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# ACTION PLAN

FOR THE TRANSITION TO A LOW-CARBON  
ECONOMY IN WESTERN MACEDONIA,  
PREPARED IN THE FRAMEWORK OF THE  
'DECARB' PROJECT

Regional Association of Local Governments of  
Western Macedonia (PEDDM)



**LGA**  
LOCAL GOVERNMENT ASSOCIATION  
**WESTERN  
MACEDONIA**

**DeCarb**  
Interreg Europe



European Union  
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## About this action plan

This Action Plan is prepared by PEDDM (Regional Association of Local Governments of Western Macedonia) in the context of the Interreg Europe project “DeCarb - Supporting the clean energy transition of coal-intensive EU regions” (Index number PGI05587).

The Plan aims to provide details on how the lessons learnt from the exchange of experience and cooperation that took place during Phase 1 of the DeCarb project will be implemented in the Western Macedonia region in order to improve the policy instrument addressed (“Regional Operational Programme of Western Macedonia 2014-2020”).

The Plan envisions the creation of an Innovation District, to be implemented during Phase 2 of the DeCarb project, and follows the respective guidelines provided in the latest Interreg Europe Programme Manual, Annex 1, as well as the guidelines of the Common Methodology of DeCarb activity 5.1. In particular, the Plan situates the proposed action in the policy (Section 1) and territorial (Section 2) context of decarbonisation in Western Macedonia, elaborating on the policy improvements to be achieved and the regional needs to be covered by an Innovation District (Section 3).

The following table summarises the identification information of the Action Plan, according to Interreg Europe instructions:

*Table 1: The DeCarb action plan*

### DeCarb Action plan - ID

#### Project

DeCarb “Supporting the clean energy transition of coal-intensive EU regions”

#### Partner organisation concerned

Regional Association of Local Governments of Western Macedonia

#### Country

Greece

#### NUTS2 region

Western Macedonia

#### Contact person & information

Lefteris Topaloglou

Email: [ltopaloglou@lga.gr](mailto:ltopaloglou@lga.gr),

Phone/mobile: +30 2461026430/ +30 6944291835

# **1 Policy context of decarbonisation in Western Macedonia**

## **1.1 EU context**

Over the past three decades, the EU has set increasingly ambitious targets with regards to its GHG emissions culminating in the decision to become a climate-neutral region, i.e. a region with no net GHG emissions, by 2050. This goal lies at the heart of the European Green Deal [1].

It is expected that such a policy change will necessitate significant changes not only to the energy sector but to the entire structure of the EU economy, de-emphasising carbon-intensive sectors in favor of sectors focusing on sustainable activities. As a result, most of the EU countries have committed to phasing out coal from the energy mix and decommissioning their coal-fired power plants.

A transition of this magnitude involves uncertainties for the activities and sectors that are being phased out. At the same time, however, this transition will bring significant benefits of economic and environmental nature for the EU communities. The leading position of the EU in sustainable technologies will provide direct economic advantages, consolidating also the EU as a global hub for green energy. Moreover, the European environment and habitats will improve as a result of this shift in energy sources, leading to an increase in the European quality of life.

### **1.1.1 The EU Green Deal and decarbonisation**

The European Green Deal, as presented by the European Commission in 2019 [1], is a set of far-reaching and wide-ranging measures that as a whole constitutes an ambitious growth strategy, which seeks to protect the European societies from the growing environmental risks and steer the EU regional economies towards a more resource-efficient path, without, however, compromising their competitiveness. Central to the European Green Deal is the transition of the EU to a climate-neutral region by 2050. To this end, the European Commission has proposed a European Climate Law [2] to legally bind EU Member States to achieve climate-neutrality by 2050. The European Council and Parliament have recently reached a provisional agreement on this topic and the law is currently into the formal adoption stage.

Inextricably linked to the transition of the EU to a climate-neutral region is the decarbonisation of the EU economy. In the present context of the energy production in the EU, this has direct implications for the coal-fired power plants and the coal mines in the EU, as coal is gradually being phased out from the energy mix.

The decommissioning of the coal mines and coal-fired power plants is expected to pose considerable challenges to the local communities in coal-producing regions. Regions in Germany, Bulgaria, Poland, Greece, Romania, Spain, and the Czech Republic are expected to be particularly impacted, as coal plays a more central role in their economies and energy production [3].



To facilitate the transition to climate-neutrality in a way that will maintain social cohesion, the EU has launched the “Initiative for Coal Regions in Transition” [4] which serves as an open forum for all relevant parties to promote knowledge and experience sharing between the EU coal regions. Moreover, the Just Transition Mechanism has been created to provide the necessary funding and overall support to related projects in the coal regions.

### 1.1.2 EU Green Deal Investment Plan (EGDIP)

With the adoption of the EU Green Deal as the new EU growth strategy and the commitments that this entails, i.e. the transition to a climate-neutral region, the EU has recognized the need to financially and legislatively support this new direction. To this end, the EU has introduced the EGDIP [5] as the investment pillar of the EU Green Deal, with the explicit aim of financing a sustainable transition, while supporting the regions and communities that are more dependent on coal and thus more exposed to the uncertainties brought about by the process of decarbonisation.

The EDGIP is based on a mix of legislative and non-legislative initiatives. In broad terms, EDGIP is organized along the three following axes:

- **Funding:** The goal of the European Commission is to use EU funds to leverage additional public and private financing. Additional resources can be provided within the InvestEU scheme. Part of the available resources is intended to be used to support communities more exposed to the risks of the transition. To this end, the Just Transition Mechanism has been created to provide the necessary funding and support to these regions and, thus, ensure a fair transition.
- **Enabling framework:** Making sure that sustainability is always considered when making decisions on investments, both in the public and private sector, through a set of legislative initiatives and incentives.
- **Implementation support:** Provide technical support to design and implement sustainable investment strategies. InvestEU will also provide advisory support to project promoters and financial intermediaries with the identification, preparation, development, and implementation of sustainable investment projects.

### 1.1.3 Just Transition Mechanism (JTM)

To ensure a fair transition, the EU has created the JTM to alleviate the social and economic risks involved in the decarbonisation of the EU energy sector. In particular, the Just Transition Mechanism is expected to assist [6]:

- **People that are particularly vulnerable to the transition.** This refers to people occupied in sectors adversely impacted by the decarbonisation process and people living in coal regions. The JTM can alleviate the risks of the transition by facilitating new employment opportunities in different sectors and providing retraining opportunities. It can also help to improve the energy efficiency of residential houses and facilitate access to clean and affordable energy.

- Industries and sectors related to carbon-intensive industries. This refers to industries with high CO<sub>2</sub> emissions, often caused by heating fossil fuels in furnaces for high-temperature processes. The primary examples are the steel and iron industry, the cement industry, refineries, and the petrochemical industry. The JTM can support a transition to low carbon technologies (either by using renewable energy sources or by employing technologies that reduce the CO<sub>2</sub> emission, e.g. carbon capture technologies), provide financial support, and foster public and private investments, providing investment for the creating of new firms and startups and invest in research and innovation.
- Member States and regions with economies particularly dependent on fossil fuels and carbon-intensive industries. It includes regions and countries with economies particularly dependent on coal for their energy production or rely heavily on carbon-intensive industries. The JTM can support the transition to low carbon and climate-resilient activities, create new jobs in the green economy, invest in renewable energy sources, provide financial help in the form of loans to local public authorities and improve the energy infrastructure district heating and transportation networks.

To this end, the JTM will facilitate investments and projects aiming to foster economic diversification and steer the economy from carbon-intensive industries to climate-resilient activities.

The three financial pillars of the Just Transition Mechanism, which are expected to provide financial aid to projects supporting the overarching goal of a fair transition, are [5]:

- The Just transition Fund, which has a budget of €17.5 billion and is expected to mobilise an additional €30 billion in investments. The expressed aim of the fund is to alleviate the social and economic costs related to the decarbonisation of the EU economies, principally through fostering the economic diversification of the regional economies and helping the regional workforce to adjust to the new needs of the labor market.
- The Just Transition scheme under InvestEU. It can support investments in the framework of the Territorial Just Transition Plan facilitating projects in areas such as energy and transport infrastructure, decarbonisation projects, economic diversification, and social infrastructure. Moreover, the InvestEU advisory hub will provide advisory support for the realization of projects supported by the Just Transition Mechanism.
- A public sector loan facility with the European Investment Bank, which leverages €1.5 billion from the EU budget along with €10 billion in loans to mobilise €25-30 billion in public sector investments.

## 1.2 National Initiatives

With the complete phasing out of lignite expected to take place in the near future and the overarching goal of achieving climate neutrality by 2050 presenting additional challenges, the Greek authorities have taken concrete measures to enable the transformation of the country's energy sector, in accordance with the EU's environmental policies, and prepare

the lignite-producing regions (principally the Western Macedonia region and Megalopolis area) for the transition.

In this context, the Greek government has presented its strategic plan (National Plan for Energy and climate) for climate and energy issues, has implemented the Just Transition Clause for the coal regions, and has implemented an alternative to the district heating that has been used in the past years for residential heating in towns located in the coal regions.

On the organisational level, the Greek government has created the SDAM committees with the aim of better coordinating the central administration with the regional administration and other institutions to effect a more successful and efficient transition process. The Committee has published a number of studies concerning the transition process, including a Master Plan for the just transition of the lignite-producing areas, and territorial plans concerning specific regions that are more exposed to the negative effects of the decarbonisation process.

### **1.2.1 National Energy and Climate Plan (NECP)**

The NECP [7] was published in 2019 by the Greek Ministry of the Environment and Climate and constitutes the strategic plan of the Greek authorities in the areas of climate and energy. It provides a roadmap for achieving the energy and climate-related targets for 2030 and preparing the country for the transition to climate-neutrality by 2050, in agreement with the suggestions of the European Commission and the UN Sustainable Development Goals.

The NECP was drafted with the expressed aim of realising a number of priorities, set by the Greek authorities, in the areas of energy and climate. These revolve around creating an integrated economic model based on sustainable economic growth, which aims to: a) combine the growth of the energy sector with environmental protection, b) create an attractive investment environment with a focus on research and innovation, c) introduce state of the art technologies in waste management, d) ensure the diversification of energy imports, and e) modernise the energy infrastructure, transforming Greece into an interregional energy hub. The specific priorities, set by the NECP, can be categorised as follows:

- Climate change and GHG emissions: Here, the main objective of the NECP is to set concrete targets for the reduction of GHG emissions with the overarching goal being to achieve climate neutrality for the country by 2050, in agreement with the direction of the European Commission. In particular, the NECP calls for a 43% reduction, compared to the reference year 1990, of the GHG emissions by 2030. Significant reductions are also envisaged in several air pollutants (e.g. SO<sub>2</sub>, NO<sub>x</sub>, NH<sub>3</sub>, particulate matter). To this end, a shift to a circular economy could lead to a significant reduction of GHG emissions through the recycling of materials, more efficient use of resources, and the introduction of new business models.
- Increased importance of renewable energy sources: The principal goal set by the NECP in this area concerns the share of renewable energy sources in total energy consumption. Specifically, the NECP calls for 35% of the gross energy consumption to be supplied by renewable energy sources by 2030 with the share rising to 61% for



electricity consumption. The primary sources of the increased energy production are expected to be the photovoltaics and wind farms with an estimated generation of 11.8 TWh and 17.2 TWh respectively by 2030.

- Improvement in energy efficiency: The NECP aims to improve the energy efficiency in final energy consumption by at least 38%. The objective with regards to the cumulative energy saving for the period 2021-2030 is set to 7.3 Mtoe. The Plan calls for an energy refurbishment of the public administration buildings amounting to 3% of the total floor area per year and for the renovation or replacement with more energy-efficient buildings of approximately 12-15% of the residential buildings by 2030.
- Energy security: The objectives in this area are related to the diversification of the energy suppliers and reducing the energy dependency rate, the optimal utilisation of the domestic energy sources and particularly the renewable energy sources, emphasising the role of Greece as a regional energy hub, ensuring adequate system capacity and the connection of the islands with currently autonomous electrical systems to the national power grid.
- Internal energy market: Market integration, coupling the Greek energy market with the markets of other Member States, is essential given the shift to renewable energy sources and it will lead to reduced costs and increased system security. Electricity storage systems will also facilitate the strengthening of renewable energy sources penetration. Improvements in the energy transmission infrastructure, the digitisation of the energy system, and addressing energy poverty are also important objectives in this area.
- Research, innovation, and competitiveness: The NECP envisages an increased emphasis on research and innovation and a surge in the funding of research in the energy and environmental sectors from 0.06% of the GDP in 2017 to 0.13% of the GDP in 2030. Key objectives in this area are the decoupling of economic growth from energy consumption and GHG emissions. Other objectives are the reduction of energy costs, thus reducing energy poverty, increasing the domestic added value of the energy sector, and the facilitation of a fair transition for the lignite-dependent areas.

