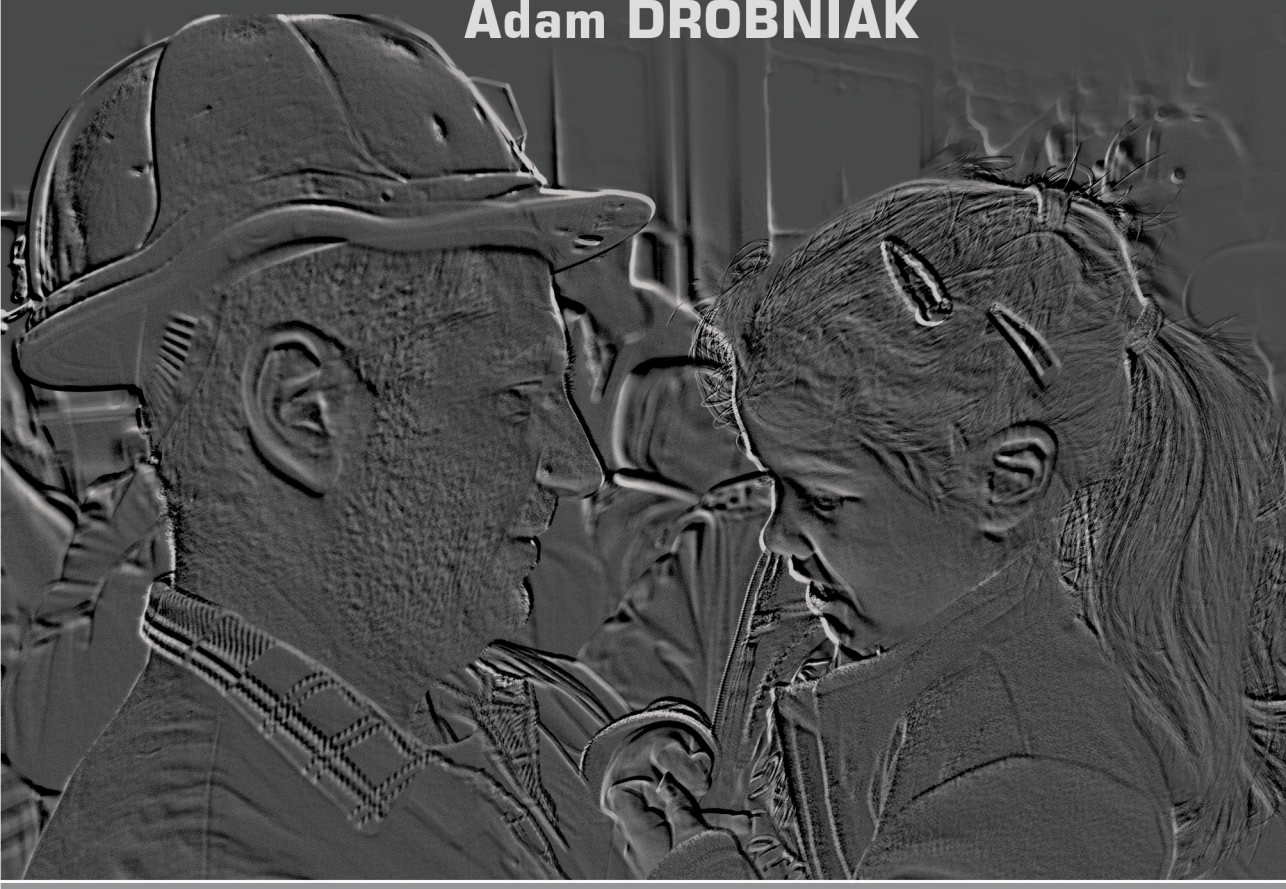
Just transition of coal regions in Poland

Impulses, contexts and strategic recommendations

Edited by

Adam DROBNIAK



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Katowice subregion – Śląskie province	Adam Drobniak, Piotr Rykała

List of abbreviations

FDI	Foreign Direct Investments
R&D	Research & development
CAN	Climate Action Network
CHP	Combined heat and power
CIT	Corporate Income Tax
COP	Conference of the Parties
EIB	European Investment Bank
EMAG	Łukasiewicz Research Network – Institute of Innovative Technologies EMAG
ETS	European (Emissions) Trading System
JTF	Just Transition Fund
GIS	Geographic Information Systems
CE	Circular Economy
CSO LDB	Central Statistical Office, Local Data Bank
GZM	Górny Śląsk-Zagłębie Metropolis
ha	Hectare
HTR	High-Temperature Reactor
ICT	Information and Communication Technologies
BEI	Business Environment Institutions
IPCC	Intergovernmental Panel on Climate Change
LGU	Local government units
JSW	Jastrzębska Spółka Węglowa S.A.
km	Kilometre
NJTP	National Just Transition Plan
KSEZ	Katowice Special Economic Zone

KWB	Lignite mine
KWK	Hard coal mine
LW	Lubelski Węgiel “Bogdanka” S.A.
MoC	Ministry of Climate
MoCE	Ministry of Climate and Environment
MSME	Micro, small and medium-sized enterprises
LSDP	Local Spatial Development Plan
NFEPWM	National Fund for Environmental Protection and Water Management
NGO	Non-governmental organizations
NUTS	Nomenclature of Territorial Units for Statistics
UN	United Nations
DSO	Distribution system operator
RES	Renewable energy sources
PGE	Polska Grupa Energetyczna S.A.
PGG	Polska Grupa Górnicza S.A.
PGNiG	Polskie Górnictwo Naftowe i Gazownictwo S.A.
PGZ	Polska Grupa Zbrojeniowa S.A.
PIT	Personal Income Tax
GDP	Gross Domestic Product
pp	Percentage point
PV	Photovoltaic cells
RDF	Refuse Derived Fuel
RIS	Regional Innovation System
thous.	Thousand
MUS	Medical University of Silesia
TJTP	*Territorial Just Transition Plan*
EU	European Union
UNEP	United Nations Environmental Programme
ERO	Energy Regulatory Office
WWF	World Wide Fund for Nature
WMO	World Meteorological Organization
WSEZ	Wałbrzych Special Economic Zone
ZE PAK	Zespół Elektrowni Pątnów, Adamów, Konin (*Pątnów, Adamów, Konin Power Plant Complex*)

Introduction

The sustainable development objectives adopted in 2015 by the UN as part of the *Agenda 2030* [United Nations, 2015] set a new perspective for a sustainable, just and inclusive future. Just transition is one of the key and multifaceted challenges. It includes transforming the economy towards a low- and zero-emission economy, while simultaneously eliminating, avoiding and limiting the social costs associated with the pro-environmental approach towards development shaping.

The current direction of the European Union's development, manifested through the *European Green Deal* [European Commission, 2019b], clearly points to three integral process that should stimulate member states on their path to a low-emission economy, namely, just transition, sustainable use and fair distribution of resources, and social justice. This approach refers to the paradigm of sustainable development and its primary goal, which is achieving generational and intergenerational justice. However, the reorientation the perception of development processes, which sways away from the traditional understanding of such concepts as economy, environment and society (capital, land, work) in favour of an integrated and adaptive approach, turns out to be important. Achieving social justice without providing conditions for equal access to resources and just transition while taking into account all social groups − is deemed impossible in this context.

The *European Green Deal* construes just transition as ensuring equal access to environmental resources (water, clean air, green areas), employment market, and social and technical infrastructure, along with eliminating development-related disproportions to provide high quality of life and long-term growth opportunities. Such an approach clearly emphasizes the social issues, i.e., the

significance of employees and local communities that experience the adverse outcomes of energy transition and reinforced environmental protection that are not limited to climate change alone [Mustata, 2017].

Just transition under Polish conditions, in terms of both media and political discussion, is often confused with energy transition, which is also dubbed "greed transition" or "green revolution" – sometimes to a degree where just transition and energy transition are considered equal. In recent years, just transition has become a downright trendy slogan, scrupulously applied by politicians, and representatives of trade unions and ecological organizations. The stakes in this game are the large expectations related to just transition, for example, in the form of obtaining funding allocated by the EU for this purpose.

Because of that, just transition is unfairly perceived in Poland as a way to restructure the mining and conventional energy sector. It is also credited with a causative function within EU policy that enforces changes in Poland's raw material and energy sector. Just transition is to provide new jobs for people leaving or losing their employment in the mining, conventional energy and related industries. It goes without saying that changes in the energy sector towards a low-emission economy or energy transition (in other words), will entail significant employment market shifts in the production structures creating value chains with traditional industries, notably in coal regions − where the concentration of such activities is the highest. This will mean the emergence of adverse social consequences, and in locations somewhat risen on coal and conventional energy – a significant change in the cultural identity resulting from the current, often more than 150-year-old path of social and economic development of coal regions.

The inevitability of change in coal regions also constitutes an outcome of broader shifts of the entire global economy that is associated with, among others, megatrends related to increasing competition in the sector of innovations, progressing economic digitization, expanding work automation and employment flexibility or reinforced globalization [Dziemianowicz, Jurkiewicz, Stokowski, 2022]. All the more, the awareness of the social consequences in coal regions due to "the emergence of a new economy" [Dziemianowicz, Jurkiewicz, Stokowski, 2022] points to a strong need for a comprehensive study of such areas and a strategic approach towards programming their development.

The goals of this monograph include collecting and organizing knowledge, experience and studies related to just transition, and formulating strategic recommendations for Poland's coal regions. It is an attempt at providing a synthetic insight into the multi-contest situations within these areas, and indicating their specificity and diversity. This also means, by providing a supporting review of the development concept and by identifying the strategic stakes of this process's stakeholders – formulating normative proposals for changes in the context

of both the green and digital economy, as well as initiating conditions for utilizing the process change associated with switching to a low-emission economy for the purposes of accelerating the development of Poland's coal regions.

The complexity of the addressed issue determines the structure of the paper, which is made up of three essential chapters. The first explains the stimuli and concepts associated with just transition and broadly understood region transformation from the perspective of contemporary development concepts. It is supplemented by the preview of best practices based on selected examples of foreign and domestic transformation projects, illustrating the uniqueness and multitude of approaches towards implementing transformation changes.

The second chapter of the study focuses on diagnosing the demographic, economic, institutional, spatial and environmental standing of Poland's coal regions. The diagnostic analyses refer to the starting state of Poland's coal regions upon the announcement of the *European Green Deal*. Therefore, the diagnostic analyses demonstrate the situation of Poland's coal regions on the verge of a just and energy transition.

The final chapter of this paper is normative in nature and contains an identification of the strategic stakes of just transition stakeholders, considerations related to the selection of the development concept for individual coal regions within Poland in the perspective of their situation diagnosed in the second chapter, and environmental trend scenarios impacting the potential transition paths for the analysed regions. Strategic recommendations in terms of just transition constitute the essence of this chapter, and have been formulated at domestic and regional levels.

The methodological aspect of the monograph covers a number of tools and techniques employed within social studies. The first chapter is conceptual and employs a domestic and foreign source literature review and case study analysis, based on, among others, the experiences of the Authors acquired in the course of the EuroStar2020 project contest. The typically diagnostic second chapter was based on statistical analyses, a review and systematization of secondary materials, GIS analyses and portfolio analyses. The third chapter was based on interviews with just transition stakeholders from Poland's coal regions (conducted in the years 2020-2021), strategic foresight tools and intervention logic (related to formulating strategic recommendations).

It should be stressed that this publication results from the involvement of its Authors in a number of tasks associated with programming just transition for Poland's coal regions, including the following activities implemented under: *Proposed recommendations for the field of just transition* [Drobniak et al., 2020], *National Just Transition Plan* [Institute of Industrial Area Ecology, Mini-

stry of Climate and Environment, 2021], *Territorial Just Transition Plan for the Śląskie Province*[1] [Marshal's Office of the Śląskie Province, 2021], *Territorial Just Transition Plan for Eastern Wielkopolska* [Marshal's Office of the Wielkopolskie Province, 2021], *Territorial Just Transition Plan for the Łódzkie Province*[2] [Marshal's Office of the Łódzkie Province, 2021], *Territorial Just Transition Plan for the Dolnośląskie Province*[3] [Marshal's Office of the Dolnośląskie Province, 2021], *Territorial Just Transition Plan for Western Małopolska* [Marshal's Office of the Małopolskie Province, 2021], tasks implemented under a research and development project entitled *Programme framework for integrated planning of just transition at domestic and regional levels*[4], the *Assumptions for the Just Transition Priority Programme Financed by the Modernization Fund* project [Drobniak, 2022], as well as over 250 meetings, presentations and consultations with the stakeholders of just transition in Poland's coal regions.

The scope of implemented work, access to information on transition-related processes and the determination of strategic stakes of individual just transition stakeholders would not be possible without the commitment of a number of persons and institutions. Given the above, we would like to express our gratitude for cooperation to the following people:

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1 Covering seven coal regions, i.e., Bielsko-Biała, Bytom, Gliwice, Katowice, Rybnik, Sosnowiec and Tychy.

2 Covering one coal region, i.e., the Bełchatów Transition Area.

3 Covering two coal regions, i.e., the Wałbrzych and Zgorzelec district.

4 A task coordinated by the University of Economics in Katowice, commissioned by the National Centre for Climate Change, Institute of Environmental Protection – National Research Institute, as part of a R&D project entitled *Society on the path to climate neutrality*, funded by the National Fund for Environmental Protections and Water Management, contract No. 1946/2020/Wn50/NE-OA-KU/D.

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- Marta Pogrzeba – Institute of Industrial Area Ecology in Katowice,
- Dariusz Prostański – Institute of Mining Technology KOMAG,

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[5] Maciej Sytek also serves as the president of the board at the Regional Development Agency in Konin.

[6] The President of Jastrzębie Zdrój, Anna Hetman, also serves as the Chairwoman of the Association of Mining Communes in Poland.

- Jakub Kupecki, Grzegorz Tchorek – Institute of Power Engineering,
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Katowice, 18th November 2022

Adam Drobniak

Chapter I

Green Deal and just transition

1. The *European Green Deal* as a new coal region transition impulses

Klaudia Plac, Agnieszka Rzeńca

Coal region transition has accelerated in recent years; however, its sources can be traced to processes dating back several dozen years. In the early 1970s, the world was stirred by the first energy crisis, and the Club of Rome published a report entitled *Limits to Growth*, which pointed out that economic growth was doubtful in the context of depleting natural resources − energy resources in particular [Meadows et al., 1973]. Despite numerous opponents against the report and the "zero growth" proposed therein, the actual shock associated with "isolating" access to oil revealed the issue of the strong dependence of national and global economies on fossil fuels.

The problems of raw material and overgeneration of pollutants were not addressed by policies during these times. At the turn of the 1980s and 1990s, deepening regional development disparities dominated the news. Such concerns became the foundation for re-evaluating EU's structural intervention toward cohesion policy, taking into account old industrial regions as well (Delors Package). Regional priority objectives targeted, among others, the reconversion of regions affected by the decline of traditional industries [Pietrzyk, 2020]. These desirable investments were, however, significantly weakened in the subsequent years.

Despite the passing years, the experience gained throughout the energy crisis in the second half of the previous century, and the indicated required

restructuring processes covering regions with declining industries, the use of traditional energy sources is still dominant, generating extreme amounts of air pollution. The results of research by climatologists and physicians published in 1981, however, underlined the strong correlation between recorded temperatures and the atmospheric emissions of greenhouse gases. This simultaneously was a wake-up call for the world against the outcomes of global warming [Hansen et al., 1981]. A worldwide debate on climate change and the related global consequences was, therefore, initiated by the World Meteorological Organization and the United Nations Environmental Program (UNEP) at the request of the United Nations (UN).

The end of the 1980s saw the establishment of the Intergovernmental Panel on Climate Change (IPCC), which developed the first report assessing climate change in 1990 and determined the range of the projected change in average global temperature [Intergovernmental Panel on Climate Change, 1992]. This report became the grounds for adopting the UN Framework Convention on Climate Change adopted at the Earth Summit in Rio de Janeiro [United Nations Conference, 1992]. Its goal for its signatory countries was, and still is, to ensure that the average temperature on Earth remains at a level safe for the environment and for human life. The activities undertaken at the time are continued through conferences of the parties to the convention commonly referred to as COP (*Conference of the Parties*)[7].

Overconsumption of fuels to ensure continuous supply of energy under conditions of increasing demand entails overgeneration of greenhouse gas emissions and leads to consequences in the form of climate change that is experienced throughout the world with a varying intensity and rapidity. Thus, since the dawn of the new century, we have observed the intensification of institutional, economic and social activities to counteract anthropopressure and to stimulate development to achieve a resource-efficient and low-emission economy. The manifestations of European Union's climate and energy policy opening include:

- *White Paper. Adapting to climate change: Towards a European framework for action* that has distinctly indicated the operational directions in combating climate change and the necessary adaptation aimed at tackling and limiting the inevitable consequences. It highlighted the need for a strategic, comprehensive and cohesive approach that covers individual economic sectors at different management tiers [European Commission, 2009].
- *Europe 2020. Strategy for smart, sustainable and inclusive growth*, wherein one of the objectives is related to climate change and energy, i.e., member

[7] 26 meetings – climate summits have been held so far. The last one in Glasgow in 2021.

states achieving a 20% greenhouse gas emission reduction relative to the 1990 level, and a 20% share of energy from renewable sources in energy consumed within the EU, as well as cutting energy consumption by 20% compared to the projections, by 2020 [European Commission, 2010].

Both documents strongly highlighted the issue of energy. As stated by A. Toffler [1997], energy is a prerequisite for the existence of every civilization. It has played and will continue to play a key role in social and economic development. The first (agrarian) civilization wave employed natural renewable energy, with such sources as the sun, wind and water. The foundation behind the development of the second (industrial) wave was energy acquired from mostly non-renewable fossil fuels, namely, coal, gas and crude oil. The third-wave (post-industrial) civilization is a somewhat return to the roots, and unlike the previous stage, must be based on renewable and highly diverse energy sources [Toffler, 1997].

Diversification of energy sources, and primarily its saving through improving energy efficiency, constitutes the direction of required activities aimed at becoming independent of fossil fuels. Reducing the general number of consumed resources involves changing the technical progress model from the current flow maximization pattern, to an effectiveness maximization pattern expressed by the economic result on a given flow [Żylicz, 1996: 171]. This approach was put into words in the:

- *Resolution of the European Parliament on a resource-efficient Europe* [European Parliament, 2012] (1) which stresses the increase in economic efficiency while simultaneously reducing resource consumption, (2) sets out and establishes new opportunities for economic growth, greater innovativeness and an improved EU competitiveness, (3) ensures the security of basic resource supplies, and (4) counteracts climate change and limits environmental impact.
- *Green Paper*: *A 2030 framework for climate and energy policies* [European Commission, 2013], wherein the main assumption was supporting innovativeness and competitiveness in harmony with sustainable development principles. It was postulated to enhance energy efficiency, and have a better and more intelligent power infrastructure, as well as to increase the capital expenditure on the modernization of the energy system.

Key international documents that have influence upon the policies of the EU and its Member States were adopted in 2015. The first was the *2030 Agenda for Sustainable Development* [United Nations, 2015] adopted by the UN General Assembly, and the second was the *Paris Agreement* [United Nations Climate

Change, 2015]. The Agenda identifies 17 sustainable development goals and 169 associated tasks, which include ensuring access to affordable, reliable, sustainable and modern energy for all (goal 7) and taking urgent action to mitigate climate change and its impacts (goal 13).

The *Paris Agreement*, signed by 195 signatory countries (as at 1 August 2022), emphasized issues related to limiting global emissions and is the first even universal and legally binding agreement in terms of climate, wherein the signature governments established the long-term objective of limiting global warming significantly below 2°C (and ultimately to 1.5°C) relative to the pre-industrial age, so as to reduce the risk and damage resulting from adverse climate change [United Nations Climate Change, 2015].

The decisions crucial for the EU in the context of the *Paris Agreement* are that adopted at the European Council meeting in December 2019 regarding reaching climate neutrality by 2050 – *Climate neutrality by 2050. A strategic long-term vision for a prosperous, modern, competitive and climate neutral EU economy* [European Commission, 2019a]. As a result, the technological change related to the transition towards a climate-neutral economy means a significant reduction of the coal-based energy in the energy mix. This is perceived as necessary in order to achieve the objectives of the *Paris Agreement*, also signed by Poland, and to counteract the outcomes of climate changes projected in the fifteenth special report of the Intergovernmental Panel on Climate Change (IPCC) entitled *Global warming of 1.5°C*[8] [Intergovernmental Panel on Climate Change, 2016].

Institutional conditions, environmental pressure and social needs have contributed to the reorientation of economic processes resulting in the evolution of economics towards a green economy development. *Green economy* is one of the ideas associated with "green growth", "low-emission development" or "low--emission growth". As a development concept, *green economy* has been functioning in the scientific discourse only relatively recently, while green economy policies been recognized and widely applied within the milieu of economic and scientific thought since 1980s and 1990s. The main stimuli behind the development of the green economy trend in the economic sciences were policies drawn up as part of international negotiations, which in turn contributed to the outcome of recognizing environmental and climate costs on the scale of the entire globe and individual regions of the world (environmental cost internalization) [Allen,

[8] Fifteenth special report – *Global warming of 1.5°C* – which addresses the issues related to the consequences of a global warming of 1.5°C above the levels from the pre-industrial period and the related global greenhouse gas emission pathways in the context of reinforcing global response to the climate threat, sustainable development and efforts to eradicate poverty.

Clouth, eds., 2012], including that based on the principles adopted under the Rio De Janeiro Declaration in1992 [United Nations Conference, 1992].

This event resulted in the development of the political concept and an integration of politics and the economic domain, wherein such approaches as green economy, low-emission development and green growth are to be the outcome of extensive efforts within the international community and agreement signatory countries [Allen, Clouth, eds., 2012]. Already during this period attention was draw to the downsides of the economic growth index applied in regional accounts and international comparisons, namely, the gross domestic product (GDP), since it fails to take environmental impact and the quality life of societies into account.

Such policies postulated within the scientific community primarily by researchers dealing with environmental or ecological economics. The Green economy notion originates from these trends exactly – the term was first referred to in 1989 by a group of scientific advisers to the British government in their breakthrough report: *Blueprint for a Green Economy*. In the beginning of the discussion on green economy, following its political origins, it constituted a response to the underestimated social and environmental costs as part of the market economy [Pearce, Markandya, Barbier, 1989]. The application of the term *green economy* in the aforementioned report resulted from an attempt to agree on a consensus in terms of sustainable development and its implications for policies, economic growth and economic project evaluation; it was probably a consequence of a synthetic reflection on the issue described by the authors [Allen, Clouth, eds., 2012]. In subsequent reports: *Blueprint 2: Greening the world economy* [Pearce et al., 1991] and *Blueprint 3: Measuring Sustainable Development* [Pearce, 1994], D. Pearce proposed applying economics to reduce global threats, including climate change, ozone depletion, diminishing resources and deforestation. However, the idea of building a green economy was barely supported at the time.

The revival of the concept did not occur before the first decade of the 21st century. This was also the period when the approach towards green growth within economy also changed – it was the transformation from a very narrow perception through the prism of green manufacturing systems, to a holistic approach towards the functioning of the entire economy. Moreover, activity within international organizations, associations and the academic community in taking up the first systematic research in the field was strongly manifested at the time. The concept of *green economy* from the perspective of all aforementioned sides was analysed by L. Georgeson, M. Maslin and M. Poessinouw [2017], who divided it in terms of description precision.

The definition advanced by the Global Green Growth Institute [2014] emphasizes the significance of resilience, justice and inclusiveness in the process of the transition to a green economy under the assumption of policy framework variability, and depending on the local/regional context. The work by R. Samans [2013] enables a conclusion that green growth is aimed at combining the economic and environmental pillars of sustainable development in a single intellectual and political planning process, hence transforming the essence of the development model so that it is able to simultaneously generate a strong and sustainable growth. In turn, pursuant to the strongly expressed approach of E.B. Barbier [2013; 2014], policies must ensure innovations and structural transition throughout the entire domestic economy, since the currently growing economic scarcity demonstrates that the presently implemented economic development is unsustainable. Barbier supported the introduction of comprehensive environmental measurement and accounting based on assessing natural capital depreciation and improved environmental information. The author stressed that such a radical approach may lead to the lack of political will for institutional transformations. According to this researcher, the concept of green economy is a long-term strategy aimed at overcoming a crisis (the financial crisis at the end of the first decade in the 21st century), with the goal of economic revival, eradicating poverty, reducing carbon dioxide emissions and halting ecosystem degradation [Barbier, 2009].

The definitions of OECD [Organisation for Economic Cooperation and Development, 2011] and UNEP [United Nations Environment Programme, 2011] emphasize accordingly, that the economy must be flexible, dynamic and more resource-efficient and that the economy and environment are mutually reinforcing. At the same time, the key to success is innovation, and, moreover, transition towards green economy may be profitable, and the combination of a healthy lifestyle with a strong economic growth is possible. This once again stressed the social aspects of green economy.

In turn, within the hierarchy of the green economy concept under the TEEB conceptualization [ten Brink et al., 2012], a *New Green Deal* is the catalyst of *green growth*, which contributes to *green economy*, which in turn is to translate to achieving *sustainable development*. The postulated pattern of the transition from a "brown" to a green economy was also presented by the United Nations Environmental Programme (UNEP) [Fedrigo-Fazio, ten Brink, 2012: 7] – cf. Figure 1. It shows, among others, that three approaches have to be considered in order to achieve the future ambitions of the transition to green economy: business-as-usual, active environmental management, and striving for sustainable development with popular support and conditioned upon good governance.

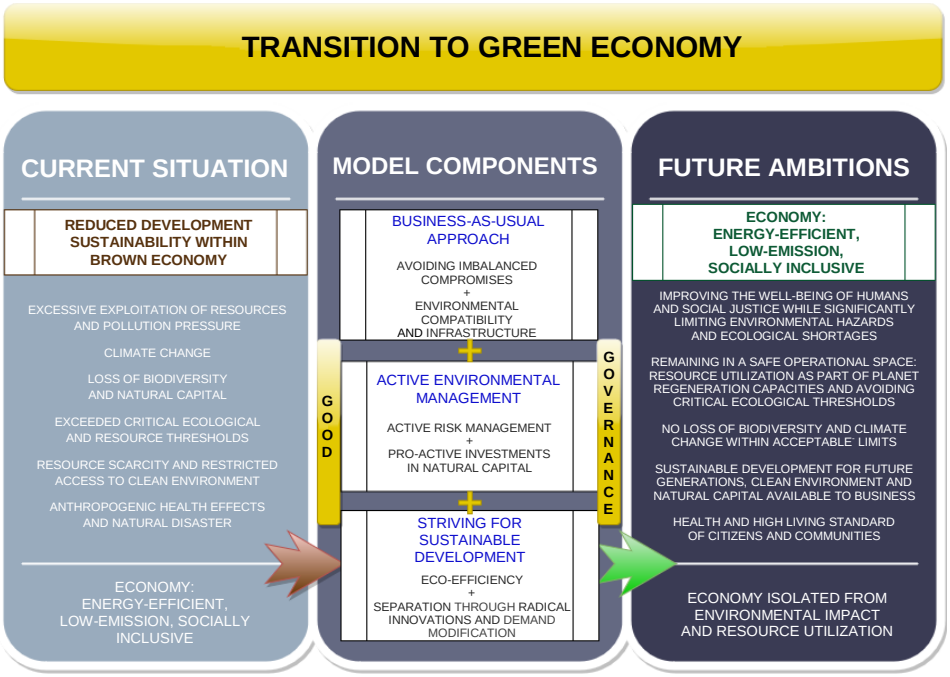

Figure 1. Diagram of components in the green economy transition model

Source: Fedrigo-Fazio, ten Brink [2012: 7].

The green economy conceptionally aims at stimulating the growth of GDP and job numbers owing to the support of investment projects related to clean technologies and natural capital, as well as human resources and social institutions. The activities under the green economy notion focus on reallocating funds within public and private investment projects as instruments critical for achieving growth, improving the environment, eradicating poverty and achieving lasting social justice, while this change is being supported by reforms of the introduced policy. In the green economy, improving the quality of life is recognized as one of the main motives behind the undertaken activities [Fedrigo-Fazio, ten Brink, 2012: 5]. The core of the green economy concept is made up of 15 segments (cf. Table 1).

Table 1. Basic segments making up green economy

Segment	Description
1	*2*
1. Energy generation	RES: solar, wind, geothermal, biomass, water, sea and tidal wave, hydrogen energy Cogeneration in the field of energy production Studying and testing RES-related solutions RES-related consulting services Associated equipment – monitoring and software for management and services

Table 1 cont.

1	*2*
2. Energy efficiency	Consulting services and energy-efficiency engineering Creating products and service effectiveness Studies in the field of energy efficiency Developing alternative applications, such as solar heating, lighting, etc. Assessing energy efficiency and measuring devices
3. Eco-transport	Alternative fuels (biodiesel, hydrogen, utilization infrastructure, resource-neutral ethanol) Motor vehicles and equipment (electric, hybrid, powered by natural gas, advanced diesel technologies)
4. Energy storage	Advances batteries Battery manufacturing components and accessories Fuel cells
5. Air and environment	Consulting services related to the environment (environmental engineering, consulting services related to sustainable business patterns) Emission monitoring and control
6. Recycling and waste management	Consulting services Recycling (paper, metal, plastics, rubber, bottles, automotive parts, electronic waste, scrap) Technologies and devices for recycling Waste processing
7. Water and wastewater management	Water preservation (monitoring systems, gauges and measuring devices) Pumping technology development and fabrication Consulting services Water processing, water and wastewater treatment products and services
8. Support for agriculture	Sustainable management of agricultural land, agricultural business support services Sustainable supply and materials employed in agriculture
9. Studies and advocacy	Activities of research organizations Providing public education in the field of renewable energy, alternative fuels and transportation
10. Business services	Legal services in terms of environmental law Green business websites Advertising websites for green professions Green marketing and PR
11. Green finances and investments	Emission trading and offsets *Venture* funds, investing private capital (Co)funding of projects (PV systems, biomass systems)
12. Technologically advances, eco-friendly materials	Bioplastics New materials raising energy efficiency
13. Green and passive construction	Design and building structures Building materials Landscape management Green properties and residential housing

Table 1 cont.

1	*2*
14. Green solutions in manufacturing and industry support	Advanced packaging Process management and consulting services Industrial surface cleaning
15. Energy infrastructure and energy transmission	Consulting and services in the field of management Cabling and equipment

Source: Grose [2013: 138-139].

One of the more important green economy development segments includes the development of RES energy generation technology and its storage, as well its common use within domestic economies so as to optimize energy systems (a peculiar postponement of using RES-based energy). The objective of these actions is a better balancing and economic-process optimization of systems based on renewable sources as pre-conditions for the obligatory development of the *Green Smart Energy* network. Energy may be stored with the application of such technologies as hydroelectric pumps, compressed air, battery-based technologies, flow cells, solar fuel, superconducting magnetic energy storage (SMES), using a flywheel, capacitors or supercapacitors, and through thermal energy storage [Chen et al., 2009].

The multitude of green economy sectors and issues, as well as the identified need to improve the quality of the living environment that will transform the social and economic system have contributed to the adoption of a new European Union strategy in 2019 – the *European Green Deal* [European Commission, 2019b]. Its intent is to remodel the EU into a just and prosperous society living within a modern, resource-efficient and competitive economy, and has the goal of reaching a net zero greenhouse gas emission level by 2050. In addition to climate neutrality, its goal is also to protect the life and well-being of EU's citizens against the threats and adverse consequences associated with the environment.

The essence of the *European Green Deal* is that the transition must be just and favour social inclusiveness, which proves to be particularly important to coal regions. The issue of lagging-behind and coal regions, the *European Green Deal* and types of investments associated with implementing the Just Transition Fund, including in the context of RES and green economy solutions, has been included in the following studies by the European Commission:

- 2015 – *Energy Union package* [European Commission, 2015],
- 2017 – *Final report. Economic challenges of lagging regions* [European Commission, 2017b],
- 2018 – *EU coal regions: Opportunities and challenges ahead* [European Commission, 2018b],

- 2019 – *The European Green Deal* [European Commission, 2019b],
- 2020 – *Overview of investment guidance on the Just Transition Fund 2021-2027 per member state. Annex D* [European Commission, 2020c],
- 2021 – *Regulation of the European Parliament and of the Council establishing the Just Transition Fund* [European Commission, 2021].

As part of its activities related to the *European Green Deal*, the European Commission has also developed the *Circular Economy Action Plan* [European Commission, 2020b], which is partly a consequence of the arrangements set out in *Global material resources outlook to 2060* [Organisation for Economic Cooperation and Development, 2018] and *What a Waste 2.0: A global snapshot of solid waste management to 2050* [World Bank, 2018]. In January 2020, the European Investment Bank announced the accessibility criteria within the framework of the *European Investment Bank Climate Action*. *Eligible sectors and eligibility criteria* [European Investment Bank Climate Action, 2020], while in March 2020, the World Bank published the *Poland engagement note: Support to energy transition in coal regions* [World Bank, 2020].

Issues associated with the pursuit of a zero-emission economy, implementing RES technologies and, more broadly, the green economy, have also been addressed in the following studies put forward by international institutions:

- *Transforming Our World: The 2030 Agenda for Sustainable Development* [United Nations, 2015],
- *Phasing-out coal, reinventing European regions* [Wuppertal Institute, 2018].

It should also be stressed that the topic of just transition, including the related preparatory activities, has been covered by the work of the Ministry of Climate, as part of the COP24 Presidency. This has resulted in developing:

- *Solidarity and Just Transition. Silesia Declaration* [Ministry of Climate and Environment, 2018],
- *Solidarity and Just Transition. Summary Report of the Actions* [Bureau of the COP24 Presidency, 2019], which summarizes COP24 (hosted in Katowice), and indicates the directions of activities associated with *Nationally Determined Contributions* related to labour market transformation, introducing sustainable production and consumption, as well as social inclusion.

The *Coal Regions in Transition* platform has been operating since December 2017 at the initiative of the European Commission. It supports the transition of coal regions in terms of diversifying the economic structures and the technological transformation to better utilize clean energy sources. Coal region cooperation is based on using funds and programs, exchanging experiences and developing a transition road map. The platform includes 41 coal regions in 12 EU

Member States, the representatives of the mining sector, coal-related industries, labour unions, universities, non-governmental organizations and experts [European Commission, 2017a].

Issues related to implementing technologies associated with renewable energy sources (RES), green economy solutions and coal region development programming at national and regional levels are also included in:

- *Energy Policy of Poland until 2040* [Ministry of Climate and Environment, 2021],
- *National Energy and Climate Plan for the years 2021-2030* [Ministry of State Assets, 2019],
- *Concept of regulation amendments supporting prosumer energy development* [Ministry of Entrepreneurship and Technology, 2019], updated on 10/9/2019,
- draft act amending the act on renewable energy sources and certain other acts,
- the paper *Od restrukturyzacji do trwałego rozwoju. Przypadek Górnego Śląska (From restructuring to continuous development. The case of Górny Śląsk)* [Bukowski, Śniegocki, Wetmańska, 2018],
- the paper *Sprawiedliwa transformacja węglowa w regionie śląskim. Implikacje dla rynku pracy (Just coal transition in the Silesian region. Labour market implications)* [Kiewra, Szpor, Witajewski-Baltvilks, 2019],
- the paper *Rozwój odnawialnych źródeł energii w sektorze Mikro, Małych i Średnich Przedsiębiorstw, w tym możliwości zastosowania rozwiązań prosumenckich. Stan obecny i perspektywy (Development of renewable energy sources in the sector of Micro-, Small- and Medium-sized Enterprises, including the potential for the application of prosumer solutions. Current status and prospects)* [Dziaduszyński et al., 2018],
- *Propozycje rekomendacji dla obszaru sprawiedliwa transformacja (Just transition area recommendation proposals)* of the "Just Transition" Expert Group, which operates as part of the Team for Renewable Energy Sources and Benefits for the Polish Economy by the Minister of Climate [Drobniak et al., 2020].

