA WILL INVEST IN A SUSTAINABLE FUTURE	48
5.1.2 BRANDENBURG WILL DIVERSIFY ITS ECONOMY	48

5.1.3	SAXONY-ANHALT TO MOVE TO A NEW ECONOMIC STRUCTURE	49
5.2	INITIAL POSITIONS FOR THE GERMAN TJTPs	50
5.3	THE TJTP FOR THE NORTHERN RUHR AREA AS AN EXAMPLE FOR THE JTF-FUNDED TRANSITION	55
5.4	SOME CONCLUSIONS DRAWN FROM TJTP FOR THE NORTHERN RUHR AREA IN VIEW OF THE POTENTIALS PROJECT	61
5.5	POST-MINING AS A NEW FIELD OF INTEREST IN GERMAN HARD COAL MINING – RUHR AREA	61
5.5.1	THE DECLINE OF HARD COAL MINING IN GERMANY	61
5.5.2	DEALING WITH HARD COAL MINING IN THE GERMAN LEGISLATION	63
5.5.3	THE GERMAN UNDERSTANDING OF POST-MINING	64
5.5.4	THE RELATION OF POTENTIALS TO GERMAN POST-MINING IN RESEARCH	66
6	CONCLUSIONS AND LESSONS LEARNT	67
7	GLOSSARY	68
	REFERENCES	70

List of Figures

Figure 2-1. Geographical location of areas included in Just Transition Agreements associated to coal (Spanish Just Transition Institute, 2022) 14

Figure 2-2. Geographical location of Asturias 16

Figure 2-3. Asturias JTP initiatives with reference projects 21

Figure 2-4. Operations envisaged by the JTP 22

Figure 2-5. Eco-industrial parks 22

Figure 3-1. Just transition regions in Poland..... 25

Figure 3-2. Mines and power plants designated for closure or restructuring..... 27

Figure 3-3. Road map for update of JTP for Silesian Voivodship..... 35

Figure 4-1. Map of Greece showing the location of transition regions in red color (Roumpos et al. 2018)..... 38

Figure 5-1. Just Transition Fund in Germany (European Commission 2022) 47

Figure 5-2. Restructuring of the Ruhrkohle AG into today’s RAG (RAG-Stiftung 2015)..... 63

Figure 5-3. Integration of the SLO into the mining life cycle (Goerke-Mallet et al. 2020)..... 64

Figure 5-4. Approach for a holistic post-mining management, State of the Art (Research Center of Post-Mining 2023) 65

List of Tables

Table 3-1. List of operational objectives of the Territorial Fair Transformation Plan for the Silesian Voivodeship28

Table 3-2. List of relevant business models (actions) 31

Table 3-3. List of relevant business models (micro-actions) 31

Table 3-4. Evaluation of the Potentials project business models against the operational objectives JTP Silesian Voivodship 32

Table 4-1. MoSCoW technique business models categorization 42

Table 4-2. List of the main operational objectives of the Greek JTDP (Just Transition Development Plan, July 2020) 43

Table 4-3. Evaluation of the Potentials project business models against the operational objectives of the Greek JTDP 44

Table 4-4. Business models regarding the operational objectives of JDTP models divided according to prioritization 45

Executive summary

This deliverable presents roadmaps for updating territorial just transition plans, recognizing the importance of keeping these plans up to date in alignment with National Energy and Climate Plans and the mid-term review of programs supported by the Just Transition Fund.

The mid-term review in 2025 offers an opportunity for resource reallocation and funding allocation for 2026 and 2027. With the POTENTIALS project expected to conclude in mid-2023, it holds significant potential for contributing to future updates and re-adoptions of territorial just transition plans.

It overviews the Spanish Just Transition Territorial Plan, focusing on the Asturias region; the Silesia Just Transition Territorial Plan; the Greek Just Transition Development Plan; and the German Territorial Just Transition Plan. These plans outline strategic frameworks, transition strategies, and operational activities to achieve a sustainable and equitable transition in their regions.

Regular updates to these plans are crucial to address evolving challenges and maintain their effectiveness in guiding the just transition process. The Just Transition Territorial Plans provide valuable insights and lessons learned for other regions and countries embarking on similar transition journeys. They demonstrate the significance of comprehensive strategies, stakeholder engagement, and integration of economic, social, and environmental considerations in achieving a successful just transition.

A possible and feasible update is presented for each region, trying to complement or correct the different operations envisaged to propose initiatives that stimulate the regional economy, making it easier to maintain employment.

1 Introduction

Work Package 5 supports the dissemination and transfer of the Accompanying Measure's knowledge and results to the European coal industry, closely related neighbouring industries, policy makers, trade unions, academia, NGOs and other stakeholders from communities that rely on the fossil fuel value chain.

Specific objectives are:

1. To deliver a roadmap for updating territorial just transition plans.
2. To ensure a relevant impact on stimulating new economic activities, developing jobs and economic value, especially concerning Coal Regions in Transition.
3. To support the dissemination of the project results.

Within this work package, Task 5.1 Roadmap for updating Territorial Just transition plans, takes into consideration that the territorial just transition plans should be updated and re-adopted when necessary, notably in case of an update of the National Energy and Climate Plans and in the mid-term review of the programmes supported by the Just Transition Fund.

While the mid-term review will take place in 2025, allowing the reallocation within each Member State of the Just Transition Fund resources, it will also provide the opportunity to allocate the funding for 2026 and 2027, which will be set aside at the start of the next period.

As POTENTIALS will be finished in mid-2023, it can make a substantial contribution in the future update and re-adoption of territorial just transition plans by giving a clear roadmap considering for the first time the synergistic potentials of end-of-life coal mines and coal-fired power plants, along with closely related neighbouring industries. This approach nowadays is entirely inexistent.

This task will be led by GIG, with the cooperation of the rest of the partners.

2 Spanish Just Transition Territorial Plan

In Spain, the closure of coal mines in 2018 is added with the shutdown of coal-fired thermal power plants, which in several cases has already been completed, while others are in the process of closure or are subject to medium-term closure plans by their companies (Spanish Just Transition Institute, 2022).

Therefore, the energy transition is highly advanced compared to other countries, and the Spanish government has already begun to roll out ambitious measures for a just transition.

Against this backdrop, in February 2019, the Spanish government launched a Just Transition Strategy with an Urgent Action Plan to address the impacts experienced in coal-producing regions and by the shutdown of power plants (Spanish Just Transition Institute, 2022) that we will analyse hereon.

The starting point for the Urgent Action Plan is the Framework Agreement for a Just Transition for Coal Mining and the Sustainable Development of Mining Regions for 2019-2027, signed by the government, trade unions and mining companies in October 2018. **This agreement guarantees immediate support measures for mine workers, economic support for mining areas and the necessary short-term funding.**

Secondly, the Agreement for a Just Energy Transition for Thermal Power Plant Closures was signed in April 2020 between the companies that own the plants, the trade unions and the government. **This agreement is resulting in the relocation of workers and the search for alternative employment in the affected areas, carried out both by the companies (through renewable energy projects and other activities) and by the government, and with the participation of the trade unions to facilitate and monitor adherence to the commitments.**

Beyond the sectoral agreements with workers and companies, to respond to the socio-economic impacts of the affected areas, the Just Transition Institute launched the Just Transition Agreements (JTAs), a co-governance tool to guarantee commitment and coordination by public administrations (national, regional and local) and to propose support instruments to facilitate the reactivation of these areas. JTAs are based on wide-ranging public participation processes and assessing socio-economic impacts at the local level (Spanish Just Transition Institute, 2022).

2.1 Strategic Framework for Energy and Climate

The energy transition process in which Spain is currently involved is circumscribed by the 2015 Paris Agreement and the United Nations 2030 Agenda for Sustainable Development, which marked the beginning of a global sustainability agenda that involves the transformation of the economic model and will lay the foundations for a new social contract of inclusive prosperity across the planet (Spanish Just Transition Institute, 2022).

The Spanish government instituted the Strategic Framework for Energy and Climate, by which measures were put in place to facilitate a shift towards a sustainable and competitive economic model that helps to curb climate change. This Strategic Framework is based on three

pillars: Law 7/2021 on Climate Change and Energy Transition, the Integrated National Energy and Climate Plan (PNIEC), and the Just Transition Strategy (JTS).

The Climate Change and Energy Transition Law decrees that emissions from the Spanish economy in 2030 must be reduced by at least 23% compared to 1990, and climate neutrality must be achieved by 2050, at the latest. In addition, by 2030, the following must be achieved: a penetration of at least 42% of renewable energies in final energy consumption, an electricity system generated by at least 74% of renewable energies and an improvement in energy efficiency by reducing primary energy consumption by at least 39.5% compared to the baseline stated by EU regulations (Spanish Just Transition Institute, 2022).

However, while the transition will generate numerous opportunities and benefits, it may also negatively impact specific areas. Thus, **discontinuing polluting energies in favour of renewable energies may impact businesses located in areas and regions where these activities represent quality jobs with a vital attraction potential, thus producing negative demographic impacts of depopulation** (Spanish Just Transition Institute, 2022).

2.2 The Just Transition Strategy

The Just Transition Strategy seeks to maximise the social gains of ecological transformation and mitigate the negative impacts that this transition could have on specific areas and people to leave no one behind. To that end, the main focus is on supporting the transformation of economic sectors towards the green economy and generating and protecting employment in declining sectors in the areas concerned, including boosting the training required by the labour market for such a transition (Spanish Just Transition Institute, 2022).

The Just Transition Strategy is a groundbreaking component of the Spanish experience, given that social justice needs to be linked to the energy transition are raised to the highest strategic level in the form of a national strategy. The Just Transition Strategy is one of the three pillars guiding Spain's energy and climate policy, together with the PNIEC and the Climate Change and Energy Transition Law. In this way, the considerations of Just Transition are not isolated actions but a guiding principle of the entire Spanish ecological transition (Spanish Just Transition Institute, 2022).

In addition, Spain is a pioneer in incorporating just transition needs at the legislative level in energy and climate policies. In this regard, Article VI of the Climate Change and Energy Transition Law requires the approval of Just Transition Strategies every 5 years to update the priorities and measures for just transition as the energy transition progresses. In this way, its continued strategic role is guaranteed by law (Spanish Just Transition Institute, 2022).

Another innovative aspect of the Just Transition Strategy is the creation of the Just Transition Institute, an autonomous governmental body with the Directorate General rank attached to the Ministry for Ecological Transition and the Demographic Challenge. This body is exclusively devoted to deploying measures to ensure a just transition in the affected territories and to coordinate the transversal inclusion of just transition needs in the government's public policies. The existence of a governmental body with exclusive competencies to implement just

transition policies in a centralised and coordinated manner is a unique feature of Spain at the European and international levels (Spanish Just Transition Institute, 2022).

While the Just Transition Strategy recognises several areas impacted by the ecological transition, an Urgent Action Plan has been established to address the impacts experienced in the coal and power plant closure areas.

Accordingly, Spain has already begun to deploy specific measures for a just transition of coal workers, structured through the Just Transition Agreements.

The main lines of action concerning the Just Transition Strategy (JTS) are (Spanish Just Transition Institute, 2022):

1. It aims to maximise the social gains of ecological transformation and mitigate the negative impacts that this transition might have on specific territories and people, not leaving anyone behind.
2. The Just Transition Institute is created, an independent governmental body attached to the Ministry for Ecological Transition and Demographic Challenge.
3. It establishes an Urgent Action Plan for coal regions and power plants that have closed down as a short-term priority objective to address the impacts that these territories are already suffering.

Finally, the main lines of action concerning the Just Transition Strategy's Urgent Action Plan are (Spanish Just Transition Institute, 2022):

1. To guarantee adequate compensation for workers who lose their jobs in mining companies that have closed down.
2. To maintain employment for mining areas through various plans.
3. To offer, during the Plan's timeframe, the ambition to establish Just Transition Agreements with the aim that closures do not impact employment and the population at the end of the process.

The following measures are part of this Urgent Action Plan (Spanish Just Transition Institute, 2022):

1. Agreements with companies and trade unions: social dialogue for a just transition.
2. A new working instrument included in the Climate Change Law: Just Transition Agreements. There are currently 13 Just Transition Agreements linked to coal closure, four in Asturias: Suroccidente JTA, Valle del Nalón JTA, Valle del Caudal & Aboño JTA.
3. The regions have the floor: social participation in just transition agreements.
4. The geographical scope of the JTAs – the physical areas on which commitments are made and support instruments deployed – is defined based on an objective and

comprehensive assessment of the socio-economic impacts of closures on local populations.

Consequently, the basis of the Just Transition Agreements is to identify the municipalities affected by the energy transition that suffer the most significant relative impacts and to concentrate support tools on them. Specifically, the impact assessment methodology, which has been subject to external technical evaluation, takes into account the following (Spanish Just Transition Institute, 2022):

a) Criteria related to the current economic impact of closures

- Location of facilities closing down.
- Relative impact on local employment.
- Relative impact on local wages.

b) Territorial coherence and cumulative impact criteria

- Cumulative impact of previous closures, particularly mining.
- Territorial coherence criteria based on the geographical continuity of municipalities and regional coherence.

The methodology takes employment as key indicator and focuses on the employment impacts of mine and power plant closures on municipalities. To that end, information is collected on the number of workers (both employees of the installation and subcontractors) affected by the closures and their municipality of residence.

Based on these data, the geographical scope of the Just Transition Agreement is delimited in such a way as to include the municipalities whose working-age population is most impacted in relative terms as a result of the closure of the facilities. A similar analysis of the impact on wages is carried out to complement the employment diagnosis.

This delimitation is complemented with criteria on territorial coherence and cumulative impact, which aim to provide geographical continuity to the JTA area and maximise the precision of the diagnosis and delimitation by analysing the cumulative impact of previous closures.

Applying this methodology results in a precise delimitation of the areas most affected by the coal transition, as shown in Figure 2-1.

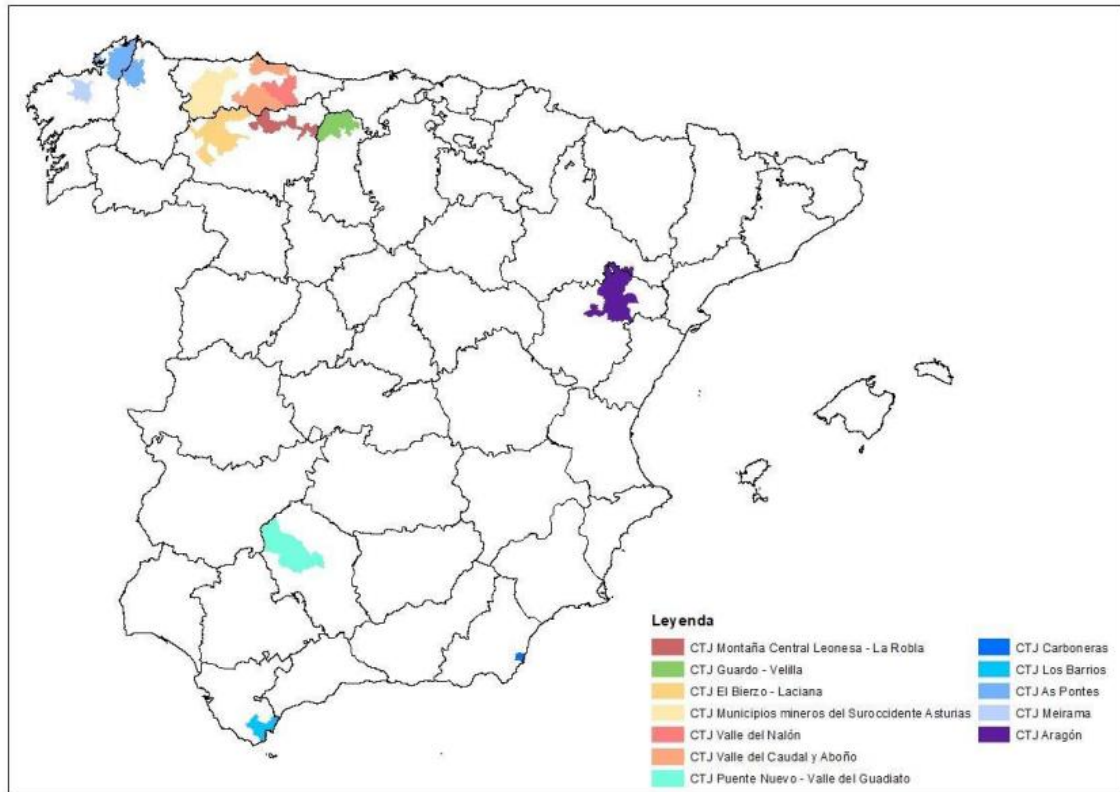


Figure 2-1. Geographical location of areas included in Just Transition Agreements associated to coal (Spanish Just Transition Institute, 2022)

According to the Spanish Just Transition Institute (2022), in Asturias, in the Suroccidente JTA action area, the Institute has allocated more than 77 million euro to support business projects, municipal infrastructures and three major environmental restoration works for mining operations. In addition to the environmental restoration of degraded areas in Buseiro, Cerredo and Tormaleo, with a total outlay of 82.4 million, 10 projects have been funded for sanitation, water supply and lighting infrastructures, energy efficiency measures in industrial estates and the construction of mini-warehouses to provide facilities for companies temporarily. Installing a plant for wood drying and thermal treatment as a renewable heat source has also received funding.