The objective directly related to the decarbonisation process in the region of Western Macedonia is the reduction of GHG emissions. The first policy measure required by the NECP in this area concerns the shutdown of all the lignite-fired power plants in the country. To this end, a precise timeline of the decommissioning of the lignite-fired power plants has been provided in the NECP. Such a shift in the national energy policy is expected to have a significant impact on the economy of Western Macedonia which is, to a considerable degree, dependent on lignite.

In terms of the post-lignite era, the rapid increase in the share of the renewable energy sources in the energy mix, envisaged by the corresponding objective, is going to have a considerable impact on Western Macedonia as various large scale investments in renewable energy sources, primarily in photovoltaics, are currently underway in the region. In addition, the increase in the energy efficiency of the residential buildings is one of the primary objectives of the NECP and has been incorporated in the Just Transition Programme 2021-2027 along with an emphasis on circular economy which is one of the main policy measures corresponding to the "Reduction of GHG emissions" objective.

The investment needs have been estimated at €43.800 billion over the period 2020-2030, indicative of the magnitude of the changes envisaged by the NECP. A significant part of the funding is expected to be provided by the funds allocated to Greece in the 2021-2027 Multiannual Financial Framework, while additional funding is expected to be provided by national sources in the context of the Public Investment Programme, the InvestEU programme, and the National Strategic Reference Framework (NSRF) 2014-2020.

### 1.2.2 The National Just Development Transition Plan (Masterplan)

As concerns the just transition of the lignite-producing regions, the Greek government has set the following priorities:

- Protecting the existing jobs and providing alternative employment opportunities for the communities in the region.
- Alleviating the socioeconomic impact from the decommissioning of the coal mines and coal-fired power plants, to maintain social cohesion.
- Ensuring self-sufficiency in terms of energy production/consumption for the regions in transition and the country in general, while further supporting the growth of the regional economies concerned.

In line with the above, the Just Transition Development Plan [8] was drafted to provide a road map for the restructuring of the regional economies, i.e. steering them away (by directly funding investments, by providing financial incentives to potential investors, and by retraining the regional workforce) from carbon-intensive industries and focusing on more environmentally friendly sectors while taking into account the competitive advantages of each region.

For a successful transition and a post-transition era, as envisaged by the National Just Transition Plan, the following axes are crucial:

- Focusing on the creation of labor-intensive jobs.
- Taking advantage of the competitive advantages of the coal regions.
- Achieving a quicker transition by emphasizing 'quick wins'.
- Enhancing the social and environmental sustainability of the regions involved.
- Promoting new technologies and innovation initiatives.

At the same time, the plan also calls for a restructuring of the economy of the regions involved around the following pillars, which are expected to cease the heavy reliance of Western Macedonia on the lignite and lead to a diversification of the economy:

- Clean energy: Photovoltaic stations with a capacity of 230 MW are currently constructed by PPC, with another 1.9 GW being at various stages of completion. Hellenic Petroleum (HP) is also constructing photovoltaic stations with a total capacity of 204 MW. These investments are expected to contribute to replacing part of the lost capacity of the lignite-fired power plants. At the same time, these investments are expected to provide wider benefits to the economy as they can indirectly help related sectors of the economy (e.g. energy storage).
- Industry and commerce: An electromobility industrial park is in the planning stage. The park could attract investments in related areas like batteries, chargers.

- Smart agriculture: Smart production units with an emphasis on alternative forms of cultivation (e.g. Hydroponics).
- Sustainable tourism: There are plans to promote ecotourism in the region, taking advantage of the capabilities of the wine producers in the region.
- Education and technology: The creation of a Field of Energy Research and Technology in the region is one of the major projects and is also related to the first pillar (Clean energy). Indicative areas of specialization are electric propulsion, hydrogen, and alternative fuels, energy storage, and others. At the same time, it could serve as an incubator for start-up companies that will provide the link between research and the market. The creation of the Field of Energy Research and Technology is also expected to benefit the University of Western Macedonia by helping it attract additional international students and researchers.

It also needs to be mentioned that significant public investment in the infrastructure of the region (improving the road connectivity of the region, railroad extension, 5G, improving the district heating infrastructure, natural gas network) is expected to take place in the following years. The investment in infrastructure will not only create a significant amount of new jobs in the region but is expected to facilitate further investment in the region.

In addition, the Just Development Transition Masterplan provides details on the provided financial incentives (broadly divided into three categories; incentives to attract new investments, incentives to help companies already operating in the region, and financial aid to people in the region), on the available funding sources to support a just transition.

An important parameter for the just transition to the post-lignite era is the new spatial planning for the region which will determine the land use and the allowed activities. This is essential for the implementation of the Just Transition Development Plan, particularly for the land currently used for the mining of lignite and energy production, since its use will change after its restoration. It is also essentially a prerequisite for the realization of the investment proposals in the region.

Finally, a salient feature of the JTDP is the retraining of the labor force of the region. This is especially relevant for the period after the realisation of the major investment projects in the region when an increased need for specialized personnel is expected. It is estimated that 47% of the current labor force could need some form of retraining to acquire additional skills.

### **1.2.3 Just Transition Development Programme (JTDP) 2021-2027**

The Just Transition Development Programme 2021-2027 [9] has been prepared with the aim of facilitating the just transition of the coal regions to a post-coal era, i.e. to ensure that the social cohesion will be preserved, that the socioeconomic impact of the transition will be moderated and that the local economies will be able to shift to more sustainable activities. To this end, it includes three Territorial Transition Plans (for the regions of Western Macedonia, Megalopolis, and the Aegean Islands and Crete respectively) which provide the details for the transition process in each region. The principal part of the

funding is expected to be provided by the Just Transition Mechanism, with the Greek government contributing around €1.6 billion from its budget.

The main priorities of the JTDP 2021-2027, following the overarching goals set by the National Just Transition Plan and the NECP, are:

- Promoting and supporting entrepreneurship: Facilitate the economic modernisation of the region by attracting new investment, supporting the creation of new companies, and placing higher importance on products and services with high added value. The areas of emphasis are:
  - Employing innovation and new technologies in priority sectors (e.g. energy, cyclical economy, tourism) to improve the competitiveness of the companies in the region. An emblematic project in this area is the Innovation Zone in Western Macedonia.
  - Improving the competitiveness of small and very small companies - Digital transformation of companies in the region. Facilitating a transition to circular economy.
  - Large scale investments.
  - Entrepreneurship infrastructure. Improving the existing infrastructure and creating new (e.g. entrepreneur and business parks).
- Energy transition and climate neutrality: Achieving the targets set by the NPEC and potentially the even more ambitious targets set by the European Climate Law are the key goals here. The main areas of interest are:
  - Improving the energy efficiency of buildings in the region.
  - Clean energy.
  - Smart energy.
- Land use changes – circular economy. The main goals revolve around land restoration and improving the natural environment in the coal areas. At the same time, emphasis will be placed on circular economy and related large-scale projects. The salient points in this priority are:
  - Land and installation restoration in lignite areas
  - Circular economy. Waste management – investments in areas like photovoltaic panels and battery recycling.
  - Rational use of natural resources.
- Ensuring a just transition for the regional workforce. This priority sets as its main goal to alleviate the socioeconomic impact of decarbonisation. This includes preserving the existing jobs in areas that are adversely impacted by it and creating additional employment opportunities in new sectors. The important points are:
  - Supporting employment and social cohesion in the impacted areas.
  - Skill upgrading and retraining for the workforce.
  - Ensuring social cohesion and promoting an equal chance policy.
  - Upgrading and modernization of the vocational education and training infrastructure.
  - Facilitating an easier adaptation of employees and companies to the reorientation of the economy.
  - Improving social care and the integration of vulnerable groups.
- Small-scale interventions – smart communities: The key points here are:
  - Improving the quality of life in the cities.

- Development in rural areas.
- Smart communities – digital transformation of the communities in the region.

### **1.2.4 Special Transitional programme 2020-2023**

Without actively taking measures to alleviate the negative impact that the lignite phase-out will have on the region of Western Macedonia, the already problematic economic situation in the region would be further exacerbated, leading to increased unemployment, damage to social cohesion, and requiring increased effort to improve the economic prospects of the region. To that end, the Special Transition Programme 2020-2023 [10] was prepared to bridge the gap until the activation of the Partnership Agreement for the Development Framework (PADF) 2021-2027, to facilitate the energy transition in the coal regions and alleviate its negative impact.

The funding for the project is expected to be provided, inter alia, by the PA 2014-2020, the Green Fund, and the Recovery and Resilience Facility.

The areas of concern are the regional units of Florina and Kozani in Western Macedonia and the municipality of Megalopolis in Peloponnese, i.e the areas where the lignite mines and lignite-fired power plants are located.

The main priorities set by the programme are the following:

- Improving the employment opportunities for unemployed and self-employed; enhancing the adaptability of the workforce and the companies, upgrading the education infrastructure.
- Alleviating the social impact of the transition; enhancing the social cohesion.
- Fostering the economic diversification of the economy.
- Improving the economic climate and attracting more investment.
- Restructuring of the energy profile of the transition regions; increasing the natural resource efficiency.
- Facilitating green economy, digital transformation and urban regeneration.
- Providing technical support to relevant projects and actions.

## **1.3 Regional Initiatives**

### **1.3.1 Territorial Just Transition Plan for Western Macedonia**

The region of Western Macedonia, and particularly the regional units of Kozani and Florina, has historically been the locus of electricity production in the country, since the majority of the lignite mines and coal-fired power plants are located therein. This places the region at the heart of the decarbonisation process in Greece. It also necessitates a comprehensive solution to the challenges engendered by the new energy direction of the country, since the region's economy already faces structural problems, evidenced by the persistently high unemployment rate and the absence of foreign direct investment. A lack of intervention would further exacerbate the economic situation in the region, possibly requiring more



effort and resources to improve the situation in the future and severely damaging social cohesion.

To address these regional issues, within the overarching frame provided by the EU objectives and the national initiatives, the SDAM committee presented the Territorial Just Transition Plan for Western Macedonia [11]. It provides, inter alia, a comprehensive analysis of the present situation of the region, of the areas and sectors impacted by the transition process, the needs of the region in view of the adverse effects of the lignite phase-out, the areas of interest for future investments and includes a timeline of the transition with the progress achieved thus far.

The Territorial Just Transition Plan for Western Macedonia places particular emphasis on several areas, related to specific aims of the Just Transition Plan, e.g. reducing GHG emissions, increasing energy efficiency, or fostering innovation and technological research. These areas are:

- Fostering entrepreneurship
- Energy transition – climate neutrality
- Developing the agricultural sector
- Land restoration and repurposing – circular economy
- Ensuring a just transition for the regional workforce – improving the human capital
- Developing the transport infrastructure and digital connectivity
- Integrated territorial investments – smart cities

### **1.3.2 Operational Programme of the Region of Western Macedonia 2014-2020**

The Operational Programme of Western Macedonia for 2014-2020 [12] was prepared within the framework of the Partnership Agreement 2014-2020 and is one of the 13 Regional Operational Programmes prepared for the regions of the country.

In its vision and proposed measures, the Programme takes into account the Research and Innovation Strategies for Smart Specialization (RIS3) study for Western Macedonia, the priorities of the “Europe 2020” strategy, the Common Strategic Framework 2014-2020, and the regional strategies related to the Partnership Agreement for the Development Framework 2014-2020. Its vision for Western Macedonia is that of a region with a competitive and sustainable economy, a high-quality natural environment, and with social cohesion.

As concerns the new development strategy, the main areas of interest are the following:

- Economy and entrepreneurship. The key goal is to create new jobs to increase the competitiveness of the regional economy through the increased emphasis on research, new technologies, and innovation and a smart specialisation in areas of strength, in which the region holds a competitive advantage vis a vis other regions or countries.
- Infrastructure and environment. The points of interest in this area are the protection of the natural environment and the natural and cultural heritage, the efficient use of natural resources and the utilisation of renewable energy sources, and the improvement of the transportation infrastructure.

- Social Inclusion and employment. The salient points in this area of interest are combating poverty and improving the health and education infrastructure and services in the region.