Just transition entails reducing pressure and ensuring ecological security through selecting optimal paths of transforming the economy toward a lean and low-emission (zero-emission) economy, and determining a new state industrial policy, as well as a novel economic development policy for regions particularly exposed to such a change, i.e., the coal regions. According to Climate Action Network Europe (CAN) [2020], EU funds allocated to transition processes should go to citizens and local governments, local (regional) communities and entities directly involved in and exposed to transition processes. System changes should discard the phenomenon of transferring transition costs onto coal regions

and their residents, the so-called decarbonization process victims [Harrahil, Douglas, 2019]. Coal region involvement enables taking advantage of the opportunities created by the *European Green Deal* to develop green, climate-neutral economies. It should be stressed that the development strategies for the Dolnośląskie, Łódzkie, Śląskie and Wielkopolskie provinces address this issue, including through detailed analyses covering, e.g., identifying mining communes based on employment in the mining sector – *Strategic Intervention Areas − SIA* [Marshal's Office of the Śląskie Province, 2019]. In addition, grassroot initiatives arising at the subregional level through participation, stimulate changes for the benefit of just transition, which include the regional and local specificity of coal regions.

2. Just transition *versus* regional transition in the context of selected development concepts

Adam Drobniak, Rafał Muster, Łukasz Trembaczowski

The *European Green Deal* and the associated schemes, such as the JTF, have introduced a number of terms into the public discourse, which refer to concepts well-established in source literature. Prior to commencing change programming, it becomes necessary to refer to the theoretical diversification of these terms and concepts that are included in official documents and constitute substantial reference framework for the entire transition concept. The concepts of *energy transition*, *energy justice* and *just transition* should be considered crucial.

Energy transition shall be narrowly construed in the context of global climate change as the process of a transformation from energy systems based on fossil fuels, to systems based on zero-emission fuels − renewable energy sources in particular. However, in a broader sense, energy transition means a quantitative and qualitative change in the field of energy supply (in terms of sources and volume) and demand [Grubler, 2015]. In this sense, a number of consecutive energy transitions could have been observed since the industrial revolution [Smil, 2017]. Regardless of the understanding, energy transition is a challenge in terms of technology and engineering, since it includes decisions regarding the replacement of emission-intensive energy sources with renewable energy or an adaptation of transmission infrastructure. At the same time, researchers point to the social aspects of such transitions. Its omission will lead to technocratic solutions discarding the consequences for the people [Mejía-Montero, Alonso-Serna,

Altamirano-Allende, 2020]. Therefore, researchers have begun to pay increased attention to the social and economic considerations of energy system functioning [Miller, Richter, O'Leary, 2015].

Introducing the social perspective into the analyses dedicated to the transition from one energy generation method to the other entails asking new questions about the energy recipient, who has access to it and under what terms, as well as the ways different stakeholders experience the transition process [Sovacool, Hess, Cantoni, 2021]. The distribution of benefits and costs, notably, the way particular energy systems create injustice and inequalities, as well as the methods to counteract these that ensure participation in the regulatory process for those affected, is the subject of afterthought as part of the **energy justice** concept [Jenkins et al., 2016]. The significance of energy transition lies primarily in the practical function of a tool supporting decision-makers and experts programming the change in determining policies related to energy system transformations, while ensuring the participation and securing the interests of process participants affected by the change [Iwińska, Lis, Mączka, 2021].

The concept comprises three basic contexts, namely, *distributional justice*, *participatory justice* and *recognition justice*. **Distributional justice** refers to the issue of fair access to resources. In this sense, energy justice means decisions related to where, how and which energy systems should be constructed, and how to distribute benefits, costs and risks generated therein [Miller, Iles, Jones, 2013]. Therefore, the potential injustice is of economic nature and refers to the inability of benefiting equally to others or incurring disproportionate costs in this respect. **Participatory justice** requires ensuring participation in decision-making processes equally to all stakeholders, in a non-discriminatory manner [Heffron, McCauley, 2014]. Therefore, it is a tool that allows both decision-makers and communities affected by the changes to make decisions and conduct negotiations and change implementation processes. Hence, the potential injustice is of political nature, referring to the decision-making process that does not ensure equal voice rights in the course of public debates and fair representation to all stakeholders [Fraser, 2009]. **Recognition justice** refers to identifying and recognizing the perspective of groups excluded due to gender, skin colour, culture or ethnic origin. Thus, it draws attention to the social and cultural aspect of energy system operation and transition processes. Injustice appears as a consequence of inequality embedded within the hierarchy of cultural values refusing recognition for culture and the values of excluded groups (particularly evident in the case of indigenous people, whose lands are often subjected to exploitation for the purposes of energy systems in violation of the rights and cultural principles of their owners).

In addition to the basic aspects of energy justice, the source literature distinguishes between universal and particular justice. Universal justice shall be understood as the international aspect of energy justice between countries experiencing similar issues associated with their energy systems. In contrast, particular justice refers to local decisions in the field of energy system impact [Iwińska, Lis, Mączka, 2021].

Energy justice is a concept that enables going beyond the purely technical view of energy transition. By drawing particular attention to the significance of justice within transition processes, it draws near to yet another idea – just transition. However, the perspective of **just transition** is broader since it integrates energy justice, climate justice and environmental justice [McCauley, Heffron, 2018].

Just transition originates in the trade union movement [Leopold, 2007]; however, after this concept spread, it exceeded the framework of trade unions and is now a part of the political debate, and the scientific, trade union and civic discourse. Therefore, this term covers diverse perspectives, which differ in terms of understanding its segments. All the aforementioned has come about because the discourse identifies differences in terms of understanding what justice should be like and how deep transition is supposed to be.

Despite its trade union origins, the term has also appeared in business milieus, and the importance and role of business constitute elements that differentiate just transition perspectives. The significance of business within just transition is highlighted by green economy proponents. As part of this approach, just transition is reduced to a labour market issue. Providing the current employees of high-emission industries with new jobs is treated as a form of justice, and the tools employed to this end include training, early retirement schemes, *outplacement* or relocation to other plants. This approach is criticized as conservative and merely providing treatment to the symptoms, instead of addressing the roots of the problem [Abraham, 2017; United Nations Research Institute for Social Development, 2018].

A slightly broader view is associated with the issue of inequalities inherent in the existing energy system that is built upon fossil fuels. Therefore, the transition should refer to these inequalities. The employees, as both beneficiaries and main change actors are set at the centre of the considerations. The path to ensuring transition should involve maximization of private and public investments. This approach can be recognized as evolutionary since it does not undermine the principles of the current social and economic system; however, it suggests greater equality of benefits and costs within the new, zero-emission energy system. It is particularly common in the case of trade unions and some pro-ecological or-

ganizations [Hubbard, Núñez, 2016; United Nations Research Institute for Social Development, 2018].

A more radical perspective refers to distributional and participatory justice. This can be dubbed a structural reform perspective [United Nations Research Institute for Social Development, 2018]. It goes beyond solving current problems reported by employees affected by the transition, by indicating a need for the social and economic transformation of the entire economy [Sweeney, Treat, 2018]. In other words, justice in the reformistic approach does not mean compensating costs incurred by employees, but instead a fundamental institutional reform. The way to achieve this target is supposed to involve the democratization of supervision over key sectors (e.g., energy) through alternative institutional and ownership forms (cooperatives, employee unions). The distinguishing factor compared to previous approaches is the contestation of the current balance of power.

The most extreme approach suggests a comprehensive reconstruction of the social and political system towards eco-socialism. The origins of this approach include the rejection of suggested permanent growth, and some authors associating capitalism with a system based on fossil fuels [United Nations Research Institute for Social Development, 2018]. However, these most far-reaching perceptions draw attention not only to economic issues, but also to the rights of marginalized groups, such as females, LGBT, indigenous people or racial and ethnic minorities [Gaard, 2015]. According to this understanding, the consequence of just transition would have to be a more fair and equal society [Cha et al., 2021].

Approaches towards just transition differ in more than just their radicality degree. They also exhibit various analytical framework. According to the above, one can distinguish classical and labour-oriented approaches, approaches that integrate energy, climate and environmental justice, viewed from the perspective of socio-technical transitions, as well as approaches based on governance strategies and public perceptions [Wang, Lo, 2021]. Therefore, reference to the just transition concept in the event of change programming requires clarifying its understanding.

Programming such a change as implementing green economy solutions arising from the *European Green Deal*, under particular social, economic, territorial and institutional conditions is a comprehensive task. Due to the current international and domestic scientific accomplishments and change programming in coal regions, it should be also related to development concepts combining social and economic concepts with the territorial aspect. It should be noted that these achievements largely determine the contemporary growth-related objectives,

directions and activities of both developed countries and their communities, among others, in the form of the EU cohesion policy. The conclusions drawn from the territorial development concept enable also to rationally approach programming changes associated with implementing social or technological solutions on one hand, while creating necessary guidelines that allow to infer in relation to the desired directions, goals, instruments and ventures contributing to just transition of coal regions on the other.

Concepts that are worth considering in relation to just implementation and energy transition in coal regions include path dependence, resilience, complex adaptive systems, related & unrelated variety, hybridization, regional innovation systems and smart regional specialisations, lagging behind regions in connection with productivity & productivity gap, geography of discontent, foreign direct investment, global value chains, institutional capabilities/capacities, polycentric urban region and regeneration economics.

Implementing technological change is a dynamic and irreversible process, which entails novelty within a given social, economic, territorial and institutional context [Boschma, Martin, 2007]. Such a process develops over time and space [Boschma, Franken, 2007], and is shaped differently depending on the historical heritage of a given community, enterprise, industry, sector and institution. Hence there is the need to recognize the history of socio-economic growth illustrating the structural changes related to knowledge and competences in the past within a given area, since these values determine the directions and dynamics of future development processes. In consequence, this context determines the economic dependence path in the form of the so-called **path dependence** [Harvey, 2005; Martin, Sunley, 2006; Gwosdz, 2014], characterized by a company industry profile, education system, technical and social infrastructure developed within a given territory, and finally, the values that are open to changes to a varying degree [Dopfer, Potts, 2009]. As a result, a discussion regarding certain regions may include talks about the so-called positive lock-in, which is characterized by greater openness to change and higher flexibility of social and economic structures, while negative lock-in is indicated in the event of other regions. Regions wherein strong traditional industry structures are still present are included in the second of the aforementioned region categories, where technological changes, breakthrough ones in particular (if they occur), are more incremental and are met with social resistance. In such a case, a regional economy remains locked within its current development path (traditional industry), which has been strongly determined by historical capital accumulation (among others, the current type and purpose of the infrastructure, company assets and education) [David, 2005].

A technological change in modern times that comes with the baggage of crisis and economic shocks or changes disturbing previous business models and social behaviours, should be implemented in a manner that reinforces the **resilience** of territories and sectors. Assuming that resilience is the ability of individuals, communities, companies and sectors, as well as cities and regions to rapidly reconfigure the current development path due to, among others, technological change [Briguglio et al., 2006; Simmie, Martin, 2009; Hassink, 2010; Drobniak, ed., 2014; Martin, Sunley, 2015; Martin, Gardiner, 2019; Drobniak et al., 2021], it can be concluded that the primary objective of development programming should be reinforcing adaptive abilities. The idea is for units and communities, companies and sectors, cities and regions to quickly adapt to new technology on one hand, and new economic structures based on it, and exhibit resistance to various types of crises and disturbance on the other [Martin et al., 2016]. This task is particularly hindered since current sectoral and territorial arrangements are perceived from the perspective of comprehensive adaptive systems [Fontana, 2013], which are characterized by a different degree of connectivity (e.g., with other regions), degree of openness (e.g., to external novelties), non-linear growth dynamics level (e.g., absence of a clear relation between expenditures and results), self-organization level (e.g., inability to identify bold ideas and implement strategic projects), adaptive behaviour level (e.g., predominance of demanding attitudes and maintaining the *status quo*), and lack of determinism (e.g., difficulty in capturing cause-and-effect relationships). Unfortunately, most of the regions wherein traditional industries are located indicate a series of negative values related to the aforementioned features.

Important conclusions in relation to technical change programming can also be drawn from the concept of **related and unrelated diversification** [Franken et al., 2005; Boschma et al., 2017]. Pursuant to the context, it is argued that the economic capabilities of a region's economy shall not be perceived from the sole perspective of expenditure on research and development (R&D), but rather through the experience that has accumulated throughout the entire economic organization within a given territory, wherein the accumulation takes place [Solheim, Boschma, Herstad, 2018]. This primarily means knowledge can be considered to be the product of the experience that is historically associated with unit activities, the interactions of which in the organizational and spatial context, shape the innovativeness of enterprises and regional development paths [Lundvall, Johnson, 1994]. The diversity of human assets (education, knowledge, experience) reinforces the creation of new knowledge and generation of innovations, and also improves the absorption capacity of enterprises, i.e., the ability to identify, assimi-

late and employ external knowledge [Cohen, Levinthal, 1990]. As it turns out, an important aspect in this regard is proper industrial "composition" existing within the region, which ensures that spillover effects associated with a given innovation/novelty occur only in the companies of a given industry (*related diversification*) or are recorded by companies in various industries (*unrelated diversification*) [Franken et al., 2005]. Hence, industry diversification, and its precise "composition" in particular, becomes a new source of regional economic growth. This means that only certain industries are mutually complementary within the regional economy, creating an additional stimulus for growth and improved productivity. It should also be emphasized that, pursuant to the concept of related and unrelated diversification, a regional economy that fails to increase sectoral and industry diversification over a prolonged time will be exposed to stagnation and structural unemployment [Pasinetti, 1993]. Thus, coal and post-coal regions are notably faced with such a challenge in relation to implementing the solutions of the *European Green Deal* [European Commission, 2019b].

The concepts related to **regional innovation systems** (RIS) and **smart regional specializations** are close to the issues of related and unrelated diversification [Asheim, Isaksen, Trippl, 2019]. Please note that the assumptions of innovation systems are in opposition to neoclassical economics, stressing the role of innovation, its dynamics and imbalance in contemporary economic processes [Weber, Truffer, 2017]. As a consequence, innovation is perceived through the results of a non-linear process based on cooperation and cumulative learning, which shapes formal and informal institutions at different territorial levels. Programming such systems and specializations should primarily result from the specificity of a given region, because at least three RIS-related solutions can be identified depending on it. The first, dubbed a "territorially embedded innovation system" [Cooke, 1998] is distinguished by the innovative activity of companies primarily based on a clearly localized inter-company learning process, stimulated by geographic proximity and knowledge-providing interactions (R&D entities, universities). Such an RIS model is distinguished by a market--oriented approach, where the demand side determines innovation dynamics and directions. An example for RIS of this type is the Emilia-Romagna region in Italy. The second RIS type refers to a "regionally cross-linked innovation system", wherein, similarly to the first case, companies and institutions are rooted in the fabric of the region; however, this system exhibits a clearly planned-like nature through initiating public and private partnership, as well as through the significant role of regional R&D entities and other institutions operating for the benefit of innovations. Of note, RIS functioning in Germany, Austria and Scan-

dinavian countries represent a demand-and-supply interaction "mix model" [Asheim, Isaksen, Trippl, 2019]. The third RIS type is the "regionalized national innovation system". It involves functional integration of certain industry segments and institutions supporting national or international innovation systems. This means that innovation-related activities are executed in cooperation with actors from outside of a given region, hence the system resembles a sectoral innovation system [Cooke, 1998; Cooke, Parrilli Curbelo, 2012]. These are a sort of innovation enclaves – "technopolises" [Phelps, MacKinnon, 2000] − and are found in France, Japan and Taiwan.

The significance of the discussed diversification in terms of initializing new solutions within a given territorial, social, economic, and institutional context is strongly emphasized in the concept of **development hybridization**. It indicates that the implementation of a novelty, among others, a new technology, under specific conditions may take three fundamental forms, i.e., imitation, hybridization or failure [Boyer et al., 2004; Kawamura, 2011; Drobniak, 2019; Drobniak et al., 2021]. Imitation is the case when the conditions under which a novel solution was developed (e.g., legal regulations, human capital competences, economic structure and diversity, business environment institutions, buyer segments) are identical to the implementation conditions. An example is the Austrian automotive industry implementing new manufacturing systems created by German car companies. Due to the similarity of legal/economic and technological systems, such solutions are put in place based on full imitation. However, if the new solution implementation conditions within a given company, sector, city or region differ significantly from the new technology (solution) development conditions, efficient implementation takes the form of a hybridization or failure. Hybridization involves either adapting the new solution to existing conditions, adapting specific conditions to the new solution or combining both. An example of modifying a new solution to fit existing conditions are changes in the *just-in-time* system that were required to be introduced by Japanese car companies establishing their factories in the 1990s in the United States. The *just-in-time* system was perfect under Japanese conditions (relatively short distances, high efficiency and punctuality of rail transport), while encountering severe obstacles in the United States (very long delivery distances and their untimeliness). The lack of openness to adaptations of both new technological solutions, and conditions will lead to implementation failure, such as not adapting the Fiat manufacturing model to the specific conditions in Russia and India. The model's implementation, despite a significant consumer market in these countries ended in failure [Kawamura, 2011].

Regional research on **foreign direct investments** (FDI) are also important in the conceptual context associated with implementing new technological solutions. The topic of FDI is often illustrated through measuring the cost and benefits of such investments [Aitken, Harrison, 1999; Barry, Görg, McDowell, 2003; Girma, Wakelin, 2007; Fu, Gong, 2011]. The set of benefits includes, above all, perceiving FDI as a growth engine, a way to technologically modernize the economy and improve innovation levels. These are all categories important from the perspective of reorienting the growth path of lagging-behind regions. The benefits associated with the spillover effects and the creation of global links that FDI companies can offer to the regional economy are also important [Asheim, Isaksen, Trippl, 2019]. Nonetheless, the types and scale of FDI-related spillover effects are crucially dependent on the absorption capacity of a given industry, sector or region. These abilities determine the capabilities of local and regional economic structures in terms of identifying, assimilating and employing knowledge associated with FDI [Wang, Ning, Prevezer, 2016].

The implementation of technological changes within a given area also requires taking into account the complex interdependencies of contemporary economy. This is because, today, despite the various types of disruptions, economic structures are determined largely by economic activities in other parts of the world [Giddens, 1990]. For example, the value of local production chains and resources is strongly determined by their competitiveness in relation to similar production chains and resources in other regions and parts of the world [Robertson, 1992]. If value chains and resources in a specific region provide relatively simple products subject to international trade, competition intensity is greater and most often based on unit costs (and not unique knowledge that enables achieving a higher productivity level). Therefore, such economic structures are more prone to changes at the global level. At the same time, global availability to production chains and resources means that, especially international corporations, reallocate value chain links to location guaranteeing low unit costs when they apply the strategy of **value chain maximization on the global scale**. As a result, starting in the 1990s, value chain composition began to reorient from regional- and national-level integration, and towards international integration, leading to the flow of information, knowledge and goods within a global space [Pieterse, 2015].

A technological change, such as a transition to low-emission economy, including decarbonization, is also enacted in the context of the so-called **institutional capacities** that can simplify or hinder adaptive processes in regions and sectors. The significance of the presence of a mix of organizational forms (pub-

lic-public, public-social, public-private, cooperation networks, associations and alliances, economic clusters, formal and informal partnerships) and a mix of goals of such organizational forms (public, business, social and environmental goals) is stressed in the context of institutional capacities stimulating changes [Johanson, Vakkuri, 2017]. The indicated institutional capacity characteristics significantly affect the quality of governance, the number and activity of institutions classified as R&D infrastructure, higher education, the business environment, labour market entities, economic promotion agencies, etc. In consequence, they determine the degree to which these institutions create an economic ecosystem that facilitates adapting social and economic structures to technological changes. At least two situations can be pointed out in this context. These are the presence of the so-called *thin regions* (such as regions in Central Europe or Wallonia in Belgium and Centro in Portugal) or regions that are institutionally "vast", i.e., with a well-developed and organized knowledge structure (*thick regions*, such as south-eastern Brabant in the Netherlands or Styria in Austria) [Cooke, Parrilli, Curbelo, 2012]. Central European regions, especially those with traditional industry, are usually characterized by institutional thinness, distinguished by the presence of a small number and scale of innovative company operations, weak R&D institutions and business environment entities, and the absence of institutional relationships with leader regions and strategic investors [Kravtsova, Radosevic, 2012].

When programming changes within a territorial and sectoral structure, it is also worthwhile to note that some regions are perceived as so-called **low--productivity lagging-behind regions** in the EU context [Bachtler et al., 2019; Barzotto et al., 2019]. Such regions are economically characterized by low productivity, i.e., the so-called **productivity gap** and its low (or negative) increment in relation to other regions within the same country or, in a broader perspective, in relation to other EU regions. The sources of low productivity most often lie in the current development path being obsolete relative to global economy and contemporary development challenges. This path is usually characterized by the dominance of low-tech sectors, strong dependence on traditional declining industries, as well as poor knowledge of networks and international business links.

In addition, as noted by L. Dijkstra, H. Poelman and A. Rodríguez-Pose [2018] and A. Rodrígues-Pose [2017], lagging-behind regions are exposed to a high risk of the phenomenon of **geography of discontent** manifested in its inhabitants feeling left behind or abandoned in the context of previous or projected changes. Discontent attitudes hinder adapting such regions to the new

challenges of the global economy, to social and economic reforms, and to changes of technological nature leading to structural modifications. The effect of discontent is usually revealed through strong social resistance to change, manifesting populistic attitudes and denying the need for change.

Another development concept, one particularly interesting from the perspective of a lagging-behind region, is the so-called **polycentric urban region**. It is a city cross-linking concept, which assumes the presence of horizontal connections between urban centres of various size and rank, determined by such factors as human capital international mobility, the presence of spatial and non-spatial corridors (e.g., high-quality transport and ICT infrastructure) that constitute peculiar gateways to areas of high geographic activity, and the functioning of interdependence and information exchange channels [van Houtum, Lagendijk, 2001]. A polycentric urban region is basically a strategic planning method in the territorial and interregional context that offers a development alternative for lower-tier cities and regions (lagging-behind regions) relative to large cities that are state capitals or global metropolitan centres (leader regions). A polycentric urban region means a territorial strategic product that enables achieving a greater impact scale and higher competitiveness (than typical individual cities) through interconnecting independent (non-metropolitan) cities, usually approx. 1 to 1.5 hours apart by car, which most usually form an interregional system of urban centres. Thus, the social and economic growth of a territory is determined not only by the scale and rank of individual urban centres, but also the system of their interconnections. Examples of polycentric urban regions in Europe include [Taylor, Pain, 2007] the Dutch Randstad (Amsterdam, Rotterdam, Hague, Utrecht), Belgian diamond (Brussels, Ghent, Antwerp, Leuven), German Ruhr and Rhine area (key cities: Düsseldorf, Cologne, Dortmund, Essen and Bochum), and central Scotland (key cities: Glasgow – Edinburgh) [Bailey, Turok, 2001].

The last of the discussed concepts, which is useful in the process of programming coal region changes, is associated with the **regenerative economics**. It applies to areas of cities and regions, the economic structures of which have been subjected (or are subject) to radical change, e.g., West Midlands and Birmingham in the United Kingdom, due to the deindustrialization combined with a high unemployment rate enforcing a need to launch processes of recovery, adaptation and deep reorientation of the previous development path [Andres, Bryson, 2018]. Change processes (e.g., deindustrialization, reindustrialization, production *reshoring*, implementing a new technology) [Vanchan, Mulhal, Bryson, 2018] take place in all cities and regions, albeit under the presence of different external and internal factors, at varying intensity levels and with di-

verse outcome scales. The concept of economic regeneration in relation to cities and regions emphasizes the distinctness of each of such centres in terms of assets, including that unique, such as reputation, image, heritage, connectivity level, magnitude, rank of the centre. Heterogeneity and complex relationships between the city and the concentration of spatial and non-spatial processes constitute the analysis centre within regenerative economics [Andres, Bryson, 2018]. Importantly, these endo- and exogenously initiated processes within the space may be the result of the irrational or semi-rational decisions of decision--makers, development actors, communities, households and units that was based on information asymmetry and limited rationality. Hence, pursuant to the assumptions of regenerative economics, development processes clarified, characterized and programmed under such conditions may have a solely idiosyncratic nature (may be appropriate/rational from the perspective of a given entity and within a given context only).

Regenerative economics primarily emphasizes economic ideas that often constitute change sources, but also draws attention to extra-economic issues, the scale of which may determine the success or failure of the assumed changes. In terms of social sciences, a change is studied within different areas related to, e.g., spatial planning and city shrinkage, regulations and *governance*, cultural and environmental values, migration and unemployment, adapting competence to the needs of new technologies, social inclusion, commercial and residential real estate market, sale of post-industrial and abandoned areas, investment volume (including FDIs), entrepreneurship, liquidation processes and the emergence of new business models. In the context of technical sciences, city-region territorial systems are perceived from the perspective of point and linear infrastructure, including, among others, school and hospital funding level, road and mass transit quality and capacity, ICT system capabilities and security, and a scattered or concentrated nature of the energy infrastructure. A technological change, of breakthrough nature in particular, such as the transition to a low--emission economy, is always introduced over several distinguished levels associated with diverse processes, behaviours, structures and effects. The essence is to capture these interconnections and indicate new interrelations that condition feedback reinforcing or weakening the implementation and outcomes of the new technology. Therefore, according to regenerative economics, change programming strongly emphasizes the need for the *place-based* approach [Churski, 2018], which is contemporarily recognized as one of the key principles in territorial development programming.

3. Best practices – selected foreign and domestic transition project-related experiences

Adam Drobniak, Marcin Baron, Artur Ochojski

The review of the so-called good practices is an afterthought stage helpful for strategic thinking. Afterthought enables identifying examples of how challenges were met in other regions, cities and sectors. Such knowledge, often impossible to be directly implemented in the case of a specific region, can, however, turn out to be useful in constructing change mechanisms, i.e., in terms of presenting cause-and-effect relationships (or lack thereof) between intervention expenditure and results, and the conditions under which such a mechanism will function (or not). Given the above, and in the context of considerations associated with the transition of Poland's coal regions, this monograph reviews several types of transition projects, i.e., ventures that enabled selected regions, cities or sectors to introduce changes favouring competitiveness growth through enhancing productivity, encouraging structural shifts that create new economic structures, and reducing environmental burdens.

To illustrate the various mechanisms that determine transition projects and expand strategic afterthought for the transition of Poland's coal regions, the following ten projects have been subjected to a synthetic case study analysis:

- Metal 3DI – implemented in South Karelia, Finland,
- BluChem – implemented in Flanders, Belgium,
- SeRaMCo – implemented in several regions of the following European countries: Belgium, France, The Netherlands, Germany, Luxembourg,
- House of Digitalization – implemented in Lower Austria, Austria,
- EcoDesign Circle – implemented in several regions of the following European countries: Estonia, Finland, Germany, Poland, Sweden,
- Living Labs Brussels – implemented in Brussels, Belgium,
- House of Skills – implemented in several regions of the Netherlands,
- Culture Zone – implemented in Katowice, Poland,
- Brainport Eindhoven – implemented in North Brabant, the Netherlands,
- Urban Sciences Lab – implemented in Barcelona, Spain.

Table 2. Synthetic summary of information on selected case studies constituting transition project examples

Project	Implementation location and context	Mechanism and products	Impact on adaptation	Impact on adaptability
1	*2*	*3*	*4*	*5*
Metal 3DI	Finland – South Karelia. A region strongly associated with the metallurgical industry, including sectors providing products for the automotive industry	Organizing a 3D printing cluster for metal elements required by the automotive industry (University of Lut, entrepreneurs). Providing free-of-charge access to 3D printers (testing), expert opinions, new technology know-how	Improving the competitiveness of the metallurgical sector, including the vendors of parts for the automotive industry	Introducing a new process – 3D printing of metal elements
BluChem	Belgium – Flanders. A region where large international chemical companies are located. This industry is on the brink of modernization due to the need for more eco-friendly activities	Constructing a business park for start-ups in the chemical industry, including financial support for prospective ideas. Specializing start-ups in creating innovative (pro-eco) solutions for large-sized chemical industry companies	Adapting to the environmental requirements of a traditional sector associated with the chemical industry	Expanding the traditional chemical industry activities with product innovations
SeRaMCo	Belgium, France, The Netherlands, Germany, Luxembourg – various sites. The construction sector generates significant amounts of waste worldwide. Materials from demolitions have previously been stored at landfills, which entailed a significant environmental cost	Directing R&D centres associated with the construction industry towards searching for solutions enhancing the level of post-demolition material recycling. Developing and manufacturing four elements (cement-made, bricks, tiles, ceramics) that can be re-used within the construction industry	Improving the competitiveness of the construction sector and reducing the environmental burden associated with re-using post-demolition construction materials	Introducing product innovations related to re-using construction materials

Table 2 cont.

1	*2*	*3*	*4*	*5*
House of Digitalization	Austria, Lower Austria. A region famous for a large number of family-run businesses from the tourism, food, construction, and sports and recreation industries that provide their services in a traditional manner	Organizing several dozen training and consulting centres for the sector of micro-, small- and medium-sized companies, providing services related to their digitization. One of the several supporting activities involved diversifying the service sales form through employing the opportunities provided by the Internet	Improving the competitiveness and resilience of the micro-, small- and medium-sized enterprise sector through digitization	Introducing process innovation related to Internet sales of services by traditional family-run businesses
EcoDesign Circle	Estonia, Finland, Germany, Poland, Sweden – various regions. Despite the dissemination of the need for greater involvement of the enterprises and communities in circular economy solutions, the level of development in this field should be recognized as unsatisfactory throughout the EU	Organizing workshops and project activities related to the circular economy. Creating 13 products that satisfy *eco-design* requirements. Consultation related to circular economy involving approx. 20 thousand people	Progressing the sector of implementing circular economy solutions through placing greater emphasis on the significance of eco-designed company products	Introducing product innovations related to eco-design
Living Labs Brussels	Belgium – Brussels. Residential housing in European cities, especially dating back to the turn of the 19th and 20th centuries that are distinguished by high energy consumption, issues with ventilation and moisture	Creating living labs focusing on energy transition. Renovating buildings in the Molenbeek district. Individual labs dealing with designing business solutions. Developing low-cost models, local companies and residents executing individual	Improving living comfort and energy efficiency of older residential buildings	Expanding the old housing fabric with new solutions in the field of energy efficiency and ventilation

Table 2 cont.

1	*2*	*3*	*4*	*5*
		renovations, and testing old building modernization technologies		
House of Skills	The Netherlands – various regions. The contemporary employment market, often due to production technology advancements, as well as changes in sales and servicing processes, is subject to frequent transformations. These changes commonly precede the qualification of talent available at a given moment, hence creating the problem of mismatch between job supply and demand	Implementing a programme of multifaceted trainings for job seekers. Establishing cooperation between job centres, the education sector and training companies, trade unions, public authorities and enterprises in implementing training for various industries, including that which are employer-conducted	Establishing a better match of supply and demand in the light of changing employer requirements	Providing a flexible and vast range of training that enable improving or changing qualifications, experimenting with new qualifications or re-qualifying
Culture Zone	Poland, Śląskie province – Katowice. A city and region strongly associated with hard coal mining; the capital of the largest coal region in the EU	Erection of the International Convention Centre, Polish National Radio Symphonic Orchestra and Silesian Museum within the former KWK "Katowice" coal mine areas, so as to enable organizing major events	Creating an auspicious change in the city's image, improving the attractiveness of the downtown area, enabling the organization of major events (among others, COP24, WUF11, Intel Extreme Masters), and increasing the number of accommodation beds from 50 000 (1990s) to over 400 000 (2019)	Expanding the city's economic profile with a new industry, namely, the event industry

Table 2 cont.

1	*2*	*3*	*4*	*5*
Brainport Eindhoven	The Netherlands, North Brabant – Eindhoven. A location that previously was an industrial centre associated with Philips and the DAF car factory and their research, manufacturing and logistic facilities. Globalization of manufacturing activities has resulted in the formation of *brownfields* − also in the central parts of the city	Creating a place linked with new technologies and innovations based on the cooperation between the R&D sector and universities through re-use of the former Philips factory. The Park is focused on industries associated with medicine, ICT, sustainable energy, smart ecosystems, and data mining	Enhancing the competitiveness of the city and region through creating new economic activity types within tech companies by providing business incubation spaces	Initiating and developing a new innovation ecosystem: companies, universities and R&D institutions
Urban Sciences Lab	Spain, Catalonia, Barcelona. Cities are facing a number of challenges associated with, among others, climate change, urban area expansion, introduction into the global chain of new ICT solutions. City activities generate a number of social, economic, environmental and spatial consequences	The Urban Sciences Lab, as a scientific and educational venture searching for solutions targeting contemporary challenges in terms of urban development through establishing interdisciplinary skills among professionals. Introducing new models, tools and methodologies for training future city professionals, including the analysis of best practices. Attracting talent and stimulating entrepreneurial and innovative behaviour	Enhancing the adaptability of the city (and region) through creating new knowledge and solutions in the light of contemporary development challenges	Generating innovations in the field of multi-entity cooperation in terms of education and research for the future of the cities

Source: own study based on the participation of an author's team on behalf of the European Commission in the RegioStar2020 competition jury for *Industrial Transition*, as well as conceptual and implementation works related to the Culture Zone in the Katowice City Hall.

This case study analysis mostly involves assessing projects submitted and awarded high marks in the annual RegioStar competition organized by the European Commission, as well as ranking the best ventures implemented with the support of EU funds. In relation to the issues of coal region transition covered by this publication, the analysis involved projects submitted in 2020 in the Industrial Transition category of the RegioStar competition. The synthetic approach to case studies was based on concepts related to (cf. Table 2):

- implementation location and its context − indicating a challenge that a given project addresses,
- mechanisms and products − revealing the scope of a given project and its specification,
- impact on adaptation – defining the long-term project benefits for a given region, city or sector,
- impact on adaptability − reflecting the process initiated over a short period of time by the initiation of a given project in a specific region, city or sector.

Transition project case study analysis was also conducted based on one of the development concepts described in the first section of the monograph, and associated with adaptation and adaptability [Hu, Hassink, 2020]. The objective of such an approach was, on one hand, to draw attention to how a given transition project contributes to initiating new processes, products and solutions in cities, regions and sectors, while indicating how such transition projects contribute to creating a new or modernizing an existing development path (cf. Table 3).