Also, in the Valle de Nalón JTA action area in Asturias, the ITJ has supported 16 municipal infrastructure projects and 21 business and minor investment projects. Funding has been provided for the construction of a care centre for the elderly, a training and rehabilitation centre and a co-housing residence, a plastics recycling plant, a project to refurbish and improve the facilities of a hotel using the criteria of sustainability, energy efficiency and promotion of the local economy.

In the area covered by the Valle del Caudal and Aboño JTA, the Institute has allocated more than 31 million euro to support a total of 31 municipal infrastructure projects and

52 business projects. These include funding for constructing a recycling plant in the shipbuilding sector, treating and recovering exhausted catalysts, installing an aluminium

waste-processing line, and adapting a former hotel into a health care centre for the elderly, specialising in brain damage.

One aspect of the Spanish measures has been the incorporation of a specific Just Transition component into the Recovery, Transformation and Resilience Plan, with four specific objectives (Spanish Just Transition Institute, 2022):

1. Environmental restoration of areas degraded by mining or coal-fired generation activities.
2. Support for improving environmental, digital and social infrastructures in areas affected by closures.
3. Promoting energy storage and energy efficiency projects in Just Transition areas.
4. Favouring professional transition and improving the employability of workers and the population directly affected by the energy transition.

2.3 Just Transition Territorial Plan for Asturias

As the University of Oviedo is located in Asturias and the decision-makers that will attend the workshop to be held in Oviedo will be from this locality, we will focus on the Just Transition Territorial Plan for Asturias (Figure 2-2).



Figure 2-2. Geographical location of Asturias

The Asturias strategy must be aligned with the two major transitions that have been signaled from Europe: the transition to a climate-neutral economy and the transition to a sustainable and digital economy. Due to the particularities of Asturias, a third component is added to these two transitions: the demographic challenge.

The future of Asturias depends on the transformation of its traditional industries (steel, chemicals, agri-food, cement, etc.) into more competitive, digital, sustainable and innovative industries that will guarantee the path towards zero net greenhouse gas emissions scenarios. This will be achieved by including different technologies (**green hydrogen, energy efficiency, reduction of resource consumption through circular economy processes, energy storage and the incorporation of renewable energies**), whose progressive maturation and inclusion in production processes will facilitate the transition towards zero greenhouse gas emissions.

The first step towards a strategy map for the Principality of Asturias, coherent inwardly between the different government departments and outwards with the inspiring principles of the primary national and European documents.

These strategies include, in the field of energy and climate, the Strategy for the Just Energy Transition of Asturias, the Energy Transition Strategy, the Asturias Raw Materials Strategy and the Strategy for the Energy Rehabilitation of Buildings in Asturias. Also noteworthy is the RIS3 Asturias.

2.3.1 Just Energy Transition Strategy for Asturias

This plan is consistent with other regional plans and strategies and the national Just Transition strategy.

2.3.2 Asturias Raw Materials Strategy

Its objectives are to promote the sustainable production of raw materials, achieve more excellent added value in raw materials, and take advantage of the experience and mining technologies in Asturias.

2.3.3 Energy rehabilitation strategy for buildings

It aims to reduce the carbon footprint of the residential sector while promoting employment and economic activity.

2.3.4 Research and innovation strategies for smart specialisation (RIS3)

This plan is aligned with the RIS3. The main area of specialisation of the S3 strategy to contribute to the decarbonisation of the territory is Energy and Circularity.

The circular and carbon neutral industry is addressed in 3 specific challenges: use of waste streams with a leading role for the process industry, decarbonisation of electricity and heat supply to industry, and efficient consumption in industry and the production of clean energy.

Also included is the area of Smart and Resilient Industry, with challenges aimed at scaling up the supply chains of international energy and transport markets by increasing value-added and efficiency in the energy and transport sectors.

In the Agri-Food area, carbon neutrality is addressed through sustainable farms with actions related to using natural resources. In Heritage and Biodiversity, the strategy prioritises the conservation of natural ecosystems and the development of Asturias as a sustainable tourist destination.

2.4 Types of operations envisaged in Asturias

The energy transition in Asturias is linked to the ecological transformation and decarbonisation of the industrial fabric and the diversification of its productive activity.

This transition also requires the rehabilitation of the areas most affected by mining activity and thermoelectric generation for decades, the promotion of R+D+I and new technologies, and specific support for the inhabitants of these territories, in particular, the most affected

sectors of the population and workers, the most affected areas being the centre and the south of the region due to their more excellent geographical proximity to the installations where the closures have taken place.

However, the unique geographical characteristics of the province, its small size and the dispersed and low population density mean that the impact of the transition affects the whole province.

For this reason, the Just Transition Plan envisages mobilising investments capable of boosting projects that will stimulate and reactivate the regional economy and create quality employment that will contribute to population stability.

Three initiatives are the main focus of activity, with reference projects in:

- Renewable hydrogen value chain, promoted in the regional ReCoDe project: generation, storage, transport and use in various sectors that are difficult to decarbonise.
- Renewable energy value chain and energy storage.
- Green transformation towards a more sustainable, digital and environmentally friendly industry.

The deployment of the FTJ will be carried out in the 6 sub-priorities using calls for grants in public-private partnerships and/or public investments.

The types of operations to be carried out in Asturias, classified according to the categories of development needs, are presented below.

2.4.1 Green industry transformation, sustainable mobility, circular economy and energy efficiency

The transition towards a climate-neutral economy in terms of CO₂ emissions of the Asturian industry will require the modification of its production processes. It will entail the introduction of changes in its production processes and will entail the introduction of significant technological changes, with high investment needs.

Initiatives related to the following aspects will be eligible:

- Application and use of renewable gases, such as green hydrogen.
- Deployment of technologies aimed at reducing the consumption of fossil fuels, enhancing energy efficiency, emission reduction and efficiency, emission reduction and energy efficiency, emission reduction and energy demand management of processes in industrial activities, including sustainable mining and quarrying.
- Circular economy solutions aimed at reducing resource consumption, carbon footprint, and waste, focusing on collaborative or urban industrial symbiosis models.

2.4.2 Boosting the value chain of renewable energies, self-consumption, energy storage and renewable hydrogen

The growing demand for sustainable and environmentally friendly energy solutions, facilitating the industrial transition to a low-carbon economy, the electrification of the economy and the need to ensure the quality and security of the electricity supply in a more renewable energy mix should be seized as an opportunity for diversification and the promotion of new value chains, and will therefore be supported:

- Renewable energy value chain, manufacture of components and capital goods: wind, offshore, marine energy, solar, biomass and renewable gases.
- Development of the green hydrogen value chain: production, storage, transport and consumption.
- Energy storage facilities and associated value chain.
- Technologically or socially innovative renewable energy and renewable gas installations (taking into account situations of energy poverty), promotion of self-consumption in industry and services, and support for energy communities.

2.4.3 Promoting SMEs and business projects that are key to the economic diversification of the territories

Support will be given to productive investment driver projects that facilitate the industrial transition towards a green and digital economy, contribute to a green and digital economy, contributing to a more sustainable economy, reduction of emissions, job creation and maintenance of existing jobs, or in new technologies and components contributing to economic diversification and the adaptability of enterprises; with special emphasis on the support and reinforcement of citizens' entrepreneurial initiatives in areas at risk of depopulation and in municipalities at risk of depopulation and in the municipalities most affected by the impact of the energy transition and, in particular, by the closure of thermal power plants.

In addition, to fix the population in the areas at most significant risk of depopulation, the following will be promoted:

- Agro-food industry projects linked to the traditional agricultural and livestock sector that help to fix the population in the areas most affected by the demographic challenge.
- Projects and initiatives for exploiting, using and developing critical raw materials and materials, including bioproducts.

2.4.4 Fostering research, development and innovation (R&D&I), ICT integration and digital transformation

R&D&I is essential for the development and growth of companies and can provide solutions in a cross-cutting manner for all proposed fields of action to achieve a fairer transition for people, the territory and the economy:

- Aid to implement improvement solutions in processes, products and business models, Industry 4.0.
- Digital transformation of SMEs and artificial intelligence. Digital transformation initiatives and cultural change in the economy: new business models, training, innovative services, public-private collaboration, hyper-automation, demonstration and innovation laboratories, proofs of concept and scalability of solutions.
- Public and private R&D&I projects related to the greening of the economy, including pilot plants and unique facilities: Clean energy production, sea energy and green hydrogen, sustainable mobility, decarbonisation, circular economy, materials, energy storage, waste reduction, CO₂ capture, eco-fuels, etc.

Creation of the following innovation poles and centres, taking advantage of existing infrastructures:

1. Innovation hub around artificial intelligence in the area of the Knowledge Mile.
2. Refurbishment of a mining pit to house an innovation hub for the agri-food industry.
3. Refurbishing a mining pit to create an innovation cluster around data storage, valorisation and cybersecurity.
4. Refurbishment of the former facilities of the Manuel Suárez Foundation (Navia) for the creation of the industrial innovation pole of western Asturias.
5. Other actions linked to innovation centres in mining shafts.

2.4.5 Environmental rehabilitation, nature conservation, biodiversity and ecosystems, promotion of historical and cultural heritage, and promotion of sustainable tourism

The energy transition must not only guarantee the preservation of Asturias' natural heritage but also contribute to mitigating the negative effects of coal-fired activity, coal-fired power generation and associated industries, and make these areas pleasant places to live in and with the possibilities for developing new activities. To this end, support will be provided:

- Projects for decontaminating degraded areas and rehabilitating mining sites, energy sites and associated installations, respecting the 'polluter pays' principle and adapting for new uses and/or transformation into natural carbon sinks.
- Valorisation of the region's mining-industrial heritage for tourism and culture, supporting initiatives for the adaptation of mining exploitations, thermal power stations or associated facilities, for new uses: co-working, reactivation and revitalisation projects, etc., under the criteria of the New European Bauhaus.
- Development of green infrastructures, associated with reactivation and sustainable tourism projects in those territories most affected by the closure of mining activity and thermal generation, away from the region's industrial centres, with a markedly rural character, in many cases in the demographic challenge, with few alternative demographic challenge, with few alternative possibilities for reactivation and located in areas of particular environmental protection.

2.4.6 Promoting social infrastructures, social economy, training & qualification initiatives

The transformation of the economy will require new professional profiles, which implies the need to re-qualification and/or training of the people most affected by the closures, especially young people, the over-55s and women. The aim is to promote jobs that are socially necessary and environmentally acceptable. It will be necessary to support:

- Actions for the recovery, rehabilitation or reuse of existing infrastructures and the adaptation of their equipment for training in areas such as renewable energies and energy efficiency, green and circular economy, including decontamination and waste management or forestry exploitation, sustainable mobility and electromechanics; and digital transformation, artificial intelligence and cybersecurity.
- Training in the field of entities involved in ecological transition or digitisation, in upskilling and reskilling and actions aimed at acquiring soft skills that complement the above and at developing and implementing digital twins.
- Youth employment and socio-economic integration of young people using aid programmes to promote job creation through aid to companies in sectors/territories directly related to Transition.

2.5 Updating Territorial Just Transition Plans: The Case of Asturias

The Just Transition Plan in Asturias aims to mobilize investments to stimulate and reactivate the regional economy and create quality employment to fix the population.

Three are the planned concentrating activities to achieve this goal: First, the renewable hydrogen value chain; Second, the renewable energy value chain complemented with energy storage; and Third, an economic transformation towards a more sustainable, digital, and environmentally green industry, as presented in Figure 2-3.



Figure 2-3. Asturias JTP initiatives with reference projects

Two are the operations envisaged by this Just Transition Plan: to promote individual projects within the previous initiatives, and to create innovation poles and centers using existing infrastructures, focusing on Artificial Intelligence, Agri-food industry, Data storage, valorization and cybersecurity, and, finally, Industrial innovation.

Obviously, innovation poles have a higher contribution to economic reactivation and fixing of population than individual projects, due to the synergies that they can achieve (Figure 2-4).

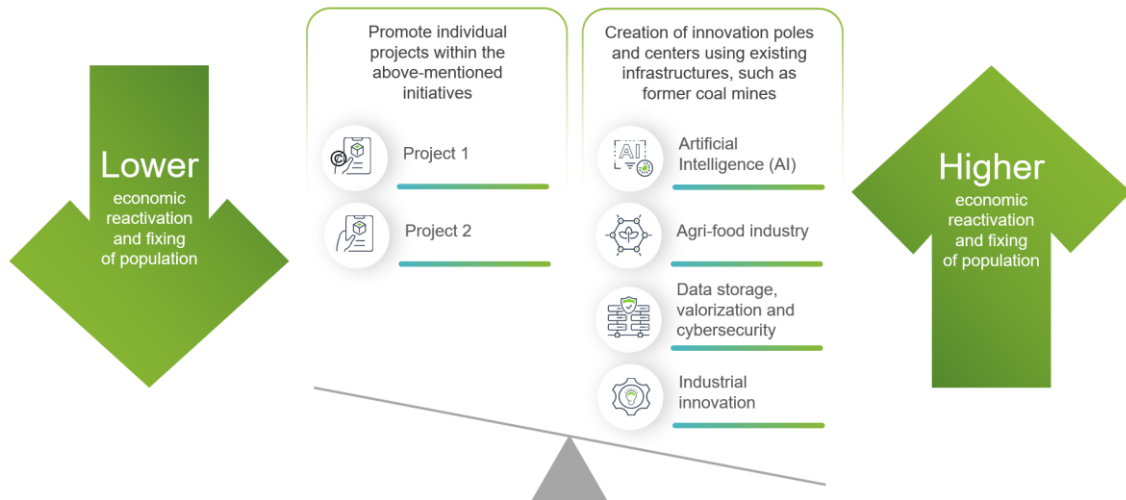


Figure 2-4. Operations envisaged by the JTP

However, Asturias Just Transition Plan fails to propose an initiative that can genuinely stimulate the regional economy making it easier to maintain employment: Eco-industrial parks with Virtual Power Plants (Figure 2-5).

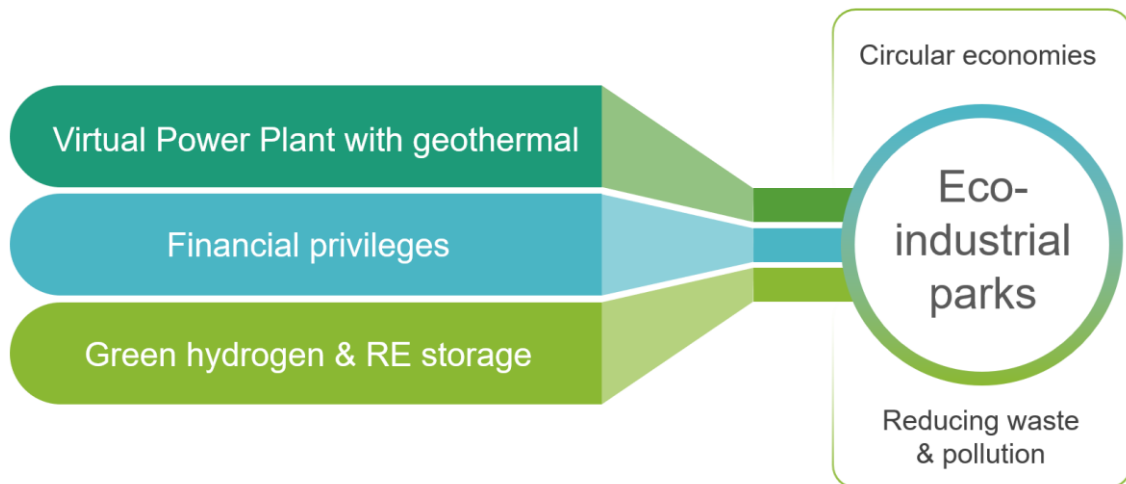


Figure 2-5. Eco-industrial parks

They are an integrated alternative for sustainable renewable energy generation, storage technologies, energy vectors, circular economy contributions, and synergies for reducing waste and pollution.

They have as a counterpart the need to be supported with financial privileges and other benefits to boost and diversify the area's economy and employment, attracting external investment. But, is that not the aim of the Just Transition Fund?

3 Silesia Just Transition Territorial Plan

3.1 Status of Poland's transition

Poland initiated the process of transitioning its energy sector away from coal over three decades ago. During this period, production of hard coal gradually decreased by 63 percent, from 147 million tons in 1990 to 54 million tons in 2020. Simultaneously, employment in the mining sector declined by 80 percent, from approximately 390,000 to 80,000 jobs. These declines are a result of the diminishing economic and financial viability of the Polish hard coal mining sector within the country's political and economic context, which is constantly evolving. In a competitive market economy, the extraction of hard coal has become less economically lucrative. In response to these challenges, a series of policies have been implemented to restructure and enhance the competitiveness of the sector, reduce unemployment among former coal workers, address the social and economic consequences of mine closures, and stimulate economic development beyond the coal industry.