Moreover, the measures and investments priorities of the Operational Programme of the Region of Western Macedonia 2014-2020 are tied to the eleven thematic objectives proposed by the European Commission [13] in the context of the Europe 2020 strategy. These objectives are:

- Strengthening research, technological development, and innovation.
- Enhancing access to, use, and quality of information and communication technologies (ICT).
- Enhancing the competitiveness of small and medium-sized enterprises (SMEs).
- Supporting the shift towards a low-carbon economy in all sectors.
- Promoting climate change adaptation, risk prevention and management.
- Preserving and protecting the environment and promoting resource efficiency.
- Promoting sustainable transport and removing bottlenecks in key network infrastructures.
- Promoting sustainable and quality employment and supporting labour mobility.
- Promoting social inclusion, combating poverty, and any discrimination.
- Investing in education, training, and vocational training for skills and lifelong learning.
- Enhancing institutional capacity of public authorities and stakeholders and efficient public administration.

Based on the above, the Operational Programme of the Region of Western Macedonia 2014-2020 shares a lot of objectives and priorities with the Just Development Transition Masterplan and the Territorial Transition Plan for Western Macedonia. As such, its implementation is directly linked both with the decarbonisation process in the region and the post-lignite era.

### **1.3.3 Operational Programme of the Region of Western Macedonia 2021-2027**

The Operational Programme of the Region of Western Macedonia 2021-2027 [14] is prepared within the framework of the Partnership Agreement for the Development Framework 2021-2027. The drafting of the Operational Programme took into account, inter alia, the regional strategies and regional action plans, the Regional Policy of Greece post-2020, the results of the Regional Operational Programme 2014-2020, the European strategies, and the available funding.

An important characteristic of this Operational Programme is that it is prepared with the decarbonisation process and the post-lignite period in mind, as the phasing out of the lignite is expected to take place within its time frame. Beyond the decarbonisation process, a lot of the challenges that the region currently face existed during the preparation of the last Operational Programme, e.g. the lack of competitiveness, the overreliance on the energy sector, and the shrinking and aging population.

The vision that the Operational Programme serves is that of a region with an enhanced and distinct role in the national and international environment based on the creation of jobs through:

- A restructuring of the regional economy and an increase of its competitiveness.
- Supporting and promoting a sustainable model for economic development.
- Maintaining social cohesion in the region.

The Operational Programme of the Region of Western Macedonia 2021-2027 sets the following priority axes, which correspond to EU policy goals:

- Enhancing the economic restructuring of the region. Important areas here are that of research, technology and innovation, the digitalisation of the public sector, entrepreneurship, and the digital development of the companies in the region.
- Supporting clean energy and green sustainable development. The key areas in this axis are clean energy and energy efficiency, adapting to climate change, waste management, facilitating a transition to a circular economy and preserving the biodiversity in the region.
- Improving the connectivity of the region. Areas of interest are digital connectivity (e.g. 5G), infrastructure and transport security, and economically and environmentally sustainable transport.
- Fostering the social development in the region. Key areas in this priority axis are the education infrastructure, the health, social care and social inclusion, employment, and retraining of the labor force.
- Providing support to integrated territorial development. The key areas of interest here are sustainable urban development, culture and tourism, and integrated territorial investment in rural areas.

### 1.3.4 Regional Specialization Strategy (RIS3)

The Regional Specialization Strategy Plan (RSSP) for Western Macedonia [15] was prepared within the frame of Regional Research and Innovation Strategies for Smart Specialization (RIS3). These are integrated, place-based economic transformation agendas with 5 main priorities:

- To focus policy support and investments on key regional priorities for knowledge-based development.
- To build on each region's strengths, competitive advantages, and potential for excellence.
- To support technological and practice-based innovation and stimulate private sector investment.
- To get stakeholders fully involved and encourage innovation and experimentation.
- To be evidenced-based and to include monitoring and evaluation systems.

To this end, a comprehensive Strength, Weakness, Opportunity and Threat (SWOT) analysis for Western Macedonia was presented in RSSP to determine the strengths of the region of Western Macedonia. The Plan focuses on research, technological development and innovation in the context of the Europe 2020 goals for smart, sustainable and inclusive

development. It also takes into account the 11 thematic objectives of the period 2014-2020.

Based on a detailed study of the specific characteristics of the regional economy, the most promising areas were determined to be:

- Agri-food
- Environment (Renewable energy sources, district heating, waste management)
- Fur farming
- Tourism

These areas were identified as priority areas due to their contribution to the regional Gross Domestic Product (GDP) and their links to the other sectors of the economy. From those, particularly interesting from an investment and research point of view are the first two areas.

The study has also identified 4 thematic objectives, stemming from the EU thematic objectives for the 2014-2020 period, in the areas of research and technologies, low carbon economy, and small and medium-sized enterprises, as the most relevant in the context of RIS3. The thematic objectives of interest along with some investment priorities are the following:

- Promoting research, technological development and innovation. Investment priorities here include: i) improving the research and innovation infrastructure, ii) promoting private sector investment in research and technology, and developing links between enterprises, universities, and research institutions.
- Improving the access and use of communications and information technology. Investment priorities here include: i) enhancing the implementations of information technologies, and ii) developing entrepreneurial skills in smart specialisation action in information technologies.
- Improving the competitiveness of SMEs. Investment priorities here are: i) encouraging entrepreneurship by facilitating the economic exploitation of new ideas and the creation of new companies, ii) supporting the ability of SMEs to participate in regional, national, and international markets and take part in innovation processes.
- Supporting the transition to a low carbon economy. Investment priorities in this area include: i) supporting the use of renewable energy sources and improving the energy efficiency in public infrastructure and residential buildings, and ii) promoting low carbon technologies and their implementation.

Finally, an investment priority that serves thematic objectives 1-3 revolves around improving the quality of human resources in the areas of research and entrepreneurship. Possible actions related to this priority include: i) specialisation of the workforce in the context of smart specialisation so that it is more in line with the needs of the private sector, ii) promoting the employment of researchers by companies, iii) supporting excellence in science, and iv) supporting interdisciplinary research.

It is evident from the above that the RSSP for Western Macedonia offers a thorough analysis of the opportunities for the region with an emphasis on research and innovation. The study has also a high degree of compatibility and complementarity in its aims with the Just Transition Development Plan and the Territorial Plan, as an emphasis on new

technologies, innovation and a transition to low carbon economy are common in all of them. As such, its results remain important for a fair transition to the post-lignite era.

### **1.3.5 Regional Strategy for Social Inclusion (RSSI) in Western Macedonia**

The RSSI [16] is a comprehensive study on the issue of poverty and social exclusion in the region of Western Macedonia, offering a detailed strategy to combat poverty and foster social inclusion. It is, thus, highly relevant in the ongoing decarbonisation process in Western Macedonia, since preserving the social cohesion during the transition is one of the main goals of the Greek authorities. In that regard, identifying the vulnerable population groups or the areas more in need of support is essential in preparing a comprehensive plan to combat poverty and support social inclusion in the post-lignite era.

An important finding of the study is that the groups that exhibited the most severe issues of social exclusion included retired people with a low income, employed individuals with low income, and unemployed people of all ages (particularly of the age group 54-65). These results highlight the importance of a realistic plan for the post-lignite era, as a lot of the jobs in the region are directly or indirectly linked to the lignite and particularly a lot of the better-paid jobs with a higher added value are related to the mining of the lignite and the lignite-fired power plants. A lack of an adequate response to the challenges presented by the phasing-out of lignite would lead to an increase in precisely those population groups that face the most significant problems in terms of social inclusion.

The situation is more critical in the regional unit of Florina (one of the two coal areas, along with the regional unit of Kozani, in the region) since the number of families that receive benefits is quite high compared to the population of the regional unit (the regional unit of Florina represents 18% of the region's total population, while 30% of the families in the region that receive benefits are residing in it).

In this respect, the strategic aims of the RSSI, and particularly the first strategic aim "Combating poverty and extreme poverty", are closely linked to the goal of the JTDP effect a transition to a more sustainable economic model while preserving social cohesion.

### **1.3.6 Regional Climate Change Adaptation Plan (RCCAP) of Western Macedonia**

Climate change and its environmental and economic impact play a central role in the new EU growth strategy (European Green Deal) and are closely linked to the decarbonisation process across Europe and the lignite phase-out that currently takes place in Greece. Tied to the need to reduce the rate of climate change and restructure the economy and the energy sector, in particular, is the need to alleviate the present and future impact of climate change. Even meeting the Paris' agreement temperature increase target of 1.5°C would require achieving more ambitious targets than those required by the European Green Deal. As a result, climate change is expected to continue in the following years, and shielding the European communities from its adverse effects is of increasing importance for the EU Member States.



The RCCAP of Western Macedonia is a comprehensive study [17], aiming to provide a detailed presentation of the vulnerability of the environment and the economic activities in Western Macedonia to climate change. The study is, thus, closely linked to the JTDP, not only with regards to the overarching goals of the Plan but also to the post-lignite era.

In particular, there is a significant increase in the average temperature (between 3.4°C and 5.2°C compared to the period 1961-1990) expected to occur by 2100. At the same time, the average annual precipitation in Western Macedonia is expected to significantly decrease for the same period. Despite that, the frequency of floods in the region is expected to significantly increase as the frequency of extreme precipitation is expected to increase. In addition, the combination of the increase in the average temperature and the decrease in the annual precipitation is expected to lead to an increase in the cases of drought in the region.

In view of the above-mentioned changes in the climate of the region that are expected to occur in the long term, the water resources of the region are considered particularly vulnerable due to their poor current qualitative and quantitative situation. This in turn has a considerable impact on the agricultural activities in the region. Ecotourism and winter tourism are also expected to be impacted by the temperature increase. There is also an increased risk of floods in more densely built urban areas, while the temperature increase might cause health issues to vulnerable population groups.

The RCCAP of Western Macedonia also includes a comprehensive list of proposed measures to address the issues engendered by climate change in the region. In particular, several of these measures are compatible and complementary to the overarching national goals of combating climate change and transition to a green economy and are, thus, integral to a just transition for Western Macedonia and a successful post-lignite era.

## 2 Territorial context in Western Macedonia

### 2.1 The social and economic importance of coal for the Western Macedonia region

#### 2.1.1 Lignite, power plants, and mines

The region of Western Macedonia has been the locus of the country's lignite production and lignite-based energy production since the 1950s, allowing the cheap production of energy and enabling the complete electrification of the country in the following years. In this regard, and despite the well-documented environmental issues engendered by it, the lignite has been inextricably linked to the modernization of the country in the post-war years. Perhaps what best encapsulates the dominance of the lignite in the energy mix during the past decades is the fact that as late as 2000, Greece, despite its relatively small size, was the fifth largest producer of lignite in the world, with only Germany, Russia, the USA and Australia producing more lignite [18].

Western Macedonia, and specifically the Florina-Kozani corridor, contains more than 1.8 billion tonnes in lignite reserves, by far the largest amount in the country as it represents more than 56% of the national reserves [19]. The dominance of the region of Western Macedonia is even more pronounced in the mining of lignite. As an example, the region was responsible for approximately 81% of the country's lignite production in 2010 [20], while in 2018 it was responsible for almost 75% of the total lignite production.

In general, the quality of the lignite produced in the country is low. The energy content of the lignite produced in Megalopolis, Amyndaio, and Drama is 975-1,380 kcal/kg, while it is 1,261-1,615 kcal/kg in Ptolemaida and 1,927-2,257 in Florina and Ellassona [21]. As a comparison, the lignite consumed in the USA has an average energy content of 3,585 kcal/kg, while the lignite consumed in Victoria, Australia has an average energy content of 2,055 kcal/kg [18]. Nevertheless, lignite has been the principal source of the country's energy production for decades, completely dominating the domestic energy production until approximately 2000 (more than 93% of the country's electricity production in 2001 was produced by the lignite-fired power plants [22]), and providing a degree of energy security for the country.

Similar to lignite production, the lignite-based electricity production infrastructure is primarily located in the region of Western Macedonia. As an example, the capacity of the lignite-fired power plants in the region in 2009 represented almost 84% [23] of the total lignite-based capacity in the country. Currently, the country is in a process of phasing out the lignite from electricity production and the decommissioning of all lignite-fired power plants has been planned for the following years. As a result, the mining of lignite is in a steep decline as the country plans to completely phase out solid fuels by 2025 [24]. This ongoing process can be seen in Table 2 [25], which shows the share of lignite in the electricity production of the country in recent years.