Table 3. Portfolio of good practices: adaptation – adaptability

Adaptation	New processes within existing businesses, including related diversity	New processes in new businesses, including unrelated diversity
Creating a new development path	**BlueChem** **House of Skill**	**Culture Zone** **Brainport Eindhoven**
Modernizing an existing development path	**Metal 3DI** **House of Digitalization** **SeRaMCo** **Living Labs Brussels**	**EcoDesign Circle** **Urban Sciences** **Lab**

Adaptability

Source: own study.

The most innovative transition projects in terms of solution application or creating a new development path are that in the top right quarter of the portfolio of good practice: adaptation – adaptability (cf. Table 3). These projects can be

dubbed **breakthrough transformation projects**. They are bold ventures involving the initiation of processes new for a given city, region or sector, the successful implementation of which contributes to creating a new development path. Such project examples include: Culture Zone in Katowice and Brainport in Eindhoven.

In turn, the bottom right quarter of the good-practices portfolio defines transition projects that involve employing new processes associated with new activities; however, the outcomes of these activities relate to an existing development path, often of innovative nature. Examples include: EcoDesign Circle regarding ecological design for the purposes of the circular economy, albeit within existing sectors, and the Urban Sciences Lab in Barcelona, which solves contemporary urban development challenges using a new didactic and scientific approach based on multidisciplinarity. Such projects can be described as: **expanding/ dynamizing transition projects**.

The third project type found in the good practices portfolio (top left quarter) includes ventures that employ new solutions and apply them to activities existing within a given region, city or sector. Examples include: BlueChem, where a traditional sector associated with the chemical industry is looking for new paths of a more sustainable development, and the House of Skills, wherein new education methods and approaches towards requalification allow employees to better adapt to labour market needs, while enabling employers a more effective entry into new development paths. Such ventures can be described as **diversifying transition projects**.

The last category of transition projects (lower left quarter of the good practices portfolio) is associated with the application of modern solutions within the activities existing in a given region, city or sector to modernize the previous development path. Such project examples include: Metal 3DI, House of Digitalization, SeRaMCo, Living Labs Brussels. Herein, incorporating new solutions, for example, 3D printing, ICT tools, building material recycling and building energy modernization are aimed at enhancing the competitiveness of the previous development path as part of all these projects. These ventures can be dubbed as **modernizing transition projects**.

Chapter II

Multidimensional context of Poland's coal region in transition

1. Poland's coal regions

Adam Drobniak

There are 41 regions (NUTS2) in the EU, with 128 functioning mines that extract approximately 500 M t of coal, i.e., 55% of all coal consumption in the EU [European Commission, 2018, p. 3]. According to EC data [European Commission, 2018, p. 3], infrastructure associated with the coal sector value chain is present in 108 regions (NUTS2), while the coal sector employs approx. 237 thous. people, most of whom work in mines – approx. 185 thous. Coal regions with the number of employees most closely related with the mining sectors include regions in Poland, followed by Germany, the Czech Republic, Romania, Bulgaria, Greece and Spain. On the EU scale, the coal region that employs the most people in mines is the Śląskie province (more than 80 thous. people)[9].

The greatest challenge for the economic development of EU coal regions is their deteriorated competitiveness caused by low productivity of mining activities in the era of increasing pressure on the use of renewable energy sources and a transition towards low-emission economy. This pressure has resulted in the shutting-down of 32 mines within the EU in the years 2014-2017, including ones in Germany, Poland, Romania, the United Kingdom, Italy, Hungary, Slovakia and Slovenia [European Commission, 2018, p. 4]. For coal regions with mines or coal sector value chains, this means a high risk of losing hundreds of thous. of jobs directly and indirectly, i.e., approx. 160 thous. jobs by 2030 [European Commis-

[9] According to CSO LDB, as in 2018.

sion, 2018, p. 4]. The fundamental issues of reorienting coal region development paths include their high dependence on the mining infrastructure and underdevelopment of other segments of the economy.

The social effects related to the gradual closure of mines are reinforced not only due to the high share of direct employment within the mining sector, but also due to the significant indirect employment in associated sectors (among others, metallurgy, coking coal, conventional power generation, mining machinery and device manufacturing, mining equipment including elements associated with coal production and construction, extraction planning, etc.), which are often also located in coal regions, which determines their high level of economic specialization and monoculture. Therefore, reorienting development paths of such coal regions requires searching for new development and technological change concepts favouring a sustainable socio-economic transition, and reuse of assets released by mining and related sectors. In consideration of the aforementioned coal regions, it should be noted that they are classified as the so-called lagging-behind regions in the context of the currently ongoing social and economic transformations, determined by a greater pursuit of respect for the elements of the natural environment [European Commission, 2019a].

The **coal region economic situation description** was based on the portfolio approach (cf. Table 4), which involved studying the relationships of two variables that illustrate key economic development parameters of the regions, i.e., GDP dynamics and job vacancy dynamics. The baseline values in 2010 and values from 2017, i.e., prior to the introduction of the *European Green Deal* were taken into account for both indices. The indices referred to have been calculated for 1270 EU NUTS3 regions. Due to the lack of statistical information on economic growth and employment in French NUTS3 regions in 2010, the authors used the NUTS2 level.

The presented portfolio approach enables identifying four region types. The first quarter (I) refers to a situation, where high economic growth rate (i.e., higher than the average for the studied region group) is accompanied by high job creation rate. Regions on such a development path are characterized by dynamic economic growth that translates to new jobs. These are places within high-productivity sectors and technologies emerging. The second quarter (II) corresponds to a situation of high growth rate with a decrease in the number of jobs. These are locations where growth is achieved through improving the efficiency of existing value chains, leading to, among others, reduced job numbers. The third quarter (III) is that of a situation of low economic growth rate and high job creation dynamics. Such environs may be characterized by employment opportunities being within the public sector and/or the development of endogenous service (previously

exhibiting a low employment level) sectors. They are also places with investment projects being of importance in terms of employment; however, their effectiveness translating to economic growth rate turns out to be low. The last quarter (IV) corresponds to a situation of low economic growth rate and low job creation dynamics or job number decrease. Such regions are in the worst situation, i.e., they experience liquidation processes or their growth processes exhibit dynamics that are lower than the average for a given set (low productivity – productivity gap). Regions classified in the fourth quarter are classic lagging-behind regions.

Table 4. Portfolio approach towards an economic assessment of regional economic development

Job number dynamics			
	+	(III) Low GDP growth and high growth of job numbers (**development determined by the public sector**)	(I) High GDP growth and high growth of job numbers (**development determined by new technologies – new development paths**)
	–	(IV) Low GDP growth and low growth of job numbers (**recession – development slowdown – current growth path fading**)	(II) High GDP growth and low growth of job numbers (**development determined by improved effectiveness within existing technologies – exploration of the current growth path**)
		–	+
		GDP dynamics	

Source: own study.

Most NUTS3 regions in the EU qualify as being either quarter II and IV regions (cf. Figure 2). That within quarter I (leader regions) are also relatively numerous. The general trend among NUTS3 regions in the EU is positive, i.e., higher economic growth rate (as measured by GDP) is accompanied by higher dynamics in job creation (linear function parameter value being +0.31).

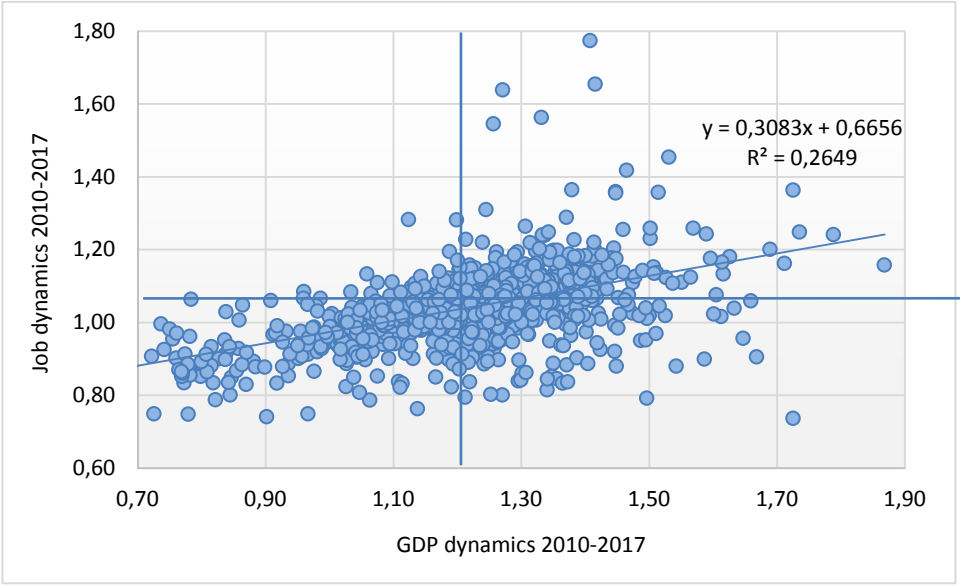

Figure 2. NUTS3 regions in the European Union (n = 1270 NUTS3 regions)

Source: own study based on Eurostat data.

By limiting this portfolio analysis to coal regions[10] (cf. Figure 3), it can be seen that the majority can be classified into quarters II and IV, which means that some (quarter II) are dominated by processes targeting the improvement of efficiency while reducing employment dynamics or experience liquidation processes accompanied by a decline in employment dynamics (quarter IV) relative to the average values for NUTS3 regions in the EU. In the case of coal regions, the overall trend of higher dynamics of GDP-measured economic growth co-existing with higher employment dynamics occurs with a lower intensity in relation to the relationship presented for all NUTS3 regions within the EU (the linear function parameter value being +0.24).

[10] Coal regions include NUTS3 regions satisfying the criteria for participation in the Just Transition Fund [European Commission, 2021], thus increasing this set with NUTS3 post-coal regions in the Ruhr area.

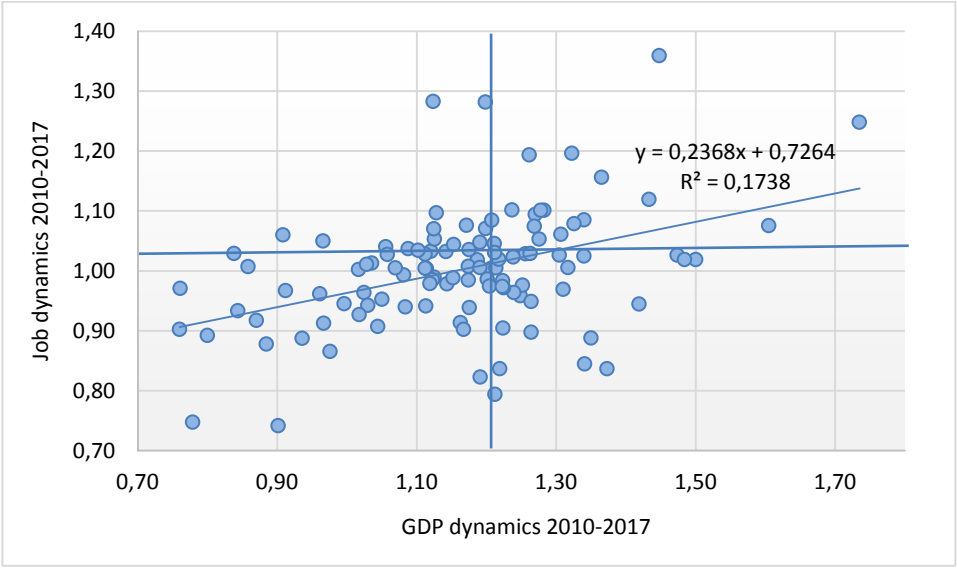

Figure 3. Coal and post-coal NUTS3 regions in the European Union (n = 111 NUTS3 regions)

Source: own study based on Eurostat data.

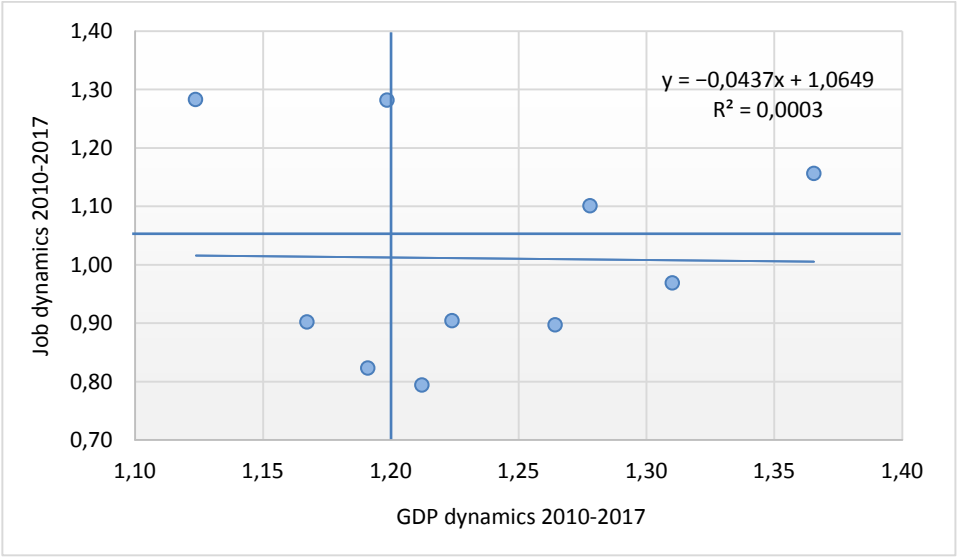

Figure 4. Coal and post-coal NUTS3 regions in Poland (n = 10 NUTS3 regions)

Source: own study based on Eurostat data.

In relation to all EU coal regions, Poland's coal regions find themselves in a difficult economic situation (cf. Figure 4). Indeed, most can be classified in portfolio quarter II (Sosnowiec, Konin, Wałbrzych, Piotrków) and IV (Bytom, Rybnik). In addition, they no longer experience the previously observed correlation between GDP growth rate and employment growth rate. This means that **higher growth rates in Poland's coal regions are accompanied by employment rate decline** (the linear function parameter value being −0.04). Therefore, on one hand, in their pursuit of improving value chain effectiveness, Poland's coal regions achieve this target while experiencing employment dynamics, and on the other, this means that there are very few coal regions in Poland that have effectively diversified and reoriented their economic structures. An exception can be found in the favourable development trends seen within the Bielsko-Biała and Gliwice (quarter I) regions only. These regions have been actively attracting investments so as to diversify their economic profile and develop entrepreneurship.

Yet another case involves Poland's coal regions that are classifiable into portfolio quarter III (cf. Figure 4), namely, the Katowice and Tychy subregions. In their case, high employment rate growth does not come with high GDP dynamics. Such a situation, in the case of the Katowice subregion (in particular), may entail the creation of a relatively large number of public sector jobs (lower productivity), including that in the local government, education, healthcare and public services because of the provincial rank of Katowice, the central city of the Śląskie province. In addition, the Katowice subregion includes a number of cities burdened with the legacy of traditional industry and adverse restructuring outcomes (Chorzów, Siemianowice Śląskie, Świętochłowice) or centres where mining activities are still active (Mysłowice, Ruda Śląska). The high job dynamics within this region can also be explained by investments in the Tychy subzone of the Katowice Special Economic Zone that are especially related to the automotive industry, which, however, has not recorded a high growth rate over the last decade.

An analysis of the economic situation in 10 NUTS3 coal regions in Poland (cf. Table 5) indicates that their economic growth rates in the years 2010-2017 (1.23) are lower than the average GDP growth rate in Poland over the corresponding period (1.29). Indeed, the analysed NUTS3 regions have recorded practically no job number increase in the years 2010-2017 (dynamics at a level of 1.00), when the increment for Poland amounted to 7% (1.07). Yet another issue worth stressing is the significantly high (just like in the entire country) productivity gap of Poland's coal regions relative to the EU average, i.e., the productivity of the indicated regions amounts to only 45.3% of the average productivity level within the EU (cf. Table 5).

Table 5. Productivity of coal and post-coal regions in Poland

Category	GDP dynamics 2010-2017	Job dynamics 2010-2017	GDP in 2017 (in M EUR)	Employment in 2017 (in thous.)	Labour productivity (in M EUR per 1 thous. employees)
EU28 – European Union, 28 countries	**1.20**	**1.05**	**15 409 890.75**	**235 899.88**	**65.3**
PL225 – Bielsko-Biała	1.37	1.16	8 436.39	292.3	28.9
PL227 – Rybnik	1.17	0.90	6 842.46	219.5	31.2
PL228 – Bytom	1.19	0.82	3 912.46	141.7	27.6
PL229 – Gliwice	1.28	1.10	6 848.08	204.4	33.5
PL22A – Katowice	1.20	1.28	11 894.94	381.3	31.2
PL22B – Sosnowiec	1.22	0.90	7 824.12	248.9	31.4
PL22C – Tychy	1.12	1.28	6 153.43	190.3	32.3
PL414 – Konin	1.31	0.97	6 207.19	247.3	25.1
PL517 – Wałbrzych	1.21	0.79	5 837.00	210.3	27.8
PL713 – Piotrków	1.26	0.90	6 713.54	254.3	26.4
Total: NUTS3 coal regions in Poland	**1.23**	**1.00**	**70 669.61**	**2 390.30**	**29.6**
Total: Poland	**1.29**	**1.07**	**467 312.90**	**16 315.00**	**28.6**
Share of coal regions in Poland	–	–	**15.12%**	**14.65%**	**103%**

Designations: colours in the table are identical to the colours in the portfolio approach.

Source: own study based on Eurostat data.

In addition to the presented purely statistical approach, which relates to NUTS3 coal regions, the real issue of just transition programming in Poland applies to 13 coal regions at various levels of territorial unit classification (cf. Figure 5).

Poland's coal regions with undertaken work associated to programming just transition solutions ultimately include:

1) in the Dolnośląskie province:
   - Wałbrzych NUTS3 subregion expanded by the Kamienna Góra commune,
   - Zgorzelec district;
2) in the Lubelskie province:
   - a modified Lublin NUTS3 subregion covering the Chełm, Lubartów, Lublin, Łęczyca, Parczew, Świdnik and Włodawa districts, and one city with district rights, i.e., Chełm (excluding the city of Lublin);
3) in the Śląskie province:
   - 7 NUTS subregions: Bielsko-Biała, Bytom, Gliwice, Katowice, Rybnik, Sosnowiec, Tychy;

4) in the Łódzkie province:
   – the so-called Bełchatów Transition Area that is part of two NUTS2 subregions, i.e., Piotrków and Sieradz;
5) in the Małopolskie province:
   – Oświęcim NUTS3 subregion, so-called Western Małopolska;
6) in the Wielkopolskie province:
   – Konin NUTS3 subregion excluding two districts, i.e., Gniezno and Września.

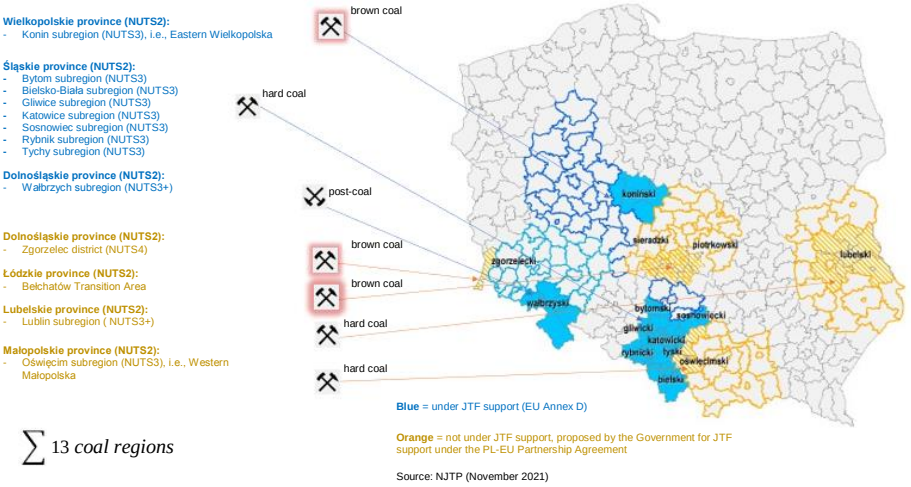

Figure 5. Poland's coal regions

Source: own study based on information dated 30/11/2021 from the *National Just Transition Plan* [Institute of Industrial Area Ecology, Ministry of Climate and Environment, 2021].

In this text, the subsequent subchapters will discuss the synthetic traits (demographic, economic, institutional, spatial and environmental contexts) of the indicated coal regions, and include portfolio analyses that summarize the situation of each in relation to the studied aspects. The contextual analysis was based primarily on data from 2019, i.e., the moment of announcing the *European Green Deal* [European Commission, 2019b], namely, the data that enables assessing the initial status of Poland's coal region transition.

2. Demographic context

Wałbrzych subregion – Dolnośląskie province

Stanisław Korenik, Dorota Rynio, Alicja Zakrzewska-Półtorak, Piotr Hajduga, Alicja Kozak

The Wałbrzych subregion is the third largest subregion of the Dolnośląskie province after the Wrocław and Jelenia Góra subregions. Its population in 2019 amounted to over 647.5 thous. The district's population is, however, in continuous decline (−5.6% in the last decade alone, wheras the decrease throughout the entire province was 0.6%). Adverse demographic trends, in addition to the shrinkage of the demographic potential, also include the ageing process as measured by applying the ageing index[11], the value of which over the last decade increased by almost 50%, to 156. However, the Wałbrzych subregion is still distinguished by having the largest number of people of working age among other subregions of the province – approx. 393 thous. inhabitants.

This subregion, relative to other subregions of the Dolnośląskie province, exhibits a specific settlement structure, namely, as many as 31 (more than 34% of all cities in the region) of its towns have been granted city charters. In contrast, the urbanization rate was 72% and 68% for the entire province. In terms of its demographic size, the Wałbrzych subregion comprises one large city (with a population from 112.6 thous.), six medium-sized cities (the population of which ranges from approx. 22 thous. to 57 thous.) and 24 small and very small cities (with a population from 2.4 thous. to more than 16 thous.).

Zgorzelec district – Dolnośląskie province

Stanisław Korenik, Dorota Rynio, Alicja Zakrzewska-Półtorak, Piotr Hajduga, Alicja Kozak

The Zgorzelec district is the sixth greatest land district (together with the Bolesławiec district) in terms of population, and fifth district (after the Kłodzko, Oleśnica, Trzebnica and Wrocław) in terms of area. The number of its inhabitants in 2019 amounted to almost 90 thous. However, the district's population is continuously decreasing (by more than 5% in the period of 2010 to 2019, where-

[11] Population aged 65+ per 100 people aged 0-14.

as that throughout the entire province amounted to 0.6%). Adverse demographic trends, besides the shrinking of the demographic potential, also include the ageing process measured by the ageing index, the value of which over the same decade increased by more than 37%, to 142. However, Zgorzelec district still stands out among other land districts of the province as having the largest number of inhabitants of working age – more than 55 thous. (occupying second place after the Lubin district).

The Zgorzelec district, relative to other land districts of the Dolnośląskie province, is not distinguished by its settlement or spatial structure, i.e., it includes two municipalities, three municipality-rural communes and two communes. There are five cities within its area and the urbanization rate is 67.78% (68% for the entire province). In terms of its demographic size, the Zgorzelec subregion comprises two medium-sized cities (with a population ranging from approx. 23 thous. to 30.5 thous.), and three small and very small cities (the population of which ranges from 2.8 thous. to more than 17.5 thous.).

Lublin subregion – Lubelskie province

Wojciech Janicki, Grzegorz Iwanicki, Andrzej Jakubowski

In 2019, the Lublin subregion was inhabited by 712.9 thous. people[12], which amounted to 33.8% of the total population of the Lubelskie province. In the years 2010-2019, the number of inhabitants in the subregion decreased by 4.8 thous, i.e., by 0.7%. Over the same period, the population of the Lubelskie province increased by 3.2%. However, the population fluctuations are characterized by a significant spatial differentiation – the years 2010-2019 saw a decrease in the number of inhabitants of Lublin and the peripheral communes of the subregion, and a dynamic growth of the population in communes adjacent to the city of Lublin, which is the consequence of suburbanization transformations.

The share of people of working age in the population of the Lublin subregion is 59.7%. This is lower than the average for the province and continues to decrease. The percentage of people of pre-working age is also declining. As a consequence, the Lublin coal region is characterized by a relatively high ageing index – amounting to 121 people aged 65+ per 100 people aged 0-14.

[12] Value including the population of Lublin (339.8 thous. inhabitants), which is a city located in the coal region centre, although is not part of the region. The Lublin coal region, excluding Lublin, is inhabited by 373.1 thous. people.

The settlement structure of the subregion is clearly dominated by the provincial capital – Lublin (339.8 thous. people) – which, despite its location relative to the coal region, is not part of it. The most important cities of the resulting Lublin coal region include: Świdnik (39,1 thous. people), Lubartów (21,8 thous. people) and Łęczna (18,8 thous. people).

Bielsko-Biała subregion – Śląskie province

Radosław Cyran, Piotr Rykała

The Bielsko-Biała subregion is the fourth most populated coal region in Poland. In 2019, it was inhabited by 667.6 thous. people. Its population increased by 1% in the years 2010-2019, which distinguishes this area from other coal regions in Poland, the population of which has constantly decreased. However, its ageing index increased over the same period by approx. 30% (from 89, to 115 people aged 65+ per 100 people aged 0-14). Despite these disadvantageous demographic trends, the value of this index was still, besides the Lublin region, the lowest among all of Poland's coal regions. The second unfavourable phenomenon within the region was the reducing number of people of working age (from 446 452, to 415 614), i.e., by 6.9%.

The settlement structure of the subregion comprises: the Bielsko-Biała district (municipality: Szczyrk; municipalities-rural communes: Czechowice-Dziedzice, Wilamowice; rural communes: Bestwina, Buczkowice, Jasienica, Jaworze, Kozy, Porąbka, Wilkowice), Bielsko-Biała city with district rights, Cieszyn district (municipalities: Cieszyn, Ustroń, Wisła; municipalities-rural communes: Skoczów, Strumień; rural communes: Brenna, Chybie, Dębowiec, Goleszów, Hażlach, Istebna, Zebrzydowice) and the Żywiec district (municipality: Żywiec; rural communes: Czernichów, Gilowice, Jeleśnia, Koszarawa, Lipowa, Łękawica, Łodygowice, Milówka, Radziechowy-Wieprz, Rajcza, Ślemień, Świnna, Ujsoły, Węgierska Górka).

Bytom subregion – Śląskie province

Małgorzata Czornik, Paulina Badura

In comparison to the Śląskie province, the Bytom subregion is characterized by a relatively high population dynamics, and a rather high ageing index. The population of this subregion in 2019 amounted to 430 thous. people, but is grad-

ually declining year-to-year (the number of inhabitants of this region was seen to decreased by almost 3% over the last 10 years). In contrast, the ageing index increased by over 26%. Combined with a decrease in the dynamics of working-age inhabitants (by more than 10% – to approx. 274 thous. people), this indicates a high demographic burden and a risk of further decline.

The settlement structure within this region is diverse – in terms of population, the region includes a very large city inhabited by more than 137 thous. people (Bytom), medium-sized cities with populations from 55 thous., to more than 62 thous. (Piekary Śląskie, Tarnowskie Góry), as well as smaller (Radzionków, Lubliniec) and very small cities (Miasteczko Śląskie, Woźniki, Kalety), with populations ranging from 7 thous., to 23 thous. people. A significant part of the subregion's area is dominated by rural communes (Ciasna, Herby, Kochanowice, Żarnowiec, Pawonków, Koszęcin, Tworóg, Zbrosławice, Świerklaniec, Ożarowice, Krupski Młyn).

Gliwice subregion – Śląskie province

Marek Magdoń, Jakub Miracki

The Gliwice subregion is one of the least populated coal regions in Poland. In 2019, it was inhabited by 466.5 thous. people, which was lower by almost 18 thous. (decrease of 3.7%) compared to 2010. Another negative demographic trend observed within the subregion is the ageing of the people – the ageing index in 2019 was 137, which was an increase by approx. 1/4 within a decade. The above-mentioned trends are also reflected in the rapid decline of the population of working age individuals, which amounted to over 12% (from 318 thous. in 2010 to 279.5 thous. in 2019) within the analysed period.

The Gliwice subregion covers the central-western part of the Śląsk region, and its settlement structure is comprised of two adjacent district-right cities (Gliwice and Zabrze), and one land district (Gliwice), which includes two municipalities (Knurów and Pyskowice), two municipalities-rural communes (Sośnicowice and Toszek), and four rural communes (Gierałtowice, Pilchowice, Rudziniec and Wielowieś). 88.5% (413 thous.) of the subregion's population live in the six cities comprising the subregion, including almost 351 thous. citizens of Gliwice and Zabrze, which are recognized as large cities (with a population around 170 thous.). Other cities of the subregion include Knurów (medium-sized status with a population above 37 thous.) and three small cities (their population ranges from approx. 1.9 thous., to slightly above 18 thous. people).

Katowice subregion – Śląskie province

Adam Drobniak, Piotr Rykała, Justyna Szymańska

The Katowice subregion is the most populated coal region in Poland. The number of its inhabitants in 2019 was just under 730 thous. The district's population is, however, continuously decreasing. In the last decade alone, its population declined by 4.8%. Adverse demographic trends, besides the shrinking of the demographic potential, also include the increase of the population of senior age measured by the ageing index, the value of which over the last decade increased by approx. 25%. However, the Katowice subregion is distinguished by the largest number of people of working age among all other coal regions – approx. 450 thous. inhabitants.

Relative to other coal regions, the Katowice subregion exhibits a specific settlement structure, i.e., it is basically a single urban centre consisting of directly adjacent towns with district rights (Katowice, Chorzów, Mysłowice, Ruda Śląska, Siemianowice Śląskie and Świętochłowice), including the city that is the capital of the Śląskie province. In terms of demographic size, the Katowice subregion comprises three large cities with populations from 108 thous., to more than 290 thous., and three medium-sized cities, with the number of inhabitants ranging from approx. 50 thous., to 75 thous.

Rybnik subregion – Śląskie province

Florian Kuźnik, Artur Ochojski

The Rybnik subregion is the seventh most populated coal region in Poland, inhabited by slightly over 630 thous. people. This amounts to just under 9% of the entire population of all of Poland's coal regions. In the years 2010-2019, it recorded a population decrease, which indicates a negative trend (similarly to the entire Śląskie province). A decline in the number of people of working age (by approx. 9%) is also a significant change recorded within the subregion. These changes are combined with a high population ageing index, i.e., 117 people aged 65+ per 100 people aged 0-14, although it is relatively low compared to other coal regions.

The fundamental settlement structure is made up of three cities with district rights: Jastrzębie Zdrój, Rybnik and Żory, and three districts: Racibórz, Rybnik and Wodzisław. The main city of the subregion and the core of the Rybnik ag-

glomeration is the city of Rybnik, which has a potential to develop agglomeration functions. Mining (based on coking coal) remains the economic foundation of Jastrzębie Zdrój, while the third of the urban centres – Żory – has undergone its own economic transformation associated with shutting down mines, and has become a centre for trade and industrial logistics.

Sosnowiec subregion – Śląskie province

Adam Drobniak, Piotr Rykała, Jakub Miracki

The Sosnowiec subregion is the second most populated coal region in Poland. Its population in 2019 amounted to over 676 thous. people. The subregion's population is decreasing at a similar rate to the Gliwice and Zgorzelec subregions, and the number of inhabitants decreased by 5.2% over the last decade. The ageing of the Sosnowiec subregion population is an even more adverse demographic trend than the population decline. The ageing index for the subregion (i.e., 161 people aged 65+ per 100 people aged 0-14) turns out to be the highest in all of the coal regions in Poland. These tendencies also lead to a rapid decrease in the number of people of working age in the years 2010-2019. This value fell from 491.8 thous., to 411.9 thous. − by more than 16%.

The settlement structure of the subregion comprises three cities with district rights (including two cities with populations over 100 thous.: Sosnowiec and Dąbrowa Górnicza) and two land districts (Będzin and Zawiercie). The current process of city sprawl and the creation of so-called *bagel*[13] communes around the Upper Silesia agglomeration have triggered strong urbanization processes within the Będzin and Zawiercie districts.

Tychy subregion – Śląskie province

Florian Kuźnik, Artur Ochojski

The Tychy subregion is inhabited by slightly under 400 thous. people (as of 2019). A minor population decrease (2.3%) indicating a negative demographic trend was observed in the years 2010-2019. The potential of working-age popu-

[13] The Upper Silesia agglomeration consists of core cities (i.e., 14 cities with district rights) of the Górny Śląsk – Zagłębie Metropolis. These include, besides the provincial capital of Katowice, the cities of Bytom, Chorzów, Dąbrowa Górnicza, Gliwice, Jaworzno, Mysłowice, Piekary Śląskie, Ruda Śląska, Siemianowice Śląskie, Sosnowiec, Świętochłowice, Tychy and Zabrze.

lation also decreased by 7.3%. This phenomenon is combined with a relatively low population ageing index as recorded in 2019. Over the ten studied years, this value changed from 79, to 99, which is a 25% increase.

The settlement structure of the Tychy subregion – one of the two least populated coal regions in Poland – is based on the city of Tychy, which has district rights, and three districts, namely, Bieruń-Lędziny, Mikołów and Pszczyna. This subregion is of diverse nature, and is formed by both urban and rural units. The dominant centre is the city of Tychy.

Bełchatów Transition Area – Łódzkie province

Aleksandra Nowakowska, Agnieszka Rzeńca

The Bełchatów Transition Area is inhabited by 517.3 thous. people, i.e., 21.0% of the total population in Łódzkie province (as at 2019). The area is characterized by a negative natural growth and negative migration balance. A distinguishing phenomenon within this area is depopulation, and its recorded rate turns out to be one of the highest in the country. The depopulation phenomenon is particularly evident in: Radomsko (with the highest change dynamics), Piotrków Trybunalski, Bełchatów and Wieluń. The migration outflow applies mainly to young citizens, which combined with the extended life expectancy, leads to high ageing dynamics within the region's population.

The greatest demographic problems can be found in the key cities of the Bełchatów Basin. For example, Bełchatów has been experiencing the most adverse changes of the demographic burden (dependency ratio), and its value in 2010 amounting to 13 people of post-working age per 100 people of working age. This statistic is predicted to rise by 2030 to 57 people of post-working age per 100 people of working age [Central Statistical Office, 2017]. These issues are already flagged by a relatively high ageing index value in the region, which amounts to 120 people aged 65+ per 100 people aged 0-14.

The Bełchatów Transition Area is characterized by a low urbanization rate, and its settlement structure is dominated by agricultural rural areas. Almost 2/3 of the communes record population densities of 100 per 1 km^2. In this area, the city of Bełchatów has the highest population density, yet it also records the highest negative migration balance. The main population migration direction is to the communes surrounding the city, i.e., Bełchatów commune and its neighbouring communes.

Western Małopolska – Małopolskie province

Krzysztof Gwosdz, Sławomir Sitek, Krzysztof Wiedermann

The Western Małopolska region, which covers the Oświęcim subregion, examplifies what is deemed an average-populated coal region within Poland. Its population in 2019 amounted to just below 550 thous. people. When analysing demographic processes within a dynamic system, it should be noted that this region recorded a decline of 1.2% over the last decade (2010-2019). However, compared to other coal regions, this value is minor (average decline within the group is 2.7%). The depopulation of working-age people, however, is much more considerable. This group decreased over the same period by as much as 7.6%. At the end of 2019, this region was inhabited by 330.4 thous. people within this age group. The quoted figure has resulted from listings detailing the numbers of individuals of post-working age, combined with listings of the simultaneous systematic depopulation of the pre-working age group. A significant change in the proportion between these population groups was recorded. In 2019, there were 121 people aged 65+ per 100 people aged 0-14, although there were only 93 representatives of this group still in 2010.