The mining sector in Poland has undergone a series of restructuring programs until 2018, each yielding diverse outcomes for its overall condition. However, the advent of the COVID-19 pandemic exacerbated the crisis, compelling the Polish government to contemplate a fresh wave of restructuring measures, including further mine closures in mid-2020. Confronted with vehement opposition from mining trade unions, the government altered its plans in September 2020 and entered into protracted negotiations to establish a "Social Contract" with the unions. The primary objective of this contractual agreement was to devise a mechanism that would forestall abrupt closures of coal mines driven by market forces and protract the phased withdrawal from coal.

In May 2021, the Polish government, accompanied by representatives from trade unions, the Association of Mining Communities in Poland (Stowarzyszenie Gmin Górniczych w Polsce), the Association of Mining Communities and Districts Authorities (Stowarzyszenia Gmin Górniczych i Powiatów), as well as representatives from coal companies covered by the contract, affixed their signatures to the agreement. The contract delineates a precise timetable for the closure of mines under the ownership of PGG, Tauron, and Wegłokoks companies. As per the outlined schedule, the initial mines were slated for closure in 2021, while the last ones were designated to cease operation by 2049, with the majority of closures anticipated to transpire post-2030. Analytical investigations conducted during the planning phase of the program revealed that most mines would necessitate financial subsidies to sustain operations in accordance with the schedule. Consequently, the contract encompasses provisions for state aid, contingent upon scrutiny and approval by the European Commission to ensure compliance with regulations governing state aid among EU member states. Although the notification process commenced in May 2021, ongoing controversy persists regarding the prospective acceptance of the proposed subsidy scheme in its entirety.

Importantly, it should be acknowledged that the contract does not encompass other entities engaged in steam coal mining, such as the Bogdanka mine situated in eastern Poland, as well as various small privately owned mines within the Silesian coal basin. Furthermore, the

contract does not extend to coking coal mines. Consequently, the document does not explicitly stipulate the termination of hard coal mining activities in Poland. Rather, it serves to protract the operational timeline of economically unviable coal mines in Silesia through the proposed state aid program.

The Social Contract does address just transition by stipulating a package of safeguards for employees of mines planned for closure. All workers employed in the mines as 25 of September 2020, have the right either to keep their jobs until they retire, or should that not be possible, to find employment in another operating mining unit; or to benefit from a special preretirement mining leave. The Social Contract also envisages an investment of more than \$4.1 billion in clean coal technologies, such as coal gasification, carbon capture and sequestration, or smokeless fuel production installations. Finally, the Social Contract calls for establishing the Fund for the Transformation of Silesia, with the objective of coordinating the transformation of former mine sites (as well as industrial and postindustrial sites) with broader economic development efforts in the region.

Poland has implemented a two-pronged approach in its preparations for the Just Transition process, encompassing both national and regional strategies. Currently, the Ministry of Climate and Environment is engaged in the development of the National Just Transition Plan (NJTP), while simultaneously undertaking efforts to establish Territorial Just Transition Plans (TJTP) specific to each of the country's six provinces hosting coal regions (Figure 3-1). Notably, seven plans have already been drafted for the corresponding sub-regions. The national Program of European Just Transition Funds entails the provision of co-financing for six horizontal activities that comprehensively cover all regions, as stipulated within the framework of the NJTP. Furthermore, co-financing is allocated to the individual regions, ensuring a tailored approach. The coordination of plan development within the regions is entrusted to the Marshal Offices, which have established dedicated working groups to facilitate this process.

Priority Just Transition region

■ No ■ Yes

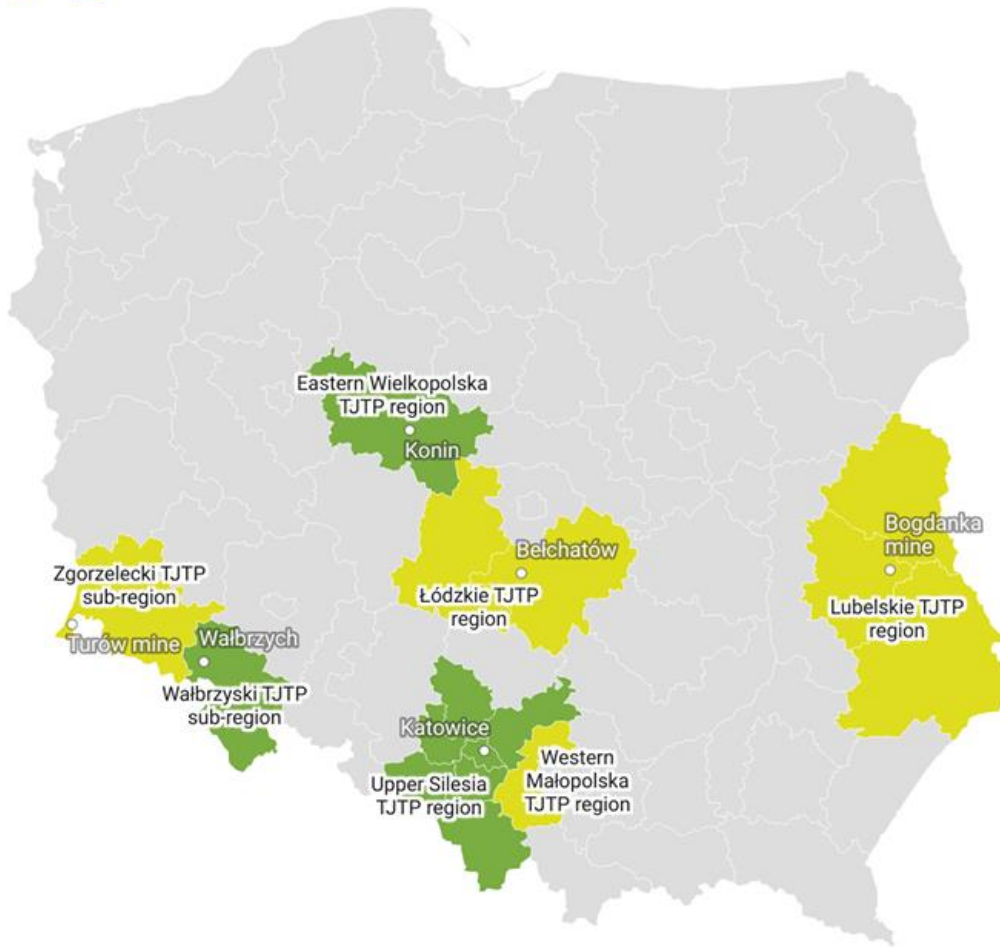


Figure 3-1. Just transition regions in Poland

Source: Ślimko E., Bartecka M., Pogoda A. (2021), Territorial Just Transition Plans for Polish Coal Regions, Briefing, Bankwatch Network & Polish Green Network

A pivotal condition for receiving support from the Fund was the submission of a timeline delineating the closure of mines by 2030 or demonstrating a substantial reduction in coal production. In the regions of Łódzkie (including the Bełchatów mine), Zgorzelec County (including the Turów mine), Lubelskie (including the Bogdanka mine), Upper Silesia, and Western Małopolska, the extraction of coal is anticipated to extend beyond 2030. Notwithstanding the initial intention of the European Commission to provide support exclusively to three Polish coal regions—Upper Silesia, Eastern Wielkopolska, and the Wałbrzych sub-region—the Ministry of Funds and Regional Policy effectively negotiated for the inclusion of an additional four regions: Łódzkie, Lubelskie, and Western Małopolska. It is noteworthy that the Commission, despite the protracted duration of the coal mine decommissioning process spanning nearly three decades, expressed its support for Upper Silesia, recognizing it as the preeminent coal mining region in Europe.

3.2 Just transformation in the Silesian Voivodeship

The Silesian Voivodeship is the largest mining region in the EU, with its economy largely based on fossil fuels and industries characterized by high greenhouse gas emissions. At the same time, the region holds a prominent position in both electricity production and consumption in the country (ranking 3rd and 2nd respectively among other voivodeships). Therefore, actions taken within the transformation area are essential to achieve the set goals at the national level. The transformation process in the region has been ongoing for nearly 30 years. In the face of implementing the European Green Deal, global climate and economic challenges, as well as the yet fully understood consequences of the COVID-19 pandemic, the region must confront the greatest transformation challenge in the EU. The transformation process will require a change in the production structure and the development of the energy sector, resulting in the need for the next stage of restructuring the mining sector. Actions in the Silesian Voivodeship, planned within the Territorial Just Transition Plan, are linked to the goals of regional and national strategies. The TJTP aims to reduce the role of coal in the energy and economy of the region by 2030. Mining operations will be terminated or significantly reduced in four mines by 2030. Three coal-fired power plants will also be shut down. Decarbonization will also extend to other sectors of the economy. The plan includes the replacement of public transport fleets with zero-emission vehicles and support for investments in renewable energy for prosumer-based power generation. The transformation will take place across the entire Upper Silesian Coal Basin (GZW), encompassing the Silesian Voivodeship and western Lesser Poland. Due to the scale of the challenges currently faced by the region, the planned actions to achieve EU climate goals go beyond the intervention envisaged within the Just Transition Fund. Figure 3-1 presents Mines and power plants designated for closure or restructuring.

It should also be noted that the changes introduced in the mining and energy sectors will result in a significant reduction in jobs and the need for the development of new economic branches, allowing for the mitigation of negative transformation effects related to the labour market. The TJTP includes support for the process of economic diversification in the region and increasing its level of innovation, including the development of R&D in the field of regional smart and technological specializations. The transition of the energy system will require the development of renewable energy sources. The TJTP includes support for such investments as an important element of diversifying the sources of energy generation in the regional energy mix. The implementation of these actions will contribute to achieving climate goals in the field of renewable energy. It is estimated that the planned interventions in this area will result in the production of 145,111 MWh of electricity per year from newly constructed renewable energy installations. This represents a 9.9% increase compared to 2020. At the same time, the planned development of renewable energy will further reduce CO₂ emissions by 48,865 tons.

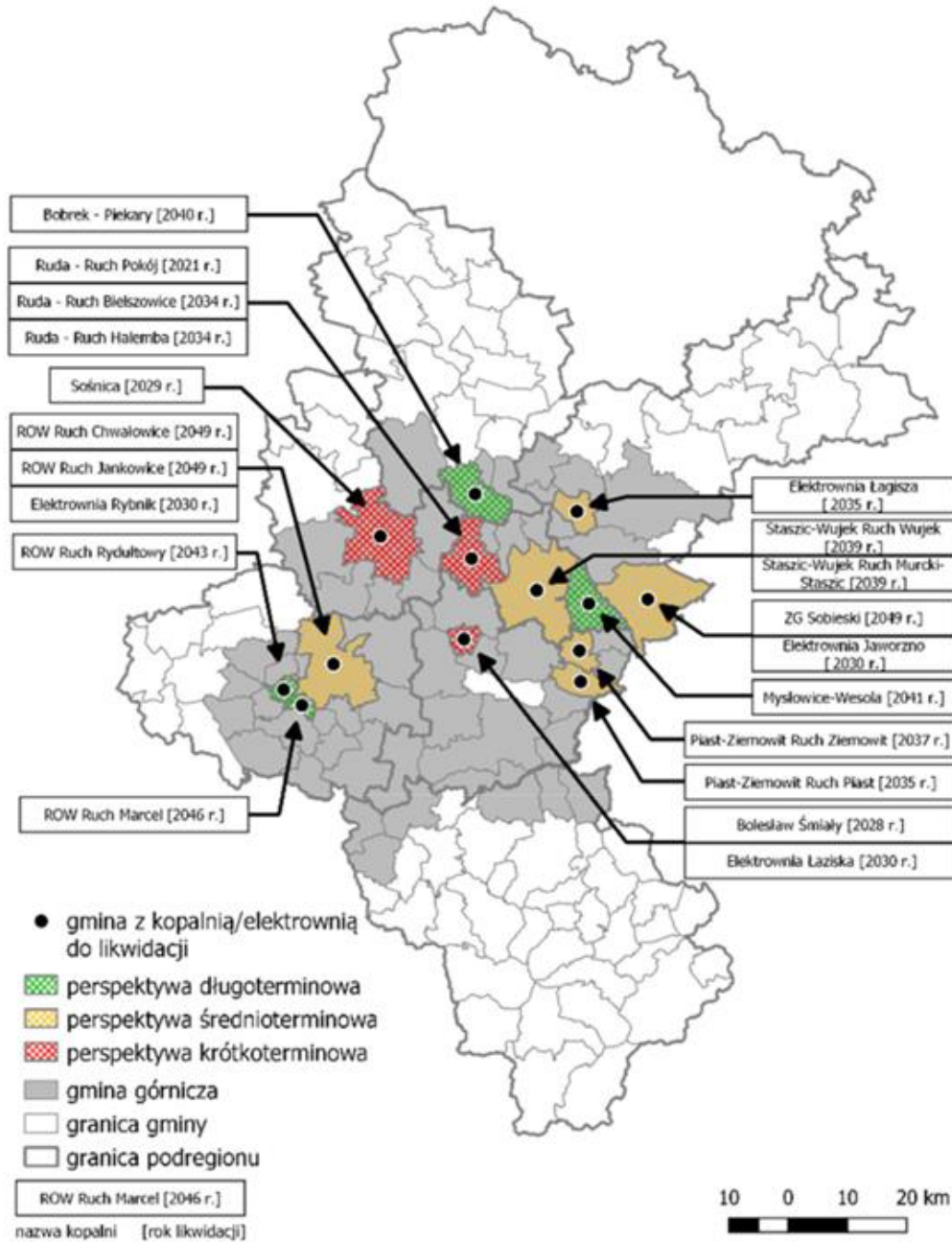


Figure 3-2. Mines and power plants designated for closure or restructuring

Source: TJTP for Silesia Voivodeship 2030

The main objective of the TJTP is to achieve a fair and efficient transformation of mining sub-regions towards a green, digital economy, ensuring a high quality of life for residents in a clean environment. This objective will be achieved through the implementation of detailed operational goals, which provide a response to the identified challenges at the diagnostic stage (table 3-1).

Table 3-1. List of operational objectives of the Territorial Fair Transformation Plan for the Silesian Voivodeship

Challenge	Symbol	Operational objective	Expected results
Establish a leading centre in the area of innovative and high-tech industry	C1	Innovative economy of mining sub-regions	<ul style="list-style-type: none"> Increasing the R&D and implementation potential of the R&D sector.
Reorienting the economy of mining sub-regions on a green, smart and digital growth path.	C2	Diversified and resource- and energy-efficient economy of mining sub-regions	<ul style="list-style-type: none"> Economic diversification of mining sub-regions. Reducing the consumption of energy, primary raw materials and increasing the share of clean technologies in production processes in order to significantly reduce or prevent the mass of waste.
Strengthening the potential of local entrepreneurship for the creation of alternative jobs in mining sub-regions.	C3	Strong entrepreneurship in mining sub-regions	<ul style="list-style-type: none"> Increase employment through the creation of new jobs in alternative sectors to mining and conventional energy. Increased competitiveness of SMEs in alternative sectors to mining and conventional energy. Increased number of new businesses in alternative sectors to mining and conventional energy. Increased access to advisory and financial support for business start-ups. Increased internationalisation of companies' activities.
Boosting prosumer energy based on the potentials and resources of mining sub-regions.	C4	Balanced distributed energy of mining sub-regions	<ul style="list-style-type: none"> Increasing the production and storage of distributed renewable energy.
Effective use of brownfield sites in mining sub-regions for economic, environmental and social purposes	C5	Effective use of brownfield sites in mining sub-regions for economic, environmental and social purposes	<ul style="list-style-type: none"> Use of brownfield sites for regional development purposes. Elimination of the effects of industrial, including mining activities on the environment, improvement of biodiversity indicators on the areas used for environmental purposes. Improvement of water relations in the area affected by mines. Systematic management of brownfield sites.

Improving the mobility of inhabitants and transport cohesion of mining sub-regions.	C6	An effective system to strengthen mobility in mining sub-regions	<ul style="list-style-type: none"> Decarbonising transport through the construction of infrastructure for zero-emission and non-motorised transport and the purchase of zero-emission means of transport. Improving the communication of mining sub-regions through the development of public transport infrastructure and measures for tariff integration and the introduction of ITS
Developing and adapting education to build the future of mining sub-regions in response to the challenges of the economy.	C7	Attractive and effective education and qualification in mining sub-regions	<ul style="list-style-type: none"> Development of professional education in cooperation with entrepreneurs, universities in particular in line with regional smart and technological specialisations. Targeted development of higher education oriented to the needs of the green economy. Creation of conditions for professional development.
Sustaining the economic activity of people employed in mining and mining-related enterprises in mining sub-regions.	C8	Attractive and effective labour market support system for mining sub-regions	<ul style="list-style-type: none"> Development of competences to provide adequate career opportunities for affected workers (in response to local approaches to economic development), in particular to the needs of the green and digital economy. Increased labour force participation of sub-regional residents.
Improving the quality of life of the inhabitants of mining sub-regions.	C9	Comprehensive social support system to activate residents of mining sub-regions	<ul style="list-style-type: none"> Increase the level of activity of communities participating in the fair transition process.
Strengthening social and governance capacities for a just transition in mining sub-regions.	C10	An effective Socially Responsible Transition Management System in mining sub-regions	<ul style="list-style-type: none"> Strengthening institutional capacity, including staff implementing the transformation process. Building a comprehensive monitoring system of transformation processes. Cooperation of local government units and social and economic partners participating in the transformation process on the basis of dialogue and open communication.