Table 2: Share of lignite in the electricity production of Greece, 2015-2020

Year	2015	2016	2017	2018	2019	2020
<b>Lignite share (%)</b>	46.43	35.10	35.77	32.97	24.67	13.91

This development is a result of the EU policies that call for the decarbonisation of the EU economies and ultimately aim to achieve climate-neutrality for the region by 2050. At the same time, the price of the energy produced by the lignite-fired power plants has been steadily increasing due to the introduction of the EU Emissions Trading System [26] which effectively increases the cost of the electricity produced by the power plants. The evolution of the additional cost in energy production can be seen in Table 3.

Table 3: Additional cost in energy production, 2015-2020

Year	2015	2016	2017	2018	2019
<b>CO<sub>2</sub> cost of the lignite-fired power plants (M. €)</b>	215.3	145.3	146.1	240.4	283.6
<b>CO<sub>2</sub> Price (€ per tonne)</b>	7.7	5.3	5.8	16.0	24.8

The CO<sub>2</sub> price has been steadily rising in the previous years, with the current price being more than 50 € / tonne. This has progressively made the energy produced by lignite (an already inefficient fuel in terms of CO<sub>2</sub> emissions / KWh) considerably more expensive, negating the primary advantage of lignite vis á vis alternative energy sources.

## 2.1.2 Data on social and economic activities and jobs dependent on coal

With an estimated population of approximately 266,000 people, the region of Western Macedonia is in terms of population the smallest non-island region of the country and is the only region without access to the sea. Approximately half of the population is concentrated in the regional unit of Kozani. The population of the region has been steadily declining in the past years with a rate faster than the national average. Moreover, the population group 20-39 is considerably underrepresented in the region compared to the national average. This might stem from the fact that younger, likely better educated, people move away from the region to study or to pursue a professional career. Such a phenomenon could potentially aggravate the economic situation of the region and considerably impact its economic outlook.

The region is characterized by a high unemployment rate, in 2019, the last year before the COVID 19 pandemic, 24.5% of the workforce was unemployed, the highest number

among all regions in the country and considerably higher than the national average of 17.0%.

With a GDP per capita of € 14,337 in 2019, the region is below the national average of € 17,102. Nevertheless, this number is higher than the neighboring regions of Central Macedonia (€ 13,576), Thessaly (€ 13,264), and Epirus (€ 12,123) [25]. This is likely due to the lignite-related activities in the region that produce a considerably higher added value per employee. At the same time, the GDP per capita of the region exhibits the largest decrease among all the regions of the country over the last 5 years, which is likely related to the current decarbonisation process.

Given the region's small population size, it is not surprising that the concentration of the vast majority of the lignite mining sites and lignite-fired power plants of the country within the region would have considerable economic consequences. Even as late as 2019, with the phasing out of lignite already in progress, 17% of the regional workforce was employed in the industry and energy sector, the highest percentage from all the regions of the country. It has been estimated that in 2020 close to 6% (4,967) [25] of the regional workforce has been directly employed by the Public Power Corporation (PPC), mostly in the mines and power plants located in the region. This number is smaller compared to the more than 8,000 people employed in the mines and the energy sector (largely in lignite-related jobs) in 2018 [27] but it still illustrates the importance of lignite to the region of Western Macedonia, particularly since studies have estimated that for each job directly related to lignite there are 2.3 jobs indirectly dependent on it.

The importance of lignite becomes even more pronounced if one considers the fact that the lignite-related jobs are considerably more productive compared to jobs in the other sectors in Western Macedonia. Mining, energy, and water supply provided in 2019 more than 38% of the gross added value in the region, whereas the entire energy and industry sector (including the mining industry) employs only 17% of the total workforce [25]. It also needs to be mentioned that the importance of lignite is even larger in the main lignite-producing areas in the region, the Florina and Kozani regional units, where the energy, mining, and water supply sector provides almost half of the gross added value. Finally, district heating, provided by the lignite-fired power plants in the region, plays an important role in providing heating for the towns of Kozani, Ptolemaida, Amyndaio.

The picture that emerges is that of a region that faces significant challenges (declining population, low education level of the regional workforce, below-average GDP per capita), with lignite-related mining and energy production being historically the primary source of well-paid and productive jobs in the region, especially in the Kozani and Florina regional units. As a result, the planned phasing out of lignite is expected to put a considerable additional strain on the regional economy and social cohesion.

### **2.1.3 The environmental impact of coal in the region**

The detrimental effects of coal-fired power plants on public health and the degradation they cause to the physical environment due to the mining and energy production processes are well established by now. For example, it was estimated that in 2013 coal-fired power plants were responsible for over 22,900 [28] premature deaths in Europe with tens of

thousands more experiencing health problems and health costs that were estimated at more than € 62 billion. Moreover, the contribution of CO<sub>2</sub>, with the coal-fired power plants being one of the primary causes of CO<sub>2</sub> emissions, to the greenhouse effect and climate change has also been proven scientifically.

The damage to public health is primarily caused by the airborne toxins and pollutants that are emitted when coal is burned. These include sulfur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>) mercury, lead, and other heavy metals. Particularly harmful to health is particularly matter released during the coal burning process. Due to the nature of these pollutants, their negative impact can be felt not only in the proximity of the power plants but far away.

Lignite is a low-grade coal and it has less carbon content and more moisture compared to higher grade coal [29]. As a result, its energy content per weight is significantly less. Burning it to produce energy creates more CO<sub>2</sub> emissions per KWh compared to hard coal and other fossil fuels (oil, natural gas) [30] further exacerbating the greenhouse effect on the planet. Lignite is also characterized as the most harmful type of coal as it emits higher amounts of pollutants to produce the same energy. In a study regarding the harmful effects of coal-fired power plants on public health, it was reported that from the 10 power plants that caused the highest amount of premature deaths in Europe, seven were using lignite to produce energy.

In the past decades, Greece had been using almost exclusively lignite to produce electricity. As mentioned, the lignite mines and lignite-fired power plants of the country are overwhelmingly concentrated in the region of Western Macedonia putting a strain on the environment of the region and adversely affecting the health of the population.

More than one-eighth of the total surface of the region is used for lignite mining [23], thus making a significant part of the region's surface unavailable for other activities (e.g. agriculture). In addition, several communities (4,000 people between 1972 and 2003 [31]) in the region have been forced to relocate to facilitate the mining of lignite and the expansion of the mining sites. Moreover, the energy production process consumes a significant amount of the available water. PPC reports that for 2017 2.2 kg of lignite and 2.78 liters of water were needed to produce a KWh [32]. In the region of Western Macedonia the PPC consumed 72 million m<sup>3</sup> of water for the needs of the lignite-fired power plants (2015)). To put that into perspective, the approximately 270,000 people of the region consumed only 43 million m<sup>3</sup> of water for their needs. Such a high water demand has put a severe strain on the water resources of the region. For example, lake Begoritida has lost more than half of its water since 1955 [33]. At the same time, the quality of the water in the region has been deteriorating due to the byproducts of the mining process that are offloaded in the rivers and lakes of the region.

As mentioned, the burning of the lignite to produce energy releases several pollutants harmful to public health. In 2010 in the Florina and Kozani regional units, 9 out of the 15 measuring stations reported pollution levels 20% higher than the European maximum values [31]. A 2009 study estimated 461 premature deaths in the region due to the lignite-fired power plants. Allergic rhinitis cases in Ptolemaida are also three times more often than in the rest of the country. Unfortunately, there is a lack of a long-term study of the impact of lignite on the health of the people in the region. Nevertheless, based on all the available data, it is inarguable that the lignite-related industry in the region has led to



a significant deterioration of the natural environment and a considerable worsening of the quality of life and health of the people residing in the region.

#### **2.1.4 The significance of the region in the national energy context**

As mentioned, the region of Western Macedonia has been the center of electricity production in the post-war era. The large majority of the installed capacity of lignite-fired power plants has been located in the region, and particularly in the Kozani regional unit, with most of the remaining located in Megalopolis. This distribution of the power plants was a direct result of the location of the lignite mining sites and of the fact that the low energy content of the lignite makes its long-range transfer economically undesirable [34]. As a result, the lignite-fired power plants need to be close to the mining sites and that is what has determined the distribution of the major power plants, and by extension the electricity production, in the country in the past decades.

The ongoing process of decarbonisation and the shift to renewable energies, with natural gas being used to bridge the gap, is expected to significantly alter this picture. With lignite being phased out, the electricity production is expected to exhibit a more homogeneous distribution in the country, primarily determined by the potential (e.g. wind energy potential, photovoltaic potential) of each region. Nevertheless, the region of Western Macedonia is expected to still have a significant share in the country's electricity production. The existence of a skilled workforce, specialized in the energy sector along with the strong photovoltaic potential of the region makes investments in solar parks, and the energy sector in general, appealing. It also preserves social cohesion as it provides an alternative for people employed in the lignite-fired power plants.

To this end, the PPC plans to construct solar parks with a total capacity of 2GW [8] in the region with additional projects being at various stages of completion. Moreover, additional investments have been planned on wind parks and large-scale investment in green hydrogen has been proposed and is currently under consideration. These investments are expected to preserve the region's importance as center of electricity production in the country (although not to the same degree as in the past decades), while reorienting the economy to more environmentally friendly activities and providing alternative employment opportunities to people currently occupied in the energy sector.

## **2.2 The decarbonisation plan for Western Macedonia**

### **2.2.1 Brief presentation of the plan**

The rapidity of the lignite phase-out process, now expected to be completed by 2025, along with the importance of the lignite for the regional economies place additional emphasis on the implementation of a decarbonisation plan for the economic recovery of the regional economy and the preservation of social cohesion.

The vision for the post-lignite era calls for a shift to more sustainable economic activities with an emphasis on smart regional specialization based on the region's strengths and the

introduction of innovations and new technologies in the economy. At the same time, there is the intention to preserve the region's status as a significant energy-producing center to utilise a regional workforce specialized in the energy sector and to ensure a fair transition. Briefly, the region is envisioned to become a center of research and production of green energy, while the emphasis should be placed on more sustainable economic activities with high added value. The 5 pillars that the plan is based on are the following:

- Green energy
- Industry and commerce
- Smart agriculture
- Sustainable tourism
- Technology and education

These should be supplemented by investments in the regional infrastructure and by initiatives encouraging the retraining of the labor force of the region, facilitating alternative land uses, providing incentives to increase the investment in the region and increase the digitalization of the economy.

The funding sources for the fair transition and the reorientation of the regional economy are detailed in the Just Transition Programme 2021-2027 and the Special Transitional Programme 2020-2023, the funds are primarily drawn from the Just Transition Mechanism and from the PA 2014-2020 with a significant part of the necessary investments expected to be financed by the private sector. Moreover, the Regional Operational Plan for the period 2021-2027, prepared within the frame of the Partnership Agreement for the Development Framework 2021-2027, is also going to be strongly complementary to the Territorial Just Development Transition Plan in terms of its aims and objectives.

### **2.2.2 Regional needs, priorities, and goals**

As mentioned in a previous section, the region faces several challenges (e.g. high unemployment rate, lack of direct foreign investment, shrinking population) and a restructuring of the economy of the region was already necessary to improve the economic prospects of the region. The need for structural changes is even more urgent due to the phasing out of the lignite mines and power plants which represent a significant part of the created value in the region.

As a result, the current needs of the region are two-fold. On one hand, the region needs to prepare for a long-term transition to a more sustainable economic model with an emphasis on research and innovation and making high-quality products with a high added value. On the other hand, and with the coal-fired power plant decommission process scheduled to be completed by 2025, there need to be some alternative employment opportunities immediately available to those presently unemployed or employed in lignite-related jobs.

In particular, the principal needs of the region, in view of the ongoing decarbonisation process, are:

- The restructuring of the regional economic model. The region needs to take advantage of the regional specialisation in the energy sector and the global shift to renewable

energy sources and energy storage to maintain its position as a significant electricity producer and turn into an energy hub. In addition, the diversification of the regional economy and improvements in the competitiveness of the companies in the region through a smart specialization in advantageous sectors and an increased emphasis on research and innovation is highly important. In this direction, the creation of an innovation ecosystem in the areas of green energy, agri-food, and information technologies along with an innovation zone in the region are considered highly desirable and are mentioned both in the World Bank study and the Territorial Just Transition Plan.