An analysis of the population dynamics processes in the spatial context requires pointing out the largest depopulation in the Oświęcim subregion, which concerned the largest cities (Oświęcim, Chrzanów and Olkusz), as well as the communes in its northern part. However, the nearby suburban zones were characterized by different trends in this regard and this provides evidence of progressing suburbanization processes. The Oświęcim rural commune experienced this phenomenon on the greatest scale. Its population in 2019 reached almost 106% of the value from 2010.

The analysed spatial differentiation of the society in terms of age structure highlights the Oświęcim subregion as an area with a high share of people aged 65+; however, this phenomenon is very diverse spatially. The smallest population ageing scale is found in areas distinguished by higher population growth rates, and the share of urban population constitutes an important determinant. Over all, these areas remain the most impacted by the progressive ageing of the population (among others: Bolesław – 176.3[14], Bukowno – 170.7, Oświęcim – 163.7 and Chrzanów – 160.6). The Wadowice district is different. Its communes are some of the youngest in demographic terms within the region. Places where

[14] Population aged 65+ per 100 people aged 0-14.

this value does not exceed 80[15] include: Wieprz (75.3), Tomice (77.4) and Lanckorona (79.3).

Eastern Wielkopolska – Wielkopolskie province

Paweł Churski, Robert Perdał, Martyna Burchardt

The Konin subregion is one of the demographically largest coal regions in Poland, and it exhibits a minor depopulation. In 2019, it was inhabited by 657 thous. people. The subregion's population only slightly decreased (0.5%). However, compared to the changes recorded in the Wielkopolskie province, which experienced a slight increase (+1.5%), that in the subregion is disadvantageous, and the decline in the share of working-age people by 7.5% is a more worrying phenomenon. This value is higher than for the entire Wielkopolskie province (–6.7%). On one hand, this situation means reduced impact on the labour market by people leaving the mining industry in the coal region, but on the other, combined with a similar dynamics of the population ageing index, such data indicates an increase in the pre-working age population in the Konin subregion that is lower than that for the entire region. The ageing index for the subregion (i.e., 106 people aged 65+ per 100 people aged 0-14) was one of the relatively lowest among Poland's coal regions. However, the adverse demographic changes ongoing within the Konin subregion are more evident than in the Wielkopolskie province.

The main hubs of the settlement network within the subregion are medium-sized cities, among which are the main city of Konin, as well as Turek and Koło, and a small city – Słupca. These centres serve as district capitals. The Konin subregion comprises six land districts and one city with district rights, namely, Konin district, the city of Konin, and Koło, Turek, Słupca, Gniezno and Września districts. Note, however, that these last two districts were not ultimately grouped under the Eastern Wielkopolska coal region, since they are within the impact zone of the provincial centre, Poznań (approx. 50 km), and have a slightly different social and economic profile than the other districts. Nevertheless, it should be underlined that the Eastern Wielkopolska coal region is internally very diverse.

[15] Population aged 65+ per 100 people aged 0-14.

Demographic context summary

Adam Drobniak

Collectively, the demographic situation of Poland' coal regions is illustrated in Table 6. In terms of demography, these regions are inhabited by approx. 7.2 M people, i.e., approx. 20% of the country's population. Almost all, except for Bielsko-Biała, have, however, experienced the adverse demographic trends associated with depopulation and ageing processes.

Table 6. Basic information on the demographic context of Poland's coal regions

Coal regions	Population (in 2019)	Population change (2010 = 100)	Ageing index* (in 2019)	Region type – settlement structure
Wałbrzych	647 499	94.4	156	Diverse
Zgorzelec	89 188	94.2	142	Rural
Lublin	712 873**	99.3	121	Rural
Bielsko-Biała	667 570	101.0	115	Diverse
Bytom	437 263	97.0	135	Diverse
Gliwice	466 491	96.3	137	Urban
Katowice	728 957	95.1	143	Urban – central
Rybnik	632 825	98.8	117	Urban
Sosnowiec	676 175	94.8	161	Urban
Tychy	397 895	97.7	99	Diverse
Bełchatów	517 342	97.5	120	Rural
Western Małopolska	549 245	98.8	121	Diverse
Eastern Wielkopolska	656 685	99.5	106	Diverse

* Population aged 65+ per 100 people aged 0-14.

** Including Lublin (339 784 inhabitants) located in the centre of a coal region, although the Lublin coal region itself does not include Lublin. Such a coal region was inhabited in 2019 by 373 089 people.

Source: own study.

The settlement structure is also diverse. On one hand, these regions are created by urban organisms that can be compared to one large city without clear borders, as in the case of the Katowice region or, to a certain degree, the Gliwice and Sosnowiec subregions. However, on the other hand, such regions exhibit a typically rural or small-town character, as in the case of the Zgorzelec, Lublin or Bełchatów regions.

In the portfolio approach (cf. Table 7) that takes into account the demographic scale and the population change, the most difficult initial situation for the transition is encountered in the Wałbrzych and Sosnowiec regions. These are coal regions with a relatively high number of citizens and a very significant depopulation compared to other analysed coal regions. In addition, the mining restructuring processes therein ended in the 1990s (Wałbrzych) or resulted in the significantly limited potential of traditional industries (Sosnowiec). Nevertheless, it was impossible to fully create an economic base over the last decades that could be compared to that of the 1990s.

Table 7. Demographic portfolio of Poland's coal regions – demographic scale *versus* population change

Population change	High decrease (above 5%)	Zgorzelec		Wałbrzych, Sosnowiec
	Minor decrease (up to 5%)		Bytom, Gliwice, Tychy, Bełchatów, Western Małopolska	Lublin, Katowice, Rybnik, Lublin, Eastern Wielkopolska
	Growth			Bielsko-Biała
		Low	Average (300-500)	High (600-700)
		Demographic scale of Polish coal regions		

Designations:

	Very high intensity of issues and challenges within a given context (5)
	High intensity of issues and challenges within a given context (4)
	Average intensity of issues and challenges within a given context (3)
	Low intensity of issues and challenges within a given context (2)
	Negligible intensity of issues and challenges within a given context (1)

Source: own study.

It should be noted that in the case of all other coal regions analysed in the demographic scale or population change contexts, these areas were classified as locations with a high or average intensity of demographic issues. Therefore, the demographic aspect constitutes a significant challenge for just and energy transitions. Currently, the coal regions of Poland are not perceived from the demographic perspective as attractive places to live in. The potential failure of just and energy transitions will lead to a further intensification of demographic issues related to, among others, depopulation and ageing.

3. Economic context

Wałbrzych subregion – Dolnośląskie province

Stanisław Korenik, Dorota Rynio, Alicja Zakrzewska-Półtorak, Piotr Hajduga, Alicja Kozak

The number of business entities determining the economic potential of the Wałbrzych subregion amounted to more than 75.7 thous. at the end of 2019. Although this indicates an increase during the 2010-2019 period, the growth rate compared to other coal regions is average, and fluctuated around a level of 4.4% in the years 2010-2019.

Relative to other coal regions, the Wałbrzych subregion is characterized by an average number of employed people (over 193 thous. in 2019) and a job number increase of more than 5%. There were 44 large-sized enterprises (employing more than 250 people each) operating within the entire Wałbrzych subregion at the end of 2019. Of these, 36% were located in Wałbrzych, and most were industrial plants (54.5% of all the entities). It is hard to unequivocally indicate the leading sectors among the large-sized enterprise in the region. Both the automotive and healthcare sectors are widely represented.

The "INVEST-PARK" Wałbrzych Special Economic Zone (WSEZ) plays an important part in the economic re-development of the Wałbrzych subregion, and is one of the most rapidly growing industrial zones in the country. More than 200 enterprises have so far invested in the WSEZ. They include global corporations, as well as small and micro family-run enterprises [Wałbrzych Special Economic Zone, n.d.]. Companies located here have invested a total of PLN 25.5 Billion and created more than 51 thous. jobs.

The WSEZ in Wałbrzych is dominated by the automotive industry, but is complemented by construction businesses. The WSEZ subzone in Świdnica is host to companies from the household appliances, chemical, electronic and plastics processing industries. In turn, the WSEZ subzone in Strzegom is home to a food industry enterprise. The industries represented in Świebodzice include plastics processing, heat technology and air technology. Investors from the construction, energy equipment, plastics production and cable bundle production industries conduct their activities within the WSEZ subzone in Nowa Ruda, while the WSEZ zone in Żarów is dominated by the automotive industry [Wałbrzych City Hall, 2018, p. 15]. Public institutions (state and local administration, hospitals, and universities) remain important employers in the Wałbrzych subregion.

Zgorzelec district – Dolnośląskie province

Stanisław Korenik, Dorota Rynio, Alicja Zakrzewska-Półtorak, Piotr Hajduga, Alicja Kozak

The Zgorzelec coal region, which is the smallest on the demographic scale, also offers the lowest economic potential measured by the number of business entities, i.e., more than 8.7 thous. in 2019. Compared to other coal regions, the business entity growth rate in the Zgorzelec district is low, amounting to less than 0.4% in the years 2010-2019.

Relative to other coal regions, the Zgorzelec district is characterized by the lowest number of employed people (more than 19.4 thous. people in 2019). The number of jobs in mining (3.5 thous.) and mining-related (more than 4.2 thous.) industries accounts for 38.2% of all employment in the Zgorzelec district. Owing to the rich lignite deposits, the leading industries in the Zgorzelec district are mining and energy. In addition, there are gravel, sand and basalt deposits located within the district. The most industrialized area in the Zgorzelec district is the City and Municipality of Bogatynia, which is the seat of the PGE GiEK S.A. KWB "Turów" Branch and the PGE GiEK S.A. "Turów" Power Plant with existing several by-companies. These enterprises employ a total of approx. 7 thous. people. There are also investment areas within the Zgorzelec district that have been covered by the Kamienna Góra Special Economic Zone for Small Entrepreneurship. The specific location of the Zgorzelec district, on the border with the Czech Republic and Germany, creates advantageous conditions for the development of enterprises and trade.

Lublin subregion – Lubelskie province

Wojciech Janicki, Grzegorz Iwanicki, Andrzej Jakubowski

The relatively high economic potential of the Lublin subregion is manifested by the significant number of existing business entities, amounting to 76.1 thous. in 2019[16]. Simultaneously, the Lublin subregion was characterized by the highest business entity number growth rate in the years 2010-2019 among all the analysed coal regions (17.0%). Very high dynamics were also recorded in rela-

[16] Due to the availability of statistical data, the analysis also included Lublin, which has not ultimately been classified as being part of the Lublin coal region.

tion to the number of employed people, which amounted in the years 2010-2019 to 14.3% and was slightly higher than the increase in the number of economic entities. There were 311.1 thous. people employed in the Lublin subregion in 2019, which constitutes one of the highest values among the analysed coal regions. The Lublin subregion is one of the coal regions where the employment level in the mining sector and associated activities can be called "average". The total number of employees in the mining and extraction sector in 2019 amounted to 5.7 thous. people, i.e., 1.8% of the total within the area. Taking into account people employed in mining-related industries, this number rises to 12.5 thous., i.e., 3.9% of all the jobs in the subregion.

The Lublin subregion is characterized by high job concentration being in Lublin. The capital of the province is also home to the majority of medium- and large-sized enterprises within the subregion (more than 80%), while the city itself is characterized by a relatively diversified economic structure. Other important centres include: Świdnik, Lubartów and Łęczna. Public institutions (hospitals, universities, judicial and prosecutorial units, provincial police headquarters, city hall) and companies under capital groups controlled by the State Treasure or the local government account for the most entities in the subregion that employ more than 250 people. The subregion's industrial profile, besides public institutions, is determined by enterprises operating in the energy, aviation (helicopter manufacturing), machinery (agricultural equipment manufacturing), food, construction, trade and transport industries. The only large-sized entity directly related to the mining sector is the Kopalnia Węgla Kamiennego Lubelski Węgiel "Bogdanka" S.A. (hard coal mine) with its seat in the Łęczyca district.

Bielsko-Biała subregion – Śląskie province

Radosław Cyran, Piotr Rykała

An increase in the economic potential was recorded in the Bielsko-Biała subregion in the years 2010-2019, and the number of business entities was significantly increased from 72.8 thous., to 79.8 thous., i.e., by 9.6%. This led to an increase in the number of people employed in the subregion by 15.3% − from 243.3 thous., to 279.4 thous., despite the decline of the population of working age (by 6.9%), while the entrepreneurship rate increased from 87 to 91 natural persons conducting businesses per 1000 inhabitants.

The economic development of the Bielsko-Biała subregion is based on over 130 companies and manufacturing plants employing more than 250 people, including 10 enterprises with more than 1000 employees and 10 companies from the Poland's 500 largest companies list. The Bielsko-Biała subregion has a diversified economic structure, both in terms of manufacturing and services, with important roles played by such industries as the production of cars, parts and accessories to motor vehicles, production of food products, production of electronic subassemblies, production of plastics and packaging, as well as production of timber products. The dominant sector is the automotive industry with its production chain. There is also significant diversification of the manufacturing and service activity fields. Small-sized entrepreneurship and crafts also play an important part. It should be emphasized that the Bielsko-Biała subregion is home to companies with a significant innovation and novelty potential in the field of industry 4.0 implementations.

The mining sector is of minor importance with regard to total employment in the Bielsko-Biała subregion, since (in 2019) only 1.7 thous. people were directly involved in mining activities, with an additional 2.1 thous. employed within related entities, i.e., 1.3% of the total number of employees within the area (the lowest percentage among all coal regions). Therefore, this situation does not indicate a structural issue associated with the labour market and a potential growth of the unemployment rate due to the gradual phase-out of the mining industry. The main economic centre is Bielsko-Biała, with other important centres being: Cieszyn, Czechowice-Dziedzice, Skoczów, Ustroń and Żywiec.

Bytom subregion – Śląskie province

Małgorzata Czornik, Paulina Badura

In the economic context, the Bytom subregion is one of the worst among the analysed regions in terms of the number of economic entities (more than 44 thous.). Nevertheless, it was characterized by high entity growth rate in the years 2010-2019 (> 9%).

With regard to the labour market, the Bytom subregion is distinguished by having one of the lowest employment levels (approx. 135 thous. people in 2019), and, relative to other subregions, by holding an equally low level of employment in the mining and related activities sector (approx. 6 thous. people in 2019). Despite this, the job number change dynamics over almost the last decade (2010-2019) is rather advantageous, with a 6% growth.

There are 33 large enterprises (more than 250 employees) within the Bytom subregion, and the dominant location (45% of the enterprises) is the Tarnowskie Góry district. There are very few companies that decided to establish plants in district cities (Bytom – four large enterprises, Piekary Śląskie – three large enterprises). The leading industries primarily include the heavy industry, energy, mining, power engineering, heating and the production of components for machinery used in heavy industry. One of the largest and most significant employers has its seat in Miasteczko Śląskie – Huta Cynku "Miasteczko Śląskie" S.A. (a zinc mill), which declares employment of 800 people.

Gliwice subregion – Śląskie province

Marek Magdoń, Jakub Miracki

Despite the demographic issues discussed in the previous subchapter, the Gliwice subregion exhibits trends advantageous in relation to its economic potential. The number of business entities increased from 48 thous. in 2010 to more than 51 thous. in 2019 (an increase of 6.8%). Large-sized companies (employing at least 250 people) constitute a significant element of the local economic fabric. There are more than 100 of these in the Gliwice subregion. They operate within very diverse industries, which include modern technologies (automation systems, production management, reconnaissance and observation, industrial software), automotive (car, filter and catalyst production), as well as the production of structural elements, electronic components and armaments.

An even higher growth (by 8.7%) was recorded over the analysed decade in relation to the number of employees, i.e., from 176 thous. to 191.5 thous, with the vast majority employed in Gliwice and Zabrze. Approximately 22 thous. people found employment in companies seated in the Gliwice subzone of the Katowice Special Economic Zone (investments by companies operating within the subzone amounted to PLN 14.2 Billion) [Sobierajski, 2022], which largely covers areas located within the Gliwice subregion (Gliwice, Zabrze, Knurów and Rudziniec).

It should be noted that in 2019, the mining sector in the Gliwice subregion employed only 3.9% of the total number of employed – however, this still means 7.5 thous. people, and translates to 9.1 thous. additional jobs in related activities. This figure was only exceeded by Rybnik, Tychy and Katowice subregions with regard to coal mining activity in Poland.

Katowice subregion – Śląskie province

Adam Drobniak, Piotr Rykała

The Katowice subregion, which is the largest in demographic terms, also exhibits the highest economic potential measured by the number of business entities, i.e., more than 88 thous. in 2019. Importantly, in the perspective of the transformation, an advantageous growth rate of business entities in the subregion has been recorded over the last decade, at a level of 7.1% in the years 2010-2019.

Relative to other coal subregions, the Katowice subregion is noted for having the highest number of employed people (over 353 thous. in 2019) and a job number growth rate of more than 7%. Almost half of these jobs were offered in Katowice (171.8 thous. in 2019). Such a high concentration of jobs in Katowice is due to the city being the capital of the demographically significant Śląskie province (approx. 4.5 M inhabitants) and, simultaneously, it being part of the Górny Śląsk – Zagłębie Metropolis (approx. 2.1 M inhabitants). Given the above, it should be emphasized that while the number of jobs in mining (15.3 thous.) and mining-related industries (18.6 thous.) is notable, it only accounts for just over 10% of the total jobs in the Katowice subregion. Nevertheless, the absolute number of jobs directly and indirectly related to mining turns out to be significant when compared to other coal regions. In this field, the Katowice subregion comes second to just the Rybnik and Tychy subregions within Poland.

As a whole, the Katowice subregion boasts a well-diversified economic structure. The industry profile of the subregion comprises large- and medium-sized companies operating within such sectors as food, metallurgy, construction (manufacturing of structural and finishing elements, and tools), furniture, automotive (manufacturing of structural elements and engines), ICT (software development, automation systems), mining, chemicals, sports (sporting equipment manufacturing), energy (manufacturing of energy network elements), armaments and modern business services. Public institutions (state and local administration, hospitals, and universities) are also important employers. It should be stressed, however, that the economic potential and (as noted) job number potential are not equally distributed within the Katowice subregion. The majority of the economic potential is focused in Katowice, while such cities as Mysłowice and Ruda Śląska are significantly "burdened" with traditional mining-related industries.

Rybnik subregion – Śląskie province

Florian Kuźnik, Artur Ochojski

The Rybnik subregion is characterized by displaying a more or less average business entity number growth rate (6.7%). Part of this process is due to a relatively significant increase in the number of B section entities (reaching a level of 45% or 80 entities in 2019). It should be underlined that the market of mining and mining-related companies in the Rybnik subregion is significantly developed and is made up of companies providing services in the field of operating machinery used in mining or power and heat supply, as well as ones specializing in methane drainage in mines and preparation of underground work. These entities often offer the capacity to diversify into new manufacturing or service specializations by expanding their portfolio within other industry disciplines (including railway, maritime and other). The mining sector employs more than 22 thous. people, i.e., approx. 11% of the total employees in the subregion. When people employed within related activities are included, this figure increases to approx. 49 thous. employees, which constitutes approx. 24% of the total employees in the subregion.

The entrepreneurship of natural persons remains at a relatively stable level – approx. 60 natural persons per 1000 citizens run a business, and the number of employees increased over the decade by approx. 5%, to approx. 208 thous. Please note that this phenomenon entails a decline in the working-age population, which most likely means an increase in the number of job offers within the subregion.

The foundation of the Rybnik subregion economic fabric is comprised of about 50 large-sized companies and manufacturing plants. These primarily include entities related to the mining industry, the basic scope of which embraces support for processes specific to the industry's functioning. Nevertheless, crucial industries in this coal region include the construction industry (including services provided for the purposes of the coal industry), the industry supporting the energy sector, and the food industry (including beverages, fruit and meat processing). The sectors related to motor vehicle parts and accessories, and the manufacturing of plastics and packaging are also important. Although it is a subregion with strong traditional economic roots, the economic fabric is diversified owing to, among others, the activity of the Jastrzębie-Żory KSEZ Subzone. It has activity led to attracting or modernizing several dozen companies, including some foreign-funded. These are enterprises from the chemical, food and automotive industries, supplemented by developing medium-sized companies that have high technological potential and internationalisation. The cities of Rybnik, Żory

and Jastrzębie-Zdrój form the economic core of this subregion, while important centres are Czerwionka-Leszczyny (automotive industry) and Racibórz with adjacent towns (chemical industry, boiler and window joinery manufacturing).

Sosnowiec subregion – Śląskie province

Adam Drobniak, Piotr Rykała, Jakub Miracki

In the years 2010-2019, the Sosnowiec subregion recorded a declining economic potential measured by the number of economic entities, the number of which decreased over this period by 1.2%, reaching slightly under 71 thous. in 2019. However, a high growth rate was recorded by business entities in the B section, with the number increasing by 90.9%. This subregion stand outs positively in terms of the number of employed people, which amounted to over 234 thous. in 2019. The entrepreneurship of natural persons remains at a relatively stable level and is approx. 80 natural persons running a business per 1000 citizens. The mining sector employees 3.5 thous. people, which constitutes slightly less than 1.5% of the total employed people.

The Sosnowiec subregion is characterized by a certain degree of production and service activity diversification, with focus on sectors related to metallurgy. The subregion is home to approx. 50 companies and manufacturing plants employing more than 250 people. There are also a dozen or so large-sized enterprises related to the mining sector in the region that offer support for the development of this industry. Dominant industries within the analysed area include metals (steel distribution, steel element production, pig iron distribution and metallurgy), machinery production, plastics production, toys, construction and the medical industry. The economic fabric is complemented by small- and medium-sized companies, and the main economic centres are: Sosnowiec, Dąbrowa Górnicza and Jaworzno. Zawiercie and Będzin remain important economic centres.

Tychy subregion – Śląskie province

Florian Kuźnik, Artur Ochojski

The Tychy subregion is characterized by a significant business entity growth rate (more than 12%), although this rate should be read taking into account the relatively low baseline value compared to other coal regions – approx.

41 thous. entities in 2010. However, in the context of transition phenomena, it is important to note that the number of B section entities doubled during the 2010-2019 period, with the number reaching 50 in the subregion in 2019.

The entrepreneurship of natural persons remains at a relatively average and constant level (almost 80 people per 1000 citizens), while the number of working people has been increasing at a relatively minor rate of approx. 4%, reaching 169 thous. in 2019. Importantly, B section entities employ 19 thous. people, which constitutes, similarly to the Rybnik subregion, 11% of the total number of employees in the subregion. However, please take into account the entities in the mining-related sector, where employment can be estimated at a level of approx. 23 thous. jobs. Combined with those directly employed in mining activities, this number rises to approx. 42 thous.

The backbone of the Tychy subregion economic fabric is comprised of about 50 large-sized companies and manufacturing plants. The majority of these produce automobiles, as well as parts and accessories for motor vehicles. Other industrial sectors are involved in food production, electronic subassemblies manufacture, plastics and packaging. Given the common belief that the subregion is dominated by the automotive industry and its production chain, it should be underlined that the manufacturing and service activity of the large-sized companies located within the subregion is diversified, which should ensure the stability of its economy, and it is home to companies of significant modernity and innovation potential in the field of industry 4.0 implementations, food industry and electronics. The main economic centre is the city of Tychy, while other important centres include the cities of Bieruń, Mikołów and Pszczyna.

Bełchatów Transition Area – Łódzkie province

Aleksandra Nowakowska, Agnieszka Rzeńca

The Bełchatów Transition Area (PL − *Bełchatowski Obszar Transformacji*) constitutes an industrial monoculture dominated by the mining and energy sectors, which accounts for approx. 12% of the total GDP of the Łódzkie province. It is the richest subregion in the province, and is characterized by a very high GDP *per capita* level.

Its economy remains dominated by large- and medium-sized enterprises. There were 27 companies employing more than 250 people each operating within the Bełchatów area in 2019. Almost 80% of these had their seat in one of the four cities of the Bełchatów Basin, i.e., Piotrków Trybunalski, Bełchatów, Wie-

luń and Radomsko. They include the entities operating under the PGE Polska Grupa Energetyczna S.A. Capital Group.

The main industries within the Bełchatów Transition Area are raw material related and based on lignite deposits, as well as electricity and heat generation, followed by, albeit to a small extent, the metallurgical, electromechanical, construction material and timber industries – all characterized by a low innovation level.

The largest employer in the region is PGE Górnictwo i Energetyka Konwencjonalna Bełchatów, which employs more than 4 thous. people in its mine and almost 3 thous. in the power plant (as at 30/6/2020). Additional employment of approx. 4.5 thous. is ensured by PGE subsidiaries operating within the area. A downward trend in the employment rate and a change of the working age structure have been observed for several years. Large labour market disproportions are becoming evident within the Bełchatów region. This is confirmed by the number of employed per 1000 inhabitants. By far, the best situation is within the Szczerców and Kleszczów communes, followed by the cities of Radomsko and Piotrków Trybunalski, and the Wieluń and Działoszyn municipal-rural communes.

The Bełchatów area recorded high (almost 12%) a growth rate in the number of businesses in the years 2010-2019. There were 44 505 enterprises operating therein in 2019. Despite this phenomenon, the index of business entities per 10 000 inhabitants was much lower than the average for the Łódzkie province (864 entities per 10 000 inhabitants in the Bełchatów area, with 1035 within the Łódzkie province). Similarly to the Rybnik region, the Bełchatów Basin is characterized by the lowest entrepreneurship index among the analysed just transition areas. For example, the number of natural persons running a business in 2019 per 1000 inhabitants of the Bełchatów area was 67 (61 in Rybnik), this figure reaching that of 74 in the Dolnośląskie province, 78 in the Lubelskie province and 91 in the the Bielsko-Biała region.

Communes of the Bełchatów region are characterized by large financial standing disproportions. This is an outcome of some being awarded significant income related to the operation of PGE GiEK S.A. on account of property tax, operating fees, environmental fees, share in PIT revenues, and share in CIT revenues. For example, the share of the operating fee alone in the own revenue structure of communes amounted to 78.3% in Rząśnia, 75.5% in Sulmierzyce, 75.4% in Szczerców and 50.5% in Kleszczów. On one hand, this situation has enabled several communes to achieve a significantly high financial independence positioning within the analysed coal region, yet on the other, a dominant

group of communes within this area generate less than 30% of own revenues in the total revenues of the region's communes.

Western Małopolska – Małopolskie province

Krzysztof Gwosdz, Sławomir Sitek, Krzysztof Wiedermann

The number of economic entities in the Oświęcim subregion reached almost 57.4 thous. in 2019, which corresponds to an average of 10.4 per 100 inhabitants. The value was close to the average for all coal regions in Poland, which is 10.5. In the dynamic context, the number of registered business entities grew in the years 2010-2019 at a rate of 7.3%. In the spatial and absolute-number perspective, the entities are mostly concentrated in urban areas, but given the fact that cities should constitute business activity focus areas, it should be noted that the values reached by the urban areas of the Oświęcim subregion are not significantly high. The rural area of the Kalwaria Zebrzydowska commune stands out the most in this context, as the commune has developed an extensive network of furniture industry enterprises. With regard to the rate of business entity number changes in the years 2010-2019, the most positive results were recorded by the districts of Wadowice – 111.4%, Oświęcim – 107.3% and Chrzanów – 107.2%. As to the communes, the figures are Zator – 124.8%, Wieprz – 124.4% and Lanckorona – 124.3%. Such positive changes recorded in Zator evidence the success of the development strategy set out by the local government. It created and promoted a business activity area, thus enabling the growth of, among others, one of the largest theme parks in more than just the region or the entire country, but Europe itself.

The group of enterprises classified under section B and operating within the Oświęcim subregion in 2019 included 110 entities. This is an increase of 189% relative to 2010. Such a growth can be associated with the ongoing restructuring processes, which often lead to the establishment of smaller units cleaved from the previous structures of larger enterprises. The overall entrepreneurship, measured by the number of natural persons running a business per 10 000 inhabitants, also increased within the analysed period. This ratio was 81 in 2019, as opposed to only 77 in 2010, which is a growth by more than 5%. According to the data available at the end of 2019, the number of people employed in the mines of the Oświęcim subregion was slightly under 4 thous. The large-sized entities operating within this area include two mining facilities extracting hard coal – KWK "Brzeszcze" and KWK "Janina", owned by TAURON Wydobycie S.A.

The civilizational challenges related to a turn away from a coal-based economy entail the need to find an alternative development path for this coal region. The share of the mining industry in added value generation in 2019 amounted to 46% for the Chrzanów district, and 36% for the Oświęcim district. However, the subregional structure is now dominated by services – 53.11%, followed by industry and construction – 37.59%, and mining – 6.44%. These figures demonstrate a gradual transition from an economy based on coal, as well as progress in both economic and social terms.

Eastern Wielkopolska – Wielkopolskie province

Paweł Churski, Robert Perdał, Martyna Burchardt

The Konin subregion[17] is average in terms of the number of existing businesses, yet it is characterized by a high growth rate with regard to their number. The business entity number growth rate in the years 2010-2019 amounted to 16.8%, which placed the Konin subregion, together with the Lublin subregion, in first place among all of Poland's coal regions. It should be emphasized, however, that the growth rate of the number of business entities within the Konin subregion is lower by 2% than within the province – 16.8% and 18.8%, respectively.

Still, the favourable trends in terms of changes in the number of business entities are accompanied by unfavourable changes in the number of employees. The Konin subregion, together with the Zgorzelec and Bytom subregions, are coal regions characterized by having the lowest number of paid workers, which in 2019 amounted to just over 137 thous. In addition, it should be underlined that the growth rate of the number of employees in the Konin subregion (12.4%) is much lower than that in the Wielkopolskie province (19.2%). Both in the Konin subregion and within the entire Wielkopolska province, there was a 50% increase in the number of entities operating within section B (mining and quarrying), but a slight (approx. 0.5%) decrease in the number of employed within this section. Therefore, it can be assumed that the increase in the number of entities is related to the division of large mining entities into smaller, and, hence, an increase in the number of companies supporting mining activities, but also classified under section B. This situation, combined with a slight decrease in section B employment, may raise concerns about the flexibility of these businesses

[17] Due to the availability of statistical data, the analysis covered the Konin subregion, i.e., together with the Gniezno and Września districts, which are not part of the Eastern Wielkopolska coal region.

and their capacity to diversify their production or service profile. However, this does not change the fact that the Konin subregion is average amongst all of Poland's coal regions in terms of the number of employees and the number of people employed in mining.

Without a doubt, the growing entrepreneurship rate among individuals within the Konin subregion is a positive indicator with regard to the subregion's transition from a coal-based economy. The figure is higher than in that of Wielkopolskie province – an increase of 16% and 9.5%, respectively. This, in turn, combined with a larger working-age depopulation than in the region, indicates an increase in the number of available jobs in the Konin subregion. Between 2010 and 2019, the Konin subregion recorded an increase in GDP from PLN 19 Billion to PLN 28 Billion, a growth of 48%, with a slightly higher growth rate in the Wielkopolskie province, amounting to approx. 53%. However, the 31% productivity growth in the Konin subregion turns out to be much lower than in the region, where an increase of 53% was recorded. Therefore, a significant disproportion in this regard to the disadvantage of the Konin subregion is becoming apparent. This may be indicative of the much lower effectiveness of human resources and the economic potential of the area (productivity gap).

Economic context summary

Adam Drobniak

The basic synthetic information on the financial standing of Poland's coal regions is presented in Table 8. Coal regions create approx. 2.6 M jobs, i.e., more than 20% of Poland's total job count, and these regions are responsible for approx. 20% of the country's GDP. Mining and related-activities are characterized by the largest employment scale in the country. In 2019, employment within the mining sector in the Śląskie province alone, exceeded 72 thous. people, with another 87 thous. jobs in related activities. Almost all of the coal regions exhibited a favourable growth in the number of business entities in the second decade of the 21st century, although it varied vastly, i.e., from 0.4% in the Zgorzelec region, to a 17% growth in the Lublin region. An exception in this dimension is the Sosnowiec region, where the number of business entities decreased between 2010 and 2019 by 1.2%.

Table 8. Basic information on the economic context of Poland's coal regions

Coal regions	Number of business entities (in 2019) and their dynamics (2010 = 100)	Employment (in 2019)	Employment in mining (in 2019)	Employment in related businesses* (in 2019)
Wałbrzych	75 748 (104.4)	193 772	0	0
Zgorzelec	8 713 (100.4)	19 405	3 500	4 235
Lublin	76 051 (117.0)	311 090	5 653	6 840
Bielsko-Biała	79 831 (109.6)	279 450	1 746	2 113
Bytom	44 328 (109.2)	134 318	2 784	3 369
Gliwice	51 306 (106.8)	191 498	7 542	9 126
Katowice	88 295 (107.1)	353 716	15 333	18 553
Rybnik	51 796 (106.7)	208 740	22 113	26 757
Sosnowiec	70 942 (98.8)	234 182	3 486	4 218
Tychy	41 404 (112.2)	168 975	19 009	23 001
Bełchatów	44 505 (111.7)	166 413	4 728	5 721
Western Małopolska	57 358 (107.3)	189 868	3 998	4 838
Eastern Wielkopolska	65 865 (116.8)	137 322	6 689	8 094

* Indirect employment was estimated using a multiplier of 1.21, employed for such purposes by the EU Joint Research Centre.

Source: own study based on CSO LDB data and information of 30/11/2021 in the *National Just Transition Plan* [Institute of Industrial Area Ecology, Ministry of Climate and Environment, 2021].

From the portfolio perspective, which takes into account the number of business entities and their growth rate in the years 2010-2019 (cf. Table 9), the most favourable situation was experienced in the Bielsko-Biała and Lublin regions. A relatively good economic standing in terms of the studied aspects is also exhibited within the Katowice, Wałbrzych, Bytom, Tychy, Bełchatów and Eastern Wielkopolska regions. The worst economic situation is encountered in the Zgorzelec region, while the Sosnowiec, Gliwice, Rybnik and Western Małopolska regions recorded an average severity of economic issues.

Table 9. Economic portfolio of Poland's coal regions – number of business entities *versus* business entity number dynamics – first portfolio

Business entity number dynamics	Low (approx. 100 and less)	Sosnowiec		Zgorzelec
	Average (101 to approx. 107)	Wałbrzych, Katowice	Gliwice, Rybnik, Western Małopolska	
	High (above 107)	Bielsko-Biała, Lublin	Bytom, Tychy, Bełchatów, Eastern Wielkopolska	
		High (75 thous. and more)	Average (30 thous. to 75 thous.)	Low (below 30 thous.)
		Number of business entities		

Designations:

	Very high intensity of issues and challenges within a given context (5)
	High intensity of issues and challenges within a given context (4)
	Average intensity of issues and challenges within a given context (3)
	Low intensity of issues and challenges within a given context (2)
	Negligible intensity of issues and challenges within a given context (1)

Source: own study.