Source: adopt from TJTP for Silesian Voivodeship 2030

However, the Territorial Just Transition Plan does not directly address the business models that should or could be implemented in the Silesian Voivodeship to achieve the transformation goals.

3.3 Prioritisation of business models for the TJTP update

The proposition for utilizing the Potentials project's achievements in the TJTP update includes the development of an Action Plan that will incorporate prioritizing business models in relation to operational goals. The prioritization of business models will be conducted using the widely adopted **MoSCoW** technique¹. This technique enables the analysis of priorities and focuses on key elements that are crucial for the successful implementation and transformation process. As a result, the Action Plan will provide clear guidelines on which business models should be implemented as a priority during the update of activities within the TJTP, along with accompanying actions (e.g., competency framework development, spatial planning, etc.), and allocate the budget accordingly. In the MoSCoW technique, business models are categorized into priorities as follows:

M (MUST)	Projects that must be implemented Projects of a critical nature to achieve minimum benefits. They form the basis for the implementation of subsequent projects.
S (SHOULD)	Projects that should be implemented Projects that are important from the user's point of view and bring specific benefits.
C (COULD)	Projects that can be implemented Projects that can potentially be implemented, however, in the event of delays, shortfalls with the agreement of stakeholders, implementation may be suspended.
W (WON'T)	Projects that may be considered in the future These are projects that extend the core functionality and are not required to be implemented in the first instance. They can be considered in the next phase of the project. They are also the least cost-effective projects.

The principle is to allocate approximately 60% of resources and activities to business models in the MUST priority group, while allocating 20% to business models in the SHOULD and COULD priority groups. Maintaining these proportions allows for flexibility, and in case of various risks, temporary abandonment of SHOULD and COULD business models is possible. This enables a relatively streamlined operation and ensures the necessary minimum within the planned work period. The allocation of resources and activities for MUST priority can be increased as desired, but a reserve of at least 20% should be kept for potential risks and lower priority business models.

Taking into account the described technique and the identified business models in the Potentials project (table 3-2, table 3-3), a matrix was developed to assess the potential impact

¹ Agile Business Consortium, "Chapter 10 MoSCoW Prioritization," Jan 2014.[Online]. [Accessed 02. 05. 2023]. Available: https://www.agilebusiness.org/page/ProjectFramework_10_MoSCoWPrioritisation.

of the business models on the achievement of operational goals for the TJTP (Territorial Just Transition Plan) – table X-4. Business models targeted at brown coal mines were excluded from the evaluation (assigned a value of 0 in the table) due to the region's specific characteristics - Silesian Voivodeship, which only has access to bituminous coal mines.

The assessment was conducted using a 0-1 system, where 0 represents a business model that does not directly impact the achievement of specific goals, and 1 represents a business model that directly impacts the achievement of specific goals. The evaluation base on the results from Deliverables D4.1-D4.3

Table 3-2. List of relevant business models (actions)

N°	Short label	Long label
1	Virtual	Virtual power plant
2	Hydrogen	Green hydrogen plant
3	Ecopark	Eco-industrial park
4	Tourist	Cultural heritage and sports/recreation areas
5	FloatingPV	Floating PV panels at flooded open-pit coal mines
6	Pumping	Pumped hydroelectric storage at former open-pit coal mines
7	Fisheries	Fisheries in flooded open-pit coal mines
8	CCGT	Combined-cycle gas turbine (CCGT) power plant powered by natural gas
9	Minegas	Mine gas utilization for gas-powered CHP power units
10	Nuclear	Small modular reactors (SMRs)
11	Biofuels	Biofuels combustion energy plant
12	Moltensalt	Molten salt plant
13	Agrophotovoltaics	Agrophotovoltaics at former open-pit coal mine areas

Table 3-3. List of relevant business models (micro-actions)

N°	Short label	Long label
1	Batteries	Ancillary services provided by batteries
2	Wasteheaps	Recovery of resources from coal mining waste heaps
3	Methane	Usage of methane from degasification units in closed coal mines
4	Water	Circular mining technologies for pumped water material recovery
5	Forest	Forest restoration at former open-pit coal mines
6	Information	Large-scale IT infrastructure - power plant
7	Geothermal	Geothermal energy
8	Gravitricity	Storage of energy in the form of potential energy using weights
9	Dense fluids	Storage of energy using dense fluids.
10	Hydropumping	storage energy in the closed coal mine shafts

Table 3-4. Evaluation of the Potentials project business models against the operational objectives JTP Silesian Voivodship

Business model	JTP goals										Sum
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	
Virtual	0	1	1	1	1	0	0	0	0	1	5
Hydrogen	1	1	1	1	1	1	0	1	0	1	8
Ecopark	1	1	1	1	1	1	1	1	1	1	10
FloatingPV	0	0	0	0	0	0	0	0	0	0	0
Tourist	0	1	1	1	1	1	0	1	1	1	8
Pumping	0	0	0	0	0	0	0	0	0	0	0
Fishers	0	0	0	0	0	0	0	0	0	0	0
CCGT	1	0	0	1	1	0	0	0	0	0	3
Minegas	1	0	0	1	1	0	0	0	0	0	3
Nuclear	0	1	1	1	1	0	1	1	0	1	7
Biofuels	1	1	1	1	0	0	0	1	0	1	6
Moltensalt	0	0	1	1	1	0	0	0	0	0	3
Agropotovoltaics	0	0	0	0	0	0	0	0	0	0	0
Batteries	0	1	0	1	0	0	0	0	0	0	2
Wasteheaps	1	1	1	0	0	1	1	1	0	1	7
Methane	1	1	0	1	0	0	0	0	0	1	4
Water	1	1	1	1	0	0	1	1	0	1	7
Forest	0	0	0	0	0	0	0	0	0	0	0
Information	0	1	0	1	0	1	0	1	1	0	5
Geothermal	1	0	1	1	1	0	0	0	0	1	5
Gravitricity	1	0	1	1	0	0	0	0	0	0	3
Dense fluids	0	0	1	1	0	0	0	0	0	0	2
Hydropumping	1	0	1	1	0	0	0	0	0	0	3

To determine the priorities for the business models analysed, the following minimum thresholds:

- Priority **MUST** - min. 8 points
- Priority **SHOULD** - min. 6 points
- Priority **COULD** - min. 4 points

The results of the prioritisation of business models regarding the operational goals of JTP models divide them into following project bundles.

MUST	SHOULD	COULD
Ecopark	Water	Geothermal
Tourist	Wasteheaps	Information
Hydrogen	Nuclear	Virtual
	Biofuels	Methane

The prioritization of business models in relation to the goals of the JTP indicates that the most desirable models during the plan's update phase will be those aiming to establish or transform existing eco-industrial parks in the region. These parks can provide a flexible framework that allows for the achievement of the Just Transition Plan's goals, focusing on sustainable energy sources on one hand and socio-economic objectives on the other, which are essential pillars of the just transition process. Combining sustainable energy generation technologies with energy storage in a single business model, integrated with economic activities and projects, presents a unique opportunity for employment growth and innovation in the region. Additionally, among the business models in the "MUST" priority category, the utilization of post-mining areas and former power plants for tourism and/or recreational activities, coupled with the production of green energy, has been included. Such solutions have been successfully implemented in other countries and in the Silesian region. However, often without the integration of energy production, these areas are not self-sustaining and difficult to maintain. Introducing sustainable energy-related solutions can lead to increased interest and better utilization of such areas, not only for tourism purposes but also for economic development. The energy transformation of the region requires the provision of new energy production and storage sources. One of the recommended solutions in feasibility studies for the Silesian Voivodeship is the introduction of a green hydrogen plant where renewable hydrogen will be produced through electrolysis of mine water and electricity from renewable sources. The potential of the areas and the existing infrastructure favor such a solution, which would not only achieve goals related to employment and economic revitalization but also promote environmentally friendly mobility and new R&D directions.

The business models related to the utilization of water and mine heaps as a source of energy and raw materials have been given priority in the SHOULD category, which aligns with the region's promoted solutions in the field of closed-loop economy. Although the activities within these models do not directly translate into employment and economic revitalization issues, they can still contribute to the achievement of JTP goals in the longer term within the regional conditions. Another noteworthy aspect is the construction of SMRs, which is in a very early stage of development for both the region and the country, and nuclear energy cannot be expected to quickly become an alternative to conventional energy sources and renewables. This is a business model that is currently in its early stages of development and can be seen as potentially feasible. The same applies to biofuel energy.

In the COULD category, there are niche solutions that will not significantly impact the indicators included in the Just Transition Plan. It should be assumed that these solutions, implemented on a pilot scale, will be developed but not prioritized; rather, they will serve as supportive measures. Of particular interest is the utilization of geothermal energy from mine waters, which can reduce the energy inputs for heat production in heating plants. However, the specific nature of mine waters requires their use in closed-loop systems. The use of methane also represents a short-term solution that may not be considered a desirable long-term direction for renewable energy. A solution based on virtual power plants, however good, may be of little benefit to the region, as jobs will be generated outside the region. It is therefore recommended that virtual power plant solutions be incorporated as a complementary measure to, for example, the construction of ecoparks.

When developing the roadmap for updating the JTP, it is necessary to determine the future approach to areas that will emerge after the phasing out of mining and power plant activities. If these areas are to be developed according to business models, pre-investment preparations should be carried out. Specifically, a feasibility study and preliminary plan of implementation should be developed for each specific business model. The business models assigned the highest priority (M) should be implemented first, while the decision regarding models with priorities S, C, and W should be made in subsequent stages of the JTP update or simultaneously with fewer resource commitments. Considering the main goal of the JTP, which is to increase employment, and the expert assessment conducted during the evaluation of business models, it has been determined that the largest number of newly employed individuals will be associated with projects categorized as MUST priority. The expected increase in job opportunities for business models with lower priorities is smaller. The roadmap, along with the estimated results, is presented in Figure 3-3.

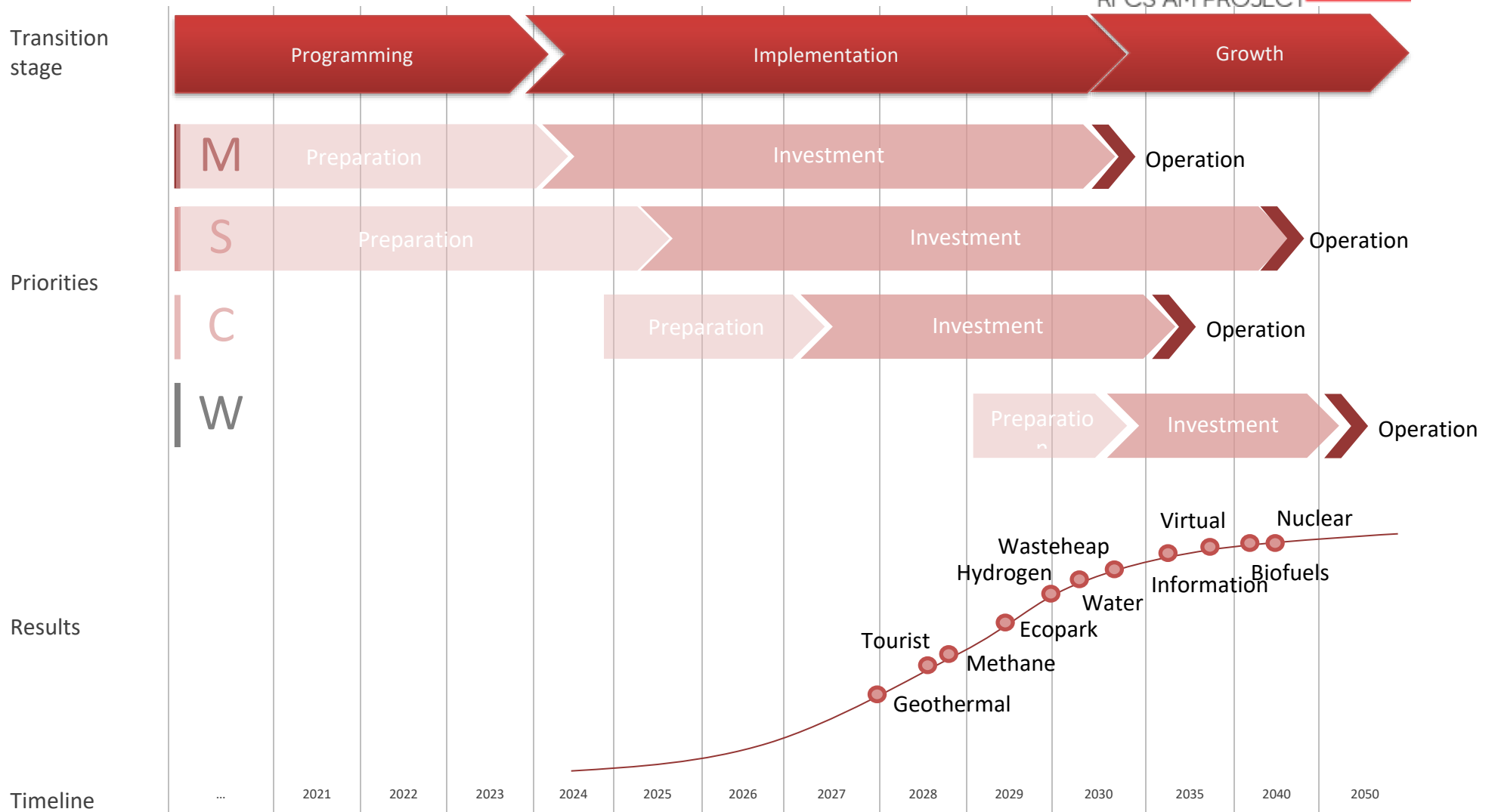


Figure 3-3. Road map for update of JTP for Silesian Voivodship

JTP update process

The process of updating the Just Transition Plan, taking into account the results of the Potentials project, which include business models, can adopt the following phased structure:

1. **Analysis and evaluation of the existing plan:** The first step is a thorough analysis and evaluation of the existing Just Transition plan. In this stage, it is important to understand what goals have already been established, what actions have been taken, and what financial resources have been allocated.
2. **Consultation and stakeholder engagement, including society:** The next important step is to engage various social groups and stakeholders in the process of updating the plan. Organizing consultations, meetings, discussions, presenting potential solutions (e.g., business models), and gathering feedback are crucial to incorporating different perspectives and community needs.
3. **Needs and priorities analysis:** Based on consultations and community input, a detailed analysis of needs and priorities should be conducted. This stage can consider factors such as social, ecological, economic, and technological aspects to determine areas that require greater support.
4. **Updating goals:** Based on the analysis of needs and priorities, goals should be updated. Goals should be measurable, achievable, and aligned with the values of the community.
5. **Updating actions and financial resources:** After establishing new goals and strategies, specific actions should be defined, incorporating proposed business models from the Potentials project, for implementation within the plan. Actions should be well-defined, evidence-based, and consider the needs of different social groups. It is also important to anticipate available financial resources and funding sources for these actions.
6. **Planning for monitoring and evaluation:** An important element of the plan updating process is to plan a system for monitoring and evaluating the progress of actions. This includes determining indicators and monitoring methods, as well as regular progress reviews to ensure that goals are being achieved and to adjust actions as needed.
7. **Adoption and implementation of the plan:** After completing the updating process, the Just Transition plan should be adopted by relevant authorities or organizations. Implementation of the plan can begin.

It is important to consider diverse business models such as those based on sustainable development principles, eco-innovation, circular economy models, or clean technology-based models. Collaboration and dialogue among different stakeholders, including entrepreneurs, government institutions, and civil society organizations, are crucial to ensure that business models are well-integrated in the update of the Just Transition plan.

4 Greek Just Transition Development Plan

4.1 Current Status

In September 2020, the Greek government submitted its Just Transition Development Plan (JTDP), to the European Commission as part of the Paris Agreement, presenting the actions that need to take place in order regions undergoing transition to experience an effective and smooth development towards green energy. The plan is in agreement with the National Energy and Climate Plan (ESEK, Government Gazette B' 4893/31-12-2019) and the European Climate Neutrality Strategy (Green Agreement, COM (2019) 640 of 11-12-2019), which foresees zero-net greenhouse gas emissions by 2050(https://www.sdam.gr/sites/default/files/consultation/Master_Plan_Public_Consultation_ENG.pdf).