- Support of the workforce and the communities that are adversely impacted by the decarbonisation process. The region already faces a persistently high unemployment rate. Without providing adequate alternative employment opportunities, the situation is expected to become worse as the lignite-related economic activity further declines. This is expected to put a severe strain on the social cohesion of the region and can potentially lead the more highly skilled part of the workforce to seek employment away from Western Macedonia, further downgrading the economic prospects of the region. To this end, the retraining of the labor force of the region with the aim of providing them with skills in areas like renewable energies, energy storage, and the energy efficiency of buildings should be a high priority, as these areas are expected to attract a significant amount of investment in the following years. An improvement in the overall skill level of the regional labor force, with increased expertise in new technologies, is also essential in increasing the competitiveness of the region and improving its economic outlook. Education institutions and the University of Western Macedonia are expected to play a salient role in this regard. Additionally, the restructuring of the regional economy should also lead to improving long-standing issues in the region, e.g. the participation of women in the labor market, youth unemployment, and improving the attractiveness of the communities in the vicinity of the lignite mines and the lignite-fired power plants, since they face significant environmental and socio-economic issues as a result of their location and the lignite-related activities.
- Alleviation of the negative impact that lignite mining and lignite-based energy production have on the environment, the health and safety of the communities in the region. A key need in this area is the restoration of the land, which is currently devoted to lignite mining and energy production or is polluted as a direct result of those activities. The current planning envisages a shift in the land use, with parts of the restored land being used for the installation of new renewable energy capacity, for energy storage, for productive activities, for the creation of an innovation zone, and the protection of the region's biodiversity and cultural heritage.

### 2.2.3 Progress so far & timeline

The timeline of the decarbonisation process in Greece is determined by the National Plan for the Energy and Climate, which is the strategic plan of the Greek government in the areas of climate and energy. By 2030, it aims to have achieved the phasing-out of lignite from the energy mix and at least a 42% reduction in GHG emissions compared to 1990, a

35% share of the renewable energy sources in the gross final energy consumption, and a 38% increase in the energy efficiency.

Newer developments call for even more ambitious targets for 2030. The European Climate Law, for which a preliminary agreement between the European Council and the European Parliament has been reached, requires a 55% reduction in GHG emissions by 2030 compared to the previous target of 40%. The Greek government was one of the proponents of this revision of the emission targets and its energy and climate policies are expected to take these new more ambitious goals into account, along with ensuring low energy prices for the end-users and covering the energy needs of the country.

The NECP has also provided a timeline for the decommissioning of the lignite-fired power plants, with the last one being decommissioned in 2023. The only exception is the new Ptolemaida 5 plant which is expected to shift to using natural gas as fuel. With regards to these targets, Greece has achieved a 16.9% reduction in GHG emissions compared to 1990 [35], with a further 18.7% [36] reduction occurring in 2020, although the latter is partially attributable to the economic downturn engendered by the coronavirus pandemic. Moreover, the share of the renewable energy sources in the gross energy consumption was estimated at 12.19% (2019). This share is expected to substantially increase in the following years as all the lignite-fired power plants are decommissioned and the installed capacity of renewable energy sources gradually increases.

Concerning the region of Western Macedonia specifically, the Territorial Just Transition Plan establishes the 3 pillars of the transition process. Each of these pillars comprises several actions, either related to the planning or the implementation stage. The 3 pillars are the following:

- Land restoration and changes in land use. The key actions here are the decommissioning of the lignite-fired power plants (scheduled to take place by 2025), the restoration of the land and the determination of the new land uses.
- Social cohesion and economic transformation. The key actions here are related to the district heating, the drafting of the Just Transition Development Masterplan along with the territorial plans and their implementation, the implementation of the 2<sup>nd</sup> and 3<sup>rd</sup> pillars of the Just Transition Mechanism, and preparing a feasibility study for the Innovation Zone.
- Governance. It includes the formation of the SDAM Committees (Government Committee, Steering Committee, and Technical Committee), the formation of the Just Transition Observatory, the creation of a Special Purpose Vehicle, to which most of the land owned by PPC will be transferred and the creation of the company Metavasi A.E.

The main actions that have already been implemented are the following:

- The formation of the Government and the SDAM Steering Committee.
- The transfer of the ownership of the land owned by PPC has been legislated.
- There has been an open invitation for the submission of investment proposals and development plans.
- The heating of the towns of Kozani, Ptolemaida, Amyntaio, and Florina in a sustainable and economically advantageous way has been ensured.
- The European Commission has adopted the revised Regional Aid Guidelines.
- The planning of employment-supporting programmes has been completed.

- The Just Development Transition programme is 2021-2027 is in the drafting phase and currently under public consultation.
- The feasibility study for the innovation Zone in Western Macedonia is currently being drafted.
- The SPV that will be tasked with the restoration of the land is currently in the process of being created.

## 2.3 The impact of decarbonisation on the local economy

The peak in lignite production occurred in 2004. In that sense, the decarbonisation process has been underway, although at a slower rate, for more than 15 years, with the first lignite-fired power plan being decommissioned in 2011. The economic crisis that hit the entire country in the previous years further exacerbated the problems of the region, which however were present even before the economic crisis or the decarbonisation process (e.g. the region exhibited the highest unemployment rate in the country in 2004). At present, the phasing out of lignite is expected to have a significant impact on the communities in the region, on the regional economy, and the environment.

In terms of the impact on the labor force and the communities of the region, decarbonisation is expected, assuming no suitable measures are taken to alleviate the problems related to it, to lead to a further decline of the region's population. Moreover, the loss of jobs in the region, as a result of the lignite phasing out, is estimated at more than 10,000 by 2029 [11]. Concomitant with that is the pauperisation of the local communities, with young people, women, and long-term unemployed being particularly hit by it. Finally, the issue of district heating, currently heating approximately 42,000 households, needs to be addressed in case it becomes a serious problem for the communities in the region.

As regards the economic impact of the decarbonisation process, most of it is expected to affect the regional units of Florina and Kozani. The loss of gross added value in the region is estimated at more than €1.5 billion by 2029. Finally, the environmental impact of decarbonisation is expected to be positive due to the reduction of air pollution levels. However, to obtain more long-lasting results in the ecosystems of the affected regions, land restoration projects are required.

### 2.3.1 SWOT matrix for decarbonisation in Western Macedonia

A SWOT (Strengths, Weaknesses, Opportunities, and Threats) matrix is a tool integral to policy planning. It helps policymakers to analyse a situation at hand, identifying the characteristics of a certain policy process or framework that give it an advantage (strengths) or disadvantage (weaknesses) vis á vis the previous state of affairs, and evaluating the elements of the environment that might prove helpful (opportunities) or detrimental (threats) to the success of the policy process in question.

In the case of the Western Macedonia region, with the decarbonisation in progress, there have been multiple attempts to evaluate the present situation of the region and assess



how the comparative advantages of the region could be exploited (opportunities) or what the threats are. Drawing from them, the following SWOT matrix can be mapped out:

*Table 4: SWOT analysis for the decarbonisation outlook of the Western Macedonia region*

<b>S</b>	<ul style="list-style-type: none"> <li>• Geographic location and the proximity to the Western Balkan countries.</li> <li>• A strong energy sector and a workforce specialized in it.</li> <li>• High-quality agricultural products.</li> <li>• A strong fur industry.</li> <li>• Rich cultural heritage and natural ecosystems with touristic potential.</li> <li>• The existence of a university and research institutions in the region.</li> </ul>	<b>W</b>	<ul style="list-style-type: none"> <li>• Lack of emphasis on information technology and research by the companies in the region.</li> <li>• Lack of funding for R&amp;D.</li> <li>• Lack of knowledge-intensive products with high added value.</li> <li>• High unemployment rate.</li> <li>• Environmental problems caused by the mining of lignite and the lignite-fired power plants.</li> <li>• Overreliance on the energy sector and the fur industry.</li> <li>• Unrealized tourism potential due to the lack of infrastructure and services.</li> </ul>
<b>O</b>	<ul style="list-style-type: none"> <li>• Adoption of policies that promote the diversification of the economy, steering the region towards renewable energy sources, high productivity agriculture, social economy, and information technology.</li> <li>• Intensification of economic relations with neighboring Balkan countries.</li> <li>• Increased desirability of the region's tourism product.</li> <li>• New ROPs emphasise innovation actions.</li> </ul>	<b>T</b>	<ul style="list-style-type: none"> <li>• The negative economic outlook has led to low investment and high unemployment rates.</li> <li>• The reluctance of adopting innovations and new technologies by SMEs could lead to low competitiveness.</li> <li>• The environmental degradation may continue in the region.</li> <li>• Increased competition by neighboring regions and countries.</li> <li>• Persistent high unemployment rates could exacerbate the brain drain.</li> </ul>

## **3 Proposed action**

### **3.1 The concept of an Innovation District**

An Innovation District is a designated area where research institutions and companies cluster, connect and develop synergies with start-ups, business incubators, and accelerators to promote innovation and contribute to the economic development of the wider region. The establishment of an Innovation District aims to act as the facilitator of such cooperative activities in Western Macedonia, attracting investment and housing economic activities which, due to their focus on knowledge and technology, can provide a new boost and orientation to regional diversification.

An Innovation District in the Western Macedonia region, which has been hit severely by the negative effects of decarbonization and the accelerated national coal phase-out strategy, could reshape and regenerate the local economy. Such an initiative will create the foundation for a local green economy and will attract new high-quality jobs in the region, limiting the brain drain. The District could spur the creation of new products, processes, technologies, and high-growth firms that will drive productivity growth. PEDDM aims to bring together the already rich human capital of the region through the cooperative space to be created by the Innovation District, which will function as a magnet for large and small enterprises, for the research and development departments of universities, and for highly skilled administrative and scientific staff, that were initially attracted to the region due to the coal industry and now are seeking new opportunities for a new sustainable and green energy model.

### **3.2 The regional need to diversify the economy and boost innovation**

The appeal of an integrated energy sector, in which research institutions and enterprises will operate in a synergetic and complementary way to produce high added-value products, in Western Macedonia is based on the economic needs of the region, the available funding, and political will to implement this plan and the suitability of the region as a center of energy production and research.

#### The economic situation in Western Macedonia

The region as a whole has a slightly higher GDP per capita than the neighboring regions (e.g. for 2019, the region of Western Macedonia had a GDP per capita of €14,337 while the neighboring region of Central Macedonia had a GDP per capita of €13,576, despite the city of Thessaloniki being located in the latter), although this is still below the national average.

This should be principally attributed to the lignite-related mining energy sector, located in the Kozani and Florina regional units. As an example, the energy and mining sector represents 38% of the total gross added value (2019) in the region while employing a considerably smaller percentage of the labor force. This highlights the importance of the

lignite-related activities not only in terms of their magnitude but also in terms of providing well-paid jobs. This becomes more conspicuous if one examines the GDP per capita of the regional units of the region of Western Macedonia. Kozani and Florina have a 50% and 70% higher GDP per capita respectively than the regional units of Grevena and Kastoria, a difference that should be largely attributed to the mining and energy production activities that take place in Florina and Kozani regional units. The conclusion from the above is that, in the absence of the mining – energy sector, Kozani and Florina would face significant economic challenges and likely a reduction of their GDP per capita to a level comparable to the Grevena and Kastoria regional units, placing the entire region in the last place in the country in terms of GDP per capita.

In addition to the overreliance on the energy-mining sector, the socio-economic outlook of the region is negative. The region is characterized by persistently high unemployment rates, shrinking population, underrepresentation of the age group 20-39, lack of access to the sea, lack of direct foreign investment, and low competitiveness. As a result, to prevent a further exacerbation of the current issues, making it potentially even more difficult and resource-consuming to reverse the situation at a later date, the region needs alternative economic activities with a high added value per employee to replace the lignite-based activities that are currently being phased out.

This typically entails focusing on some knowledge-intensive economic activities (this also includes to a degree agricultural activities). Given the region's profile and overall economic outlook, the energy sector (e.g. RES, energy storage, energy efficiency) appears to be the most suitable candidate. Large-scale investments in RES have already been planned in the region, however, it is unlikely that they will be able to fully replace the impact of the lignite by themselves. To this end, the investments in RES should be supplemented with complementary activities with high added value per employee (i.e. knowledge-intensive) that would support and enhance the RES-based energy production and provide additional employment opportunities.

To summarize, the region will likely need to specialize in additional high added value per employee economic activities, even if one takes into account the large-scale investments in energy production currently planned for the region. Activities complementary to energy production, supporting and improving it, are the most realistic alternatives for quality jobs in Western Macedonia, given the characteristics of the region. The more these activities are knowledge-based and can be linked to and enhanced by research and the implementation of new technologies, the higher the added value will be (provided that the overall product is still competitive). On the other hand, an inability to achieve that would likely result in simply importing the end product/service from other regions or abroad, leading to a failure to add significant value to the end product/service. As such, the creation of an integrated energy sector, in which research institutions, universities, and enterprises are brought together and benefit from a symbiotic relationship, likely constitutes the best opportunity to replace the economic impact of the lignite in the region.