The good economic diversity in Poland's coal regions is also made visible through applying the second portfolio approach, which takes into account the total number of employed in the region and the number of employed in the mining sector (cf. Table 10). A high severity with regard to economic issues, primarily associated with a significant mining sector employment scale, is readily seen within the Tychy region. In turn, the Katowice, Rybnik, Gliwice, Zgorzelec and Eastern Wielkopolska regions experience an average scale of this phenomenon.

A low severity of economic complication related to employment in the mining industry, relative to the number of total employees, can be seen in the coal regions of Lublin, Wałbrzych, Bytom, Bełchatów and Western Małopolska. Regarding this, the following must be considered: the complete closure of mines in Wałbrzych and a significant reduction of jobs in the 1990s in Bytom and Western Małopolska and their strong dependence on jobs in related and conventional power generation (Bełchatów) sectors.

A minor severity of economic problems associated with the scale of mining sector employment as compared to the total number of employees is recorded in the Bielsko-Biała and Sosnowiec regions. These are places where the mining industry no longer plays an important role within their economies.

Table 10. Economic portfolio of Poland's coal regions – total number of employed *versus* number of employed in mining – second portfolio

Employment in mining	High (above 15 thous.)	Katowice, Rybnik	Tychy	
	Average (5-15 thous.)	Lublin	Gliwice, Eastern Wielkopolska	
	Low (below 5 thous.)	Bielsko-Biała, Sosnowiec	Wałbrzych, Bytom, Bełchatów, Western Małopolska	Zgorzelec
		High (200+ thous.)	Average (100 thous. to 200 thous.)	Low (below 100 thous.)
		Number of employees		

Designations:

	Very high intensity of issues and challenges within a given context (5)
	High intensity of issues and challenges within a given context (4)
	Average intensity of issues and challenges within a given context (3)
	Low intensity of issues and challenges within a given context (2)
	Negligible intensity of issues and challenges within a given context (1)

Source: own study.

Industry links of the mining and conventional power generation sectors in Polish coal regions – value chains

Adam Drobniak, Klaudia Plac, Marcin Baron

The decomposition of the coal, conventional power generation and mining-related industries was achieved using the value chain concept [STRATEGOR, 1995; Porter, 2001; Klasik, 2011; Dziemianowicz, Szlachta, 2016]. The value chain concept was adapted for the purposes of the study by distinguishing the individual links corresponding to the process of coal mining, combustion and processing, i.e., in accordance with the traditional industry technological sequences. The outline process involves only the activities that are directly related, to coal mining, combustion and processing, i.e., key industries with connection to hard coal (and lignite) mining, conventional power generation, coal-related chemical industry, along with metallurgy. This made it possible to highlight the most relevant industries for which coal (or a post-coal-processing product) is a primary resource or one of the key resources enabling business activity and gaining competitive leverage.

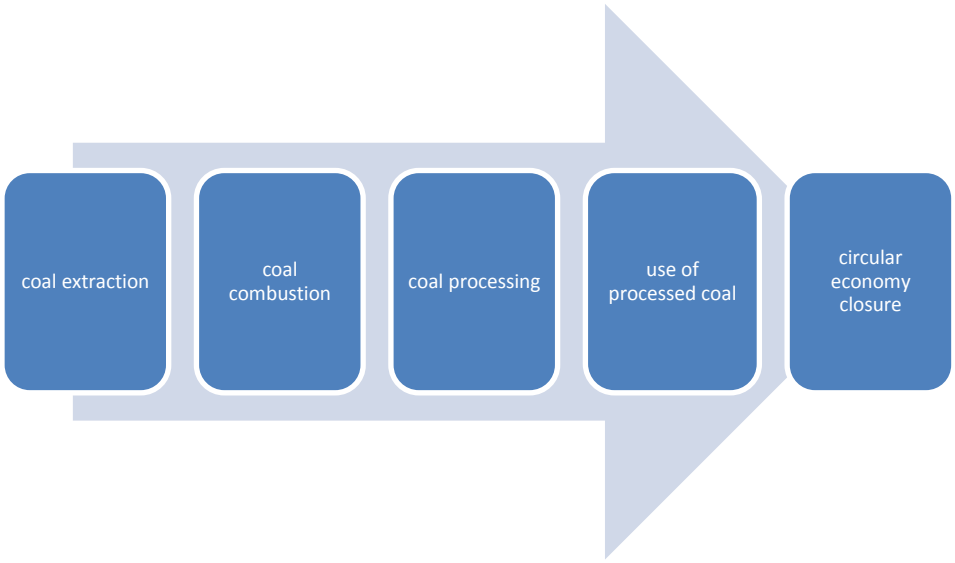

Figure 6. Value chain diagram for the coal industry and related industries

Source: own study.

The proposed solution in terms of the mining industry, conventional power and mining-related activity value chain should be considered as an approximation of the correlations occurring between the studied industries. It does not include, among others, section F 'Construction', due to the limited possibility of distinguishing construction activities strictly related to the mining, metallurgical and conventional power generation industries. The same was done for section H 'Transportation', the PKD (Polish Classification of Activity) sections and subsections of which do not have direct references to the studied industries.

The multiplying effect of mining, conventional power generation and industries directly dependent on coal on Section I 'Accommodation and food service activities' was also not taken into account, due to the limited possibilities of separating from the PKD classification. For identical reasons related to the inability to clearly define the links with mining and conventional power generation in creating the value chain, selected business activities related to section M 'Professional, scientific and technical activities (including architectural and engineering activities, technical research and analysis, scientific research and development in other natural and technical sciences, specialized design activities)' were not taken into account.

The possible inclusion of the aforementioned additional business activities in relation to the available statistical information exposes the conducted study to a high degree of inaccuracy and a probable overestimation of the scale of the studied value chains for the mining and mining-related sectors. Nevertheless, it should be emphasized that the correlations between the mining or conventional

power generation sectors and transport activities or construction exist and are of great economic importance, particularly in coal regions. Table 11 shows a detailed decomposition of the analysed value chain, highlighting various PKD codes.

Table 11. Value chain for the coal industry, conventional power generation, related chemical industries and mining-related sectors

Chain link	Activity by PKD codes
Link I. Coal extraction	05.10.Z – Mining of hard coal. 05.20.Z – Mining of brown coal (lignite). 09.09.Z – Service activities supporting other mining and quarrying. 09.90.Z – Test drilling within coal prospecting and service activities supporting hard coal mining. 28.92.Z – Manufacturing of machinery for mining, quarrying and construction. 43.12.Z – Coal mining site preparation. 46.64.Z – Wholesale marketing of machinery for the mining, construction and civil engineering industries
Link II. Coal combustion – conventional power generation	35.11.Z – Electricity production. 35.12.Z – Electricity transmission. 35.13.Z – Electricity distribution. 35.14.Z – Electricity trading. 35.30.Z – Production and supply of steam, hot water and air for air-conditioning systems. 42.22.Z – Work associated with the construction of telecommunications and power lines. 27.1 – Manufacturing of electric motors, generators, transformers, and electricity switchgear and controlgear (including: 27.11.Z / 27.12.Z). 28.11.Z – Manufacturing of engines and turbines (excluding aviation, automotive and motorcycle engines). 28.21.Z – Manufacturing of furnaces, furnace heaths and furnace burners
Link III. Processing of coal and its combustion products. Coal-based chemical industry	19.10.Z – Production and processing of coke/coke furnace operation. 19.20.Z – Production of hard coal briquettes. 20.11.Z – Production of technical gases. 20.12.Z – Production of dyes and pigments. 20.14.Z – Production of other basic organic chemicals. 23.52.Z – Production of lime and gypsum. 23.62.Z – Production of gypsum construction products
Link IV. Use of processed coal – metallurgy and metallurgical industry	24.10.Z – Manufacturing of pig iron, ferroalloys, cast iron and steel (…). 24.20.Z – Manufacturing of pipes, conduits, sections (…). 24.31.Z / 24.32.Z / 24.33.Z / 24.34.Z – Manufacturing of other steel products. 24.42.A/B – Manufacturing of metallurgical aluminium/aluminium products. 24.43.Z – Manufacturing of lead, zinc and tin. 24.5 – Metal casting (including 24.51.Z / 24.52.Z. / 24.53.Z). 25 – Manufacturing of finished metal products (entire section). 28.41.Z – Manufacturing of metalworking machinery. 29.91.Z – Manufacturing of machinery for metallurgy. 46.72.Z – Wholesale of metals and metal ores. 46.74.Z – Wholesale of metal products, and hydraulic and heating equipment and accessories
Link V. Activities related to value chain closure – "cleaning up" after mining, chemical industry, metallurgy and smelting	38.22.Z – Processing and disposal of hazardous waste. 39.00.Z – Activity related to reclamation and other service activities related to waste management. 46.77.Z – Wholesale of waste and scrap

Source: own study.

Given the proposed methodology for analysing the value chain for the mining and mining-related industries associated with coal extraction, processing and utilization, it should be noted that most business entities involved in this type of activity are located in the coal regions of the Śląskie province (more than 15 500 entities), i.e., 28.5% of the total entities included in the value chain for all coal regions (cf. Table 12 and Figure 7).

Table 12. Number of business entities by individual value chain links broken down into provinces with coal regions

Category	Coal regions in the province:					
	Dolnośląskie	**Lubelskie**	**Łódzkie**	**Małopolskie**	**Śląskie**	**Wielkopolskie**
Link I	887	481	588	1 305	1 265	740
Link II	1 562	683	837	1 148	1 532	1 742
Link III	87	40	74	81	161	123
Link IV	5 476	2 412	3 474	6 649	11 239	8 309
Link V	625	208	366	495	1 370	620
Total: value chain links	8 637	3 824	5 339	9 678	15 567	11 534
Share of coal regions by provinces	**15.8%**	**7.0%**	**9.8%**	**17.7%**	**28.5%**	**21.1%**

Source: own study based on REGON data.

Chains of the mining sector and related industries are also very extensive within Eastern Wielkopolska (21.1% of the total number of analysed business entities found in all of Poland's coal regions), Western Małopolska (17.7% of the total number of analysed business entities found in all coal regions within Poland) and the coal regions of the Dolnośląskie province (15.8% of the total number of analysed business entities found in all of Poland's coal regions).

In the case of all of the analysed coal regions, **the fourth (IV) value chain link related to the use of processed coal** is the most represented in terms of the number of business entities (37.6 thous.). This includes activities related to: production of pig iron, ferroalloys, cast iron and steel; production of tubes, pipes, sections; production of other steel products; production of metallurgical aluminium or aluminium products; production of lead, zinc and tin; metal casting; production of fabricated metal products; production of metalworking machinery; production of machinery for metallurgy; wholesale marketing of metals and

metal ores; wholesale marketing of metal products and hydraulic and heating equipment and accessories. The most numerous sectors within these industries are related to the production of finished metal products. A high number of business entities was also registered for such production fields as the manufacture of metal structures and their elements, metalworking and metal coating, and wholesale marketing of metal products and hydraulic and heating equipment and accessories.

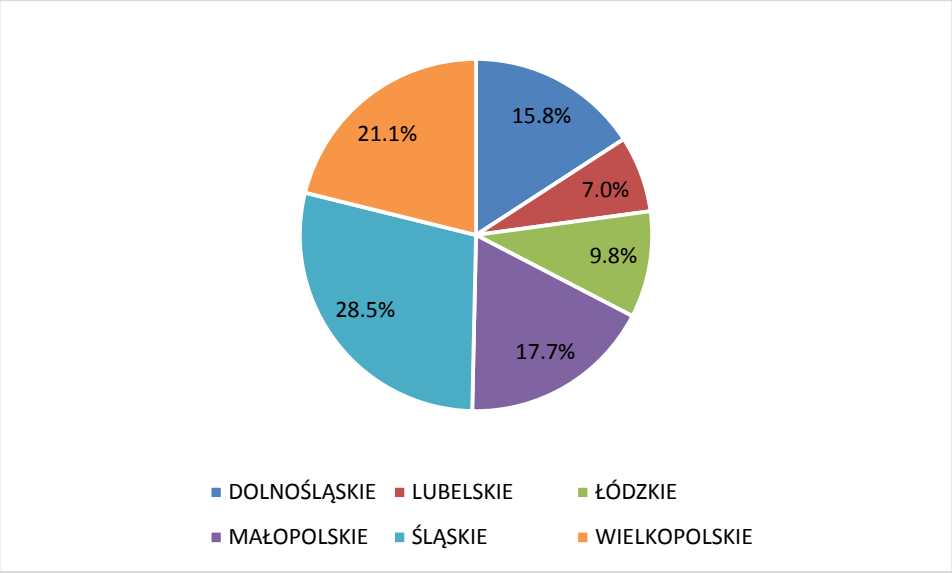

Figure 7. Number of business entities by individual value chain links broken down to provinces with coal regions

Source: own study based on REGON data.

A high number of business entities (7 500) within the studied value chain was also recorded for **link II: coal combustion – conventional power**. It involves such activities as electricity generation; electricity transmission; electricity distribution; electricity trading; generation and supply of steam, hot water and air for air-conditioning systems; work associated with the construction of telecommunications and electric power lines; manufacture of electric motors, generators, transformers, electricity distribution and control apparatus; manufacture of engines and turbines (excluding aviation, automotive and motorcycle engines); manufacture of furnaces, furnace heaths and furnace burners. The most numerous branch represented within cell II in terms of the number of business entities is electricity generation. During the period of study, a very high number of business entities was recorded by the industry 'Work associated with the construc-

tion of telecommunications and power lines'. It was followed by the manufacture of electricity switchgear and controlgear.

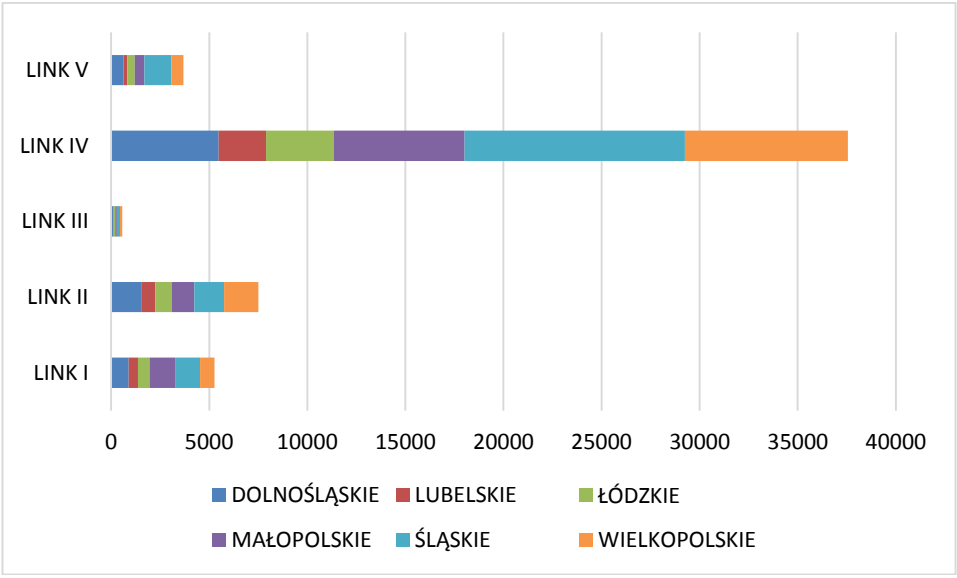

Figure 8. Mining sector value chain numbers by individual coal region provinces

Source: own study based on REGON data.

The third most numerous link in terms of the number of businesses is **link I: coal mining** (5.3 thous. businesses), which comprises such activities as mining of hard coal and lignite; service activities supporting other mining and quarrying; test drilling within coal prospecting and service activities supporting hard coal mining; manufacturing of machinery for mining, quarrying and construction; coal mining site preparation; wholesale marketing of machinery for the mining, construction and civil engineering industries. Coal mining site preparation is the major mining-related business activity. This is followed by activities related to test drilling within coal prospecting and service activities supporting hard coal mining. There are also numerous entities operating in the sectors of manufacturing of machinery for mining, quarrying and construction, and wholesale marketing of machinery used in mining.

In terms of individual coal regions, the largest number of business entities with connection to the mining and mining-related sectors is located within the Katowice subregion (2 526 business entities), but their share in the total number of business entities does not exceed 3%. An almost identical number of entities in the mining and related activities sector (2 521) is found in the Sosnowiec subregion, although their share in the total number of business entities significantly

exceeds 3% (i.e., 3.6%). Such a high share of mining and mining-related entities is also found in the Bytom subregion (3.6%). Moreover, a high number of coal--related business entities in the analysed value chain is also exhibited by the Bielsko-Biała (2 399 entities with a share of 3.0%) and Wałbrzych (2 078 entities with a share of 2.7%) subregions – cf. Table 13.

Table 13. Number of entities associated with mining and related activities in individual coal subregions

Coal region	Value chain links						Total number of business entities within each coal region	Share of mining and mining-related value chain in the total number of business entities
	I	II	III	IV	V	Total		
Wałbrzych	234	207	14	1 498	125	2 078	75 748	2.7%
Zgorzelec	26	118	4	74	15	237	8 713	2.7%
Bielsko-Biała	218	219	11	1 806	145	2 399	79 831	3.0%
Bytom	148	147	12	1 142	151	1 600	44 328	3.6%
Gliwice	95	139	14	1 048	139	1,435	51 306	2.8%
Katowice	199	364	44	1 618	301	2 526	88 295	2.9%
Rybnik	156	131	15	1 154	81	1 537	51 796	3.0%
Sosnowiec	189	209	25	1 801	297	2 521	70 942	3.6%
Tychy	128	132	13	1 064	80	1 417	44 104	3.2%
Lublin	154	150	7	630	42	983	76 051	1.3%
Bełchatów	83	123	14	832	73	1 125	44 505	2.5%
Western Małopolska	245	110	22	1 250	117	1 744	57 358	3.0%
Eastern Wielkopolska	83	151	12	824	74	1 144	65 865	1.7%

Source: own study based on REGON data.

The structure of the value chains in each coal region is quite similar, i.e., **link IV related to the use of processed coal** in most of them, ranging from metallurgy, metalworking and construction to metal products, turns out to be the most developed in terms of numbers. The share of this link ranges from 64% to 75% of the total number of businesses analysed in each coal region. The exception is the Zgorzelec region, where the dominant is **link II: coal combustion – conventional power generation**, which comprises 50% of the total number of business entities in the value chain of mining and related industries. In turn, this link ranks second in terms of the number of business entities in almost all (except the Bytom region) of the other coal regions. In these, the share of entities involved in energy-related activities ranges from 9% to 15%.

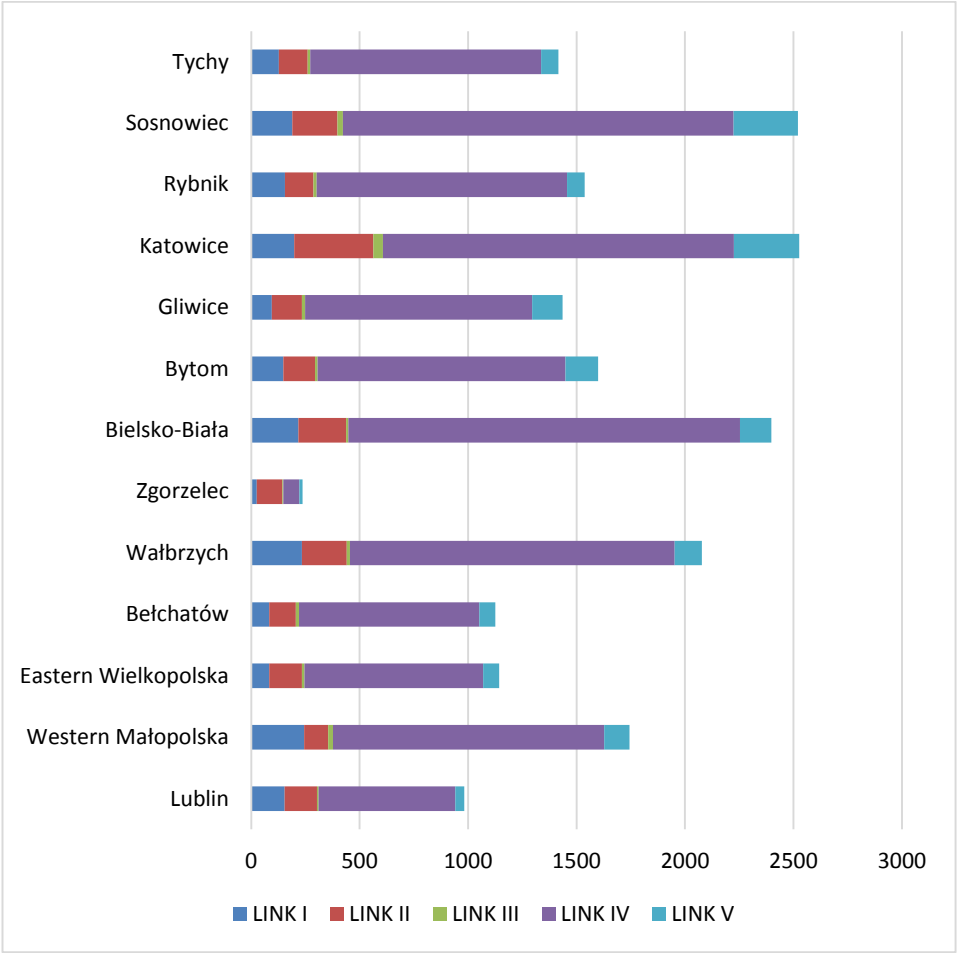

Figure 9. Number of entities associated with mining and related activities that create value chains within the individual coal regions

Source: own study based on REGON data.

In the Bytom region, however, the second most numerous value chain link represented by business entities is **link V**, which includes **activities related to post mining, metallurgical and chemical industry value chain closure**, i.e., processing and disposal of hazardous waste, activity related to reclamation, and other service activities related to waste management, as well as wholesale marketing of waste and scrap (a high share of these sectors is also registered in the Gliwice region).

Link I related to coal mining covers 7% to 16% of all entities within the value chain of mining and related activities. Its largest share (as measured with the applied methodology) is recorded in the Lublin region (16%), and the small-

est (7%) in the Gliwice, Sosnowiec and Bełchatów regions. The results of the study showing the relatively high number of link I entities related to coal mining in the Wałbrzych region are also interesting in cognitive terms. Their share in the value chain 11%. This is particularly notable in the light of the fact that the activities strictly related to coal mining in mid-1990s were completely phased-out in the region. However, a detailed analysis of the REGON (Business Registry No.) section indicates that the Wałbrzych coal region is still home to companies related to coal mining site preparation (204 entities), the manufacture of machinery for mining and quarrying (16 entities) and service activities supporting other mining and quarrying activities (10 entities).

4. Institutional context

Wałbrzych subregion – Dolnośląskie province

Stanisław Korenik, Dorota Rynio, Alicja Zakrzewska-Półtorak, Piotr Hajduga, Alicja Kozak

In terms of the potential of business environment institutions (BEIs), the Wałbrzych subregion shows an average level of development with regard to universities, research and development centres and BEIs related to, among others, industrial parks and business incubators. The institutional situation in the Wałbrzych subregion is shaped by 13 entities based herein, which coordinate the operation of clusters. They are primarily located in Wałbrzych and Świdnica, as well as Nowa Ruda, Strzegom, Szczawno-Zdrój, Krzyżowa and Bystrzyca Kłodzka. The distribution of BEIs throughout the Wałbrzych subregion (excluding scientific and research institutions), i.e., chambers of commerce, associations, business incubators, technology and industrial parks, centres for technology transfer, consulting centres, financial institutions and development agencies, is uneven. The Wałbrzych subregion is home to, among others, the Lower Silesian Technology Park "T-Park", Nowa Ruda Industrial Park (Nowa Ruda Business Incubator, Nowa Ruda Industrial and Technological Park, "Nowa Ruda" Techno-incubator), Dzierżoniów Industrial Park, Świdnica Industrial Park, Świebodzice Industrial Park and Wałbrzych Industrial Park.

In terms of supporting entrepreneurship, an important part is played by, among others, the Sudety Business Incubator, Wałbrzych Business Incubator, Wałbrzych Regional Fund, "Wałbrzych 2000" Foundation, the Lower Silesian Social Economy Support Centre, Sudety Association of Economic Initiatives,

Sudety Chamber of Industry and Commerce, "Wolna Przedsiębiorczość − *Free Entrepreneurship*" Association, Association of Entrepreneurs and Merchants of Świdnica, Innovation Centre by the Świdnica Council of the Federation of Scientific and Technical Associations of the Central Technical Organization, Guild of Miscellaneous Crafts and Small Entrepreneurship, and the "AGROREG" S.A. Agency for Regional Development in Nowa Ruda, as well as professional and economic self-government organizations, such as the Lower Silesian Employers [Wałbrzych City Hall, 2018, p. 14]. Institutions related to research and development activities also include: The "Free Enterprise" Association, the activity scope of which is declared to provide support for R&D projects related to innovative technologies, and the Wałbrzych Energy Cluster, which operates as a cooperative of local government units, research and development units, entrepreneurs and institutions supporting the development of renewable energy sources and promoting environmental protection ideas.

There are two public universities located in the Wałbrzych subregion, both located in Wałbrzych (the Angelus Silesius State University, which had previously operated as the Angelus Silesius State Higher Vocational School, and a branch of the Wrocław University of Technology – the Faculty of Technology and Engineering). There are also five non-public universities in the subregion (two of which are branches and one is an off-site teaching centre). These are located in Wałbrzych (the Higher School of Management and Entrepreneurship), Świdnica (one branch, one off-site centre and the Higher Theological Seminary of the Świdnica Diocese) and Kłodzko (the Higher School of Medicine and a branch of the "Edukacja" Higher School of Management). Higher education institutions in the Wałbrzych sub-region primarily provide education in the humanities and social sciences, with only some providing courses on technical and science subjects. In conclusion: the potential of BEIs in the Wałbrzych subregion is average, while the level of dominance of traditional industries is relatively low.

Zgorzelec district – Dolnośląskie province

Stanisław Korenik, Dorota Rynio, Alicja Zakrzewska-Półtorak, Piotr Hajduga, Alicja Kozak

Compared to other coal regions, the Zgorzelec district is characterized by having low BEI potential (as considered through the locations of universities, scientific and research units, science and technology parks or industrial parks).

The basis for the development of coal regions is the level of intellectual capital, which is an important criterion for the selection of investment sites, high-tech investments in particular. The Zgorzelec district is characterized by good accessibility to education (up to the secondary level); however, the efficiency of education and its quality are relatively low, which translates to a low level of intellectual capital, and consequently affects innovation and the presence of such entities as research centres, technology parks, business incubators and universities. The primary institution in this field within the district is the ZKlaster (Zgorzelec Renewable Energy Development and Energy Efficiency Cluster).

Compared to the national average, residents of the Zgorzelec district have a lower level of education [Polska w liczbach – *Poland in Numbers*, n.d.]. This is due to, among other issues, the small higher education offer in the district. The district is home to: The Regional Education Centre of the Higher School of Economy in Zgorzelec, and the TWP Higher School of Humanities in Szczecin – Branch in Zgorzelec. Summing up, the potential of BEIs in the Zgorzelec district is low, while the level of dominance of traditional industries is relatively high.

Lublin subregion – Lubelskie province

Wojciech Janicki, Grzegorz Iwanicki, Andrzej Jakubowski

The Lublin subregion is a coal region characterized by a well-developed (given the proximity of Lublin, which, however, is not part of the Lublin coal region, but is nevertheless located in its central part) institutional potential in terms of higher education, scientific and research institutes and business environment institutions. Crucial in this regard is the activity of nine higher education institutions located not in the coal region itself, but in its immediate vicinity, i.e., in Lublin (including the Maria Curie-Skłodowska University, the John Paul II Catholic University of Lublin, the University of Life Sciences, Lublin University of Technology and the Medical University). The varying profile of the universities ensures a diversified teaching curriculum and a wide range of ongoing scientific research. Taking into account the presence of two universities (the so-called *non-adjectival* – classic universities), it should be noted that the offer of the academic centre's higher education institutions contains numerous faculties of social and humanities profile, although the portfolio of technical majors is constantly expanding. Courses of a medical and agricultural profile are very significant due to the activities of the two so-called *adjectival* – specialized universities, i.e., the Medical University and the University of Life Sciences. In

addition to the universities, there are also two research institutes operating within the subregion (in Lublin) (Bohdan Dobrzański Institute of Agrophysics of the Polish Academy of Sciences and the Witold Chodźko Institute of Rural Medicine), as well as ECOTECH-COMPLEX serving as an Analytical and Program Centre for Advanced Environmentally Friendly Technologies.

The relatively numerous BEIs provide extensive support for the development of entrepreneurship. There are 15 entities of this kind in the subregion (12 in Lublin), including two subzones of the EURO-PARK MIELEC Special Economic Zone – the Lublin Subzone and the Lubartów Subzone, the Economic Activity Zone (SAG) in Świdnik, the Lublin Science and Technology Park in Lublin and the "Świdnik" Regional Industrial Park, as well as several business incubators.

Bielsko-Biała subregion – Śląskie province

Radosław Cyran, Piotr Rykała

The Bielo subregion has an institutional potential well-developed in terms of universities, research and development centres and other BEIs. Teaching and scientific/research activities are conducted by 11 universities, eight of which are located in Bielsko-Biała, two in Cieszyn and one in Żywiec. Bielsko-Biała is home to the Instytut Badań i Rozwoju Motoryzacji BOSMAL Sp. z o.o. (*Institute of Automotive Research and Development*) and TRW Steering Systems Poland Sp. z o.o., which received funding to implement an investment project entitled *Expansion design for the research & development centre in Bielsko-Biała* under the *Programme for Supporting Investment of Strategic Importance for the Polish Economy* [Council of Ministers, 2019].

The following entities also operate within the Bielsko-Biała subregion: Bielsko-Biała Technology Park for Aviation, Entrepreneurship and Innovation; Bielsko-Biała Industrial and Service Park; Entrepreneurship Incubator; Academic Entrepreneurship Incubator; Agencja Rozwoju Regionalnego S.A. (*Regional Development Agency*) in Bielsko-Biała, Czechowice-Dziedzice, Radziechowy-Wieprz, Rajcza, Węgierska Górka; and the Jastrzębie-Żory Subzone of the Katowice Special Economic Zone.

Bytom subregion – Śląskie province

Małgorzata Czornik, Paulina Badura

Although the Bytom subregion is dominated by traditional industry, it is also a rather important location for research and scientific centres, in the field of medicine in particular. Bytom has the greatest potential in this regard, with its Specialist Hospital No. 2 running the Departments of the Medical University of Silesia and making its wards available to the students of the University of Silesia (majoring in medical physics). In addition, Bytom is home to two more facilities of the Medical University of Silesia (*Academic Centre for Dentistry and Specialized Medicine*, and a branch of the MUS), as well as a branch of the Research and Development Centre of the Polish-Japanese Academy of Information Technology that is unique on the domestic scale and one of the few in Europe. In addition, one of the four faculties of the University of Management and Administration in Opole is located in Tarnowskie Góry, while a faculty of the Częstochowa University of Technology is located in Lubliniec.

In terms of BEI presence, the subregion is characterized by a moderate potential, mainly due to its weakened, post-industrial economic structure. Bytom again plays a dominant role when it comes to existing institutions, with as many as 6 of the 10 business environment institutions located in this coal region. These are primarily development agencies − industrial parks or zones related to economic activity (Chamber of Industry and Commerce, Business Incubator, Industrial and Technological Park, Ożarów Economic Activity Zone). The Special Revitalization Zone, which is important for areas related to the mining industry, operates in Bytom.

Gliwice subregion – Śląskie province

Marek Magdoń, Jakub Miracki

The institutional potential of the Gliwice subregion, measured by the number of entities active in the R&D sector, universities and other BEIs, has to be defined as high. Only the potential of the Bielsko-Biała and Katowice subregions can be assessed at the same level among the coal regions within Poland. The Gliwice subregion is home to the faculties of four universities – two public (Silesian University of Technology and the Medical University of Silesia) and

two non-public (the Higher School of Security and the Higher School of Technology). All are located in Gliwice and Zabrze. In addition, the subregion has science and technology parks and clusters (including, among others, Silesian Medical Technology Park, the Incubation and Technology Transfer Centre of the Silesian University of Technology and the Industrial Culture and Tourism Cluster), operating in such fields as industrial culture and tourism, technologies, medical devices and products.

There are 17 R&D centres operating within the Gliwice subregion (16 in Gliwice and Zabrze, one in Sośnicowice), which include such entities as the: Institute of Welding, Centre for Polymer and Carbon Materials of the Polish Academy of Sciences, Institute of Mining Technology "KOMAG", Ośrodek Badawczo-Rozwojowy Urządzeń Mechanicznych "OBRUM" Sp. z o.o. (*Research and Development Centre for Mechanical Devices*), Zbigniew Religa Foundation for Cardiac Surgery Development, and the M. Skłodowska-Curie National Institute of Oncology.

Katowice subregion – Śląskie province

Adam Drobniak, Piotr Rykała

Compared to other coal regions within Poland, the Katowice subregion has the best-developed institutional potential in terms of universities, R&D centres and other BEIs related to, among others, science and technology parks, industrial parks or business incubators. The Katowice subregion is home to nine R&D institutions (including, among others, the Central Mining Institute, EMAG, Institute for Ecology of Industrial Areas) and several science and technology parks (including, among others, the "EURO-Centrum" Science and Technology Park, Upper Silesian Industrial Park, "Porcelana Śląska" Industrial Park) specializing in passive construction and design.

The key asset in terms of institutional facilities related to the education of human resources and the creation of new value chains within the subregion are 21 universities, most of which are located in Katowice (including the University of Silesia, the University of Economics, the Medical University of Silesia, the Academy of Fine Arts, the Academy of Music, the Academy of Physical Education, the Silesian University of Technology, among others). Higher education institutions (or their branches) are also located in Chorzów, Mysłowice and Ruda Śląska.

Rybnik subregion – Śląskie province

Florian Kuźnik, Artur Ochojski

When analysing and evaluating the institutional capacity, especially in terms of BEIs, it should be considered as reaching an average level. Business environment entities are represented by the well-functioning Jastrzębie-Żory KSEZ Subzone. This form of support is complemented by local entities offering access to administrative and office premises and training services. These include industrial parks, business centres, chambers, craft guilds and a development agency.

However, support for business processes requires access to knowledge transfer and training centres. In the case of the Rybnik subregion, this process is made possible by the location of the subregion's cities within the coverage zone of the universities and research & development units located in the Upper Silesian agglomeration (Katowice, Gliwice, Sosnowiec, Zabrze). Only branches of universities operate in the subregion, including a branch of the University of Economics in Katowice.

Sosnowiec subregion – Śląskie province

Adam Drobniak, Piotr Rykała, Jakub Miracki

The Sosnowiec subregion has an institutional potential well-developed in terms of universities, research and development centres, and other business environment institutions. Teaching and research activities in the subregion are conducted by eight universities. These are located in Sosnowiec (5), Dąbrowa Górnicza (2) and Jaworzno (1). In addition, the Silesian Branch of the State Geological Institute operates in Sosnowiec.