The European Commission approved the JTDP in June 2022, offering financial support of €1.63 billion, of which €1.38 billion are provided through the JTF Programme (https://ec.europa.eu/commission/presscorner/detail/en/ip_22_3711). More than half of the funds offered are going to support new and existing companies, simultaneously creating a more direct connection between companies and the Research and Innovation sector. About 20.4% of the remaining financial support will be used to help the economy in these regions through the creation of new jobs, as well as upskilling and reskilling of workers that are affected by the transition process. The last share of fund will focus on helping with the energy transition, land use adaptation and circular economy.

The overall goal of the transition phase is to close all the operating lignite plants in the country by 2028, mainly focusing on de-carbonisation of the Western Macedonia and Megalopolis Regions (Figure 4-1). In addition, islands located in the North-South Aegean together with Crete will be supported during the coal phase out.

The transition phase in the Region of Western Macedonia and Megalopolis is expected to take place via three main aspects: a) employment protection, b) compensation of the socio-economic impact of the transition and c) energy self-sufficiency of lignite areas and the country at large. The vision for the “next day” in the transition regions is based on the following five development pillars:

- Clean energy
- Industry, small industry and trade
- Smart agricultural production
- Sustainable tourism
- Technology and education

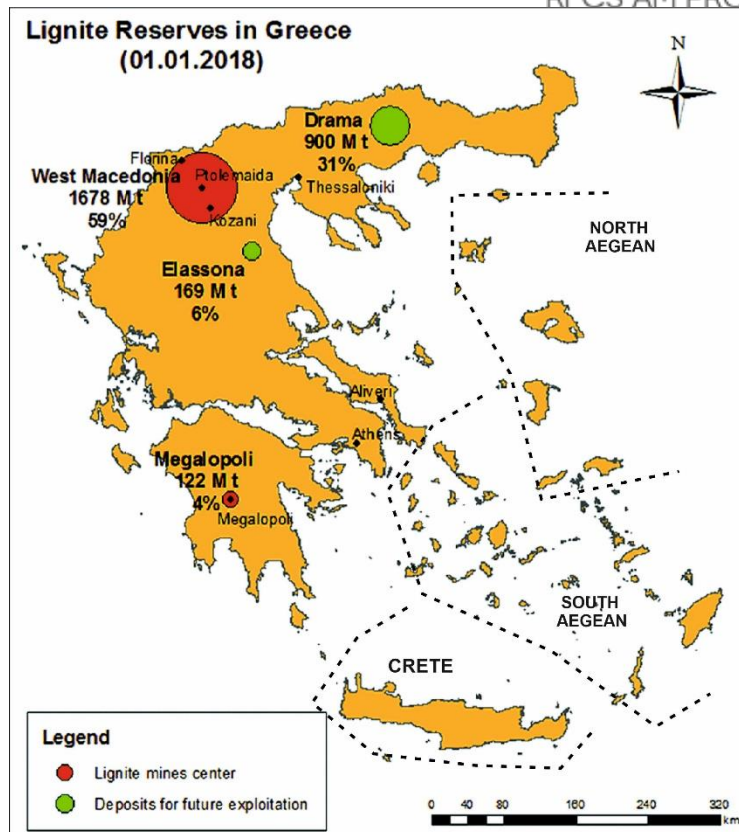


Figure 4-1. Map of Greece showing the location of transition regions in red color (Roumpos et al. 2018)

4.2 Potentials and Greek JTDP – Similarities

The POTENTIALS project presents a strategy including a set of scenarios and actions aiming to provide solutions for the transitioning areas in Greece, Poland, Germany and Spain. Those scenarios and actions comprise potential alternative solutions for green energy production in the coal-transitioning regions, in order to mitigate job losses due to the mine closure, as well as energy deficiency due to the closure of coal power plants and mines. The goal is to exploit these areas, the already existing facilities and infrastructure, as well as the former coal workforce, in order to produce energy from renewable sources.

The JTDP was created in accordance with the Green Deal and the goals and regulations set by the European Union for the just transition to clean energy in order to achieve net zero greenhouse gas emissions. The POTENTIALS project aligns and supports the targets of reducing GHG emissions, increasing the RES share in the gross energy consumption and improving energy efficiency via supporting the network. The scenarios presented in the project that include energy production via RES, will contribute to the national energy security, a key-aspect issue also presented in the JTDP.

The proposed plans for the closure of lignite mines, and RES potential in the transitioning areas are extensively presented in the JTDP. These data can be complemented and upgraded by the scenarios presented in the POTENTIALS, regarding alternative solutions for the exploitation of the transitioning areas for green energy production and accompanied solutions. Another aspect mentioned in both the JTDP and POTENTIALS is the utilization of the existing infrastructure by adapting new technologies for RES applications and green energy production. There are already projects under licensing led by the PPC in the transitioning areas, regarding RES (mainly photovoltaics). These projects could be further improved and developed by the scenarios presented in POTENTIALS (Just Transition Development Plan, July 2020).

The key-aspects of the Greek JTDP align in various sections with the goals and actions proposed by the POTENTIALS project (Just Transition Development Plan, July 2020). For example, the Greek JTDP foresees to adopt the transformation of the transition regions in the country and support the Clean energy pillar of development through increase in energy production from RES. The electricity produced is going to be mostly as a result of solar energy through the construction of photovoltaic parks of ~ 2GW in the Western Macedonia Region and ~ 0.5GW in the Megalopoli Region (Just Transition Development Plan, September 2020). Lastly, the JTDP also mentions the importance of gaining knowledge from international experience and European union regions in energy transition, which may be aided by the POTENTIALS, as a collaborative project between different EU countries (Just Transition Development Plan, July 2020).

The primary scenario of Eco-Industrial Parks (EIPs), by the definition given in the POTENTIALS project, includes RES such as wind turbines and photovoltaics. These green energy alternatives are extensively mentioned in the JTDP of Greece, as well as the regional Just Transition plan of Western Macedonia, as viable and mature technologies for alternative energy sources in Greece. Both wind turbines and photovoltaic parks are already extensively applied throughout Greece, in both transitional and non-transitional areas. These technologies are effectively and widely applied in the country due to the ideal Mediterranean climate, characterised by strong periods of sunshine and several periods of wind (Just Transition Development Plan, July 2020; September 2020).

Three other major scenarios presented in the POTENTIALS project that are also mentioned in the JTDP of Greece, specifically for the Western Macedonia Region, include: (a) the “Green H2 Plant”, as green hydrogen production (b) the Biofuels (the POTENTIAL scenarios are divided to “Biofuels production” and Biofuels combustion”), and (c) Hydro-pumping as a specific-site scenario for Greece. Regarding the latter, the JTDP mentions the alternative of hydroelectric energy generation for the lignite-transitional area of Western Macedonia. It strongly supports this solution and provides information about already existing hydroelectric plants and under-construction projects in this area and throughout Greece. These data indicate the suitability of Greece’s geomorphology (or topography) and hydrological conditions, further justifying its selection as a site-specific scenario (Just Transition Development Plan, 2020; September 2020).

Waste management and circular economy is also issued in the JTDP, which can also be supported by specific scenarios developed in the POTENTIALS project. Circular technologies based on waste heap materials recovery, pumped water material recovery, and usage of methane from degasification units on closed coal mines were proposed as supporting micro-actions to the main scenarios. Another important scenario for an alternative fuel, that is mentioned in the JTDP of Greece, is renewable methanol or biomethanol which can be produced from biomass gasification (contrariwise to conventional methanol which is produced by coal or natural gas). Renewable or green methanol can also be produced from green hydrogen and captured CO₂ (Just Transition Development Plan, 2020; bp Energy Outlook, 2023; <https://www.iberdrola.com/about-us/what-we-do/green-hydrogen/green-methanol>; https://www.iea-amf.org/content/fuel_information/methanol; <https://serene.advent.energy/methanol-hydrogen-carrier-fuel/>). Methanol is also considered an ideal hydrogen carrier, being able to produce hydrogen fuel in its turn (<https://serene.advent.energy/methanol-hydrogen-carrier-fuel/>). In line with the POTENTIALS scenarios of biomass combustion and green H₂ plant, renewable methanol can therefore be effectively implemented in the Western Macedonia region.

The scenarios of the POTENTIALS project promote research and development in green applications and renewables, through introducing: a) process and product innovations, b) novel patent applications, and c) the full-time employment of new researchers. These goals are in accordance with the relevant JTDP targets for R&D activities, innovation, new technologies and related new jobs (Just Transition Development Plan, July 2020).

Another major advantage that the POTENTIALS project will provide, is the full-time employment increase in the RES sector, as well as the relevant sectors that are included in the supporting actions, such as waste recycling and batteries. The job opportunities that the EIPs will provide involve direct and indirect jobs related to solar energy (PV panels), wind energy, geothermal energy, and other synergies involved. The direct jobs will include mechanics, technicians, operation and maintenance specialists, jobs related to manufacturing and construction, or repair and monitoring. This will help fight and alleviate the risk of unemployment, which is extensively mentioned in the JTDP, and which has already been observed to occur in the transitioning areas of West Macedonia and Megalopolis within the last years. Data regarding the use of fossil fuels and electricity in the transition areas, as well as the demographics with the specific characteristics of the population of each transition area (such as the educational level and the employment sectors), are extensively mentioned in the JTDP. Upon that information, JTDP is setting a goal for a just transition to fight the potential job losses. Therefore, POTENTIALS may also contribute in the achievement of these targets (Just Transition Development Plan, July 2020).

The necessity of reskilling and training new employees or former coal-related employees in job occupations related to green jobs, mainly in the RES sector, is also a key goal of the JTDP, and a mandatory action to fight unemployment in the coal sector (Just Transition Development Plan, July 2020). The POTENTIALS project will contribute

by considering the requalification needs that are required for direct and indirect jobs in the Eco-Industrial Parks and other accompanying synergies and actions. These needs involve basic skills that include the knowledge level, technical skills and soft skills (non-technical qualifications). The main areas of focus should be Mechanical, Technological, Operation & Maintenance and Construction knowledge & skills that will be adapted in the targeted sectors, such as solar energy, wind energy, geothermal energy, and other synergies.

The JTDP signifies the opportunity for new business activities, along with the necessity of funding schemes and to support RES projects, which is aligned with the relevant targets of the POTENTIALS project. The setting of a legislation and policy framework that will enable and support RES relevant projects mentioned in POTENTIALS will help developing business opportunities and economic activities as presented in the JTDP. The importance in the involvement of both governmental support and the attraction of investors and stakeholders is also a priority in order to make the proposed scenarios and actions achievable (Just Transition Development Plan, 2020).

4.3 Potentials and Greek JTDP – Contributions

Potentials project scenarios contribute to the improvement of the Greek JTDP by offering alternative solutions to the closure of coal mines in the country. A specific roadmap will be presented in the project that takes into consideration the synergistic potentials of end-of-life coal mines and coal-fired power plants, along with closely related neighbouring industries.

Deliverable 4.1 Business model justification of Potentials concludes that EIPs are the most effective business model for areas that are currently in a transition phase from coal-dependent to green energy. In order to increase the efficiency of the EIPs, Potentials suggests the additional implementation of scenarios such as Green H2 plant, molten salt plants, batteries and biofuels to the main sources of energy. The main objective of the EIP is to reduce waste and pollution by promoting short-distance transport and optimising the parks' materials, resources, and energy flows.

Although the main sources of energy will be complemented by additional implementation scenarios, the challenge if the amount of energy produced will be enough to cover the country's energy needs arises. To overcome this issue, Greece has turned its focus to another type of energy production, hydro-pumping. Such examples are the Hydroelectric Power Plant units in Kozani, Western Macedonia Region, that are in commercial operation, connected to the lignite areas in the region and considered as RES Production Stations (Just Transition Development Plan, September 2020). The system is comprised by 5 production Hydroelectric Power Plant units, 2 at Ilarionas and 3 Polifito, located on the Aliakmon river/basin, with a total capacity of 528 MW.

The production of hydroelectric energy has proved to be efficient, however there is need to incorporate the concept of (hybrid) pumped hydro storage (H)PHS systems that will include open-coal pit mines which are no longer in use. Potentials encourages the implementation of (H)PHS in the Greek JTDP for transition areas that are

characterized by open-pit coal mines, which could prove to be an effective additional source of energy, through exploitation of the existing infrastructure. Greece benefits from the presence of open-pit coal mines, which constitute the majority of mines in the country, and which due to their topography allow the construction of reservoirs at different elevation.

Such example is the ATLANTIS research project, which aims to focus on the repurposing of the depleted Kardia open-pit mine in the Western Macedonia Region. The mine is considered to be used for the construction of a (H)PHS system with a potential energy storage capacity from 1.09 to 5.16 GWh (Krassakis et al., 2023). Overall, the topography in addition to the presence of natural and artificial lakes makes these areas favorable for the construction of (H)PHS. Another benefit of constructing (H)PHS in areas of open-pit mines is that they are close to the Lignite Power Station used for the energy transmission, thus allowing direct access and connection to the energy grid (Soumelidis, 2022; Krassakis et al., 2023). This solution will also play a positive role, in relationship to the social impact due to the closure of coal mines, through the creation of new job opportunities in the RES sector for its employees.

The Greek Government has introduced a more transparent, efficient and simplified legislative framework (Law 4685/2020, Government Gazette A' 92) which modernizes and accelerates the first phase of licensing of RES projects (Ministry of Environment and Energy, 2020). The new framework is replacing the Electricity Production License from RES of Law 3468/2006 (Government Gazette A' 129) with the producer certificate granted through an automated process of the new electronic register of electricity production from RES. Although this represents an important development in the process of licensing RES projects, hydropower electricity has smaller share compared to other RES in the country. Less complexity in bureaucracy could also promote and speed up the production of energy from (H)PHS projects.

4.4 Prioritisation of business models for the Greek JTDP

The integration of Potentials project's results in the JTDP update of Greece includes the development of an Action Plan that will incorporate prioritisation of business models in relation with the operational objectives. The prioritization of business models will be conducted using the MoSCoW technique. In the MoSCoW technique, business models are categorized into priorities as presented in Table 4-1.

Table 4-1. MoSCoW technique business models categorization

M (MUST)	Projects that must be implemented Projects of a critical nature to achieve minimum benefits. They form the basis for the implementation of subsequent projects.
S (SHOULD)	Projects that should be implemented Projects that are important from the user's point of view and bring specific benefits.

C (COULD)	Projects that can be implemented Projects that can potentially be implemented, however, in the event of delays, shortfalls with the agreement of stakeholders, implementation may be suspended.
W (WON'T)	Projects that may be considered in the future These are projects that extend the core functionality and are not required to be implemented in the first instance. They can be considered in the next phase of the project. They are also the least cost-effective projects.

The main operational objectives of the Greek JTDP, are presented in Table 4-3.

Table 4-2. List of the main operational objectives of the Greek JTDP (Just Transition Development Plan, July 2020)

Symbol	Greek JTDP Objectives
C1	an integrated model of sustainable development in all economic sectors
C2	combining energy sector development with environmental protection with decisive measures to combat climate change
C3	the choice of energy policies with the best cost-benefit ratio for energy transition
C4	waste management and utilization with modern technologies of circular economy
C5	the transformation of Greece into an energy hub with a strong contribution to the energy security and security of supply of the EU
C6	the strategy of diversification of energy imports, along with the modernization and development of energy infrastructure
C7	an attractive investment environment to support the energy transition, with an emphasis on innovation and new technologies
C8	maximizing the use of Community resources and mechanisms
C9	extroversion and innovation to achieve growth that will create new jobs

Taking into account the MoSCoW technique and the identified business models in the Potentials project (Deliverables D4.1-D4.3), a matrix was developed to assess the

potential impact of the business models on the achievement of the objectives for the Greek JTDP.

The assessment was conducted using a 0-1 system, where 0 represents a business model that does not directly impact the achievement of specific goals, and 1 represents a business model that directly impacts the achievement of specific goals. The evaluation is based on the results from Deliverables D4.1-D4.3 (Table 4-3).

Table 4-3. Evaluation of the Potentials project business models against the operational objectives of the Greek JTDP

Business Model	Greek JTDP Objectives									Sum
	C1	C2	C3	C4	C5	C6	C7	C8	C9	
Virtual	1	1	1	0	1	1	1	1	1	8
Hydrogen	1	1	1	0	1	1	1	0	1	7
Eco-Industrial Park	1	1	1	0	1	1	1	1	1	8
FloatingPV	0	1	1	0	0	1	1	0	1	5
Tourist	1	1	0	0	0	0	1	1	1	5
Pumping	0	1	0	1	0	0	0	0	0	2
Fishers	0	0	0	0	0	0	0	0	1	1
CCGT	0	1	1	0	1	1	1	0	0	5
Minegas	0	1	1	1	0	1	1	0	0	5
Nuclear	0	1	1	0	1	1	1	0	1	6
Biofuels	0	1	1	1	1	1	1	1	1	8
Moltensalt	0	1	1	0	1	1	1	0	1	6
Agropotovoltaics	0	1	1	0	0	1	1	1	1	6
Batteries	0	1	1	0	1	1	1	0	0	5
Wasteheaps	0	0	0	1	0	0	0	0	0	1
Methane	0	1	1	1	1	1	1	0	1	7
Water	0	0	0	1	0	0	0	0	0	1
Forest	0	0	0	0	0	0	0	0	0	0
Information	0	0	0	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0	0	0	0
Gravitricity	0	1	1	0	0	1	1	0	0	4
Dense fluids	0	1	0	0	0	1	0	0	0	2
Hydropumping	0	1	1	0	1	1	1	1	1	7

To determine the priorities for the business models analysed, the following minimum thresholds are set:

- Priority MUST - min. 8 points
- Priority SHOULD - min. 6 points
- Priority COULD - min. 4 points

There are cases, such as the construction of geothermal power plants, that even if they are considered cost efficient generally, in the case of West Macedonia are not well-suited. That is the reason this scenario has been attributed with lower values. The results of the prioritisation of business models regarding the objectives of JTDP are presented at the following Table 4-4.