### Funding

The ongoing transformation of the energy sector of the country and the entire structure of the economy of Western Macedonia necessitates large-scale investments in the energy infrastructure to obtain the necessary capacity to cover the energy needs of the country.

Furthermore, additional resources would be needed, in terms of grants, constructing additional research infrastructure, to create an integrated energy sector in the region. As such, a prerequisite for turning Western Macedonia into a center of energy production and research is the availability of sufficient funding.

In terms of the construction of the energy-producing infrastructure (e.g. PV panels, wind turbines) in the region, there are significant investment projects in various phases of completion. In that regard, the position of the region as a major energy producer in the post-lignite era is ensured. Additional funding is also expected to be provided by EU sources, particularly from the new Partnership Agreement for the Development Framework 2021-2027 and, since the Western Macedonia is a coal region in transition, according to the Just Transition Mechanism. Both green energy/green economy and promoting research and innovation (particularly bringing together research institutions and enterprises and incorporating the innovations and new technologies to the production process) are major thematic objectives of the EU.

In addition, energy is considered a smart specialization sector for the region. As such, it is reasonable to expect that considerable resources could be obtained from the EU to fund projects related to creating an integrated energy sector in the region and turn it into a center of energy research and production. Finally, the Greek authorities have publically voiced their support to this vision, so their energetic support in terms of additional funding and legislative measures should be expected. To summarize, both the funding and the political will for transforming the regional economy and steering it into a more sustainable and technologically advanced path, are currently present.

#### An opportunity for synergies between green energy production & research

Establishing the suitability of the region of Western Macedonia as a hub for energy research and production is an important part of the decision process. The argument in favor of Western Macedonia relies on the importance of establishing a link between research and production. This way, research efforts can be focused on economically desirable areas and subsequently applied to the production process and only in this way can significant funding for R&D purposes be obtained from the private sector. The need for such a symbiotic relationship, whereby both sides benefit from the created synergies, has been realized both by the EU and the Greek authorities.

In this context, the principal advantage of Western Macedonia is that it is by far the more specialized region in the energy sector (In 2019 the region produced 19.1 % of the total added value in the mining, energy, and water supply sector in the country, the second-highest amount of any region, only behind Attica, a region with more than 10 times its population. Moreover, most of the value-added in Attica is likely going to stem from the energy/water network and the refineries and not the energy production), particularly in the energy production.

As such, the region already possesses a labor force specialized in energy production and a significant energy production capacity, something that is expected to continue in the future in view of a large number of planned investments in RES in the region. This makes Western Macedonia an excellent option to establish a synergetic and cooperative environment between research institutions and energy companies in the region, particularly since the University of Western Macedonia is already active in the areas of

energy and the transition to a post-lignite era and has established some links with companies in the energy sector.

Seen as a whole, the region is an excellent candidate to establish synergy and complementarity between the industry and research in the energy sector. In addition, such a development would be highly beneficial to the region and provide an alternative to the lignite-related activities that are currently being phased out. To this end, the establishment of an innovation district, with an emphasis on low carbon technologies and innovations, is essential in bringing together research institutions and companies and establishing synergies between them.

### 3.3 Policy instrument addressed

PEDDM's participation in the DeCarb project aimed to address certain policy gaps in the Regional Operational Programme (ROP) of Western Macedonia 2014-2020. However, the development of the action plan has coincided with the end of the ROP's funding capacities and the transition to the 2021-2027 funding period. As a result, PEDDM has encountered practical difficulties in designing the action plan: on the one hand, PEDDM is tied to the ROP 2014-2020 within the DeCarb project, yet, to implement the action plan, PEDDM will need funding resources from the upcoming programming period.

To overcome this conundrum, PEDDM intends to request the replacement of the ROP 2014-2020 with a new policy instrument for Phase 2 of the DeCarb project, namely the Just Transition Development Programme 2021-2027. This way, PEDDM can secure that the action proposed in this plan will be successfully implemented. To this end, this section includes the presentation of both policy instruments and the alignment of the action plan with both.

#### 3.3.1 Regional Operational Programme of Western Macedonia 2014-2020

The policy instrument currently addressed by PEDDM in the context of the DeCarb project is the Regional Operational Programme (ROP) of Western Macedonia 2014-2020. It includes 10 Thematic Objectives (TOs), comprising the regional strategy to develop a competitive economy that prioritises sustainable jobs, high environmental standards, and social cohesion.

Main objectives: The Programme aims to boost economic development and create job opportunities in Western Macedonia. It contributes to achieving Europe 2020 targets for smart, sustainable, and inclusive growth, also in line with the Smart Specialisation Strategy. EU funding will also contribute to meeting the requirements of the European Union's acquits, in particular as regards greenhouse gas reduction in CO<sub>2</sub> and increase in energy efficiency.

Funding priorities: The OP substantially contributes to promoting the following key EU and national development priorities:

- Strengthening research, technological development, and innovation.



- Enhancing the competitiveness of SMEs
- Supporting the shift towards a low-carbon economy across all economic sectors
- Promoting climate change adaptation, risk prevention, and management
- Promoting sustainable and quality employment as well as labour mobility
- Promoting social inclusion, combating poverty and discriminations

The decarbonisation and modernisation of the energy sector are directly linked to the RIS3 strategy of Western Macedonia, since the energy sector is at the centre of the regions' 6 TO priorities; in particular, "Energy production" and "Energy distribution" (in tandem) are directly identified as S3 priorities. Nonetheless, the region is not currently adequately prepared for the shift to a low-carbon economy, and the socioeconomic consequences can be dire. The construction of a new 650 MW lignite-fired power plant (turned to gas to comply with new phase-out objectives) will only cover a fraction of the losses from closing down older sites; current estimations place directly linked job losses at 12.5K and local income loss at €1.14 billion<sup>11</sup>.

#### ROP Thematic objective 4: Support the transition to a low-carbon economy in all areas

The Western Macedonian energy sector is dominant both in the regional economy and in its contribution to the overall energy production at the national level, as it owns the main reserves of domestic solid fuels and has the largest fleet of thermal and hydroelectric units.

During the period 2010-12, the Heat and Hydroelectric Units of the region participated with 52% to 55% in total electricity production. In particular, concerning thermal units, the lignite unit involvement was from 86% to 87% of total lignite power generation. A large amount of energy production and the use of solid fuels is also reflected in the large CO<sub>2</sub> emissions rates, where, per relevant environmental assessments, the contribution of the regional facilities to the total CO<sub>2</sub> emissions was 55% during the last decade. Renewables have a limited presence (wind, hydroelectric energy, biomass and biogas, photovoltaic, high-performance electricity and heat cogeneration), as stations source less than 10% from clean energy sources.

#### Pressing regional needs

- Reduce carbon emissions by promoting clean energy production, the exploitation of modern technological applications and the use of carbon capture and storage technologies.
- Promote energy efficiency and the use of renewable energy sources in public infrastructures, residences, and businesses.
- Reduce the primary energy requirements and dependence on solid fuels.
- Disseminate information and conduct awareness-raising actions for the rational use of energy resources and renewable energy sources.

#### Contribution to the objectives of the Europe 2020 strategy

The transition to a green, clean energy economy is one of the two pillars of the Europe 2020 strategy to achieve sustainable development and is promoted by the EU flagship initiative 'A Resource-efficient Europe', aiming to disconnect economic growth from oil and coal resources, to reduce the release of carbon dioxide, to increase the use of renewable



energy sources, and to promote energy efficiency in transport and buildings. The quantified targets set for 2020 refer to energy efficiency - reduction of energy consumption (368 MTOE and 2.85 MTOE at Union level and Greece), to reduce greenhouse gas emissions (by 20% or 30% if the circumstances allow it for the EU and 4% compared to 2005 for Greece), and increasing the renewables percentage (20% on mixed final consumption in the EU and Greece). The aim is to maintain the identity of the region as an energy node in Greece while emphasizing the environmental dimension and the most effective use of resources.

#### ROP objectives addressed by DeCarb

The fourth TO of the ROP, namely "Supporting the shift towards a low-carbon economy in all sectors", comprises the regional strategy to develop a competitive economy that prioritises sustainable jobs, high environmental standards, and social cohesion, focusing on promoting research and innovation on low-carbon technologies required to reduce CO<sub>2</sub> in the overburdened region, in order to meet EU2020 targets.

To this end, the action plan addresses:

- Thematic Objective 4: Supporting the shift towards a low-carbon economy in all sectors
  - Investment Priority 4f: Promoting research and innovation in, and adoption of, low-carbon technologies

#### Policy gaps to be addressed through the DeCarb project

The ROP foresees funding for projects under TO4, namely "Supporting the shift towards a low-carbon economy in all sectors", to accelerate the adoption of low-carbon technologies and to reduce CO<sub>2</sub> emissions. Regional value chains face sustainability challenges, not only because of the decarbonization but also because of the low level of local R&D results. To this end, PEDDM recognises the need to develop business support services so that the local economy can use innovation as a lever for transitioning to a new clean energy model; the ROP lacks such specific measures, thus requiring improvement.

It has been observed through the experience gained from the DeCarb project that the development of innovation support services can accelerate the transition to a low-carbon economy by empowering businesses to innovate regarding clean technologies and models, providing a major impetus to the Western Macedonia region. Incorporating the lessons learned from interregional cooperation, PEDDM aims to improve the ROP 2014-2020 through:

- New projects on innovation support services, both in terms of infrastructure (Innovation District) and advisory services for businesses seeking to invest in low-carbon solutions.
- Management changes in the ROP on how to efficiently allocate amounts between loans, guarantees, and types of venture capital financing in connection to innovation support actions.

As a public organisation representing the 13 most coal-dependent municipalities of the region, PEDDM can influence the Managing Authority (Western Macedonia Region) in managing grants, introducing new projects to be funded, selecting investment priorities to be covered, and developing funding procedures and selection criteria for beneficiaries.

### 3.3.2 Just Transition Development Programme (JTDP) 2021-2027

The Just Transition Development Programme, the policy instrument expected to replace ROP 2014-2020 in the DeCarb project, has been drafted with the decarbonisation of the Greek energy production already in progress and after the presentation of the National Plan for Energy and Climate and the announcement of the European Green Deal. As such, its objectives reflect these policy shifts at the national and European level. More specifically, the Programme aims to revitalise the economies of the intervention regions (regions of Western Macedonia, Crete, South Aegean, North Aegean and the municipalities of Megalopoli, Gortinia, Tripoli, and Oichalia), secure jobs that are impacted by the shift to renewable energy sources and create new jobs in sustainable economic activities.

#### Priority areas of the Just Transition Development Programme 2021-2027

The Just Transition Development Programme places particular emphasis on the six following areas:

1. Enhancing and promoting entrepreneurship
2. Energy transition – climate neutrality
3. Land use change – circular economy
4. Ensuring a just transition for the regional workforce and enhancing the human capital of the region
5. Integrated small-scale interventions – smart communities
6. Technical support

#### Alignment of DeCarb with the Just Transition Development Programme

As described above (see also Section 1.2.3), the Just Transition Development Programme 2021-2027 was prepared when the decarbonisation process and the national and European climate policies were at a much more mature stage compared to the time the ROP 2014-2020 was drafted. As a result, it has moved towards addressing the policy gaps present in the latter and has incorporated policy improvements based on the experience acquired since 2014.

With regards to the policy gaps in ROP 2014-2020, which DeCarb sought to address, Priority 4 in the 2021-2027 Programme addresses the need to link the ongoing decarbonisation process to the need to retrain the labor force of the region. It aims, in particular, to provide the regional workforce with the necessary skills, thus, allowing employees in the impacted sectors to participate in the labor market in the post-lignite era. Moreover, the need to link the new energy policies, i.e. the decarbonisation and the shift to renewable energy sources, to a sustainable growth path is addressed by Priority 2, in conjunction with Priorities 1 (innovation, entrepreneurship) and 4 (workforce retraining).

#### Complementing the Programme's innovation actions (Innovation Zone)

An emblematic project mentioned in Priority 1 of the Just Transition Development Plan is the creation of an Innovation Zone in Western Macedonia. Its purpose is to serve as a vehicle that promotes innovative entrepreneurship in the fields of clean energy and environmental technologies and act as a lever for the transformation of the economy of

Western Macedonia in the post-lignite era. In particular, the main priorities of the Innovation Zone are specified as follows:

- Spatial planning, infrastructure development, and innovation initiatives in the region (e.g. Technological Park, incubators, clusters).
- Coordinating initiatives that take place in the Innovation Zone, to promote technological applications and innovative entrepreneurship in the areas of clean energy and environmental technologies.
- Attracting, and subsequently supporting, investors and research institutions from other regions/countries.
- Planning and implementing projects that serve the above aims.