The activities of other BEIs in the Sosnowiec subregion are implemented by nine entities, which offer support in the areas of administrative and office services, premises for rent, training and consulting. These are: Jaworzno Industrial Park, Sosnowiec Science and Technology Park, Zawiercie Industrial and Technology Park, Agencja Rozwoju Lokalnego S.A. in Sosnowiec, Zagłębie Business Incubator, Będzin Business Incubator, Dąbrowski Business Incubator, Silesian Design Cluster and Silesian NANO Cluster.

Tychy subregion – Śląskie province

Florian Kuźnik, Artur Ochojski

Similarly to the Rybnik subregion, Tychy subregion also relies mainly on the availability of the academic portfolio and knowledge transfer support made possible by the immediate vicinity and sphere of influence of universities and R&D units located in the Upper Silesian agglomeration (Katowice, Gliwice, Sosnowiec, Zabrze). Entities offering research for the mining industry and environmental and agricultural analysis have developed here based on sectoral competences.

The Tychy KSEZ Subzone and the District Chamber of Industry and Commerce have remained important BEI entities in the Tychy subregion for years. While the former generates new investment areas and provides investor-related services, the latter serves as an entity that integrates local and regional companies, including municipal enterprises. Beyond these, new business environment entities have been established in the subregion. They include the Modern IT and Graphic Design Technology Park, which provides office and training space, as well as incubation support for small- and medium-sized companies.

Bełchatów Transition Area – Łódzkie province

Aleksandra Nowakowska, Agnieszka Rzeńca

The network of business environment institutions is an underdeveloped link within the economic system of the Bełchatów area. On one hand, the vast majority of innovation and entrepreneurship centres have been operating for many years and are well recognized within the local environment, while on the other, these institutions are of local or sub-regional nature and do not create a significant development stimulus for the entire mining and energy basin. Gaps and weaknesses in business networking relationships and poor organization of the local economic fabric are evident. Nevertheless, the role of the Bełchatów-Kleszczów Industrial and Technological Park (a leading institution with a well-established position within the regional milieu, and operating since 2004), as well as the Kleszczów Municipality Development Foundation should be emphasized.

There are no independent universities within in the Bełchatów area, only branches/local offices of universities located elsewhere. These schools (except for the Jan Kochanowski University in Kielce) are part of the private university sector. The academic potential of this area is concentrated in two cities, i.e., Piotrków Trybunalski and Bełchatów.

Western Małopolska – Małopolskie province

Krzysztof Gwosdz, Sławomir Sitek, Krzysztof Wiedermann

The Małopolskie province offers significant academic potential. It is home to 39 higher education institutions, which makes it a domestic leader. However, the only higher education institution within the Oświęcim subregion is the Cavalry Captain Witold Pilecki State University of Małopolska in Oświęcim. It was established in 2005 at the initiative of the local government authorities of the Oświęcim district, the city of Oświęcim and the Małopolska province. It offers education in fields important to an innovative and green economy, i.e., computer science, mechatronics and production management and engineering. The educational potential is supplemented in Olkusz by a branch institution of a non-public university, representing the Holding of Higher Schools of Banking.

Currently, there is not a single entity with a research and development centre status operating within the subregion. The largest innovative R&D potential is concentrated around large manufacturing companies, i.e., Synthos, Kęty Group and Maspex. The Centre for Sustainable Development and Energy Conservation, however, is located in the Kraków district, in close proximity to the subregion. It co-creates an infrastructural network as part of the smart specializations of the Małopolska region.

The relatively weak R&D base in the subregion is compensated for by the good spatial accessibility of science and innovation centres located in Kraków, GZM, and, to a lesser extent, in Bielsko-Biała.

Eastern Wielkopolska – Wielkopolskie province

Paweł Churski, Robert Perdał, Martyna Burchardt

Compared to other coal regions in Poland, the Konin subregion is characterized by an average potential with regard to business environment institutions, combined with an excessive degree of specialization and a high level of tradi-

tional sector dominance. There are, however, 17 institutions that provide institutional support to the business environment in the Konin subregion. Most of these are located in Konin (6), and in Turek and Września (3 each). Supporting these types of institutions is intended to ultimately lead to economic activation and improvement in the investment attractiveness of Konin subregion's municipalities and districts. These activities are primarily focused on developing the entrepreneurship and investment services (e.g., Economic Activity Zone in Września, Entrepreneurship Incubator in Turek, Konin Chamber of Commerce, Agencja Rozwoju Regionalnego S.A. in Konin), career counselling and training for adults and youth (e.g., Centre for Research and Development of Modern Technologies in Grzymysławice, Agencja Rozwoju Regionalnego S.A. in Konin, Craft Guilds), financial counselling and intermediation (e.g., Agencja Rozwoju Regionalnego S.A. in Konin, Konin Chamber of Commerce, Turek Chamber of Commerce, Regional Development Agency in Gniezno). The business environment institutions in Turek exhibit a relatively high activity level. For example, there are more than 30 entities within the Turek Business Incubator, and nearly 140 entities from Turek and the surrounding area are affiliated under the Turek Chamber of Commerce. In addition, it should be mentioned that seven entities operate in the Września district under the institutional support of the Wałbrzych SEZ ("Invest-Park"). In turn, there are two entities each in Turek and Przykona (Turek district), and investment areas have been created in Koło, Turek and the Przykona commune in Turek district under the institutional support of the Łódź Special Economic Zone.

R&D units located within the Konin subregion exhibit a clear correlation with the subregion's economic profile. There are two energy clusters in Konin and Turek, but they are focused on RES, a field that is intended to provide an alternative to lignite-based energy generation. In addition, there are two R&D entities in Turek related to microbial technology, which is associated with the development of the bioeconomy, reinforcing the agricultural production potential and improving food quality. These entities provide significant support for Wielkopolska's well-developed agri-food production and processing sector.

There are six higher education institutions within the Konin subregion. They include three public schools: two state vocational schools in Gniezno and Konin, and a branch of the Adam Mickiewicz University in Poznań – in Gniezno. There is also the Higher Theological Seminary in Ląd, which is a Catholic college. The remaining higher education institutions are non-public and are located in Konin and Gniezno. The higher education institutions of the Konin subregion conduct courses in the humanities and social sciences (including pedagogy, economics, management, administration and philology), health sciences

(including nursing, midwifery and physiotherapy), as well as technical sciences (including computer science, production management and engineering, transportation, logistics and energy). The Konin subregion is located in the draw zone of large academic centres such as Poznań, Łódź, Toruń and Bydgoszcz, which, due to the relatively close distances, provide an alternative and highly diversified higher education base. The profile of the subregion's universities and the close proximity of large academic centres consequently ensure a diversified educational offer, which remains relatively weakly linked to the economic profile of the region. Contrary to appearances, this situation can be a positive condition and may advantageously stimulate the development of new industries related to manufacturing and services.

Institutional context summary

Adam Drobniak

Individual coal regions exhibit very different institutional potentials as analysed primarily in the context of BEIs associated with universities, R&D institutions, and business support infrastructure such as science, technology and industrial parks (cf. Table 14). The development level of institutional facilities, assessed in conjunction with the type of a given region's economic structure enable inferring the potential adaptability of the coal regions of Poland with regard to just and energy transition.

Coal regions with a developed institutional base and a diversified economic structure are in a better starting position in terms of implementing changes, including technological amendments related to decarbonization and transition towards a non-carbon economy. Such regions include Bielsko-Biała, Gliwice and Katowice.

Coal regions characterized by specialization related to traditional industries and a weak institutional potential are in a much worse initial situation with regard to the planned transformation processes. Examples of such regions are Zgorzelec and Bełchatów.

Table 14. Basic information on the institutional context of Poland's coal regions relative to the dominance level of traditional industries and economic structure type

Coal regions	Traditional industry dominance level	Economic structure type	Potential of business environment institutions (universities, R&D, science and technology parks, industrial parks)
Wałbrzych	Low	Weakened post-industrial	Average
Zgorzelec	High	Over-specialization	Low
Bielsko-Biała	Low	Mix of industries and services	High
Bytom	High	Weakened post-industrial	Average
Gliwice	Low	Mix of industries and services	High
Katowice	Low	Mix of industries and services	High
Rybnik	High	Over-specialization	Average
Sosnowiec	Low	Mix of industries and services	Average
Tychy	Average	Balanced	Average
Lublin	High	Over-specialization	Average
Bełchatów	High	Over-specialization	Low
Western Małopolska	Low	Mix of industries and services	Average
Eastern Wielkopolska	High	Over-specialization	Average

Source: own study.

The aforementioned relationships are confirmed by the portfolio analysis related to the potential of business environment institutions and the level of dominance of traditional industries (cf. Table 15). The most difficult situation in the context of the potential transition applies to regions with a relatively low institutional potential and a high level of dominance of traditional industries in the field of mining, conventional power generation and related industries, i.e., the Bełchatów and Zgorzelec regions. Still, serious transition-related issues in the context of institutional development level in relation to the existing economic structure are encountered in the regions of Bytom, Rybnik, Lublin and Eastern Wielkopolska (nevertheless, due to their proximity, these regions can benefit from the institutional support of the cities of Katowice, Gliwice, Lublin and Poznań, where the BEI development degree is high).

Table 15. Institutional portfolio of Poland's coal regions: business environment institution potential *versus* traditional industry dominance level

Traditional industry dominance level	High		Bytom, Rybnik, Lublin, Eastern Wielkopolska	Zgorzelec, Bełchatów
	Average		Tychy	
	Low	Bielsko-Biała, Gliwice, Katowice	Wałbrzych, Sosnowiec, Western Małopolska	
		High	Average	Low
		Potential of business environment institutions		

Designations:

	Very high intensity of issues and challenges within a given context (5)
	High intensity of issues and challenges within a given context (4)
	Average intensity of issues and challenges within a given context (3)
	Low intensity of issues and challenges within a given context (2)
	Negligible intensity of issues and challenges within a given context (1)

Source: own study.

Bielsko-Biała, Gliwice and Katowice regions experience the most favourable situation in terms of institutional potential development. This is due to the low level of dominance of traditional industries and because a number of universities, R&D institutions and types of scientific, technological and industrial parks are active.

5. Spatial context – post-industrial areas

Adam Drobniak, Klaudia Plac

Post-industrial areas, including mining areas, pose a major challenge in the transition of coal regions, both economically and environmentally/spatially. These areas determine the extent and scale of possible adverse impacts of mining and related activities on the technical infrastructure and the environment through the presence of extensive mining damage, dumps and pits in areas where mines operated or are still operating [Marshal's Office of the Śląskie Province,

2020]. The effects of decommissioned or in-decommissioning traditional industries, including mining, negatively affect the investment and residential attractiveness of coal regions, as well as deteriorate or severely damage the ecosystems. These consequences become particularly acute if they occur within urban areas, including downtown zones, in the context of both the economy and the quality of life.

The scale of issues related to post-industrial areas in Poland has not been yet thoroughly recorded and studied. Only approximations can be applied in this context. For example, the scale of the post-industrial area problems is particularly evident in the Śląskie province. In the course of developing *Local Revitalization Programs* or *Municipal Revitalization Programs*, Silesian (*Śląskie*) communes and municipalities identified a total of 405 degraded areas and 376 revitalization areas, with degraded[18] areas covering a total of 2262 km^2, i.e., about 18% of the area of the entire Śląskie province [Marshal's Office of the Śląskie Province, 2020].

In order to estimate the scale of the post-industrial area issue in individual coal regions within Poland, and given the lack of a system to collect comprehensive data, the authors applied the following approximations:

- the location of mineral deposits (based on MIDAS data) in each coal region was derived;
- the share of devastated land that require reclamation or reclaimed land within the geodetic area of the provinces (in relation to the built-up and urbanized area/industrial land) wherein the coal regions are located was determined (based on CSO BDL data);
- the share of mining land, heap and dump land, and land under construction within the geodetic area of coal regions (based on CORINE Land Cover data), and additionally the share of mining land, industrial and manufacturing land within the geodetic area of coal regions (based on Open Street Map data) was assessed.

The area of fossil fuel deposits (cf. Figure 10) indicates the approximate scale of coal, lignite and peat resource location within individual coal regions. The largest concentrations of such resources (hard coal) can be found in almost all coal regions of the Śląskie province (with the exception of the Bielsko-Biała coal region) and in the Lublin coal region.

Spot-wise, high concentrations of lignite resources can be found in Eastern Wielkopolska and in the Bełchatów region, while smaller spatial lignite and hard coal concentrations are located in the Zgorzelec and Wałbrzych districts. These

[18] However, degraded areas primarily cover urban zones, including post-industrial areas.

deposits consequently set out both current and potential post-industrial areas associated with mining.

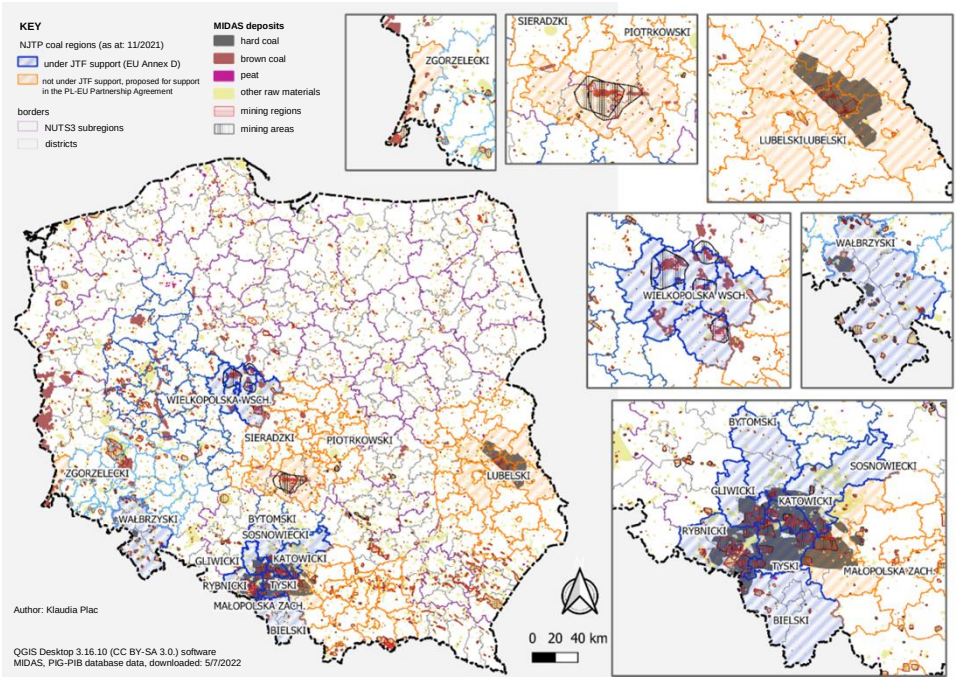

Figure 10. Fossil fuel deposits within Poland's coal regions

Source: own study based on MIDAS system data (author: Klaudia Plac).

The scale of post-industrial areas can also be recognized using CSO BDL data on the area of devastated and degraded land. However, the use of CSO BDL data enables studying the analysed issue only at the level of individual provinces, i.e., without specific reference to coal regions.

Such a preliminary approach to determining the scale of post-industrial areas indicates that their share in the geodetic area of Poland amounts to only 0.2%. The largest share of post-industrial sites, i.e., twice as high as the national average, is recorded in the Śląskie province (0.4%). The following provinces are also characterized by high shares of devastated and degraded areas: the Wielkopolskie (0.35%), Dolnośląskie (0.32%), Świętokrzyskie (0.32%), Łódzkie (0.28%) and Opolskie (0.27%). These are provinces where intensive exploitation of natural resources continues or was conducted in the past.

A far greater magnitude of the post-industrial land issue appears when juxtaposing devastated and degraded land against urbanized and built-up areas. The highest value of post-industrial sites in such terms is recorded by the Święto-

krzyskie province (6.54%), followed by the Wielkopolskie (6.15%), Łódzkie (4.64%), Warmińsko-Mazurskie (4.59%), Opolskie (4.40%), Dolnośląskie (4.36%), Kujawsko-Pomorskie (4.17%) and Śląskie (3.12%).

From the perspective of the planned transition of Poland's coal regions, the problem of the scale of post-industrial land can also be related to areas that currently have an industrial function (or are still listed as such in the geodetic registers). This approach enables looking at the spatial scale of the industrial activity currently conducted in each province, some of which will be subject to the transition. A breakdown of industrial land, together with devastated and degraded land, related to urbanized and built-up area shows that the largest share of this type is recorded in the Śląskie province (17.01%), with the national average of 10.77%. Moroever, the Dolnośląskie (14.44%), Świętokrzyskie (13.63%), Opolskie (12.83%), Wielkopolskie (12.46%), and Łódzkie (11.43%) provinces also exhibit high shares of industrial, devastated and degraded lands (cf. Table 16).

Table 16. Share of devastated and degraded land, and post-industrial areas in the geodetic area, and in built-up and urbanized areas (in 2019, %)

Territorial unit	Share of devastated and degraded land in the total geodetic area	Share of devastated and degraded land in the built-up and urbanized area	Share of devastated and degraded land and post-industrial areas in the total geodetic area	Share of devastated and degraded land and post-industrial areas in the built-up and urbanized area
1	*2*	*3*	*4*	*5*
Poland	0.20	3.58	0.60	10.77
Dolnośląskie	0.32	4.36	1.06	14.55
Kujawsko-pomorskie	0.22	4.17	0.61	11.41
Lubelskie	0.12	3.10	0.29	7.43
Lubuskie	0.12	2.57	0.36	7.70
Łódzkie	0.28	4.64	0.69	11.43
Małopolskie	0.13	2.05	0.68	10.29
Mazowieckie	0.10	1.68	0.45	7.61
Opolskie	0.27	4.40	0.80	12.83
Podkarpackie	0.10	2.08	0.42	8.32
Podlaskie	0.14	3.55	0.28	7.39
Pomorskie	0.16	2.88	0.49	8.95
Śląskie	0.40	3.12	2.20	17.01
Świętokrzyskie	0.32	6.54	0.66	13.63

Table 16 cont.

1	*2*	*3*	*4*	*5*
Warmińsko--mazurskie	0.18	4.59	0.33	8.47
Wielkopolskie	0.35	6.15	0.70	12.46
Zachodniopomorskie	0.13	2.78	0.44	9.76

Source: own study based on CSO LDB data.

A more detailed outline of the issues related to post-industrial areas within coal regions is possible through employing information from the CORINE Land Cover database. Categories of information in the database enable previewing the scale of the analysed phenomenon from the perspective of both strictly post--industrial (heaps and landfills) areas, as well as areas currently occupied by mining activities (mining areas, areas under construction) – cf. Table 17 and Figure 11.

Table 17. Mining areas, heaps and landfills, and areas under construction in Poland's coal regions (2018)

Coal region	Region area (in ha)	Mining areas (ha)	Heap and landfill areas (ha)	Areas under construction (ha)	Share in area (%)
Wałbrzych	457 545.28	1 851.13	140.39	64.56	0.45
Zgorzelec	83 851.41	2 611.47	187.91	0.00	3.34
Lublin	820 267.30	1 017.14	0.00	44.11	0.13
Bielsko-Biała	235 290.77	609.73	101.46	0.00	0.30
Bytom	157 729.29	318.13	689.83	427.47	0.91
Gliwice	87 922.31	31.31	1 220.38	42.99	1.47
Katowice	38 030.55	122.34	620.76	0.00	1.95
Rybnik	135 314.37	650.05	1 111.40	366.38	1.57
Sosnowiec	180 204.00	4 739.18	434.26	146.30	2.95
Tychy	94 427.02	415.76	721.52	0.00	1.20
Bełchatów	366 810.64	7 569.30	467.98	0.00	2.19
Western Małopolska	203 992.18	12 494.30	605.54	0.00	6.42
Eastern Wielkopolska	443 896.46	5 540.06	467.51	141.42	1.39

Source: own study based on CORINE Land Cover (2018).

Pursuant to such an approach, post-industrial and industrial areas associated with mining constitute a high share in the total area of the following coal regions: Western Małopolska (6.42%), Zgorzelec (3.34%), Sosnowiec (2.95%), Bełchatów (2.19%) and Katowice (1.95%).

Table 18. Mining, industrial and manufacturing areas located within Poland's coal regions (2022)

Coal region	Region area (in ha)	Mining areas (ha)	Industry and manufacturing (ha)	Share in area (%)
Wałbrzych	457 545.28	1 643.61	2 456.42	0.90
Zgorzelec	83 851.41	3 026.07	265.84	3.93
Lublin	820 267.30	945.87	1 313.76	0.28
Bielsko-Biała	235 290.77	158.23	1 782.10	0.82
Bytom	157 729.29	165.78	2 364.03	1.60
Gliwice	87 922.31	17.79	2 815.05	3.22
Katowice	38 030.55	8.62	2 919.33	7.70
Rybnik	135 314.37	334.13	2 006.29	1.73
Sosnowiec	180 204.00	856.42	4 491.50	2.97
Tychy	94 427.02	96.02	2 255.58	2.49
Bełchatów	366 810.64	5 770.00	2 001.27	2.12
Western Małopolska	203 992.18	595.02	2 347.36	1.44
Eastern Wielkopolska	443 896.46	5 031.89	942.85	1.35

Source: own study based on Open Street Map (2022).

However, by using data from the Open Street Map database (2022), it is possible to additionally indicate the scale of industrial land associated with mining and production activities in each coal region (cf. Table 18 and Figure 11). In the proposed context, the share of land allocated to mining and production is highest (7.70%) in the Katowice region. The following coal regions also have high shares of industrial land related to mining and production: Zgorzelec (3.93%), Gliwice (3.22%), Sosnowiec (2.97%), Tychy (2.49%) and Bełchatów (2.12%).

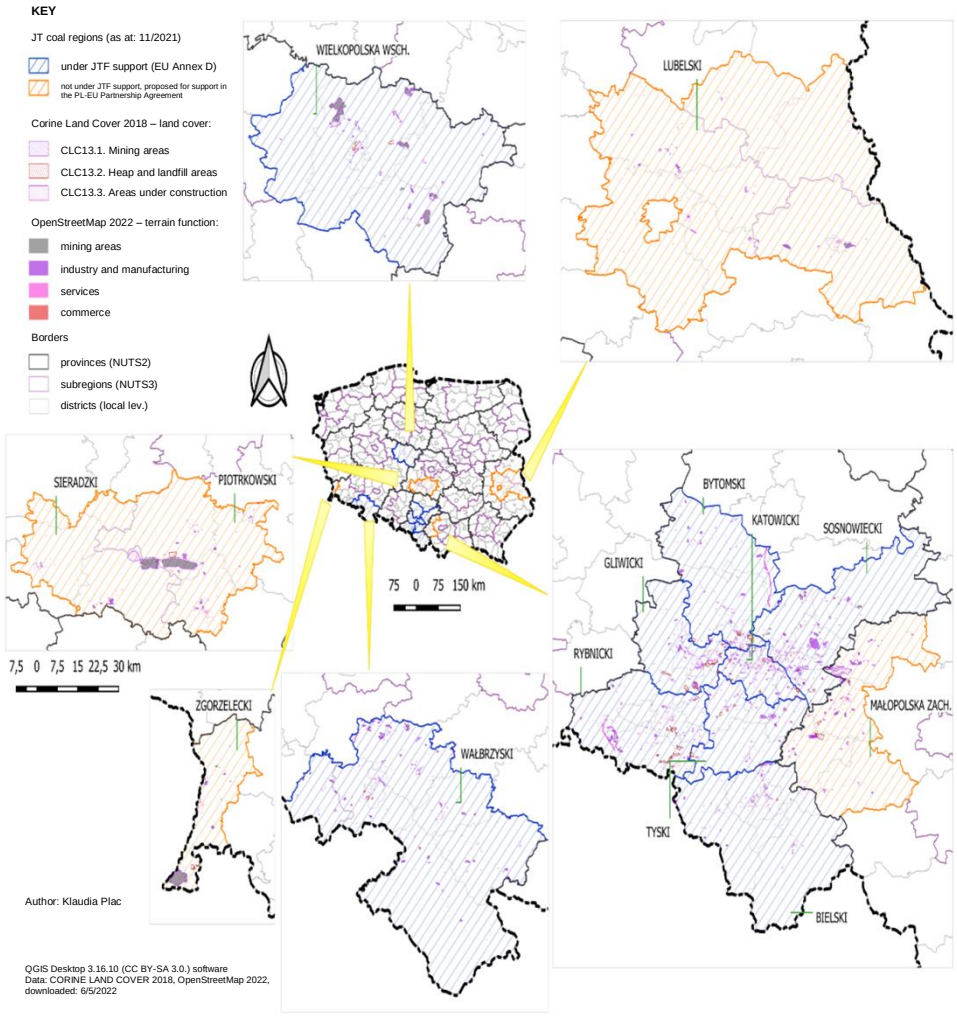

Figure 11. Industrial and post-industrial areas associated with mining

Source: own study based on Open Street Map system data (author: Klaudia Plac).

Spatial context summary

Adam Drobniak

In the portfolio context, which analyses the scale of post-industrial and industrial mining-related areas in relation to the level of dominance of traditional industries, the most difficult situation in relation to the transition is encountered in three subregions, namely, Zgorzelec, Sosnowiec and Bełchatów. The Gliwice,

Katowice, Tychy and Western Małopolska regions also face significant challenges associated with reclaiming post-industrial areas.

Table 19. Spatial portfolio of Poland's coal regions – scale of post-industrial and industrial areas *versus* traditional industry dominance level

Traditional industry dominance level	High		Gliwice, Katowice, Tychy,	Zgorzelec, Sosnowiec, Bełchatów
	Average	Bytom	Rybnik, Eastern Wielkopolska	Western Małopolska
	Low	Wałbrzych, Lublin, Bielsko-Biała		
		Low	Average	High
		Scale of post-industrial and industrial areas related to mining		

Designations:

	Very high intensity of issues and challenges within a given context (5)
	High intensity of issues and challenges within a given context (4)
	Average intensity of issues and challenges within a given context (3)
	Low intensity of issues and challenges within a given context (2)
	Negligible intensity of issues and challenges within a given context (1)

Source: own study.

In contrast to the aforementioned areas, Wałbrzych, Bielsko-Biała and Lublin regions experience relatively smallest challenges related to the reclamation of post-industrial areas.

6. Environmental context

Wałbrzych subregion – Dolnośląskie province

Stanisław Korenik, Dorota Rynio, Alicja Zakrzewska-Półtorak, Piotr Hajduga, Alicja Kozak

The Wałbrzych sub-region stands out among other studied coal regions with the lowest level of CO_2 emissions. This is associated with the low presence of traditional industries, including mining. The averaged annual level of PM10

emissions is average compared to other coal regions, while the mean annual level of PM2.5 is relatively low.

The level of gaseous emissions has been steadily decreasing in the course of the economic transition since the 1990s. However, daily standards of particulate pollutants are still exceeded, especially in the autumn and winter season, mainly due to municipal activities.

Zgorzelec district – Dolnośląskie province

Stanisław Korenik, Dorota Rynio, Alicja Zakrzewska-Półtorak, Piotr Hajduga, Alicja Kozak

The Zgorzelec district is characterized by a high level of CO_2 emissions compared to other coal regions, although this level has been significantly reduced during the economic transition (as recently as 2010, the value almost doubled that of 2019). The level of dominance of traditional industries within the economic structure is relatively high; the Turów mine and power plant play a significant role in the district. The average annual level of PM10 and PM2.5 emissions turns out to be average compared to other coal regions. Gaseous pollutant emission level standards and daily dust pollution standards are, however, exceeded in the district, especially in the autumn and winter seasons.

Lublin subregion – Lubelskie province

Wojciech Janicki, Grzegorz Iwanicki, Andrzej Jakubowski

The Lublin subregion is characterized by one of the lowest CO_2 emission levels among the analysed coal subregions, even though it is slightly ahead in terms of population potential of the Katowice subregion alone, which emits three times the amount of the greenhouse gas in question. Such low emissions also show no correlation with economic potential, since in terms of the number of businesses, the subregion is only surpassed by the Katowice and Bielsko-Biała subregions[19]. In addition, compared to these two areas, Lublin is also characterized by a high level of dominance of traditional industries, which, combined with local CHPs (combined head and power plants), constitute the main emitters of CO_2. The relatively low level of emissions of this gas in the entire subregion,

[19] However, the analysis includes the city of Lublin, which is ultimately not part of the Lublin coal region.

compared to other coal subregions, is the consequence of the lack of conventional power plants.

There are incidental annual exceedances of the permissible standards for gas and dust emissions in the Lublin subregion, especially during the heating season, but there has been a steady overall decrease in their emissions over the past decade. Note that the average annual air pollution with PM10 and PM2.5 dust is clearly lower than the permissible standard, despite coal production at LW "Bogdanka" almost doubling in 2010-2019.

Bielsko-Biała subregion – Śląskie province

Radosław Cyran, Piotr Rykała

Due to the low share of traditional industry in the economic structure, the Bielsko-Biała subregion is characterized by the second lowest (after the Wałbrzych region) CO_2 emission level measured in tons. However, pollution standards for NO_x, CO_x, SO_x and PM10 and PM2.5 are exceeded throughout the year. PM values are high mainly during the heating season and result from the insufficient replacement of non-environmental heat sources in residential buildings. The 2010-2019 period recorded a noticeable reduction in CO_x (by 16.1%), NO_x (by 49.9%), SO_x (by 60.9%), PM10 (by 37.5%) and PM2.5 (by 41,8%) emissions.

Bytom subregion – Śląskie province

Małgorzata Czornik, Paulina Badura

Compared to other analysed coal regions, the Bytom subregion has one of the lower average levels of CO_2 emissions. The region is largely dominated by areas of rural communes, which relatively reduces the potential for air pollution emissions from large post-industrial plants. Hence, the most difficult situation in this regard is in the district cities, especially Bytom, which is the location of plants particularly troublesome for air purity. Nevertheless, the level of gaseous pollution has been consistently decreasing year-to-year. Unfortunately, this is does not apply to PM10 and PM2.5 particulate pollutants, the emissions of which in the subregion still remains at a relatively high, although constant level.

Gliwice subregion – Śląskie province

Marek Magdoń, Jakub Miracki

The average level of CO_2 emissions in the Gliwice subregion is one of the lower among Poland's coal regions. Despite the dynamic economic growth in the subregion, the level in the 2010-2019 period fluctuated around 1 million t/y (ranging from 835 338 to 1 078 361), with the most developed municipalities, i.e., Gliwice and Zabrze, accounting for almost 90% of the emissions. Increasing energy consumption and related CO_2 emissions are compensated for, among others, by ongoing thermal upgrading of buildings, improving the efficiency of electricity and heat generation, and organizing social campaigns aimed at urban residents (as major energy consumers).

In the case of particulate matter, a trend indicating a decrease in the value of average annual concentrations can be observed in 2010-2019 – however, the permissible level of average annual concentrations for PM2.5 is still exceeded, and for PM10, the permissible level was reached for the first time in 2019. Accordingly, the need to take further actions aimed at improving air quality in the subregion is evidenced by the fact that PM10 standards, as measured by the annual frequency of 24-hour average concentrations higher than those considered permissible, are being significantly exceeded.

Katowice subregion – Śląskie province

Adam Drobniak, Piotr Rykała

In relation to other coal regions within Poland, the Katowice subregion, despite the greatest economic and population potential, is characterized by a relatively average level of CO_2 emissions. This is due to the lack of conventional power plants within the analysed subregion, hence, the average level of CO_2 emissions compared to other coal regions is determined by local CHPs and a high concentration of economic activities, including those of a traditional nature (metallurgical and chemical industries).

It is also worth noting that in the course of the economic transition ongoing in the subregion since the 1990s, levels of emissions of gaseous pollutants have been steadily declining, but nevertheless their standards are exceeded even today. This situation also applies to particulate pollution, especially PM2.5.

Rybnik subregion – Śląskie province

Florian Kuźnik, Artur Ochojski

The main challenge for the Rybnik subregion is its significant share of CO_2 emissions in the scale of coal regions (the fifth largest emitter), reaching a total of 6%. This is primarily caused by the activity of a conventional power plant, but also by the activities of other economic entities concentrated in the subregion. Activities aimed at reducing gas emissions have, however, become noteworthy. Over the past decade they have resulted in a reduction of CO_2 by 45%, NO_x by 75% and SO_x by 85%. Periodic low emissions and a significant share of coal-fired furnaces used for home heating remain burning issues for the subregion.

Despite a decline in PM10 and PM2.5 readings, during periods of increased heating and unfavourable weather conditions, there are cases of these standard being exceeded severalfold, often being the highest values in the country.

Sosnowiec subregion – Śląskie province

Adam Drobniak, Piotr Rykała, Jakub Miracki

In relation to other coal regions within Poland, the Sosnowiec subregion is characterized by a high level of CO_2 emissions, distinguished by the second (highest) emission level measured in tons, which amounted to more than 15 M in 2019. The high level of pollution occurring in the analysed subregion is associated with the activities of traditional industry enterprises (metallurgy, automotive industry) and, above all, with the operation of a conventional power plant in Jaworzno. Despite measures to reduce PM10 and PM2.5 emissions, values exceeding standards are still observed during the heating season.

Tychy subregion – Śląskie province

Florian Kuźnik, Artur Ochojski

The Tychy subregion belongs to that group of units where the problem of CO_2 emissions can be evaluated in terms of their average intensity, while the reduction of high PM10 levels is relatively slow. All parameters of gas and par-

ticulate pollutant emission readings have decreased over the last decade. Although PM10 standards are exceeded only for short periods of time, emission values are regularly exceeded during periods of increased heating demand, which consequently leads to an increase in the problem of low emissions.

Bełchatów Transition Area – Łódzkie province

Aleksandra Nowakowska, Agnieszka Rzeńca

Anthropogenic spot sources in the Łódzkie province account for the largest share of total SO_2, NO_2 and dust emissions, with these values essentially determined by one emitter – the Bełchatów Power Plant. The Bełchatów area is characterized by the highest sulfur oxide and nitrogen oxide emission densities, and a high PM10 emission density. The power plant is responsible for generating 1/3 of all dust in the Łódź region.

CO and CO_2 emissions have increased dramatically over the last decade by 103.7% and 10.4%, respectively. However, between 2010 and 2019, the Bełchatów complex reduced emissions of SO_2 (by 59.1 p.p.), nitrogen oxides (by 40.2 p.p.), and dust (by 56.2 p.p.), while CO_2 and carbon monoxide emissions increased. Despite the measures taken, the Bełchatów complex is, today, the major source of pollution in the region and in the country.

Western Małopolska – Małopolskie province

Krzysztof Gwosdz, Sławomir Sitek, Krzysztof Wiedermann

The environmental conditions in Western Małopolska is monitored by three measuring stations included in the system of the Chief Inspectorate for Environmental Protection. The widest and longest scope of observations is offered by the measuring station in Trzebinia. As of 2019, information on PM10 values has become available for stations located in Oświęcim and Olkusz.

Between 2010 and 2019, there was an improvement in the air pollution situation and a decrease in the values of all the parameters in question. PM10 and PM2.5 levels recorded the greatest reduction. Their readings in 2019 were about 60% of those recorded in 2010. Moreover, the reduction in nitrogen oxides was lower and amounted to 25%. Given the applicable standards, it should be noted that only the PM2.5 index slightly exceeds the permissible level.