Table 4-4. Business models regarding the operational objectives of JTDP models divided according to prioritization

MUST	SHOULD	COULD
Virtual	Hydrogen	Pumping
Eco-Industrial Park	FloatingPV	Fisheries
Biofuels	Tourism	Wasteheaps
Methane	CCGT	Water
Hydropumping	Minegas	Forest
	Nuclear	Information
	Moltensalt	Geothermal
	Agropotovoltaics	Gravitricity
	Batteries	Dense fluids

The business models presented in Table 4-3 take into consideration the synergistic potentials of end-of-life coal mines and coal-fired power plants. Table 4-3 is, generally, in agreement with Deliverable 4.1 Business model justification of Potentials, which concludes that EIPs are amongst the most effective business model for areas that are currently in a transition phase. Virtual plant, biofuels, methane and hydropumping are other effective business models in the “MUST” priority category, as proposed by the MoSCoW analysis. Table 4-3 is also in agreement with the deliverable 4.2 of Potentials, as hydropumping was selected as a potential source of green energy for transition areas in Greece. These “MUST” business models are of critical nature in order to achieve the necessary energy demand for the country and form the basis for the implementation of other similar future projects. However, in order to increase the efficiency of the business models that belong in the “MUST” category and achieve the national energy security,

Potentials suggests the additional implementation of scenarios, that belong in the “SHOULD” category as additional sources of energy or alternative scenarios, such as the Green H2 plant, molten salt plants and batteries.

4.5 Summary

1. The key-aspects of the Greek JTDP align in various sections with the goals and actions proposed by the POTENTIALS project.
2. The production of electric energy from solar energy prevails other sources of energy production, as emphasis is placed on the construction of photovoltaic parks in both the Western Macedonia and Megalopolis Regions.
3. The installation of photovoltaics will be complemented with the possibility of setting up of an individual green hydrogen plant, in the Western Macedonia Region.
4. For the assurance of energy stability, the development of a “battery plant” along with a (hybrid) pumped hydro storage plant providing energy to the grid, is considered to be an additional suitable energy source for the transitional Regions, as suggested by Potentials.
5. Taking into account the MoSCoW technique, the results obtained are in agreement with the suggestions provided in Deliverables 4.1 and 4.2 of Potentials, regarding the hierarchy of business models presented.
6. Based on the MoSCoW technique analysis the “MUST” business models for the transitioning areas included the EIP, the virtual plant, biofuels, methane and hydropumping, whereas Hydrogen, Floating PV, Tourism, CCGT, Minegas, Nuclear energy, Moltensalt, Agrophotovoltaics and Batteries are categorised as “SHOULD” option. The Pumping, Fisheries, Wasteheaps, Water, Forest, Information, Geothermal, Gravitricity and Dense fluids are regarded as the less feasible options compared to the other two categories and they are grouped as “COULD” options.
7. According to the MoSCoW technique analysis, the business model of (hybrid) pumped hydro storage plant presented by Potentials is quite promising (“MUST” category) and it is recommended as an addition in the Greek JTDP.
8. From the above, it can be concluded that an update of the Greek JTDP should be considered, including some key performance indicators for its evaluation of performance and the additional proposed actions/business models for the coal transitioning areas of Greece suggested by Potentials.

5 German Territorial Just Transition Plan

5.1 Introduction

On 21 October of 2022, the European Commission has approved the Territorial Just Transition Plans (TJTPs) in Germany in the period 2021-2027 for the four supported coal regions of the German Countries (“Länder”) North Rhine-Westphalia, Brandenburg, Saxony and Saxony Anhalt.

These four regions, most impacted by the green transition, receive 2.5 billion Euro from the European Union’s Just Transition Fund to help the shift to climate-friendly economy and to move away from coal in a fair manner.

The JTF support is concentrated on the reskilling of people and businesses, diversification of the economy, investing in sustainable mobility, digitalization and energy efficiency.

The central goals of the JTF support in Germany can be visualized as in this chart (Figure 1) of the press release of the European Commission accompanying the approval. These central goals are support for SMEs and start-ups, jobs and upskilling and reskilling in the just transition regions.



Figure 5-1. Just Transition Fund in Germany (European Commission 2022)

As the Commission has announced in the press release Germany committed to 65% less CO2 emissions by 2030 and climate neutrality by 2045. The country's commitment to

phase out coal by 2038 or earlier, will be an important step towards its climate goal. The €2.5 billion Territorial Just Transition programs will help these four regions making sure that their transition to climate neutrality does not leave anyone behind in the local economy and society. The JTF supports the territories that face specific challenges in the transition towards a climate-neutral economy.

The identification of these territories is specified in Territorial Just Transition Plans (TJTJs) and it is carried out through a dialogue with the Commission in the framework of the negotiations of the 2021-2027 Partnership Agreements and the associated programs.

The TJTJs, developed in close consultation with local partners, set out the challenges in each territory, as well as the development needs and objectives to be met by 2030. They also identify the types of operations envisaged along with specific governance mechanisms.

The approval of TJTJs opens the door to dedicated financing under the other two pillars of the Just Transition Mechanism (JTM): a just transition scheme under InvestEU and a Public Sector Loan Facility for Just Transition that combines Commission grants with European Investment Bank loans.

The press release of the European Commission has also declared the special main points of the different German Länder with view to JTF support and their TJTJs, which are presented hereafter.

5.1.1 North Rhine-Westphalia will invest in a sustainable future

North Rhine-Westphalia will receive €680 Million. The Northern part of the Ruhr area, the former so called 'coal pot' of Europe will move from a coal-based industry to an industry based on renewable energy. Investments will focus on restoring the land of lignite mines and creating new small and medium businesses (SMEs) and start-ups in the green sectors like resource efficiency, circular economy, bio-based alternative raw materials, but also land rehabilitation. This will create new job opportunities.

Moreover, in the Rhenish territory (Rheinisches Revier), the lignite mines and power plants will be closed, and the JTF will invest in particular in targeted training and coaching to retain jobs.

5.1.2 Brandenburg will diversify its economy

Brandenburg will receive €785 Million to diversify its economy and smoothly move away from a lignite and petrol-based economy. Investments will be made especially in the Lausitzer Revier by supporting innovative SMEs in the green sectors like bio-based

materials, resource efficiency and circular economy and the establishment of a hydrogen plant as alternative to the local lignite-based production.

In Schwedt in the sparsely populated Uckermark, where the Germany's fourth largest oil refinery is located, the JTF will invest in renewable district heating, in an innovation campus and in job training.

New job opportunities in the green sectors will ensure the employment of lignite workers and skilled young people remain to work in the region.

Saxony will focus on renewables and circular economy

In Saxony, €645 Million will be invested in a just transition of the Lausitzer Revier, the Mitteldeutsche Revier and the city of Chemnitz, dependent on a lignite mining and energy production with lignite.

The EU funds will support innovation and the uptake of technologies, mainly focused on renewable energy and circular economy. Raw materials such as gypsum, derived from coal-fired power plants, will be replaced by green, hydrogen-based solutions. Investments will be made in SMEs specialised in green energy and circular economy, which will create new jobs.

Moreover, the Fund will help reskilling almost 1,300 people and expand vocational schools.

5.1.3 Saxony-Anhalt to move to a new economic structure

In Saxony-Anhalt, €364 Million will support the greening and phasing out of lignite from the Mitteldeutsches Revier. The JTF will also support the cleaning-up and renovation of mining sites in a sustainable manner, but also the creation of a new hydrogen infrastructure and of green start-ups and SMEs. Moreover, investments will be made in decentralised transformation centres and sustainable transport in the rural core regions of the Revier.

These projects will create new jobs in the green sectors, like bio-based materials, green hydrogen for industry, and circular economy. Funds will be allocated also for the training of workers in the lignite sector which will enable them to keep an employment. Finally, the Fund will also implement measures in line with the New European Bauhaus, such as the use of alternative raw materials.

5.2 Initial Positions for the German TJTPs

Germany has fixed nationally in accordance with the energy and climate policy ambitions of the European Union a gradual transformation to a climate-neutral economy in 2045 and taken provisions to the reduction of climate gases by at least 65% (in relation to 1990) until 2030. The largest contribution must be made by the fossil energy sector via a reduction of 77% of the CO₂ emissions until 2030.

A central building block of the German energy transition is the phase out of coal power generation in a socially and regionally acceptable manner until 2038 at the latest as politically decided in 2020/2021 and fixed in corresponding legal and contractual provisions. The coal phase out could be “ideally” accelerated until 2030 due to the Coalition agreement of the new elected Federal government in 2021 in dependance of the progress of expansion of renewable energies and power grids.

The direct dependance of German lignite mining as supplier of power stations (around 90% of the German lignite production is dedicated to power generation) will force a shutdown of 18 of the 30 lignite power stations beforehand until 2030, as well as a rescheduling and shortening of the open cast mining activities in respective lignite areas. But, the transition of the most affected regions will proceed as a result of the European and national climate targets differently because of regional peculiarities and varying starting points. The structural change in all of the most affected regions will cause a reduction of employment and the challenge of avoiding unemployment.

To overcome the socio-economic consequences as absent investments, low company formation, migration and desolation, there must be identified investment priorities in and for the regions. Furthermore, accomplished adequate economic policy measures are needed to reach the goal of strengthening technological efficiency, a close interlocking with the persisting regional economy and a systematic transfer of knowledge and technology for reinforcing the development potential of the regions. Moreover, measures have to be initiated for occupational education, training and up-skilling to develop successfully the present professional skills and make the regions more attractive for start-ups, spin-offs and company settlements by taking into account the needs of existing and interested firms.

The scenario of coal phase-out in Germany is intending a gradual reduction of coal power generation from 39,7 GW in 2019 to 30 GW in 2022 (now modified temporary because of the energy crisis) and to a maximum of 17 GW in 2030. The total coal phase-out should be reached in 2038 at the latest. The coal power capacities must be substituted step by step by investments in Renewables (and their necessary infrastructure). Current studies are showing that the demand for fossil fuels in Germany will shrink significantly until 2030, not only as decided for coal but also, for example, for oil products by half of the demand in 2018. By this, fossil fuel refinement processes also

cease to apply (coal coking, petroleum refining). Job losses must be expected corresponding to the reduction of all these productions.

The major burden of the transformation in general and especially the coal phase-out has to be borne by the regions with high shares of regional value-added by power based on fossil fuels as lignite and coal and the refinement of fossil fuels (coking coal, mineral oil), respectively where the former mining of fossil fuels is still shaping the regional economy (coal mining).

The German Coal Commission (officially Commission „Growth, Structural Change and Employment“) has shown by its intensive regional data analysis that the most affected regions are the lignite areas of Lusatia in Brandenburg (City Cottbus and districts Dahme-Spreewald, Elbe-Elster, SpreeNeiße, Oberspreewald-Lausitz) and in Saxonia (districts Bautzen, Görlitz), the Central German coalfield („Mitteldeutsches Revier“) in Saxonia (City Leipzig, districts Leipzig and Nordsachsen) and Saxonia- Anhalt (City Halle, districts Anhalt-Bitterfeld, Burgenlandkreis, Mansfeld-Südharz, Saalekreis), all in Eastern Germany, and the Rhenish territory (“Rheinisches Revier“) in North Rhine-Westphalia/Western Germany (districts Aachen, Düren and Heinsberg, Rhein-Kreis Neuss, Rhein-Erft-Kreis, City Mönchengladbach). Moreover, there are some smaller but also strongly affected areas in Germany in Brandenburg (district Uckermark), the City of Chemnitz in Saxonia and in North Rhine-Westphalia the Cities Bottrop, Gladbeck, Dorsten and Marl in the Northern Ruhr area. This development area backdrop is congruent to the investment guidelines for the JTF.

Result of a detailed analysis for single parts of some supplemented regions (districts Aachen and Heinsberg, City Mönchengladbach) has been that a large part of the population and the local economy is depending on the lignite industry and considerably affected by the coal transition. A similar result ensues for Chemnitz because of the power supply only based on lignite. A strong dependence of the Uckermark region on the PCK refinery in Schwedt, specialized on liquid fuels and therefore depending on the shrinking fossil mobility, makes it to the most affected refinery location in Germany. This transition will be fostered by the announced phase-out of buying crude oil from Russia, the only crude oil refined by PCK. Affected regions in North Rhine-Westphalia are furthermore caused by the consequences of the complete closure of hard coal mining in 2018 and the finishing of refinement and industrial use of imported coal as well as by the reduction of coal power generation in the near future.

The predominant sectors and industry structures in the three different German lignite regions are not identical. But, these regions have in common that the lignite industry has a highlighted role. The degree of industrialization without consideration of the lignite industry is in all three areas lower as in the rest of Germany. An exception are some so-called intermediate goods (e.g. chemical industry and other energy-intensive

industries). Beside the energetic use of lignite, some industries are actually dependent on lignite as a raw material in the production of gypsum.

The lignite regions have different strengths and weaknesses related to the service sector. A common feature is a lower importance of financial and insurance services as well as information and communication services and research and development. Subsequently, the lignite industry is of high importance as an employer in these regions. There have been 19,430 directly employed workers in the year 2020, mostly jobs with a relatively high level of qualification. The salary is above average in relation to other employees in the regions and other industries. Taking into consideration indirect and induced employment effects, estimated by the Economic Research Institute RWI 2016, the German lignite industry counts for more than 31,000 jobs and 1,4% of all jobs subject to social insurance in the regions (which is 0,9% of all jobs in the German industry and 0,2% of the whole German manpower). The shares are considerably higher in some parts of the lignite regions and therefore are more affected by the coal transition.

In any case, the phase-out of coal power generation will cause significant economic consequences. The gross value added of power generation based on lignite amounted to 3.356 Million Euro in 2016 (RWI) with shares of 1.705 Million Euro in the Rhenish territory, 1.221 Million Euro in the Lusatian area and 430 Million Euro in the Central German area. This gross value added will steadily be reduced until 2030 and is later going to cause welfare losses in the regions. The comparison of the shares of gross value added and employment by the lignite industry demonstrates that the share of gross value added (in %) is higher. This is an indication for the relative high working productivity of the lignite industry in comparison to the industries in the regions. That means the loss of employment in the lignite industry will cause a lower income per person.

The situation in the Northern Ruhr area is similar to that. Hard coal mining was completely finished in 2018 by the closure of the last mines. Retreating and filling work will be presumably completed in 2027. The (former) mining and now post-mining company RAG (Ruhrkohle) employed 1,240 workers in 2021 and will have only around 470 employees after the end of the retreat. Furthermore, the refinement and industrial use as well as power generation of imported coal is an important economic factor in North Rhine-Westphalia with several hundreds of employees, which are all affected by the coal phase-out.

Taking into consideration of the whole value chain of hard coal, there will be a loss of around 3,300 jobs which is 3,6% of all jobs subject to social insurance and 10,7% of the industry jobs in North Rhine-Westphalia. Mostly affected are the Cities Bottrop, Dorsten, Gladbeck and Marl in the Northern Ruhr area. The retreating work of RAG needs above all installers, masons, fitters and civil engineers not only as employees of RAG but also by specialized external companies. The closure of hard coal mining has reduced a wide spectrum of jobs in the coal regions and will reduce it further after the complete retreat.

Besides pure mining occupations around the mining activities no longer needed, also mine building and engineering or processing and transport of coal and material and additionally a lot of other occupations as electricians, locksmiths, surveyors or diverse administrative jobs will be gone. A lot of companies in the fields of refinement and use of hard coal are settled near the coal deposits of the Ruhr area, now also affected by the transition to a climate-neutral economy.

The City Bottrop had been the location of the last coal mine in the Ruhr coalfield and is still the location of the coking plant Prosper owned today by the steel company Arcelor Mittal. This coking plant employs 450 workers and delivers two thirds of its production (+/- 2 million tons of coke per year) to the Arcelor Mittal steel factory in Bremen, which has no coking plant by itself, and one third to other Arcelor Mittal steel factories in Europe, mainly in France and Belgium. While the consumption of steel will increase in the years to come, there is expected a fundamental transformation of steel production, not only in Europe because new technologies in steel production will be deployed to reduce the consumption of coking coal and the emission of CO₂. In Germany, coking coal in steel industry shall be substituted by hydrogen with first steps already until 2025.