The need to facilitate and promote links between research institutions and businesses in the region of Western Macedonia had been identified during the DeCarb project, through the experience sharing between the project partners and through the good practices observed in other regions in transition. These conclusions have been implemented in the action suggested in the present document (i.e. the foundation of an Innovation District), which is expected to act complementary to and support certain actions of the Innovation Zone, thus amplifying its potential impact. The specific nature of the Innovation District is elaborated in the following sections.

### **3.4 Nature of the action**

The main action of the PEDDM action plan will be an Innovation District, a specialized area conducive to the establishment of innovative companies and research institutions according to triple helix principles, facilitating innovative actions and synergies and contributing to the economic decarbonization of the regional value chain.

The development of the Innovation District will strengthen business-research links with the support of the regional administration and it will act as a regional accelerator where applied research will be coupled with business ideas, to retain the rich human capital of Western Macedonia and to enable the low-carbon transition of the regional economy.

The Innovation District, as a service to be developed by PEDDM, will provide technological, innovation, and business development support to companies and employees in an inclusive way, and will act as an organizational structure that facilitates networking, matchmaking, and human resources development in the region.

The District will place particular emphasis on a) low-carbon ideas and innovations that can redirect the regional workforce away from carbon-related activities, b) supporting new energy-saving technologies, and c) exploiting synergies with EU funds to bring change through the ROP of Western Macedonia, aiming to cooperate with the national Green Fund and the Just Transition Fund.

### 3.4.1 Relevance to the project

The mission of the DeCarb project focuses on exchanging experiences and transferring knowledge on how to transition from the carbon-intensive energy model towards a clean energy one, supporting regions to secure sustainable development, economic and societal stability, and a role in the 2030 energy mix.

The provision of innovative business support services is considered to be a key factor for the sustainable creation and development of a new low-carbon economy in coal-dependent regions, assisting businesses and SMEs to increase their competitiveness and their ability to access new markets, after decoupling from lignite-based value-chains, ensuring their financial sustainability and ability to adapt to a new energy framework.

PEDDM regards that the local market, currently affected by the negative effects of decarbonization and the COVID-19 crisis, could greatly benefit from the services of an Innovation District focusing on providing business support services. The reason for this choice is that business and innovation support services can strengthen the recovery of the local economy and enable the transition to a different economic model, based on cooperation and dissemination of knowledge, including indirect support in the form of business-tailored services (e.g. innovation management, developing funding opportunities into concrete ideas, translating regional R&D efforts to practical applications).

The Innovation District will act as business facilitator and enabler, responsible for developmental activities in the field of science-industry collaboration, knowledge transfer and the popularization of research activities on green and low-carbon business ideas. The District will co-operate closely with the University of Western Macedonia as well as other regional, national, and EU research organizations and public sector institutions. To that end, the Innovation District will:

- Provide new or established businesses with networking and co-operation solutions, to enhance the technological and innovation capacity of regional businesses that struggle to shift to a low-carbon economy.
- Encourage participation in research projects and facilitate access to funding through European and national programmes.
- Strengthen companies' research and innovation capacities, contributing to the creation of synergies with regional research organizations and promoting cooperations.
- Provide practical information on funding opportunities through relevant regional, national, and EU tenders.
- Offer business planning and consultancy services, including drafting business plans for all business activities, including research, sales, marketing, and human resources activities.
- Provide practical information on relevant legislation, to raise awareness on policy barriers.

The Region has been inspired by one case encountered in the DeCarb project, in the German region of Lusatia. The Lusatia region has a strong lignite background and is already on the path to extensive decarbonization. In A1.2 deliverable "Identification of good practices on decarbonization and clean energy transition", similar initiatives were identified in the Lusatia region. In 2019, the Lusatia Region, together with the Free State of Saxony, the Technical University of Dresden, Siemens Energy, and the Fraunhofer Institute announced the launch of an 'Innovation Campus'. Its focus was to develop technologies for the energy transition from fossil fuels to renewable energy sources. This included the promotion of various decarbonization and manufacturing technologies, including a lab for start-ups to pursue promising ideas, focusing mostly on hydrogen rollout; a hydrogen test center run by the Fraunhofer should open by 2024 and will include

electrolytes to convert water into hydrogen using renewable energy and to capture excess wind and solar energy.

This idea was discussed with and picked up by local stakeholders during the A2.2 social dialogue events, and, after further discussions with social partners, PEDDM decided that an innovation support infrastructure could be useful in regional decarbonization efforts, also addressing policy gaps in the ROP.

### 3.4.2 Description of the action

The Action consists of three sub-actions:

1. Sub-action 1: Development and operation of an Innovation District, focusing on providing:
  - a. Support to start-ups, SMEs and businesses to innovate and lead the transition to a low-carbon territorial economy
  - b. Training for employees and individuals that want to innovate in the field of clean energy technologies, to withhold brain drain
  - c. The Innovation District will seek to create synergies with leading regional R&D&I projects, involving high-skilled scientists, as well as the whole ecosystem of companies in the region (e.g. clusters, cooperatives, universities, chambers of commerce, SMEs, NGOs).
2. Sub-action 2: Training of staff who will manage the Innovation District. To this end, PEDDM will train (and will regularly retrain) the relevant staff that will populate the District.
3. Sub-action 3: Developing criteria and mechanisms for monitoring Innovation District-supported businesses in the future ROP calls. This will include the development of:
  - a. Eligibility criteria for beneficiary enterprises
  - b. Monitor mechanism for assessing the success of the support provided

The following tables detail the indicators to monitor and ensure the participation of innovative businesses in funding schemes, to be developed within the context of the PEDDM Innovation District.

*Table 5: Funding eligibility criteria (indicative)*

#### A. Eligibility criteria

<b>Businesses should be:</b>	Active in the clean energy economy and/or assist in the transition to the low-carbon economy
	The founding business plan and the business model (upon on-site examination if necessary) is not based on coal and fossil fuel generation
	Preferably start-ups and/or SMEs (prioritization)
	Registered in the region of Western Macedonia
	Comply with Payment of taxes regulations or social security contributions

	Not be questioned on matters of insolvency, conflict of interests, or professional misconduct
	Operate legally with the appropriate licensing document.
	Operate exclusively with one of the forms of corporate / commercial business.
	Not be in a state of bankruptcy, liquidation, or forced management.
	Not to the detriment of recovery of state aid following a European Commission decision declaring an aid illegal and incompatible with the internal market.
	Ensure that the costs included in this funding application have not been funded by other national or community resources.
	There are no grounds for excluding Article 40 of Law 4488/2017.
	Submit a single application for funding per VAT number in this action.

Table 6: Monitoring mechanism with indicators (indicative)

Indicator	Measurement unit	Target (first 5 years)
<b>Number of companies receiving support</b>	Business (absolute number)	15
<b>Creating new jobs</b>	EME	30
<b>Personnel re-training</b>	Absolute number of employees	50
<b>Employing formerly lignite-related business personnel</b>	Absolute number of employees	50
<b>R&amp;D partnerships / collaborations</b>	Absolute number of collaborations	20
<b>Investing in innovative technologies/products/processes</b>	Percentage of grant (percentage)	40%
<b>New patents</b>	Patents	2



## **Introduction of innovations in the business model of business**

New / modified models  
(absolute number)

20

### **3.4.3 Stakeholders involved & engagement model**

Indicatively, the stakeholders to be involved in implementing the Action will be (currently in consultation):

- **Managing Authority**
  - a. **Region of Western Macedonia:** The Region of Western Macedonia will be involved as the Managing Authority of the policy instrument addressed; this will allow PEDDM to mobilize capacities for the implementation of the DeCarb action plan.
- **Energy Providers**
  - a. **Public Power Corporation S.A.:** The Public Power Corporation S.A. (DEI) is the operator of all lignite-fired plants; the low-carbon provisions of the ROP are directly linked to PPC activities. PPC's support to the Action Plan is instrumental for the adoption of innovative low-carbon technologies and the transition towards a clean energy sector.
- **Local Municipalities**
  - a. **Kozani, Florina, Eordaia, and Amintaio:** The municipalities of Kozani, Florina, Eordaia, and Amintaio are the lignite-intensive areas of the region. Their involvement is necessary to ensure consensus on proposed actions through the ROP, since the impact of the low-carbon economy will be mostly felt in these areas.
- **Regional Development Agencies**
  - a. **ANKO S.A. - Regional Development Agency of Western Macedonia:** ANKO implements development policies and measures in the region. The implementation of actions to stimulate alternative growth trajectories falls also under its responsibility, especially as regards involving local businesses and promoting initiatives to reskill the workforce.
- **Academic Institutions/R&D Institutes**
  - a. **University of Western Macedonia**
  - b. **University of Applied Sciences of Western Macedonia:** The University of Western Macedonia and the University of Applied Sciences of Western Macedonia will provide technical expertise to exchange and transfer operational knowledge on low-carbon technologies and alternative uses of lignite (e.g. production of renewable fuels).

Regarding the engagement model followed, the stakeholders above have been actively collaborating with PEDDM, providing input and shaping the actions of this action plan. In particular, stakeholders have contributed in defining the relevant challenges to be addressed in the region of Western Macedonia, contributing with intelligence that was integrated in the SWOT matrix.

The main pathway for stakeholder engagement during the implementation of the actions outlined will be dedicated stakeholder meetings, in the model of those conducted in the context of DeCarb activity A2.1. These regular meetings provided an excellent opportunity for the regional stakeholders to voice their opinions on the various DeCarb activities and on topics related to the DeCarb objectives, in a bottom-up process that contributed considerably to the overall goals of the project and provided additional points of view from each region. The discussions that took place during the stakeholder meetings played a decisive role in selecting suitable actions that facilitate a just transition for the region and alleviate its adverse socio-economic impact on the local communities. As regards the implementation of the action plan, the stakeholder meetings envisioned (two times per year) will be part of the already existing governance mechanism that is in place in Western Macedonia<sup>1</sup>.

### **3.4.4 Timeframe, expected budget & funding sources**

The proposed Action will be implemented between 2021 and 2023, according to all relevant Interreg Europe guidelines.

The overall budget of all actions are expected, indicatively, to be around 250 000 EUR, which will be part of the technical assistance budget that has already been allocated for innovation actions in the latest decarbonisation roadmap of the Western Macedonia region<sup>2</sup>. PEDDM will create synergies with the Ministry of Environment, the MA of the existing as well as upcoming policy instruments, the Prasino Tameio/Green Fund of Greece, the University of Western Macedonia to collaboratively implement the action. 150 000 have been allocated to a study to be conducted to define all the organizational and planning issues of the Innovation District (action 1). The remaining funds will be used to train PEDDM's personnel and hire additional staff to increase its capacities in operating the District (action 2). Action 3 does not require funding to be implemented, as the development and implementation of the monitoring mechanism will be carried out by the existing staff of PEDDM.

The funding source for the Action will be the Regional Operational Programme of Western Macedonia 2014-2020. However, PEDDM is also considering developing synergetic actions with the upcoming Structural Funds programmes and the Prasino Tameio/Green Fund of Greece, since the currently addressed policy instrument may not continue to fund actions beyond 2021. In particular, PEDDM will examine the establishment of synergies with the Special Transition Programme 2020-2023 and the ROP of Western Macedonia 2021-2027 which include actions that promote the establishment of an innovation zone in the Western Macedonia region.

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<sup>1</sup> In particular, the stakeholder meetings envisioned will feed into the Regional Committee platform, as outlined in the World Bank report "Managing the Lignite Transition for Coal Regions in Western Macedonia, Greece – Proposed Governance Arrangements" which can be accessed here: [https://www.sdam.gr/sites/default/files/consultation/Greece - Proposed Governance Arrangements for WM June 2020 Final.pdf](https://www.sdam.gr/sites/default/files/consultation/Greece_-_Proposed_Governance_Arrangements_for_WM_June_2020_Final.pdf).

<sup>2</sup> <https://yperdiavgeia.gr/pdfjs/web/viewer.html?file=/decisions/downloadPdf/40048065>

Regarding the timeline and milestones of implementation, the second and third actions are expected to be finalized first (milestone 1 & 2), by the middle of Phase 2; action 1 is expected to be implemented by the end of Phase 2 (milestone 3).