Eastern Wielkopolska – Wielkopolskie province

Paweł Churski, Robert Perdał, Martyna Burchardt

The situation related to the adverse impact of economic activities on the condition of the natural environment in the Konin subregion is systematically improving. The level of environmental pollution with carbon, nitrogen and sulfur oxides has decreased over the 2010-2019 period. Sulfur oxide emissions were reduced the most (by 43%), while those of carbon and nitrogen oxides decreased by a lesser amount (by about 30%). Unfortunately, CO_2 emissions remain high compared to other coal regions within Poland.

Despite the fact that PM10 particulate matter emissions have been reduced by a modest 10%, it should be noted that their level is among the lowest in Poland's coal regions. It should be assumed that reduced lignite mining and the generation of electricity based on this fuel over the next decades will entail a significant depollution, thus decreasing environmental anthropopressure.

Environmental context summary

Adam Drobniak

A synthetic summary of the environmental context is presented in Table 20. Overall, Poland's coal regions are responsible for about 40% of the country's total CO_2 emissions. The largest emissions are associated with coal regions with conventional power plants, i.e., Bełchatów (PGE in Bełchatów), Sosnowiec (TAURON in Jaworzno), Eastern Wielkopolska (ZE PAK), Zgorzelec (PGE, Turów Power Plant) and Rybnik (Rybnik Power Plant).

Table 20. Basic information on the environmental context of Poland's coal regions relative to the traditional industry dominance level and economic structure type (in 2019)

Coal region	CO_2 emission (in t)	PM10 emissions (in µg/m^3)	PM2.5 (in µg/m^3)	Traditional industry dominance level
1	*2*	*3*	*4*	*5*
Wałbrzych	488 262	27.55	15.4	Low
Zgorzelec	5 541 763	n/a	n/a	High
Lublin	960 064	24.50	18.2	High

Table 20 cont.

1	*2*	*3*	*4*	*5*
Bielsko-Biała	687 887	27.83	24.6	Low
Bytom	743 633	34.00	22.8	High
Gliwice	1 018 885	36.50	26.4	Low
Katowice	2 972 474	36.78	25.9	Low
Rybnik	5 488 911	n/a	n/a	High
Sosnowiec	15 501 904	31.15	n/a	Low
Tychy	4 043 802	n/a	n/a	Average
Bełchatów	38 518 600	n/a	n/a	High
Western Małopolska	2 353 469	29.70	20.4	Low
Eastern Wielkopolska	7 535 701	23.32	n/a	High

Source: own study based on CSO LDB data, and the University of Economics in Katowice [2021].

In the portfolio context (cf. Table 21), showing the relationship between the volume of CO_2 emissions and the level of dominance of traditional industries, the biggest transition-related issues in environmental terms apply to the following coal regions: Zgorzelec, Rybnik, Bełchatów and Eastern Wielkopolska. The scope of transition-related environmental issues is related with the operation of large raw material and energy complexes in these coal regions, the profitability of which will gradually decrease due to the increase in CO_2 emission fees. This situation from the perspective of a just and energy transition will be aggravated by the territory of the indicated coal regions being highly dominated by traditional industries.

Relatively, the most favourable situation in terms of environmental issues concerning CO_2 emissions and the dominance of traditional industries is encountered within the Wałbrzych and Bielsko-Biała regions. There are no large conventional power plants in those regions, thus the CO_2 emission level therein is relatively low. A similar situation is applicable with regard to the Gliwice, Katowice and Western Małopolska regions.

Table 21. Environmental portfolio of Poland's coal regions – CO_2 emissions *versus* traditional industry dominance level

Traditional industry dominance level				
	High	Bytom, Lublin		Zgorzelec, Rybnik, Bełchatów, Eastern Wielkopolska
	Average		Tychy	
	Low	Wałbrzych, Bielsko-Biała	Gliwice, Katowice, Western Małopolska	Sosnowiec
		Low (below 1 M t)	Average (from 1 M t to 5 M t)	High (above 5 M t)
		CO_2 emissions		

Designations:

	Very high intensity of issues and challenges within a given context (5)
	High intensity of issues and challenges within a given context (4)
	Average intensity of issues and challenges within a given context (3)
	Low intensity of issues and challenges within a given context (2)
	Negligible intensity of issues and challenges within a given context (1)

Source: own study.

Strategic recommendations for just transition in Poland

III Chapter

1. Strategic stakes of just transition stakeholders

Adam Drobniak

Just transition stakeholders, namely, territorial governments, the mining and power sectors (along with their associated entities), the new RES sector and BEI differ in terms of perceiving their role in the economy's decarbonization process and activities mitigating such a transition. The direction and rate of energy and just transition also differ according to the individual stakeholder groups. Indeed, there is a strict division of the desirable change directions between the new RES sectors and the sector of mining with conventional power generation and related industries. In the context of the transition towards green economy, this division seems obvious, since the implementation of technological changes associated with low-emission, decarbonization and, more widely, the green economy, will bring in the most benefits to the new RES sector and potentially the greatest adverse consequences, including social, to the traditional sectors [Drobniak, 2021].

For the purposes of identifying the strategic stakes related to just and energy transition processes, in 2020 and 2021, the authors conducted 42 interviews with the representatives of the four main stakeholder groups, i.e., local governments, the mining sectors with the energy sector and related industries, the new RES sector and business environment institutions that operate within Polish coal regions[20]. The matrix of each of the interviews included questions referring to

[20] The interviews were conducted as part of works on the *Propozycje rekomendacji dla obszaru sprawiedliwa transformacja [Recommendation proposals for the field of just transition]* by the

several basic transition contexts that are to take place in Poland's coal regions. These contexts are related to: (1) perception by the stakeholders of desired change directions, (2) current conditions and potential favouring the transition, (3) restrictions hindering or even inhibiting the ongoing transition process in Poland's coal regions.

The new RES sector advocates for very rapid implementation of the *European Green Deal* provisions related to the transition towards a low-emission economy. To this end it expects the development of appropriate legal regulations and forms of support, including instruments stimulating the demand for renewable energy solutions.

The mining and conventional power generation sector and related activities, until the end of May 2021, i.e., the date of the conclusion of mining employee social agreements, was essentially an opponent of changes arising from the *European Green Deal*. Such an attitude is, in a sense, manifested by the significant investments of the last decade associated with increasing conventional power capacity (e.g., new energy units) and at the step-wise commissioning of new deposits and mines (e.g., hard coal in the Śląskie province and brown coal in the Łódzkie, Wielkopolskie and Dolnośląskie provinces). However, since mid-2021, the traditional industry sector has started to take adaptive actions related to the challenges of the *European Green Deal*, which has led to the pursuit of diversification, including towards RES development. Simultaneously, this sector advocates for maintaining the possibility of "experimenting" with coal technologies and extending their period of use with respect to preserving the energy security of Poland. Given its strong dependence on the current dependence path and the hard-to-overcome "closure" effect (*path dependence* and *lock-in*), such a behaviour is rational in the economic sense; however, it deviates from the assumptions of the *European Green Deal*, which assumes creating a zero-emission economy[21].

"Sprawiedliwa Transformacja" (*Just Transition*) expert group under the Team for Renewable Energy Sources and Benefits for the Polish Economy by the Minister of Climate, dated 2 April 2020, item 21 [Drobniak et al., 2020], and also in 2021, in the course of conducting cognitive task entitled *Ramy programowe dla zintegrowanego planowania sprawiedliwej transformacji na poziomie krajowym i regionalnym (Programme framework for integrated planning of just transition at domestic and regional levels)*, under an R&D project entitled *Społeczeństwo na drodze do neutralności klimatycznej (Society on the path to climate neutrality)*, funded by NFEPWM, contract No. 1946/2020/Wn50/NE-OA-KU/D – tasks coordinated by the University of Economics in Katowice, commissioned by the National Centre for Climate Change, Institute of Environmental Protection – National Research Institute [University of Economics in Katowice, 2021].

[21] The situation is further complicated by the outbreak of the war in Ukraine in 2022 and the embargo on energy resources imported from Russia.

Both sectors, i.e., the new RES sector and the mining sector combined with conventional power generation, perceive the formational aspect associated with energy transition in terms of the organization of the future energy market. The new RES sector strives for coordination between the clusters of energy cooperatives, micro-, small- and medium-sized enterprises, natural persons, territorial governments and housing cooperatives in the distribution of RES. The expectations of this stakeholder are directed towards obtaining significant financial support and appropriate regulations ensuring advantageous conditions for RES development within the distributed model. The mining and conventional power generation sector, however, emphasize the will to play a decisive part within energy (and just) transition processes, justifying such a position with the need to mitigate the social effects through maintaining jobs in traditional sectors and coal regions. Still, stakeholders related to the sector of mining and conventional power generation particularly stress that if they do not diversify their activities towards RES and fail to reinforce their position within the renewable energy market, they be ones suffering the most from the consequences of green energy transition. That rationale cannot be discarded, especially in the context of adverse social impacts.

From the socio-economic, technological and environmental perspectives (for the time, leaving the specificity of coal regions aside), the distributed, multi-entity model proposed by the RES sector is more socially just in the context of the entire country, since it also provides the opportunity for desirable structural change towards enhanced productivity. It is also probably unavoidable due to the technological progress in the field of RES. This is supported by the argument of high location-wise independence of RES technologies, which can be implemented in many parts of the country, not necessarily coal regions (as was the case with mines and conventional power plants, the location of which remained directly dependent on the raw material deposits). However, given the potential socio-economic consequences of the energy transition in coal regions, it should be concluded that it is also important to suggest the role that the mining, conventional power generation and related industries should play within this process. This also means that government entities need to undertake, in addition to the procedures associated with just transition programming, also appropriate, simultaneous program arrangements in the field of restructuring, including a diversification in the activities of the mining, conventional power generation and related industries. Only this kind of coordination of just transition and energy transition policies by conventional sectors can ensure the effective interventions, a positive balance of change benefits and costs, and their appropriate (just) distribution.

The proposals of **local governments** and **business environment institutions** (BEIs) resemble the demands of the new RES sector. The first group of stakeholders recognizes the economic and socio-environmental costs that will be associated with the phase-out of the mining sector (including a decline in revenues to municipal budgets, the problem of post-industrial areas and facilities, including degraded ones, and the issue of freed human capital). Despite this fact, local governments see the need to overcome the challenges related to the *European Green Deal*, and for many, the low-carbon economy is becoming a priority for the next decade, and is already reflected in the provisions of their development strategies until 2030. The change towards a low-emission economy is perceived by local governments from the perspective of the potential extensive implementation of green economy industries (e.g., RES, passive construction, water and wastewater management, spatial management, circular economy, low- or zero-emission transport) to diversify the economic structures of cities and regions, improve the quality of life of their residents, and increase housing and investment attractiveness. The important role of local governments, municipalities in particular, within the transition process, is also determined by their position as energy consumers. Cities are and will probably remain centres where, due to the high concentration of social and economic activities, the demand for energy is, and will continue to be, the highest. Hence, local governments perceive RES development from the perspective of long-term energy cost savings.

BEIs operating in coal regions, especially in the field of R&D, consider their role within just and energy transition processes as sort of initiators of new business activities. In essence, their primary task is to diversify current traditional industrial activity and to create new value chains. R&D institutions are left with the knowledge and often the experience drawn from pilot innovation projects, and this can be effectively applied to creating new development paths within the coal regions. The BEI sector, therefore, expects the just and energy transition process to support activities related to the implementation of new technologies, to enhance multi-stakeholder cooperation between enterprises, R&D, local governments and educational institutions, and enable the transfer of knowledge to the economy. The R&D sector already has a number of high-tech solutions, which when implemented under pilot projects, may contribute to creating new activities in coal regions.

To illustrate the strategic stakes of the various stakeholders, this monograph presents synthetic and organized statements, observations and postulates collected through interviews (IDI – *individual direct interview*) with entities representing such groups of stakeholders of just and energy transition as local governments (provincial and communal governments), the new RES sector (RES

companies), the mining and conventional power generation sector, and BEIs (business clusters, science and technology parks, research institutes). The statements of the stakeholders were recorded as part of the work by the "Just Transition" Expert Group appointed by way of a Resolution of the Minister of Climate of 2 April 2020 [Ministry of Climate and Environment, 2020], and also in the course of implementing a research task entitled *Ramy programowe dla zintegrowanego planowania sprawiedliwej transformacji na poziomie krajowym i regionalnym [Programme framework for integrated planning of just transition at domestic and regional levels]* commissioned by the National Centre for Climate Change – Environmental Protection Institute in Warsaw, under a research and development project *Społeczeństwo na drodze do neutralności klimatycznej [Society on the path to climate neutrality]* funded by the National Fund for Environmental Protections and Water Management [Drobniak et al., 2021].

The considerations include a synthetic presentation of the conclusions drawn from the conducted interview, as arranged by: 1) stakeholder perception of the desired directions of change in connection with just and energy transitions; (2) stakeholder views on the conditions and potentials that can be employed in within just and energy transition; (3) stakeholder views on the constraints and barriers applicable to just and energy transition processes.

Local government

Adam Drobniak

Local governments point out that **desirable change directions** associated with creating a zero-emission economy and more broadly, a green economy, should be related to:

- **Simplifying legal regulations**, including a simplification of provisions related to the construction of the RES system, combined with simplifications concerning local spatial development plans and the introduction of regulations providing the activities in the field of clean energy with greater dynamics.
- **Increasing the RES energy capacity**, including the provision of: exemptions, tax reliefs, tax returns; high subsidies for renewable energy projects implemented by residents, entrepreneurs, cooperatives, local governments, and municipal companies.
- **Increasing city resistance to climate change** through expanding the zero-emission economy framework and including all green and blue economy industries, starting with ventures involving energy and water efficiency.

- **Developing distributed energy with support for prosumers** – actual energy transition, as well as just transition, means the need to implement large--scale measures associated with the low-carbon economy, involving individual consumers and residential unions, cooperatives, micro- and SMEs, along with minimizing the need for long-distance energy transmission. This means energy balancing on urban and regional levels, and creating local energy potential.
- **Strengthening activities for green and friendly cities**, including increasing energy efficiency in the residential and public sectors; making energy efficiency buildings a priority in local development; improving the quality of the urban environment; subsidies for passive construction.
- **Supporting green infrastructure development, through applying green urban solutions** (among others, green building and bus station facades, rain gardens), the protection of compact and park greenery complexes, the designation of greeneries near existing housing, and the construction of strip-like recreational spaces.
- **Providing support for blue infrastructure** in the field of utilizing rainwater and their redirection to small retention systems; creating polders collecting rainwater from areas with limited absorption capacity (e.g., residential rainwater polders); using existing natural watercourse valleys as city ventilation and oxidation channels.
- **Supporting rational wastewater management**, including the introduction of requirements for the use of greywater systems, with priority awarded to new buildings and public utility buildings, and the management of sewage sludge, along with the generation of energy from waste disposal.
- **Developing new waste processing technologies**, among others, the pyrolysis and gassing processes under conditions of limited oxygen availability. The technology is applicable to the processing of municipal waste in the form of RDF alternative fuel, waste from the plastics industry or biomass and other types of waste into energy products: gas, pyrolysis oil and carbonate.
- **Supporting the takeover and reuse of post-industrial areas**, including degraded ones, for the purposes of implementing the strategic projects of local governments, hence building their competitive position, i.e., new economy districts, technology hubs, creative industries, etc. Such activities lead to economic diversification and growth of intellectual potential in coal regions, and contribute to the creation of new jobs within the green, digital and creative economy.
- **Reclaiming and diverse redeveloping post-industrial areas**: mitigating water and soil pollution effects while applying simultaneous preventive and reclamation activities; protecting of contaminated brownfield sites located in

the vicinity of existing residential dwellings; converting brownfield sites located in the vicinity of industrial zones for economic purposes, while maintaining ecological (zero-emission) standards; converting post-industrial areas and facilities of valuable industrial into areas offering a variety of socio-economic functions, while preserving cultural heritage.

- **Developing district heating infrastructure and green heat sources**, especially within urban areas, where the economic profitability of infrastructure construction is higher. The development of such infrastructure applies, in particular, to old multi-family dwellings of diverse ownership structure.
- **Developing micro-cogeneration and trigeneration**, primarily within building complexes and large facilities such as hospitals, schools and offices that often exhibit a high demand for electricity, thermal energy and cooling with ventilation and air conditioning.
- **Developing low- and zero-emission transport** – preparing and implementing transport plans at the coal region, agglomeration and municipality levels, together with promoting clean and energy-efficient vehicles, and increasing the use of non-motorized transport (including city bikes, expanding bike and pedestrian lane network, transfer centres).
- **Supporting social processes** associated with energy transition and the new identity of coal region communities that are being subjected to change, including professional retraining schemes and counteracting energy poverty.
- **Supporting local entrepreneurship and BEIs in the creation of low-emission economy value chains and economic structure diversification**, including providing support for companies, start-ups and institutions related to RES SMEs, green and blue infrastructure, electromobility, the Internet of Things, education in schools at all levels, installation and operation of RES systems, research on industrial innovations (photovoltaic farms, reservoirs with water turbines, energy self-sufficiency, increased share of energy production in high-efficiency cogeneration, hydrogen technologies, and energy storage).
- **Efficient transition programming** – this includes undertaking research on the efficiency of RES efficiency indicators and the socio-economic impact of coal region energy transition.

According to local governments, there are a number of advantageous **conditions and potentials** that can be beneficial with regard to the transition to a zero-carbon economy and just transition. These include the following elements:

- **Scientific and research facilities** – some of coal regions are home to academic centres that enable training personnel in the field of energy, as well as research institutes related to the development of energy technologies, as well

as significant number of companies (including start-ups), in the new energy technology fields, a large number of generating units and leading energy groups.

- **Smart regional specializations** – all of the provinces with coal regions have smart specializations designated and supported under SRS in the areas of, among others, energy and/or green economy industries. Coal regions, having developed energy sectors, offer facilities for testing and full-scale implementation of innovative solutions (existing infrastructural equipment for energy generation, transmission and consumption).
- **Availability of external funds** – individual provinces and their coal regions are benefiting from EU funds earmarked for, among other concepts, implementing innovations, replacing energy sources or upgrading employee skills. This means that they have an institutional structure that enables financing using external funds.
- **Experience of coal regions in reorienting post-industrial area functions** – some coal region local governments have experience in the successful transformation of brownfields, among others, the Katowice Culture Zone with the conceptual project "3xNoweMiasto" and "NIKISZ 4.0", which is the progenitor of the planned Gaming Hub; the "Centrum" Old Mine in Wałbrzych, the Guido Mine and the Coal Mining Museum in Zabrze, Geosfera in Jaworzno, multi-stakeholder cooperation for the Transition of Eastern Wielkopolska in Konin, Jasienna Low-Carbon Economic Zone.
- **Presence of post-mining or post-industrial areas** – areas that, if properly worked on, can be used for other functions, thereby diversifying the economy of coal regions. However, detailed stock-taking of post-industrial areas and the creation of a multi-entity cooperation model for their reuse is necessitated.
- **Human potential** – professional requirements for people employed in mining, power and related activities have increased in recent years. There is an opportunity to apply both the competencies and extensive experience of the identified individuals in other industries, especially in industrial processing, transport, construction, circular economy or renewable energy.
- **Growing awareness of local residents and entrepreneurs in the field of low-emission economy**, knowledge regarding potential savings owing to RES, in particular. The number of **prosumers** is also growing, which may evidence not only an increased ecological awareness amongst the residents, but also the will to rationalize living costs.
- **Unused green energy sources** in the form of biowaste and municipal wastewater; potential biogas generation and use of wastewater treatment biogas.

Local governments believe that **constraints and barriers** associated with just and energy transition include the following:

- **Large scale and extent of technological, social and economic changes** – in the case of coal regions, some of which are still significantly dependent on traditional industries, the scope of change will impact a significant number of entities, employees and their families.
- **High change costs** – as a consequence of the large extent and scale of change, incurred not only in the economic sphere (rebranding, investments in the development of new value chains, capital expenditures related to low-carbon economy), but also in the social sphere (mining communes characterized by a relatively high level of employment in the mining and mining-related sectors, retraining costs, creation of new jobs, creation of development opportunities for mining families, tax revenue decline) and the technological sphere (expenditures on RES sources, transmission network, new means of transport with accompanying infrastructure).
- **Infrastructural deficiencies of the gas and heating networks** – gas is supplied to only 58% of the country, with heating networks covering an even smaller area. Using gas as a transition fuel in achieving a low-emission economy will entail significant capital expenditure.
- **Limited social acceptance of the changes** – both in terms of the mining sector transformation and RES energy generation (e.g., wind energy). Overcoming it means the need for a world view transformation, awareness of the need for collecting and further use of rainwater, more efficient waste segregation, switching from passive to active social attitudes, and having trust in benefits of a low-carbon economy. Limited public acceptance for change is associated with continuously low public awareness of the impact of inadequate air quality on health and the environmental condition; eco-behaviour, such as the effects of burning waste in equipment not intended for this purpose; the use of RES against seeking the cheapest heating method due to investment and operating costs; lack of knowledge (e.g., fear of wind turbines).
- **Restrictions in the operation of energy clusters and cooperatives** – there are currently a number of legal barriers hindering the operation of such entities, the role of which within energy transition (as well as just transition) proves to be crucial.
- **Absence of support mechanisms for entrepreneurs interested in larger-scale investments in renewable energy** in the development of local communities, e.g., in relation to solar, wind and water systems.

- **Absence of mechanisms stimulating demand for low-emission or circular economy technologies for natural persons**, e.g., no RES-related PIT relief, thermal modernization for people who are not owners of single-family buildings. In the case of multi-family buildings, there are opportunities to use RES (PV, wind energy, heat pumps), but their owners cannot deduct such expenses from the tax base.
- **Limited availability of funds to subsidize RES and to increase the energy efficiency of multi-family residential buildings**. The issue applies to municipal buildings, housing cooperatives and also other private multi-family dwellings. The urban development fabric in coal regions contains a large number of old and degraded buildings (tenement houses, and so-called *familoks*), owned by private individuals, which require thermal modernization and the supply of clean heat and energy sources.
- **Absence of clear legal regulations**, e.g., restrictions imposed on wind turbines have resulted in a virtual suspension of such investment projects. This issue is also related to outdated laws on RES, efficient water management (lack of provisions on rainwater use and greywater systems), responsibility of packaging manufacturers (e.g., labelling of packaging indicating which waste group it belongs to, fees charged from manufacturers of non-recyclable packaging), manufacturers of equipment with possible repairs and replacement parts. Regulatory shortcomings also relate to the revitalization of brownfields.
- **Energy-related organizational inefficiency of small communes** due to lack of funds to maintain adequate job positions in the field of coordinating environmental activities, as well as energy and just transition consulting.

New RES sector

Adam Drobniak

As indicated by the RES sector, **desirable change directions** associated with creating a zero-emission economy and more broadly, a green economy, include:

- **Changing the model of economy** previously dependent on fossil fuels and characterized by capital intensity towards a modern, low-emission one. A successful economic transition requires: the development of renewable energy (including within brownfield sites) and energy storage technologies so as to ensure energy security; intensive development of electricity distribution in-

frastructure; creation of investment zones within brownfield sites for new low-carbon industries; regulatory support and the proper political climate for the creation of such investment zones.

- **Designating competent entities in individual coal regions**, i.e., entities with knowledge in terms of local conditions. Their diversified composition would be comprised of local government representatives, entrepreneurs and the academia in the form of a cluster model.
- **Intensifying the implementation of RES-related projects financed with EU funds**, particularly through investments in SMEs (including start-ups), leading to the economic diversification and restructuring of coal regions. This should be complemented by support for business incubators, consulting services, research and innovation projects, and transfer of advanced technologies.
- **Supporting the development of "intellectually intensive" industries** that are characterized by high involvement of the science world and of highly skilled personnel. Such new industries will determine the pace and scope of adaptation to a low-carbon economy in all three aspects of the transition, i.e., economic (switching to modern industries, based on scientific and technical knowledge and highly developed human capital), social (meeting the needs of the regions' inhabitants, including the development of education, health care level improvement, creation of healthy lifestyles, building social ties and a shared and conscious social responsibility) and environmental (measures to preserve nature and landscape, restoration of natural values within post-industrial areas, and economical management of resources).
- **Providing incentives for the rebranding of engineering, technical and all other personnel groups interested in taking up employment in emerging industries** in order to inhibit the outflow of this human resources category, as well as for labour market balancing.
- **Creating a legal environment for the operation of independent energy storage facilities** – such storages currently demand high initial outlays, and therefore, similarly to RES, their operation requires stable revenues, which ensure the possibility of financing them in the long term. What is needed in this regard are solutions such as ensuring network neutrality by exempting the storage facility from distribution charges for both consumed and supplied energy (limiting the storage facility operating costs to depreciation, maintenance costs, and house-load energy consumption); introducing a mechanism to ensure profitability and "bankability" of such projects (energy storage facility earns money by purchasing cheap energy during oversupply periods and selling it during excessive demand periods). However, the progressive saturation of the market with storage facilities, which guarantees system sta-

bility, will lead to a significant decrease in the difference between maximum and minimum prices.

- **Supporting the development of complementary industries** – energy transition will change the economic model, but for it to be socially acceptable, measures to support complementary industries are necessary. These include, in particular, activities to develop: SMEs (e.g., in the fields of tourism, sports and recreation, health services); services in the field of social activation; modern secondary education forms, which should be the base for proper social development and a high level of professional activation of future generations; preservation of air, water, soil and landscape qualities.

The RES sector believes that the **current conditions and potentials** that can be utilized within the just and energy transition process relate to:

- **Human capital** – a large portion of the people employed in mines, conventional power plants and cooperating companies are highly qualified engineers and technicians in various fields, with extensive professional experience. Due to the gradual shutting down of traditional sectors, these individuals should constitute a significant human and competence inflow into existing and new industries in coal regions.
- **The experience and current function of local governments** as stimulators of development processes at the local level, especially in cities located in coal regions. By law, local self-governments conduct activities to satisfy the various needs of local communities – under current institutional conditions, they are key actors in local development, and have more than 30 years of experience in driving development processes. Thus, local governments should share the responsibility for energy policy initiatives, including the creation of local energy policy based on their own energy potential.
- **Organizational solutions related to energy clusters and cooperatives** – already under current conditions, entities of this kind can be key stakeholders in the development of distributed energy (in the legislative sphere, the manifestation of prosumer energy includes, for example, individual prosumers, energy cooperatives and energy clusters).

The new RES sector also recognizes **the significant constraints and barriers** associated with creating a zero-emission economy and implementing just transition solutions. They include the following elements:

- **Low level of coal region community awareness and knowledge in the field of just transition** – currently, especially the traditional sector employees in coal regions, are not at all aware that energy transition should be just. This state of affairs has been fostered by the behaviour of decision-makers influencing ambiguous perception of the energy transition, on the one hand, and

by environmental organizations pushing idealistic models of a zero-carbon economy without paying attention to social aspects, on the other.

- **Lack of a broader dialogue with stakeholders of just and energy transition** – effective implementation of the transition will not be possible without prior dialogue and arrangements with process stakeholders, including fuel and energy companies and their employees, but also local governments, R&D institutions and the new RES sector. This will be a difficult task due to the scepticism and concerns associated with the "coal tradition" within transition areas. Currently, there is a belief among traditional sectors that the *status quo* is the only option for keeping thousands of jobs in the coal, energy and related industries.
- **Absence of a reliable analysis assessing the actual possibilities of the energy transition** – there is a need for a reliable analysis of the economic standing in coal regions, in which the transition will change the social situation associated with the source of income generation and the existing competitive advantage. These regions should be subject to special monitoring by dedicated institutions with knowledge of both local and global conditions associated with modern development processes. These institutions should also be tasked with appropriate change modelling and management.
- **No clear policy on shutting down mines and restructuring conventional power plants** intensified after the deep geological changes triggered by the conflict in Ukraine in 2022.
- **Legal barriers** – so far, the legislator has failed to provide RES entrepreneurs with guarantees of a stable legal environment. There are still many solutions advocated by experts and NGOs to foster the creation of an internally consistent and logical legal system for the new RES sector that have not been addressed by the legislator. The legal system should regulate the broadly understood energy policy, taking into account a sustainable and coherent transition from centralized energy sources to the generation of this energy in the formula of distributed RES sources. The issue of entities that will manage energy sources in the context of ensuring the country's energy security also remains an important aspect. Currently, the main obstacle is an attempt to compare RES energy with conventional power features. It should be noted that one of the biggest constraints on the development of the RES sector is the absence of tariffs for local energy producers, also able to distribute it locally to end users without using the national grid.
- **Economic monoculture** – economic activity in coal regions is largely based on the cooperation between mines and power plants, combined with other enterprises with capital ties to these plants. Some coal regions do not record

new investment as a potential alternative to the existing business model, which mainly cooperates within and around a kind of fuel and energy holding.

Business environment institutions

Adam Drobniak

Business environment institutions (BEIs), including R&D entities and industrial and technology parks, have identified the following as the **desirable change directions** that are associated with just and energy transition:

- **Developing a transition plan** with specific actions to be implemented by 2030 and with a perspective of 2050. Such a plan should define a transition roadmap for each coal region, setting out the postulated vision and change directions to create a low-emission economy and to minimize adverse social effects.
- **Setting out strategic and operational objectives for the policy supporting a transition towards a low-emission economy at state level**, with a reference to individual coal regions. This task involves making sectoral decisions in terms of the traditional industry transition with their simultaneous territorialization to coal region level (sector-territorial coordination).
- **Developing new organizational, financial and legal structures**, including those enabling the broad inclusion of local communities in the just and energy transition process. The currently available technology, e.g., RES, enables implementing the transition. The lack of adequate decision-making, as well organizational, capital and social structures to strengthen the transition to a low-carbon economy remains a problem to be solved.
- **Replacing emission-intensive energy and heat sources with renewable and low-emission sources** to eliminate smog, combined with investing in new energy components, installation and operation, as well as efficient RES-based district heating systems.
- **Developing the circular economy** in coal regions through utilizing resource potential and creating hybrid solutions based on wastewater and municipal waste streams (including sewage sludge), as well as industrial waste.
- **Improving enterprise innovation levels** – providing support for the implementation of solutions aimed at rebranding enterprises towards energy-efficient and climate-neutral industries.
- **Enhancing the transfer of process innovations** from universities and R&D centres to enterprises − possibly through the creation of consortia and joint application for funding of research and development projects.

- **Stimulating the local economic environment** with particular emphasis on the SME and start-up sector, and building platforms for cooperation between local governments, universities, businesses and the local community. The parties should implement activities related to supporting the internationalization of SME activities, organizing economic missions, supporting solutions arising from the assumptions of the Industry 4.0 concept (including the use of digital economy solutions) or solutions that are part of the development of low- and zero-emission transport and passive construction.
- **Undertaking educational activities** targeting wide groups of recipients, to educate current and future personnel for the sectors of industrial processing, transportation, logistics, construction (including passive), circular economy, and taking into account the assumptions of the *European Green Deal*.
- **Undertaking and supporting investment projects to create new or diversify existing value chains** in the field of research, education, creating pilot projects, manufacturing of components and products, as well as sales and logistics.

According to BEI representatives of business environment institutions, **existing conditions and potentials** that can be utilized within the just and energy transition processes include:

- **Local economic and social structures** – in coal regions with R&D entities, business environment institutions, local governments, enterprises, and non-governmental organizations (NGOs) that should be involved in the transition processes.
- **Post-industrial areas**, including post-mining areas. These entities constitute a potential facility base for the construction of RES systems and facilities, including wind power plants, PV systems and hybrid systems based on mine water geothermal and methane resources.
- **Available resources**, among others: geothermal, hydrothermal, solar and wind energy resources, biomass, methane, mine water.
- **Relatively good communication in coal region agglomerations** – such a situation provides opportunities for the relocation of traditional industry employees to new investment sites.
- **Personnel potential**, i.e., workers employed within a transforming traditional industry.

Constraints and barriers associated with the just and energy transition process, as seen through the eyes of business environment institutions, are as follows:

- **Lack of a structured** (supported by parameters) **vision of just and energy transition** and lack of indicated end result of these processes both at the state

level and, more often than not, partially in the coal regions (and not all of them).

- **Lack of functional organizational solutions** (corporate governance) that incorporate and enable the construction of a zero-carbon economy within a commune, district, region, state.
- **Competition between just and energy transition stakeholders** – the lack of cooperation patterns consequently prevents the entire process of transition to a low-carbon economy from being comprehensively executed. Such a complex process implies the need to move away from structures based on maximizing the profit of individual entities, towards building a system for entities to cooperate on a cooperative or quasi-cooperative basis, and to work together for the benefit of local communities and new sectors of the economy.
- **Continuously low social awareness in terms of low-carbon economy** – many people and social groups are unaware of the far-reaching consequences of climate change, and underestimate the risks associated with global warming and air pollution and the impact of these changes not only on health and quality of life, but also on Poland's economy. Changing this state of affairs requires an appropriate system of financial incentives (and penalties), both indirect and direct, such as through innovative waste management solutions.

Mining – conventional energy

Adam Drobniak

According to the mining and conventional power sector, **desired change directions** related to just and energy transition include the following:

- **Diversifying mining and conventional power sector activities** towards RES, circular economy and modern industrial technologies, for which the construction of relevant facilities and knowledge centres is planned. Diversification of the activities linked with financial standing improvement and new jobs in coal regions should be the main focus within the transition to a low-carbon economy.
- **Enacting wide-ranging educational and informational policies** that determine each change and raise public awareness in terms of just and energy transition.
- **Increasing the use of RES potential at regional and domestic levels**, including the release of opportunities, namely, constructing hydroelectric power plants (micro, small, new damming, micro-retention, retention); building

waste-based biogas plants; fabricating wind power plants (unlocking the use of post-industrial, post-mining areas – heaps); constructing PV plants, as well as PV module processing and waste recovery facilities. Within the framework of this direction, the important notions include introducing changes to local land development plans; increasing the intensity of installer and engineer training; subsidizing the cultivation of energy crops and pollution-absorbing plants; increasing the share of biocomponents in liquid fuels; modernizing energy infrastructure (distribution networks, transmission infrastructure, interconnections, development of smart grids); coordinating efforts to increase the availability of electric vehicles and charging stations (along with vehicle subsidies); facilitating changes to electrical systems in homes; increasing the e-mobility population; building energy storage facilities as part of the power system to provide backup for blackouts (this involves rebuilding the system, in the northern part of the country, in particular).

- **Developing passive and energy-efficient construction**: transitioning from "coal or gas boiler" heating systems, to "heat pumps and PVs"; use of air conditioners and canopies (climate warming). New constructions (skyscrapers, office buildings) should be erected taking into account increasing temperatures and energy conservation. This implies adopting new building material standards and enhancing the education of construction engineers.
- **Using mining and conventional power fixed assets to develop new business segments**, e.g., in the field of greenhouse gas storage. This requires amendments in legislation that facilitate running a business, not only by accelerating administrative decisions, but also by applying all sorts of relief to the mining and energy industries. A possible direction for innovative solutions could be, e.g., an underground waste storage technology (including greenhouse gases, e.g., CO_2) that meets 21st century standards.
- **Accessing tax-free funds allocated to investments for companies in the peri-mining sector and related industries**, allowing more efficient transformation of assets and use of human potential in other industries.
- **Establishing special economic zones in post-mining and post-energy areas** – according to the representatives of the traditional sector, indication of such zones and the definition of new development directions should be the responsibility of mining and energy companies, which are most affected by this issue.
- **Lobbying for funding opportunities and development of modern, low-carbon fossil fuel-based technologies and supporting large entrepreneurs** – investments by such entities will be associated with significantly greater job creation opportunities, as well as enhanced social and economic benefits.