The more restrictive climate ambitions of the Federal government written down in the German Climate Protection Law will increase the adjustment pressure in the steel industry in Germany. The plan of the steel producer ArcelorMittal is providing for a production of 600.000 tons of “green steel” in Bremen and other locations in Europe in the next years up scaled to 3.5 Million tons of green steel based on hydrogen already in 2026 to reduce carbon emissions. By these developments the demand for coke from the coking plant in Bottrop will significantly be reduced and could be lost totally in medium term as well as the jobs connected.

The coal phase-out in Germany affects also the utilization of hard coal in the power generation based on coal by the gradual reduction since 2020 and the complete phase-out until 2038 at the latest, maybe even earlier. Therefore, also the Ruhr area has seen the first closures of coal power stations in 2021 and has to expect the next closures in the years to come. The coal phase-out evokes a significant loss of value added and employment not only in the coal power stations, but also for supplier, logistic, maintenance and other service companies in the Northern Ruhr Area with all its indirect and induced effects, see the number above.

This menace of job losses in the near future could restrict also future employment possibilities for the next generations in the Northern Ruhr area. The Cities Bottrop, Gladbeck and especially Dorsten are characterized by an economic structure with firm sizes below average (in comparison with the average in Germany). The potential of the existing companies in regions to compensate the job losses is restricted. The unemployment rate in Bottrop, Dorsten, Gladbeck and Marl is today above the average in Germany and North Rhine-Westphalia. While the share of long-time unemployment

in North Rhine-Westphalia is around 35%, this share is around 45% in Bottrop and Dorsten and more than 50% in Gladbeck and Marl; people in long-term unemployment are often persons with a low degree of education and no professional qualification. The former reduction of employment in coal mining could be managed in a socially acceptable manner, especially by early retirement of mine workers. Hence, the unemployment rate at locations of mine closures in the last years as in Bottrop does not reflect the complete burden of the job market by the loss of the jobs in coal mining. This structural weakness caused by the former structural change is diminishing the capability of the region to master the additional socio-economic consequences of the transformation to a climate-neutral economy by its own.

Beside the jobs, also apprenticeships and training places are in danger in the regions. Already today there is a lack of training places, but also a matching problem. The mining and coal industry companies in the Northern Ruhr area had been and are still pillars of the vocational training in the region, especially in technical and commercial occupations. RAG had been one of the largest training and instructing companies for professionals in the whole Ruhr area, not only by training for its own demand but also for the demand of other companies. Even ArcelorMittal has more trainees than required by itself and is managing a training combination with other firms as the Chemistry companies Evonik at the location in Marl or Ineos Phenol in Gladbeck. A loss of these training places could affect occupations as industrial mechanics, electronic technicians, mechatronic technicians, cutting machine operators or professionals for metallurgy and chemical work.

The supply and matching problem for the job training market in Northern Ruhr area will be aggravated by the transformation if the structure of the re- and upskilling facilities will not be bettered. Special attention is also needed for the people still in the coal industry with lower qualifications, handicaps and of old age (before retirement) by individually tailor-made consultation and qualification. Looking to the professional requirements in the whole region Emscher-Lippe (surrounding the four cities), there is a large request for professionals in general and especially for experts in energy and electronic techniques.

Another problem of this region is that the number of inhabitants of Bottrop, Dorsten, Gladbeck and Marl has decreased in the last 20 years with the largest reductions of 8% in Dorsten and more than 10% in Marl. For all these cities a further reduction of inhabitants by around 7% is forecasted until 2040 and the composition of the population is shaped by an increased aging.

Another problem not only but also in the Northern Ruhr area are the environmental long-term effects of the former coal mining. There are a lot of former coal areas with difficulties for a market-driven development because they do not fulfill the necessary requirements for commercial areas. On the other side, due to the long mining history in

the German coal regions there are profound experiences and longtime-proved procedures for the phase-out of mining operations under protection of the polluter pays principle. This is legally provided by the German Mining Law (Bundesberggesetz). Mining in Germany was and is allowed only on the base of operational plans reviewed by the mining authorities. For the phase-out of mining it is necessary to notice and get approved a closing operation plan including all provisions to protect people from risks for health and live by the former operations. In this case, all the provisions and aftercare duties have been fulfilled by RAG.

However, the closing operation plan and aftercare duties do not and cannot comprehend obligations and measures for the rehabilitation of the surface areas as high-quality and sustainable areas for commercial purposes or for green infrastructure. For a subsequent use of former coal mining areas in such a way additional measures and more expenses are needed in this region. Under certain circumstances, mining-related subsidence must also be compensated. In Bottrop or Marl the share of areas with serious restrictions of use caused by the former coal industry is more than 66%. Because of these large shares of wasteland, the availability of market-driven commercial areas in the whole Ruhr region and especially in the cities Bottrop, Dorsten, Gladbeck and Marl is decreasing. The existing area reserves in Dorsten will be exhausted in less than 15 years, in Marl in less than 10 years. This is an important obstacle for the transformation of the regional economy and the creation of new jobs in the Northern Ruhr area.

This area is confronted with an enormous socio-economic challenge on the way to climate-neutrality. Therefore, the cities Bottrop, Dorsten, Gladbeck and Marl have a priority for support by EU structural measures and the JTF, especially because they are not included in the financial aids provided by the national coal phase-out law. The support by the Just Transition Fund and the TJTP for this region should help to adjust and diversify the regional economic structure, to create new jobs and to compensate the social, economic and ecological consequences of the phase-out of coal mining and the use of coal for power generation and steel production.

5.3 The TJTP for the Northern Ruhr area as an example for the JTF-funded transition

This chapter presents the exemplification of a summary of the TJTP for the Northern Ruhr area because this region is the one German coal region with the most coverage to the preconditions of the POTENTIALS project: (former) underground coal mines with corresponding infrastructure, some coal power stations nearby and a surrounding industry. All other coal regions in Germany with TJTPs are lignite regions with open cast mines and less industry in the vicinity. Nevertheless, the linkage to the green energy business models developed in the POTENTIALS project is weaker in the Northern Ruhr area than in the lignite regions. But, this demonstrates more clearly that TJF support in

Germany is more focused on economic diversification and the problems of employment, not new energy.

The main reason is that the coal phase-out in Germany is seen primarily as a matter of regional policy beyond energy and climate policy goals, which are pursued on the national level with priorities for national measures. The German plan for the green transformation and the expansion of wind and solar power generation is nationwide with no focus on coal regions, which are regarded as region with special structural problems and deficits.

The TJTP for the Northern Ruhr area has identified the following development needs until 2030:

- Provisions for sufficient commercial areas for the transformation and the diversification of the regional economy. A lot of wasteland as follow-up of the coal history is a big challenge. This wasteland has to be prepared for commercial use as basis and prerequisite for the transformation and diversification of the economic structure of the region. Hence, it is a primary goal of the TJTP to develop wasteland of the former mines in Bottrop, Gladbeck, Marl and Dorsten for commercial use of existing companies and start-ups until 2030 and to compensate the job losses as well as the losses of value added in the coal industry caused by the coal phase-out and the transformation.
- For this purpose, the existing companies in the region with or without connections to coal industry must be enabled to master the transformation along the whole value chain with new business areas and new jobs. But, the needed jobs cannot be saved by existing companies alone. It is necessary to develop the endogenous development potential in the Northern Ruhr area by a smart specialization. The focus should be on business fields with a high, but underdeveloped economic potential. Starting points are seen in the circular economy and in universities, research institutions and professional training centers. So, a main point for the JTF intervention will be an improvement of the structures of the professional education and training markets. The future demand for professionals must be satisfied by people from the region as far as possible with new technical and commercial job profiles, especially in the greenification, digitalization and sustainability of all businesses.
- To compensate the reduction of coal-based power generation, wind and solar capacities will be expanded in the whole country. There will be no more promotion and no JTF support of any fossil fuels. For the Ruhr area including its Northern part, it is intended to switch coal locations to locations for hydrogen and green gases. Still, the precondition and priority for the next time is the expansion and rebuilding of the grid infrastructure for a connection, for example,

to wind power from offshore wind parks in the Northern Sea or hydrogen imports.

- The TJTP for the Northern Ruhr Area must be in coherence with other relevant national, regional and territorial strategies. In relation to the national coal phase-out, the Government of North Rhine-Westphalia is implementing the so-called Five-locations-program for five locations with coal power stations in the Ruhr area in the cities of Duisburg, Gelsenkirchen, Hamm, Herne and the district Unna, which are not part, but partially in the neighborhood of the Northern Ruhr area. The purpose is to develop and strengthen sustainably the economic structure of these locations and to make them more attractive for the time after the coal phase-out. The priority is to promote the existing non-coal potencies in the locations and to open them up for external potentials. The guideline for their transformation is a more resilient and more digital transformation. There are five strategic goals for the Five-location-program; (1) Recycling and upgrading of the existing area potentials (2) New and more robust structures for the innovation system in the region (3) Consequent implementation of the transformation to a more resilient and sustainable economy (4) Optimization of the value chain of the education and training markets (5) A more efficient and sustainable transport system in the region. This Five-location-program is regionally connected and should be a complementation to the JTF-support for the Northern Ruhr area, especially for the safeguarding and creation of jobs and training places.
- The TJTP for the Northern Ruhr area will get additional support by the innovation strategy, the sustainability strategy, the digitalization strategy and the energy and environmental strategy of the Country North Rhine-Westphalia, its new mission statement for a greener industrial policy and its new concept for the promotion of start-ups (“Neue Gründerzeit”). Above all, the innovation strategy is taking into account regional strategies guided by the principle of a smart specialization as in the Rhenish territory or in the Ruhr area. There are seven fields of innovation, which are expected to strengthen the regional potentials: Smart production and innovative materials; connected mobility and logistics; environmental and circular economy; energy efficiency and innovative building activity; innovative medicine, health and life science; media, cultural and creative economy, innovative services; information and communication technologies and other key technologies. There a lot of cross-sector topics, especially in connection with information and communication technologies, which could give impulses to different fields. Digitalization, sustainability (including climate protection and climate resilience and resource efficiency) and innovative business models for SME should be at the center of all fields of the innovation strategy. This strategy is also bound to flanking the JTF support for the Northern Ruhr area. There could be productive interactions, if the JTF support creates

additional dynamic for the innovation process in the region and the country, for example in research and development.

- The JTF support for the Northern Ruhr area will be in accordance to national and regional climate plans and strategies as the Climate Protection Plan 2020 of the Federal government and the Long Term Renovation Strategy for energy, industry and mobility.
- The selection of projects for the JTF support has taken into account the experiences of the transformation in the Southern part of the Ruhr area, for example the development and reactivation of the former mining and automotive area Mark 51⁷ in Bochum to a modern, high-quality campus for industry, technology and knowledge business with new jobs and training places. This is a master example for the revitalization and upgrading of a location after the termination of former business activities by making it attractive for new businesses, start-ups and SME.
- The sustainable development or renaturation of former mining areas for new commercial use and/or green infrastructure will be a priority for the Northern Ruhr area. Green infrastructure will contribute to the cushioning of the ecological challenges of the future and the transformation. But, all projects for the development of areas have to take into consideration the characteristics of the locations and their surroundings and to balance the economic and ecologic concerns. By the use of previous mining areas, it is possible to reduce the consumption of other areas and to give them more space for new activities.
- The area development in the Northern Ruhr area by JTF support will be concentrated on the renaturation, revitalization and recycling of wasteland from former mining and steel industry sites with several projects: (1) The cooperation project “Freiheit Emscher” on a former mining site in Bottrop at the border to the City Essen, will create new residential building, future-oriented commercial locations in connection with traditional industries, technology-based companies and start-ups as well as education and research institutions. (2) The former site of RBH Logistics in Gladbeck, a service company of the coal industry for the maintenance of trains for the transport of imported coal from the river port in Duisburg to the cookeries and the coal power plants in the Ruhr area, will be developed for innovative trade activities. (3) Wasteland of the former mine Graf Moltke I/II in Gladbeck will be developed for new commercial use and production-oriented services. (4) Wasteland of the former mine Zweckel in Gladbeck will be developed for new commercial use by start-ups. (5) The cities Dorsten and Marl will realize as a cooperative location for an innovative industrial estate the former RAG location “Südlich Schwatten Jans” until 2026 partial projects with JTF support.

- JTF support will be used for knowledge and technology transfer from universities and research institutions in the region as Hochschule Ruhr West in Bottrop, Prosperkolleg Bottrop and the (adjacent) Westfälische Hochschule Recklinghausen to SMEs. Further support should go to the organizational and technical infrastructure and their scaling up of planned new incubator and technology centers (offices, laboratories, demonstration plants, machines, and tools, logistic facilities) to transform them into innovation hubs to activate start-ups and dynamize the knowledge and technology transfer and the economic diversification of the region. This could be accompanied by coaching and mentoring programs. Similar projects are scheduled for the promotion of craft skills and for freelance professions.
- Investments in modern infrastructures and the readjustment of qualifications for a future-oriented professional training and continuing education to enhance the job opportunities in the region. There is the role model of a “Zukunftscampus” for the unification of professional and academic education. One example is the planned establishment of a university for digital craft skills in Marl. There is also urgent need for energetic renovation of the buildings for training facilities and extension buildings. Necessary are special qualification, training and consulting measures for people in the coal industry and their supplier industry, including many SMEs. By the program “Changescout” some former coal people should be enabled to be key persons and multiplier of knowledge to initiate change and transformation processes in the companies. Other plans are the qualification of professional teachers for this target group, preemptive qualification approaches for green skills, outreach advice for employees endangered by the transition, special participatory training, coaching and consulting centers as well as tailored financial aid (by a budget for the education about transformation issues) for affected SMEs, support for networking initiatives of SME, also for the exchange of employees (“Arbeitsmarkt-Drehscheibe”) or the better matching of apprenticeships, establishment of a regional office for job consulting (“Beratungsbüro Arbeit”) with competence to initiate projects, to acquire project partners and to transfer successful project concepts from outside in the Northern Ruhr area.
- Mobilization of additional investments of the private and the public sector for the goals of the just transition including digitalization, renewables and sustainable energies (especially the promotion of green hydrogen and efficient district heating grids), sustainable mobility, environmental infrastructure for smarter use of water and sewage, measures for enhancing energy efficiency including integration and renovation of buildings, urban renovation and renewal, circular economy, restoration of soil and ecosystems and decontamination according to polluter-pays-principle, promotion of biodiversity, social

infrastructure including social housing and care facilities, facilities for qualification, training and retraining for all fields of the transformation.

- Establishment of governance mechanisms: The TJTP has been set up in participation of all relevant responsible and stakeholders. There had been a common video conference for both area sceneries in North Rhine-Westphalia (Rhenish territory and Northern Ruhr area) on the 06.10.2021 with regional and local authorities, business associations and social partners, representatives of the civil society and environmental NGOs, institutions for the promotion of social inclusion and disabled people, civil rights, gender equality and anti-discrimination as well as research institutions and universities. Likewise, responsible actors from the European Commission DG REGIO and DG EMPL were represented. This conference presented the legal framework and the area scenery of the JTF. After that, only a few position papers were launched. A second video conference on the 18.11.2021 was arranged, where the ministries for the economy and for labor of the country government in North Rhine-Westphalia have presented the TJTP for the Northern Ruhr area and discussed it with the participants with no further outcome. But, for the further participation in the planning, implementation, monitoring and evaluation process the EFRE/JTF monitoring committee has been installed (with 50 members related to the EFRE program in North Rhine Westphalia) and supplemented for the JTF program with five additional members : 1. Zukunftsagentur Rheinisches Revier, 2. WiN-Emscher-Lippe GmbH, 3. Bundesagentur für Arbeit (RD West), 4. Prosperkolleg e.V., 5. NABU-NRW. Participating with a consulting voice will also GD EMPL and the NRW Country government departments for the regional policy in the Rhenish territory and the Ruhr area. One year after the approval, it has to be set up an evaluation plan with indicators for the achievement of the goals of the TJTP decided by the monitoring committee. The coordination and the monitoring of the JTF support and its properly completion (fund approvals and calls, proofs of use) will be carried out in analogy to the EFRE and ESF measures by the relevant administration authorities of the Country government, who will regularly inform the monitoring committee about the progress. Needed changes in the regions have to be noticed by regional agencies and the still to be established office for job consulting (Beratungsbüro Arbeit) in the Northern Ruhr area. Their recognitions will be used to close funding gaps and to develop new needs-based measures (based on European Commission 2022; German Coal Commission 2019; EFRE-NRW 2021).

5.4 Some conclusions drawn from TJTP for the Northern Ruhr area in view of the POTENTIALS project

The TJTP for the Northern Ruhr area has no direct connecting points to the energy-centered business models developed in the POTENTIALS project because of other priorities of the regional policy in Germany as explained before.

But, currently there are plans to develop the whole Ruhr area to a model region for the use of hydrogen. If the production of hydrogen will become an option on the regional level some insights of the POTENTIALS project could be helpful.