## 3.5 Relevant good practices from the EU & around the world

### 3.5.1 Limburg, Netherlands

#### Brief Introduction

Limburg is the first European region that successfully phased out coal, with the last coal mine closed in 1974 [37]. Before that, 53,000 people were employed directly in the coal mines, with another 30,000 indirectly dependent on coal mines. In total, 35% of the jobs in the region were directly or indirectly related to coal mining. The primary motivation, at the time, behind the coal phase-out was a reduction in the competitiveness and profitability of the Dutch mining activities as a result of the falling world prices in 1958 and 1959 and the increasing costs of coal mining in the region due to the increasing depth of extraction. Moreover, the discovery in the Netherlands of the largest natural gas field in Europe provided a more desirable alternative and facilitated the transition.

#### Innovation and the coal phase-out

The first strategy for the phase-out process was presented by the Dutch government in 1965. It involved the closure of some of the mines, support measures to the mines still operating and facilitating the restructuring of the industry of South Limburg. The second policy document was presented in 1969; it called for the closure of all coal mines by 1975.

The third strategy was presented in 1977, in an environment of economic recession and rising unemployment rate. It was the first that featured innovation as a central part of the policy measures, focusing on stimulating innovation in successful firms and on increasing the knowledge infrastructure of the region through founding new Universities and developing international institutes. Maastricht was also tasked with creating international institutions and higher education. Moreover, the University of Maastricht was founded in 1976, while the head office of the Dutch Open University was established in Heerlen as part of the overall restructuring process in the region. Finally, the Limburg Investment and Development Fund was created in 1975 to invest in innovative companies.

#### Conclusions

The transition process was considered complete by 1990. By then, the unemployment rate in the region was equal to the national average and new high added value economic activities had replaced the mining activities in the region. The latter should be attributed to the creation of favorable framework conditions such as knowledge infrastructure and support for industrial network creation. These developments highlight the success of the transition process. In addition, the transition was largely successful for the workforce

employed in the coal mines as the large majority of the miners were either reemployed or received a pension.

### **3.5.2 Bottrop, Germany**

#### Brief history

Bottrop is a city located in the Northern Ruhr region in the North-Rhine Westphalia state in Germany. For the last 160 years, the city has been characterized by the coal mining activities taking place in the area; in fact, the last hard coal mine in the country operating until 2018 was located here. In 2009 the InnovationCity Ruhr competition was launched to find a candidate city in the region to test sustainable structural changes, with Bottrop being the city selected to participate in this project [38].

#### Aims and results

The aims of the project revolved around low-carbon revitalization of the urban areas through the use of new, innovative technologies as well as employing sociotechnical approaches. In particular, the project aimed to halve the city's CO<sub>2</sub> emissions by 2020. To this end, emphasis was placed in the areas of the energy efficiency of buildings, renewable energy generation, and sustainable urban development. One of the principal goals of the project concerns the decentralization of energy production, which calls for the transformation of the local energy consumers into energy producers. To effect that change, a number of innovative technologies have been implemented. An important part of this process is the collaboration between the industry, academia, businesses, and municipal and state administrations to provide the most effective solutions to the challenges related to the transformation of the city.

Of particular importance for achieving the goals of the project has been the participation and collaboration of leading enterprises and research institutions, providing the city with a strong knowledge base. The project has also benefited from diversified funding sources, including European, state, and private funding sources. Finally, consulting and financial support to real-estate owners has been a major contributing factor to the high energetic modernization of buildings in the area.

As a whole, the "InnovationCity Ruhr | Model City Bottrop" has been successful. The CO<sub>2</sub> emissions of the city have been halved by 2020 [39]. At the same time, the various sub-projects that took place in the area offered valuable knowledge in various areas, such as technological solutions/innovations for the refurbishment of the buildings to an energy-positive standard, sustainable urban development, and energy self-sufficiency.

#### Conclusions

Overall, the project should be considered successful in the sense that the goals of the project have been achieved. Perhaps what is more important, is that the project provides valuable knowledge on how to transform a previously coal mining city into an energy-efficient, sustainable city. To this end, efforts have been made to share the gained insights with the larger region. As a result, the regional project "InnovationCity roll-out" has been

launched with the explicit aim of transferring the acquired experience to 20 other cities in the Ruhr area.

### **3.5.3 Alberta, Canada**

#### Brief history

Alberta, located in Western Canada, is the largest producer of coal-fired electricity in the country with a 6,300 MW of installed capacity (2016). Economically, the region is successful, recording the highest GDP increase in the period 1995-2015 and having a below-average unemployment rate [37]. The energy production of the region is largely based on the lignite that is mined locally, with almost half of the energy being produced by coal-fired power plants.

The Canadian government announced in 2016 its intention to phase out coal by 2030. To this end, it has initiated a Just Transition Process to address the social impact of the transition. Alberta had already in 2015 adopted its own coal phase-out plan, aiming to eliminate any emissions from coal power by 2030, implementing an economy-wide carbon price and setting tangible goals with regards to renewable energy. Similar to the previous cases, the transition is driven by economic factors since the competitiveness of the coal sector is declining and natural gas has become a more appealing alternative. At the same time, such a transition is expected to contribute to the planned reduction of GHG emissions.

#### Innovation and the coal phase-out

Innovation and clean technologies play an important role in the transition process in Alberta as they constitute one of the six action areas in the Climate Leadership Plan. To provide conducive framework conditions and facilitate innovation the Government of Alberta after consultation with various stakeholders (e.g. academia, industry, and environmental organisations) created the Climate Change Innovation and Technology Framework. Moreover, the Alberta Carbon Conversion Technology Center was established to enable the cooperation between the government, technology developers, and research scientists to provide innovative carbon capture and use technologies at a large industrial scale.

#### Conclusions

Although the coal phase out in Alberta is still an ongoing process, there are elements of the transition process that suggest that the transition will be successful. The involvement of the stakeholders, the support of the local communities, and the emphasis on innovative technologies and knowledge-based processes are elements that were present in the successive transitions mentioned before. The carbon pollution pricing system has also proven to be successful in stimulating innovation as it has made coal-fired electricity more costly. The decision to eliminate coal-fired electricity production by 2023 [40], much earlier than 2030, is also indicative of the preliminary success of the transition plan.

## References

- [1] European Commission, "COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS," 2019.
- [2] European Commission, "European climate Law," 2020. [Online]. Available: [https://ec.europa.eu/clima/policies/eu-climate-action/law\\_en](https://ec.europa.eu/clima/policies/eu-climate-action/law_en).
- [3] ESPON, "Structural change in coal phase-out regions".
- [4] European Commission, "Coal Regions in Transition," 2017. [Online]. Available: [https://ec.europa.eu/energy/topics/oil-gas-and-coal/EU-coal-regions/coal-regions-transition\\_en](https://ec.europa.eu/energy/topics/oil-gas-and-coal/EU-coal-regions/coal-regions-transition_en).
- [5] European Commission, "Financing the green transition: The European Green Deal Investment Plan and just Transition Mechanism," 2020. [Online].
- [6] European Commission, "The Just Transition Mechanism: making sure no one is left behind," [Online]. Available: [https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/just-transition-mechanism\\_en](https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/just-transition-mechanism_en).
- [7] Ministry of the Environment and Energy, "National Energy and Climate Plan," 2019.
- [8] ΣΔΑΜ, "Επικαιροποιημένο Master Plan Δίκαιης Αναπτυξιακής Μετάβασης των λιγνιτικών περιοχών," 2020.
- [9] ΣΔΑΜ, "Πρόγραμμα Δίκαιης Αναπτυξιακής Μετάβασης 2021-2027 (Στρατηγική του προγράμματος και ανάλυση προτεραιοτήτων)," 2021.
- [10] ΣΔΑΜ, "Στρατηγική, αρχιτεκτονική και Περιεχόμενο του "Ειδικού Μεταβατικού Προγράμματος για τη Δίκαιη Αναπτυξιακή Μετάβαση 2020-2023"," 2020.
- [11] ΣΔΑΜ, "Εδαφικό Σχέδιο Δίκαιης Μετάβασης Δυτικής Μακεδονίας," 2021.
- [12] "Επιχειρησιακό Πρόγραμμα Περιφέρειας Δυτικής Μακεδονίας 2014-2020".
- [13] European Commission, "Glossary, Thematic Objectives," 2012. [Online]. Available: [https://ec.europa.eu/regional\\_policy/en/policy/what/glossary/t/thematic-objectives](https://ec.europa.eu/regional_policy/en/policy/what/glossary/t/thematic-objectives).
- [14] "Σχέδιο Επιχειρησιακού Προγράμματος Περιφέρειας Δυτικής Μακεδονίας 2021-2027," 2021.
- [15] "Σχέδιο Στρατηγικής Έξυπνης Εξειδίκευσης περιφέρειας Δυτικής Μακεδονίας 2014-2020," 2015.
- [16] "Περιφερειακή Στρατηγική για την Κοινωνική Ένταξη Περιφέρειας Δυτικής Μακεδονίας," 2015.
- [17] "Περιφερειακό Σχέδιο Προσαρμογής στην Κλιματική Αλλαγή Περιφέρειας Δυτικής Μακεδονίας," 2015.
- [18] "Wikipedia," [Online]. Available: <https://en.wikipedia.org/wiki/Lignite>.



- [19] SDAM, "just Transition Development Plan," 2020.
- [20] "https://tracer-h2020.eu/," [Online]. Available: <https://tracer-h2020.eu/west-macedonia-greece-el53/>.
- [21] PPC, "https://www.dei.gr," [Online]. Available: <https://www.dei.gr/el/oruxeia/apothemata-kai-poiotita>.
- [22] R. A. f. Energy, "General Information on the Greek Electricity Sector for the period 2000-2003 : Installed capacity, production & consumption levels, Renewable Energy Sources and Long Term Energy Planning."
- [23] F. Chatzitheodoridis, A. Kolokontes and L. Vasiliadis, "Lignite mining and lignite-fired power generation in western Macedonia of Greece: economy and environment.," The Journal of Energy and Development.
- [24] P. Lague, "https://www.powerengineeringint.com/," [Online]. Available: <https://www.powerengineeringint.com/coal-fired/greece-commits-to-2025-coal-phase-out/>.
- [25] ΣΔΑΜ, "Εδαφικό Σχέδιο δίκαιης και αναπτυξιακής μετάβασης Δυτικής Μακεδονίας," 2021.
- [26] European Commission, "https://ec.europa.eu/," [Online]. Available: [https://ec.europa.eu/clima/policies/ets\\_en](https://ec.europa.eu/clima/policies/ets_en).
- [27] L. Christiaensen and C. Ferre, "Just Coal Transition in Western Macedonia , Greece - Insights from the Labor Market," 2020.
- [28] WWF, Sandbag, CAN Europe, HEAL, "Europe's Dark Cloud," 2016.
- [29] [Online]. Available: [https://energyeducation.ca/encyclopedia/Coal\\_types](https://energyeducation.ca/encyclopedia/Coal_types).
- [30] [Online]. Available: [https://www.volker-quaschnig.de/datserv/CO2-spez/index\\_e.php](https://www.volker-quaschnig.de/datserv/CO2-spez/index_e.php).
- [31] Hellenic Boell Stiftung, "Lignite in the Greek Energy System, Facts and Challenges," 2015.
- [32] SDAM, "Just Transition Development Plan," 2020.
- [33] L. Karamoutsou, A. Psilovikos, P. Stalnacke and C. Farkas, "Lake Vegoritida's water level and catchment area alterations as a result of natural processes and human interventions."
- [34] Plant Engineer's Handbook.  
<https://www.sciencedirect.com/book/9780750673280/plant-engineers-handbook>
- [35] European Environmental Agency, [Online]. Available: <https://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer>.

- 
- [36] B. kontogianni. [Online]. Available:  
<https://greekreporter.com/2021/05/07/greece-documents-largest-drop-carbon-emissions-eu-2020/>.
- [37] R. ,. D. P. P. ,. R. A. Popp, "Transforamtive change throug innovation: an analysis of the role of innovation in five transition regions.," 2018.
- [38] "InnovationCity Ruhr: Model City Bottrop".
- [39] [Online]. Available: <https://www.bottrop.de/innovationcity/aktuelles/bottrop-hat-co2-emissionen-halbiert.php>.
- [40] "https://www.cbc.ca/," [Online]. Available:  
<https://www.cbc.ca/news/canada/calgary/road-ahead-alberta-coal-power-electricity-decline-1.5761858>.