Maybe in a later phase of the TJTP or in the next period of JTF support after 2027, when special problems or needs in the energy sector of the region become more visible or get more drive, other ideas of the POTENTIALS project like an Eco-industrial park or biofuels production on locations of former coal sites could gain more interest.

A central problem of the region is the creation of new jobs and job profiles in accordance with the green transformation. This feature is object of the RFCS-project GreenJOBS that is connected with the POTENTIALS projects in time and could draw more insights of the experiences of the presented TJTP for the Northern Ruhr area.

The TJTP for the Northern Ruhr area is demonstrating that the research on reactivation and transition of mining regions must be intensified here as in all former coalfields and not only (but of course also) in relation to new sustainable energy possibilities.

5.5 Post-Mining as a new field of interest in German Hard Coal Mining – Ruhr area

5.5.1 The Decline of Hard Coal Mining in Germany

Germany finally got out of hard coal in 2018 and has been in the so-called post-mining era ever since. Still, the way to get into this era was long and the exit was gradual. The final end, in turn, was preceded by many years of planning and the gradual closure of mines and the shutdown of hard coal production. This decline has been evident since the 1960s. The main reasons for this were high production costs and the competition on the global market at the time was too great.

Accordingly, in 1968 the mining companies that were still active in the German Ruhr area merged. This is how Ruhrkohle AG was founded. In addition, there was government support for ensuring a secure supply of electricity. Furthermore, as a result, many jobs in the mining sector at that time were still preserved and kept the economic profitability and regional development of mining regions stable.

The next major restructuring took place in 1997 with the restructuring of Ruhrkohle AG into today's RAG, which still exists. However, the plants were separated from the remaining business areas. The goal behind it was to increase financial flexibility. In 2007, however, the federal government decided to finally phase out and thus turn away from hard coal. The decisive point for this was the canceled subsidies from the European Union, which were the deciding factor.

Nevertheless, Germany can look back on many years of experience in the closure and the associated structural change, since these changes did not just go hand in hand with the final end in 2007, but have been gradually apparent since 1960. Nevertheless, there was an additional adjustment process initiated by the federal government to deal with the social consequences. This creates a close link between trade unions, mining companies and political institutions for appropriate restructuring.

In the social dimension, the jobs that are primarily affected are those that are lost as a result of the plant closures and have to be compensated for. Associated actions include, but are not limited to, appropriate early retirement, retraining, alternatives, and financial support. But the subsequent use of former mining areas also plays a major role.

On the one hand, industrial culture and thus the preservation of mining heritage as a monument plays a major role, primarily in the Ruhr area of Germany, but on the other hand, adequate subsequent use through, for example, the integration of renewable energy alternatives in former mines or heaps (based on RAG 2016; Tiganj/Kretschmann 2022).

The change from active mining to post-mining changes the demands on the former mine operators. The focus is on the orientation towards sustainability and the consideration of structural change to maintain the balance between social, economic and ecological aspects. Accordingly, RAG is now responsible for minimizing damage to people and the environment from the previous mining.

Following on from this, the federal government introduced a financing law, which provides for the extent to which financial support must be provided for the termination of hard coal mining. As a result, RAG split up. On the one hand, the RAG Foundation was founded, along with the subsidized coal mining unit and trade, as well as the management of land and the development of the respective locations. Furthermore, there is now the subsidiary Evonik Industries, known as a chemical company, and on the other hand, the RAG (AG) already mentioned earlier (RAG-Stiftung 2016) (Figure 5-2).



Figure 5-2. Restructuring of the Ruhrkohle AG into today's RAG (RAG-Stiftung 2015)

5.5.2 Dealing with Hard Coal Mining in the German Legislation

Mining is an integral part of German law. The Federal Mining Act (valid since August 13, 1980) regulates mining law in Germany and describes in detail how to deal with all aspects of mining (to be found at the Federal Ministry of Justice under the BBergG) (Federal Ministry of Justice 2023).

An amendment to this law is currently being discussed in order to adapt the legal situation to the prevailing circumstances and, for example, possibly also to post-mining. These talks are ongoing and were initiated by the Federal Ministry of Economics, among others (TableESG 2023). Also concise and an integral part of Germany with the closure is the operator responsibility for mines in the sense of the "Social License to Operate (SLO)". On the one hand, this means that it is clearly regulated who is responsible for the management of this situation after the closure of a plant or facility, and for as long as it belongs to the person responsible. All associated costs for the maintenance of the areas and facilities, including safety aspects, must be borne by the operator.

The "Social License to Operate" builds on this responsibility and is particularly aimed at the stakeholders concerned in order to address socio-political structures even in complex situations and to take the social aspects of such closures seriously and to consider them as fully as possible. This applies to dealing with the environment as well as with people (Goerke-Mallet et al. 2020).

This integration and the promotion of the integration of concepts such as the SLO is important for the future orientation of Germany in post-mining and dealing with the energy transition and climate change. This plays a role under the post-mining aspects, starting with appropriate mine water management, through monitoring of mine sites to the analysis of material properties and the preservation of industrial culture to finally the renaturation of areas and the transition. Therefore, it is advisable to integrate the SLO into the whole mining life cycle to efficiently ensure the development of a mining

site to be useful, even if it is not actively used anymore in its initial purpose (as also shown in Figure 5-3).

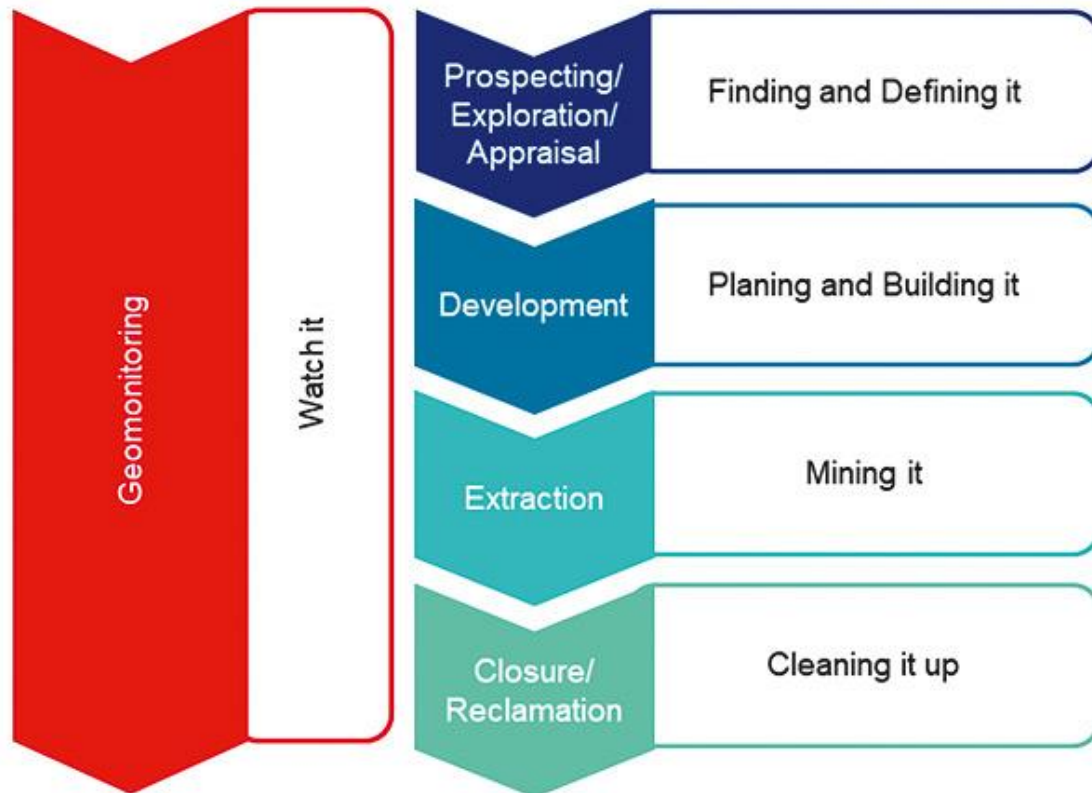


Figure 5-3. Integration of the SLO into the mining life cycle (Goerke-Mallet et al. 2020)

5.5.3 The German understanding of Post-Mining

Germany has been in the period of post-mining for several years now and depending on which area you look at: Saarland, Ibbenbüren or the Ruhr area, the phase-out of hard coal was between 5 and 10 years ago as of 2023. Official research on post-mining has been classified since 2015. Accordingly, the field of "post-mining" can be described as an important aspect for the German context, which will also become important for other countries that are about to face this upheaval.

In research, post-mining management can be broken down into four main cornerstones: mine water management and and dealing with the so-called perpetual tasks; (geo)monitoring in post-mining areas; the material sciences as well as the preservation of industrial heritage and last but not least the area of reactivation and transition (Research Center of Post-Mining 2023) (Figure 5-4):

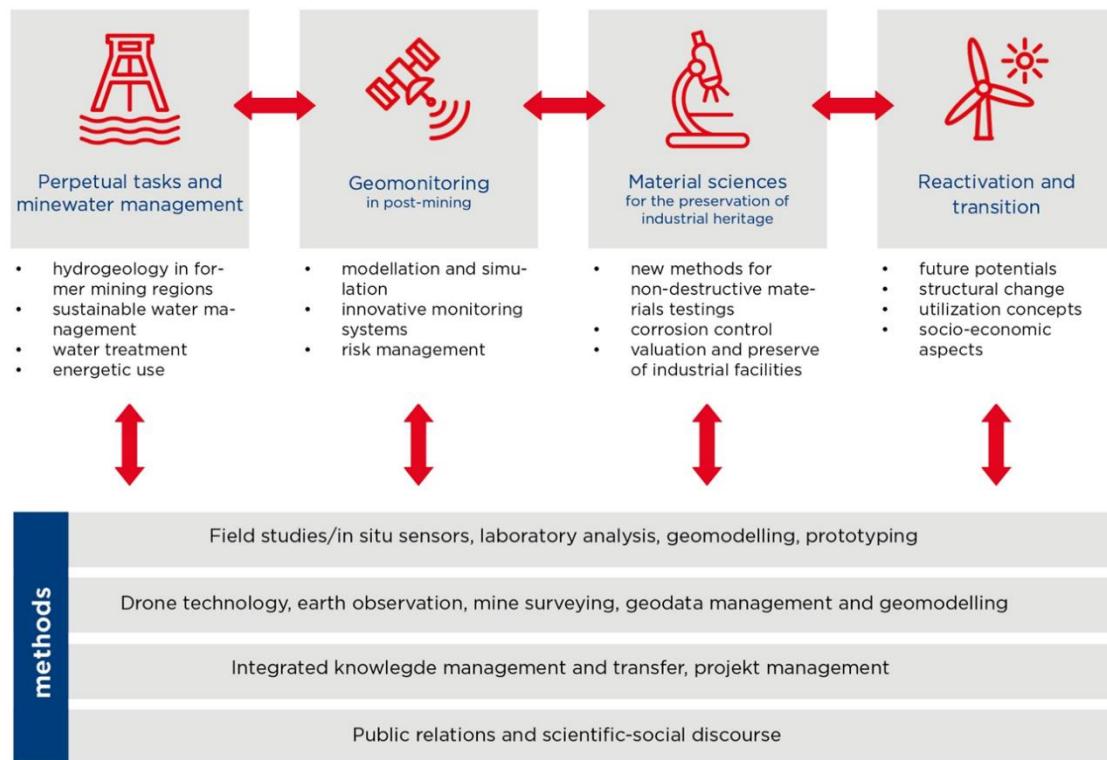


Figure 5-4. Approach for a holistic post-mining management, State of the Art (Research Center of Post-Mining 2023)

- 1. Perpetual tasks and minewater management:** When talking about the perpetual tasks, it is actually describing only the handling of the resource water in different and needed ways. It concerns the technical factors for the different former mining areas for an indefinite time, because the minewater is rising up due to the no longer actively used mines and therefore needs to be pumped. This is why this research area contains the pumping of surface water, as well as the monitoring of the ground water and the management of mine water.
- 2. (Geo)monitoring in post-mining:** This area is concentrating on the collection of geoinformation to build up a base for developing 3D models. This is mainly done by using different data from: drones and their sensors, such as thermal infrared, multispectral and RGB or from satellites and deep sea probes. Also old archives are used for the transfer into a modern and today's use. The long-term goal is therefore to create a digital simulation for optimized risk assessment systems in post-mining.
- 3. Material sciences for the preservation of industrial heritage:** When industrial culture (for example: coking plants, abandoned collieries, machines and blast furnaces) are preserved, it is important to efficiently analyze the status of the material used on a regular basis. Otherwise it can happen that the material is

damaged by external influences, i.e. by the environment. Climate change favors this through large periods of heat, but also heavy rain events. The frequent changes between hot and cold pull on the outer skin of, for example, headframes and can lead to corrosion, material splintering or even encourage the growth of harmful plants that endanger stability. The sooner such damage is recognized and eliminated, the less money it costs and the more resources are saved.

4. **Reactivation and transition:** This area primarily deals with the analysis of current circumstances in politics, the economy and the legal situation in order to develop suitable concepts for the subsequent use of former mining sites (new residential areas, business parks, renewable energy facilities and recreational areas). In addition, the social aspects are considered that result from a structural change with the closure of mines. In addition to employment effects and the possibilities to create new employment impulses, this also means the effects on people and the environment when such upheavals are carried out (Research Center of Post-Mining).

5.5.4 The Relation of POTENTIALS to German Post-Mining in Research

The POTENTIALS project represents a major link to the research area of reactivation and transition within post-mining, as it can currently be found in the status quo of German research at the post-mining research center. On the one hand, this is due to the fact that POTENTIALS aims to find modifiable or suitable post-use concepts for different locations and thus also for different circumstances, dependencies and characteristics. On the other hand, pure subsequent use for different types of locations is not the only added value. Rather, it is about the consequences that result from the integration of concepts: the creation of infrastructure, the creation of short-term and long-term jobs, alternative orientations for affected regions and the guarantee of their further development as well as the protection of costs and resources, through which use of what is available. Accordingly, this project forms an important pillar for the German framework, not only to further advance regional and national development, but especially in the knowledge transfer with other countries and the future challenges of transition.

6 Conclusions and lessons learnt

The just transition territorial plans serve as strategic roadmaps for achieving a just transition in their respective regions. They encompass a range of actions, including energy and climate strategies, operational activities, and prioritization of critical business models. The plans aim to ensure a sustainable and equitable transition while promoting economic diversification, environmental rehabilitation, and social development.

The lessons relevant to the Project from this deliverable can be summarised as follows:

1. The mid-term review in 2025 of territorial just transition plans offers an excellent opportunity for resource reallocation and funding allocation for 2026 and 2027.
2. Promoting individual projects within planned concentrating activities has a small effect on economic reactivation and population fixing.
3. Innovation poles have a higher contribution to economic reactivation and population fixing than individual projects, due to the synergies they can achieve. However, they are challenging to implement due to their specificity.
4. The initiative that can genuinely stimulate the regional economy, making it easier to maintain employment, is Eco-industrial parks with Virtual Power Plants, an integrated alternative for sustainable renewable energy generation, storage technologies, energy vectors, circular economy contributions, and synergies for reducing waste and pollution.
5. Eco-industrial parks with Virtual Power Plants have as a counterpart the need to be supported with financial privileges and other benefits to boost and diversify the area's economy and employment, attracting external investment. But is that not the aim of the Just Transition Fund?
6. When developing a roadmap for updating JTPs, it is necessary to determine the future approach to emerging areas after phasing out mining and power plant activities. If these areas are to be developed according to business models, pre-investment preparations should be carried out. Specifically, a feasibility study and preliminary implementation plan should be developed for each business model.

7 Glossary

AEL – Associated emissions levels

BAT – Best available technique

CCGT – Combine-Cycle Gas Turbine

CAES – Compressed Air Energy Storage

CSP – Concentrated Solar Power

DNSH – Do no significant harm

ENCP - Integrated National Energy and Climate Plan

EPA – United States Environmental Protection Agency

ES – Ecosystem Services

EU – European Union

GHG – Greenhouse gas

GTP – Geothermal Technologies Programme

I&C – Instrumentation and control

ILUC – Indirect land use change

IT – Information Technology

JTAs - Just Transition Agreements

JTS - Just Transition Strategy

MSP – Malten Salt Plant

NPV – Net Present Value

PHS – Pumped Hydroelectric Storage

PCBs – Polychlorinated Biphenyls

PNIEC - National Integrated Energy and Climate Plan

PV – Photovoltaic

R&D – Research and Development

RE – Renewable Energy

RE H&C – Renewable Heating and Cooling

RFCS – Research Fund for Coal and Steel

RTE – Roundtrip efficiency

RTRP – Recovery, Transformation and Resilience Plan

SMR – Small Modular Reactors

TRL – Technology Readiness Level

UNIOVI – University of Oviedo

UPHS – Unconventional Pumped Hydro Storage

VPP – Virtual Power Plant

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