- **Taking into account and even legally enforcing the use of secondary components as recyclate, not as waste within the economic processes** – every production, manufacturing and processing procedure includes elements of raw material production and consumption. Each such element entails liquid, solid or gaseous waste generation and emission. Recycling procedures can significantly improve this condition.
- **Introducing via a top-down approach, the percentage use of materials and substances of anthropogenic origin** – this kind of regulation will enhance and expand the circular economy, contributing to the reduction of emissions of undesirable substances in primary manufacturing cycles, and safeguarding the consumption of natural raw materials by limiting their use within primary processes.
- **Ensuring an even distribution of costs and benefits in the implementation of the energy transition** on two levels: among economic sectors and among member states. According to conventional power sector representatives, the discussion on tightening the greenhouse gas reduction target by 2030 should take into account economic and social aspects, including the potential effects of the SARS-CoV-2 pandemic (and now also geopolitical changes resulting from the conflict in Ukraine). Per European Commission estimates, implementing a European climate neutrality strategy by 2050 will require increasing expenditures to 2.8% of the European Union's GDP [European Commission, 2018]. However, member states are at different starting points. As found in an analysis by the Centre for Climate and Energy Analyses [2019], the estimated capital expenditure for Poland's energy sector alone in 2021-2050 may amount to about EUR 179-206 billion (not including the additional costs of purchasing CO_2 emission allowances). The Modernization Fund and the Investment Fund, dedicated as a compensation mechanism under the ETS, will not be able to cover the estimated costs.
- **Reorienting interventions from the JTF** to: (1) large-scale energy sector projects (renewable energy sources, research and development projects); (2) large-scale district heating sector projects (construction of large heat sources, expansion of district heating networks, with financial support for adapting buildings to district heating; (3) retraining and ensuring adequate working conditions for that portion of the workforce that will be most affected by the social effects of the changes (retraining profiles should be preceded by detailed analyses of needs in the future labour market). According to the representatives of the traditional sector, directing JTF to the SME sector alone can be considered a mistake. This sector does not exhibit sufficient potential to implement a just and energy transition on its own. Such a position is

justified by the *National Report – Poland 2020* [European Commission, 2020a], which indicates support for large enterprises as being an essential element of JTF functioning.

- **Supporting just and energy transition in the form of grants or loans** with the possibility of remitting a significant part of the debt for the implementation of transition activities. Particularly for the countries most heavily burdened by the transition costs, it is considered necessary to introduce expanded compensation mechanisms in the form of, among others, significantly increased (in terms of budget) JTF, Modernization Fund and Innovation Fund.
- **Increasing subsidies for the replacement of inefficient and environmentally harmful heating equipment**, providing support for the carbochemical potential of coal, including the development of so-called clean coal technologies, CO_2 capture and storage or utilization.
- **Implementing systems based on water, biomass, biogas, solar, wind, nuclear and gas that are complementary to conventional power generation**: using biomass and waste, electrifying heat sources (in areas beyond the reach of the district heating networks) and producing synthetic gas, establishing heavy industry clusters, producing and utilizing hydrogen, as well as the use of high-temperature reactors (HTR).
- **Developing high-efficiency cogeneration (CHP), expanding and modernizing district heating networks, encouraging thermal modernization of buildings** – so as to improve urban air quality, as well as to increase the share of energy from RES in heating and cooling sectors. Constructing thermal energy storages for use of heat in periods of increased demand; accelerating energy efficiency measures (mainly through comprehensive and massive thermal modernization of buildings combined with a change in heating methods to that more environmentally friendly, with particular emphasis on the employment of system heat).
- **Developing dynamic tariffs**, ***smart home*** technologies and energy-related products and services, including enhancing energy efficiency, commercializing the use of hydrogen fuel and increasing the share of biofuels in transportation.
- **Creating a strong yet flexible energy distribution grid** – the growing share of RES in the energy mix and newly emerging energy consumption needs significantly increase the dynamics of electricity flows in the grid. This creates an urgent need for investments aimed at changing the technology and topology of power grids and their reconstruction at all voltage levels. This also requires improvements to existing transmission lines and the construction of new hybrid transmission networks (HVDC/HVAC).

The traditional sector also draws attention to **current conditions and potentials** that can be employed in the processes of just and energy transition. They include the following elements:

- **Mine methane discharge gas and coke oven gas** – possible use for energy-related purposes.
- **Research and implementation facilities of the traditional sector** – the mining and energy sector is already implementing projects in the field of: (1) photovoltaics (building competence within dedicated RES teams, PV system development within mine sites); (2) CE (recycling of solar systems, reuse of rare earth minerals, silicon or assembly components); (3) alternative use of solid fuels within the gasification process; (4) use of by-products (crushing plant enabling the production of certified aggregates); (5) technology for mixing and homogenization of substrates (residual stone and silt); (6) prevention of adverse environmental effects of mining water; (7) implementation of the Water Framework Directive and the EC package (enabling coal mining, along with improving the wastewater management efficiency in a cost--effective and resource-efficient manner); (8) development of industrial technologies (interdisciplinary teams implementing new technologies in the production process, including robotization, materials engineering, metallurgy).
- **Existing heating networks** – possible use to develop cogeneration (combined heating and power).
- **Mine shafts** – possible use in heat generation and for new coal technologies, and brown and black hydrogen generation.
- **Storage areas, technical and manufacturing facilities** – possible use in the production of components for certain RES, and future planning of recycling, e.g., of PV modules.
- **Stabilized heaps and landfills, backfilled water reservoirs** – potential land use sites for RES (PV and wind farms).
- **R&D institution potential** – studying the possible utilization of the potential in traditional industries to create a zero-emission economy or to diversify these institutions. The current R&D base has human and knowledge resources, as well as numerous projects with companies operating within the fuel and energy sector.
- **Growing public awareness in terms of air quality** – NGOs and local governments are already conducting numerous activities related to reducing smog, and hence, changes in the heating system (including the use of district heating or changing to a lower-emission sources) and in transportation (e.g., developing electromobility, placing restrictions on diesel-powered vehicle

traffic). This gradually builds awareness in terms of the need for a transition toward a low-emission economy. Anti-smog resolutions adopted by local government assemblies confirm this.

- **Availability of funds** dedicated to supporting the just and energy transition: the three pillars of the Just Transition Mechanism, the Modernization Fund, the Innovation Fund, the Cohesion Fund, the European Regional Development Fund, the European Social Fund, national resources from the National Environmental Protection and Water Management Fund.

Constraints and barriers that the representatives of the mining and conventional energy sector see in relation to the processes of just and energy transition include:

- **Legal barriers**, among others: (1) Law on Spatial Planning and Development [2022] (Art. 10(2a): need to designate RES locations above 100 kW); (2) Construction Law Act [2021/2022]: construction permit for PV system above 50 kW; (3) the procedure for amending existing LSDPs usually covers several years (from 1.5 to 5 years) due to the complexity of the plans and the number of consultations; (4) land classification and surveying inconsistent with the current state of affairs; (5) when applying for an electricity grid connection, it is possible to refuse RES connection due to lack of technical conditions (no consequences for the DSO, the only possibility is to appeal to the ERO); (6) lack of clear regulations for RES system for own use; (7) too frequent changes to the RES Act (causing market disruption) and no auction (2020 without RES energy auctions); (8) randomness in the scope of environmental impact reports covering investments, together with the need to develop additional expert opinions, which generate high investment planning costs and prolong the lead time; (9) administrative procedures and regulatory barriers to the development and implementation of new and innovative technologies.
- **Social and administrative constraints** related to fears against wind generators or PV systems. In this regard, it is necessary to educate the public and, above all, the local administrators involved in the process of issuing opinions and decisions related to RES. Moreover, there is an excessive number of over-interpretations and inaccurate data. In addition, energy transition will entail loss of jobs, the need for retraining, a mental change requiring a breaking of ties with multi-generational traditions and operating models.
- **Limited access of the mining and conventional energy sectors to funds of an appropriate scale**, i.e., the scale that would avoid impoverishment of the society in coal regions (a good example in this case is the limitation to the

use of JTF, which does not finance disadvantaged enterprises); investments related to the production, processing, distribution, storage or combustion of fossil fuels (financial support for mining enterprises is essential for the proper introduction of the changes, including involvement in research and development projects in clean coal technologies, development of brownfield sites).

- **Barriers and economic constraints to the transition of the energy sector** related to the cost of technological transition, and the need for financial support to enable the transition of the economy towards low carbon. The *Fit for 55* proposals being processed in terms of changing emission targets in countries such as Poland will result in the need to build a low-carbon energy system within a decade, which, in the light of the long-term nature of the investments and their capital intensity, means that national energy groups will not be able to satisfy these requirements without significant resources from both earmarked funds and commercial financing sources.
- **Constraints introduced by the provisions of the Law on Revitalization (dated 9 October 2015) [2015]** – the statutory provisions do not contain explicit regulations applicable to selected areas of support, particularly those held by entrepreneurs. The act in question should include: (1) amendments to allow revitalization of post-industrial/post-mining areas not covered by the Municipal Revitalization Programs and to ensure real influence on planning concepts related to these areas; (2) identification of rules for the implementation of revitalization projects in the economic sphere, thereby creating conditions for economic activity and the introduction of new activities in post-industrial areas, including post-mining areas; (3) elimination of the percentage limits related to the area and number of residents living in a given degraded area; (4) revision of the criteria and indicators applicable to degraded and revitalization areas in such a way, so that the concentration of negative social phenomena, particularly unemployment, poverty, crime, low level of education or social capital, as well as insufficient level of participation in public and cultural life, do not constitute grounds for their designation (especially for post-industrial areas).
- **Technical barriers for the energy sector** related to the difficulty of maintaining the stability of electricity supply to end users with the growing share of unstable sources. Significant emission reductions will mean the need to shut down existing conventional sources and replace these with low- and zero-emission solutions, including those with electricity storage capabilities. Such an approach requires introducing novel technological solutions and the use of skilled personnel, which is impossible in the short run and requires gradual evolutionary changes.

- **Moderate conditions for the application of certain RES technologies** for geographical and climatic reasons, especially in the coal regions of the Dolnośląskie, Małopolskie and Śląskie provinces (e.g., geothermal, hydroelectric, wind energy), which negatively affects the potential for installed green energy capacity (according to estimates by the Joint Research Centre of the European Commission, this potential, in the case of the Śląskie province, is about 13 GW and is lower compared to other Polish coal regions).
- **High concentration of mining activities in the Śląskie province coal regions** – the scale of traditional industries, such as coal mining, metallurgy or conventional power generation, as well as related industries in Śląskie province's coal regions, is the largest in the EU. This greatly hinders the possibility of a relatively quick and smooth transition to a low- or zero-carbon economy. The high number (compared to other coal regions in Poland) of people employed in the mining industry means that it may not be possible to fully offset the process of downsizing in traditional industries by creating new jobs (e.g., in the field of RES or other green economy industries).
- **Despite potential sources of financial support, limited opportunities to finance just and energy transition**, especially by some local government units, cooperatives and housing communities, and enterprises that are faced with difficult financial situations. The lack of stability and financial surpluses of these entities, which are the primary stakeholders of just and energy transition, will mean difficulties in contributing to transition projects.

Summing up the conclusions of the interviews (cf. Figure 12), it should be noted that the perception of just and energy transition processes varies depending on the different stakeholder groups. Moderate supporters, in the context of implementing low-carbon economy solutions, include stakeholders represented by local governments and business environment institutions. This moderate optimism within local governments probably stems from their awareness in the field of the social effects of the changes that the energy transition will bring in traditional sectors. Such social effects, particularly related to high unemployment, are not unfamiliar to local governments in some of the coal regions. Local governments experienced these effects in the late 1990s and early 2000s, and in many cases were left to deal with labour market and social exclusion issues on their own [Karbownik et al., 1998; Kuźnik, ed., 2003; Nawrocki, 2006; Muster, 2011].

In the case of business environment institutions, their moderate optimism arises from the fact that, while having knowledge of low-carbon, including green and digital economy solutions, they are fully aware that their implementation of the economy requires unique knowledge, competence, experience and often political will. It also proves to be a process extended over time, especially for coal regions with high levels of economic monoculture and weak institutional facilities.

The new RES sector is among the biggest proponents of the *European Green Deal*. The success of often limited in scale, but nevertheless viable projects, has convinced this sector of the significant market potential associated with PV systems, for example. However, many more issues related to implementing the green economy remain to be addressed and marketed. Still, the green turn is perceived by this sector as a strategic opportunity to gain a competitive advantage.

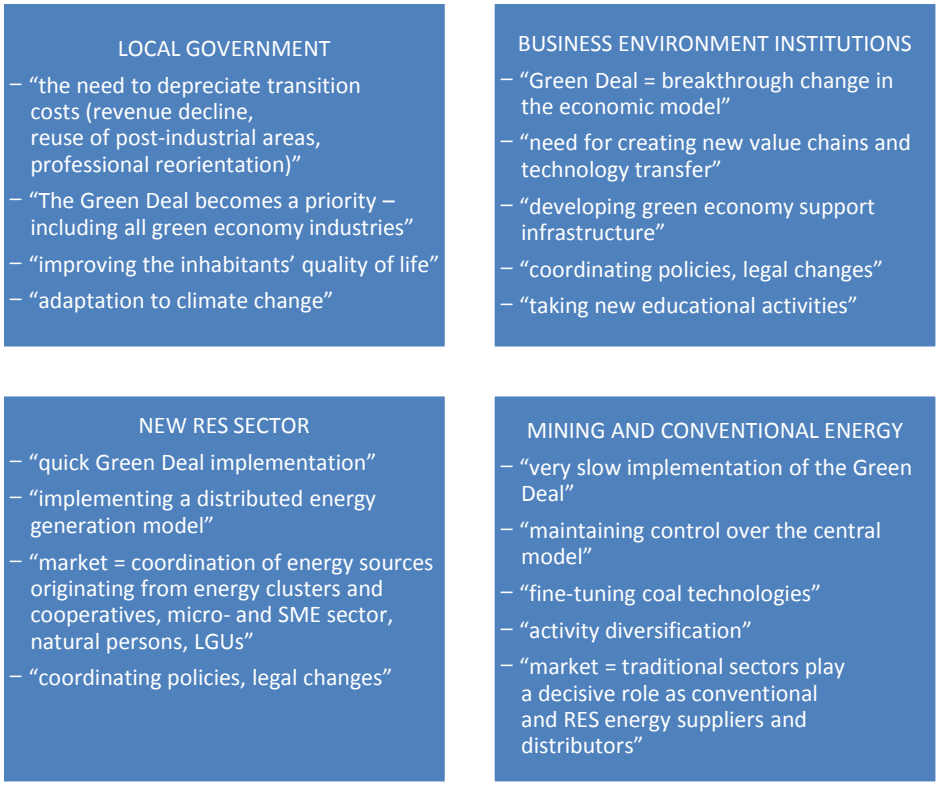

Figure 12. Statements by main just transition stakeholders

Source: own study.

The traditional sector, i.e., primarily mining, conventional power generation, peri-mining and related industries, is the least optimistic about the energy transition process, as well as just transition. Green transition represents a kind of an "assault" on the fundamentals of its long-standing operation. Moreover, EU regulations [European Commission, 2021] leave little room for the sector to be included in the support that finances the transition.

Synthesizing the considerations covering the opinions of the main transition stakeholder groups enables advancing a proposal to include them in the formula of strategic stakes depicting the mutual potential relationships between these entities within the transition processes (cf. Table 22). The arrangement of these relationships, in terms of cooperation – neutrality – conflict, is the resultant of opinions arising from the interviews. They demonstrate that local government units, together with the new RES sector and business environment institutions, form a potential alliance interested in the relatively rapid implementation of technological change towards a low-carbon economy. Relationships among this group of entities are based on the exchange of knowledge and the possibility of joint implementation of the solutions.

Table 22. Strategic stakes of just transition stakeholders

	Local government units	**New RES sector**	**Business environment institutions**	**Mining and conventional energy sector**
Local government units		Cooperation to increase the RES potential, zero-carbon economy solutions, diversification of energy sources	Cooperation in acquiring knowledge on RES solutions, low-carbon economy, diversification of energy sources	Neutrality, potential conflicts over brownfield sites, transition rate, recognition of cooperation opportunities
New RES sector			Cooperation in creating and pilot implementation of novel solutions	Conflict over the energy market model and access to support measures
Business environment institutions				Neutrality, potential cooperation conditioned upon availability of support measures
Mining and conventional energy sector				

Source: own study.

Relationships of neutrality, potential conflict or cooperation occur between local governments and the traditional sector (mining and conventional energy). Potential conflicts, but also potential cooperation, may arise in the context of the acquisition and development of brownfield sites, especially in situations where these sites are located in urban centres or district centres. In such a case, the strategic stakes involved in the future development of brownfield sites can be both convergent (in the case of coherence of the revitalization vision) and completely opposite (leading to a conflict).

Neutrality of strategic stakes also appears in the case of relationships between the traditional sector and business environment institutions. Admittedly, a number of the latter have been cooperating with the traditional sector for decades (research institutes specializing in mining and conventional power issues), however, their sectoral ties are significant and often subordinated to the strategic orientation of large fuel and energy sector companies. Changing this relationship towards the transfer of knowledge regarding low-carbon economy solutions will be conditioned upon appropriate targeting of support funds for this purpose.

In the course of analysing the strategic stakes among stakeholders of the just and energy transition processes, it should also be noted that a situation of conflict is emerging between the new RES sector and the traditional sector. This dispute plays out on many levels, from the energy model, the preservation of control over this model, and to regulatory changes, as well as the access to transition support funds. Its resolution, however, is in the hands of policy-makers, the tasks of whom is to create a viable vision for energy and just transition, and to generate a sound foundation for advancing the legislative and financial conditions for its implementation.

2. Development concept selection for the transition of Poland's coal regions

Adam Drobniak

Poland's coal regions exhibit a high diversity of internal conditions under which their social and economic transition will take place (cf. chapter II and Table 23). There is a great difference in the intensity of issues and challenges in each of the regions, discussed in the second part of the study from the perspective of the demographic, economic, institutional, spatial and environmental aspects.

Table 23. Coal region portfolio based on the portfolio assessment of the context (initial state)

Coal regions	Demo-graphic	Economic I	Economic II	Institu-tional	Spatial	Environ-mental
Wałbrzych						
Zgorzelec						
Lublin						
Bełchatów						
Bielsko-Biała						
Bytom						
Gliwice						
Katowice						
Rybnik						
Sosnowiec						
Tychy						
Western Małopolska						
Eastern Wielkopolska						

Designations:

	Very high intensity of issues and challenges within a given context (5)
	High intensity of issues and challenges within a given context (4)
	Average intensity of issues and challenges within a given context (3)
	Low intensity of issues and challenges within a given context (2)
	Negligible intensity of issues and challenges within a given context (1)

Source: own study.

In organizing the considerations as based on a summary of the scale of problems and challenges that are associated with the transition of Poland's coal regions, their following categorization can be suggested:

- **Transition-friendly regions** – are places where the transition will find potentially fertile ground. Regions of this type already have a well-developed, including diversified economic structure that is based on new economic activities unrelated to traditional industries. These are areas where excessive environmental or large-scale brownfield problems are not registered. Only one coal region – Bielsko-Biała − is classified as such in Poland.
- **Difficult-transition regions** – ambiguous places with already present social, economic and institutional structures that have been transformed to a significant degree; and, as well, reveal good examples of post-industrial area reclamation. Simultaneously, these are regions where the scale of activities related

to traditional industries is still very high. In the economic and spatial sense, these coal regions are kind of a patchwork of processes associated with modernization and with maintaining the *status quo* in terms of traditional industries. This group includes the coal regions of Bytom, Gliwice, Katowice, Sosnowiec, Tychy and Western Małopolska.

- **Extremely difficult-transition regions** – are locations where the scale of demographic, economic, institutional, spatial and environmental challenges is very significant. Decades of heavy reliance on traditional industries are manifested in both their economic monoculture, lower settlement attractiveness, weak institutional capacity and environmental problems. A transition under these conditions can be a complex process that is exposed to a number of risks, including social risks associated with protests. These regions include Zgorzelec, Bełchatów, Rybnik and Eastern Wielkopolska.

Using the indicated coal region typology enables proposing matching them with the development concepts applied in programming the development and transition of the regions, analysed in the first part of the publication. The purpose of such matching of development concepts to different types of coal regions is to ensure greater consistency between the peculiarities of a particular coal region and the change mechanisms that are characterized by each development concept.

In the case of **transition-friendly regions** (the Bielsko-Biała region), the consequences of the previous dependence path are significant, albeit not to the same extent as is the case of extremely difficult-transition regions. The transition-friendly regions have been able to develop a new development path and their current progress is no longer based on traditional industries. What is worth building development processes upon in this group of regions, are the concepts of resilience, as well as of complex adaptive systems and of associated and unrelated diversity. Similarly, recommendations arising from the concepts of regional innovation systems and smart regional specializations should be of great importance in their case. Moreover, recommendations resulting from concepts related to institutional capacity building, attracting foreign investment and regeneration economics, should also be further investigated. The concept of the geography of discontent is of marginal significance to transition-friendly regions, since the vast majority of human capital is already engaged in economic activities unrelated to traditional industries.

In the case of **extremely difficult-transition regions**, an important point to start thinking about change is to go beyond the existing development conditions, as indicated by the concept of the dependence path. In the context of these regions, it is difficult to talk about the full application of the recommendations

based on the concept of resilience, because the change in socio-economic structures within these areas has not yet taken place, i.e., there has been no release of funds to base the process of building resilience in the future upon. Similarly, the conclusions of the concepts of comprehensive adaptive systems and development hybridization can be applied to these regions in a limited way. The concept of related diversity will also be of little importance in this case, assuming that the economic profile diversification in these locations should tend towards new industries of the economy. Therefore, the concept of unrelated diversity, also that based on direct investments, including foreign investments, may turn out more helpful. In relation to the transition of such regions, concepts derived from regional innovation systems and smart regional specializations are also of limited importance at the current stage of their development. The analysed group of regions (Zgorzelec, Bełchatów, Rybnik and Eastern Wielkopolska) is characterized by a relatively large economic monostructure, which so far has not developed the resources, knowledge, skills and institutional capacity to quickly adapt the benefits provided by regional innovation systems and smart specializations. On the other hand, the concept related to the geography of discontent can be given great importance in extremely difficult-transition regions, on the other hand, concepts associated with regeneration economics and adaptability can be employed in a skilful way, i.e., by gradually building "from the bottom". Due to the location of the analysed group of regions, including the relatively small scale of their urban centres, the concept of the polycentric city region is less relevant to their transition.

An interesting case of the selection of development concepts are the **difficult-transition regions**. These are places which, due to the diverse scale of their social, economic, environmental, spatial and institutional problems, do not represent such a relatively easy case of the selection of development concepts as the transition-friendly and extremely difficult-transition regions. Hence, the matching of development concepts in this case should be even more balanced and adapted to the specifics of the place. In general, in the transition of this category of regions, all of the development concepts analysed may prove helpful in laying new foundations for their advancement, albeit to varying degrees. It is likely that all of these regions will see the effects highlighted by the concept of development hybridisation due to the simultaneous co-occurrence new and traditional industry structures. The concept of a polycentric urban region built in a strip of southern Poland with Wrocław and Kraków, as well as with Ostrava, which lies to the south in the Czech Republic, may be of great importance in the case of the Katowice subregion. However, the concept of institutional capacities, which are

de facto already well developed herein, may be of lesser importance for this subregion. These, in turn, may prove to be very important for the Lublin and Wałbrzych subregions. Similarly, very important conclusions in terms of creating new development paths for these two subregions and the Bytom subregion, may arise from the concept of direct foreign investments. The concept of the geography of discontent is less relevant for the Wałbrzych subregion due to the lack of human capital linked to traditional industries, since the mining sector was shut down in mid-1990s. In contrast, the concepts related to regional innovation systems and smart regional specialisations, mainly due to the accumulation of significant scientific and research potential and other business environment institutions in these places, are of great importance to the development of the Katowice and Gliwice regions.

The proposed categorisation of coal regions, based on the scale and nature of their transition-related challenges and the selection of development concepts in this context, allows for a more rational programming of their future development. Rationality manifests itself primarily in better matching the conclusions of a given development concept to the specifics of individual coal regions. Such a way of proceeding reduces the risk of formulating transition priorities, objectives and projects that are of little relevance to the specifics of the transition-related challenges for individual coal regions and are not supported by relevant causal mechanisms (characterised by the development concepts), thus having low feasibility and socio-economic viability.

Table 24. Matching the development concept to the specificity of Poland's coal regions

Coal regions	Path dependence	Resilience	Comprehensive adaptation systems	Related diversity	Unrelated diversity	Development hybridization	Regional innovation systems	Smart regional specializations	Lagging-behind regions and the productivity gap	Discontent geography	Direct foreign investments – global value chains	Institutional capacity	Polycentric urban region	Regeneration economics
Wałbrzych	++	++	++	++	++	+++	++	++	++	+	+++	+++	+	++
Zgorzelec	+++	+	+	+	+++	+	+	++	+++	+++	++	++	+	++
Lublin	++	++	++	++	++	+++	++	++	++	++	+++	+++	+	++
Bełchatów	+++	+	+	+	+++	+	+	++	+++	+++	++	++	+	++
Bielsko-Biała	+	+++	+++	+++	+++	+	+++	+++	+	+	+++	+++	++	+++
Bytom	++	++	++	++	++	+++	++	++	++	++	+++	++	+	++
Gliwice	++	++	++	++	++	+++	+++	+++	++	++	++	+	+	++
Katowice	++	++	++	++	++	+++	+++	+++	++	++	++	+	+++	++
Rybnik	+++	+	+	+	+++	+	+	++	+++	+++	++	++	+	++
Sosnowiec	++	++	++	++	++	+++	++	++	++	++	++	++	+	++
Tychy	++	++	++	++	++	+++	++	++	++	++	++	++	+	++
Western Małopolska	++	++	++	++	++	+++	++	++	++	++	++	++	+	++
Eastern Wielkopolska	+++	+	+	+	+++	+	+	++	+++	+++	++	++	+	++

Designations:
+ This concept falls in line with the issue of a given coal region's transition to a lesser degree.
++ This concept falls in line with the issue of a given coal region's transition to a higher degree.
+++ This concept falls in line with the issue of a given coal region's transition to a very high degree.

Source: own study.

3. The future of Poland's coal regions in the context of green economy – contributions for foresight studies

Artur Ochojski

Foresight studies may be the foundation to identify processes conditioning the future of Poland's coal regions in the context of a green economy. According to the adopted canon [Klasik, Biniecki, Ochojski, 2014], the foresight approach takes at least two orientations-perspectives into account. The first heuristic and systemic perspective is directly related to the search for answers to the question: *what is the essence of the field to be analysed?* The second perspective refers to a situational and exploratory orientation evidenced through the search for answers to the question: *under what conditions will we operate in the future?* Both of these perspectives can be the subject of a broader approach – strategic foresight, which takes into account two further perspectives, i.e., the axiological and normative perspective that is linked with the search for answers to the question: *what kind of future do we want?*, and the strategic and decisive perspective, expressed in the search for answers to the question: *what actions should be taken so that, taking into account future conditions, it is possible to create the desired future?* The foresight approach was adopted within this study; however, without exploring its strategic context. Nevertheless, following the development of external condition scenarios ("evolution scenarios"), the consequences of these scenarios towards the situation diagnosed in the transforming coal regions were assessed. A pre-condition for conducting the situational and exploratory analyses was a heuristic and system review, discussed in chapters I and II.

The review of thematic studies dedicated to the issue of fair transition and the macroeconomic situation in Poland and the EU involved an assessment of the social, economic, institutional and environmental situations, taking into account their spatial components. The trends formulated on this basis were subjected to an expert assessment, with an identification of those key ones that significantly condition the situation within coal regions. It should be noted that these trends are not only of current significance (at this point of time, they are occurring in a way that permanently affects the socio-economic situation), but will also impact the next year or so. The adoption of such a time perspective, different from many foresight studies working with distant time frames, results from the current geopolitical and economic situation, which enforces more cau-

tious assessments of future development conditions in the coal regions of Poland.

Five socio-demographic trends, nine trends identified in the economic context, seven institutional trends and five trends of spatial and environmental provenance can be considered as the most important processes conditioning both the current and future transition of coal regions (cf. Table 25). What characterises our country today from the demographic perspective is, on the one hand, the depopulation process (a negative phenomenon due to the loss of people mobile in terms of skills and age), and, on the other hand, an ageing population. Of course, one can observe a significant migration movement caused by the armed conflict in Ukraine, triggering an increase in the population in Poland. A trend towards increasing multiculturalism in society can also be observed. This is determined by the growing number of foreign companies and the aforementioned immigration from Ukraine and other countries. Contemporary disparities in territorial development also translate to increasing marginalisation of disadvantaged groups. Last but not least, an important social process is the growing importance of acquiring experience, skills and knowledge in the field of the digital world. A consequence of this may be the hitherto unknown phenomenon of a significant deepening of independent learning in separation (significant, almost total) from the education system.

Table 25. Coal region surroundings – processes conditioning the current and future transition

D1	The persisting negative phenomenon of depopulation in the country and the negative balance of migration – outflow of mobile people both in terms of skills and age, temporarily compensated by emigration from Ukraine
D2	An ageing society generating new or reinforcing existing challenges of family care, social assistance and coping with the challenges of civilisation
D3	Increased society multiculturalism, in metropolitan areas and large cities, in particular
D4	Risk of an increasing marginalisation of disadvantaged groups
D5	Further growth in the importance of the digital world as the foundation for acquiring knowledge and skills, deepening the independence of learning from the education system
Ec1	Rapidly changing labour market conditions and needs, as well as labour market pressure for higher competences, skills related to occupations of new and transforming industries (medicine, energy, ICT, industry 4.0, etc.)
Ec2	Degree of independence of local labour markets from traditional industries still maintained at a relatively high level
Ec3	Relatively low level of employment and professional activity of the inhabitants, also in the post-working age group
Ec4	High employment rate in sectors directly associated with the mining industry, estimated in the 1.16 to 1.35 range, and vast affiliation chains

Table 25 cont.

Ec5	Increasing marginalisation of social groups, increasing economic and social poverty and reinforced loneliness (understood as broken bonds in peer groups, e.g., in schools or work environments), among other consequences, of epidemic pressures and global challenges in the years 2020-2022
Ec6	Insufficient innovation level of enterprises resulting in low economy internationalization
Ec7	Insufficient funds allocated to innovation and R&D activities, and a continuously low level of science-business cooperation
Ec8	Developing trend of economic changes and transition toward digital, green and creative economy industries, which requires significant systemic support
Ec9	The prospective nature of the logistics, transport and construction sectors capable of absorbing workers from the mining and mining-related industries, conditioned upon the stabilisation of the financial and commodity market situation and the stabilisation of the geopolitical situation
I1	Insufficient but growing stakeholder capacity to effectively manage the transition process, combining top-down and bottom-up approaches
I2	Weakening economic strength of local governments, which translates to lost investment capacity, resulting from the deepening LGU financial system collapse, periodically rescued by ENP funds
I3	Unfinished economic transition processes from the 1990s in the spatial and functional, economic and social spheres, leading to land degradation, social problems and loss of the economic base
I4	Lower effectiveness in human resource vocational training – ageing personnel, obsolete equipment and teaching infrastructure
I5	Vast practical and educational experience in the field of revitalization, readaptation, regeneration, reclamation, renaturization, decontamination and remediation processes related to post-industrial areas, including post-mining
I6	Extensive European Commission and national programmes supporting the arrangements of the *European Green Deal*, which constitute support for coal region transition, and which have been developed since 2015
I7	Market destabilization due to the prolonged impact of the SARS-CoV-2 pandemic and the Russian military aggression against Ukraine, and the associated global economic consequences
En1	Decreasing amounts of agricultural land and green areas as a consequence of the deepening suburban area urbanization process
En2	Growing economic importance of implementing processes characteristic for circular economy (including new and alternative products, reducing waste collection fees)
En3	Growing share of renewable sources energy generation, yet still insufficient on the national scale, also due to the low efficiency of system networks within urban and suburban areas
En4	Significant air pollution burden of the living environment in periods of increased heat demand in traditional coal subregions
En5	Deepening climate change pressure, which generates additional burdens for local natural ecosystems and the living environment (including droughts, winds, fires, extreme temperatures in developed areas)

Source: own study.

In the economic sphere, the main trends to be distinguished are those related to the labour market and its transition. These include not only new professions, changing competence expectations as a result of the new economy development or the dynamic transformation of selected industries, but also the local dependence of some labour markets on traditional industries (also in terms of education). This is compounded by the processes of the continuously insufficient level of innovation among business entities, as well as science-business relations that are difficult to develop or a relatively low employment rate.

In the institutional sphere, we are dealing with the increasing potential of stakeholders and their importance related to the effectiveness of the transition process, accompanied by the historical backwardness of the transformation that has been ongoing since the 1990s, despite the vast implementation experience of Poland's coal regions in urban regeneration processes (including economic and environmental regeneration). On the other hand, we see the weakening economic power and financial independence of local governments. Two institutionally significant processes that have shaped and continue to shape the civilizational situation in terms of economy and society are the destabilisation of markets as a direct consequence of the pandemic and the war in Ukraine, and the environmental demands of the *European Green Deal*.

The trends observed within the environment are, on the one hand, the reduction of dedicated agricultural and green areas due to investment (development) activities and climatic pressure on ecosystems, including the human habitat, and, on the other, a range of pro-environmental activities with a greater or lesser level of success and the specificity of conditions that can determine it.

The set of mentioned trends was subjected to a structural analysis, identifying direct, followed by indirect, relationships. The expert assessment method applied revealed 650 direct impacts within the set, which were rated on a scale of 0 to 3. The strongest impacts were rated as 3, while the lack of influence on the evolution of a trend was marked as 0. The result of the structural analysis, taking into account both direct and indirect links (MICMAC software was used to this end), is a set of three trend types (cf. Table 26). The first group, the so-called "causative trends" (with the highest mobility and low dependency) includes: Ec7, I6 and I7. The second group, i.e., trends with a high mobility level, but also a high level of dependency on others, referred to as "unstable trends", includes: Ec1, Ec6 and Ec8. Importantly, these are trends of the economic context, with a strong link between Ec6 and Ec8. And finally, the third group, which includes trends with a low mobility level and a high dependency level, referred to as "resultant trends". It comprises: Ec2, Ec3, Ec5, Ec9, D2, D4, I2, I3, I4, and En2 and En4.

Table 26. Trends conditioning the development of Poland's coal regions – mobility–dependency arrangement

Mobility	– (low)	+ (high)
+ (high)	Motor trends: Ec7 I6, I7	Unstable trends: Ec1, Ec6, Ec8
– (low)		Dependent (result-based) trends: D2, D4 Ec2, Ec3, Ec5, Ec9 I2, I3, I4 En2, En4
	– (low)	**+ (high)**
	Dependence	

Source: own study.

The graph method was used to identify cause-and-effect relationships. The chains of related trends identified on this basis enabled identifying two scenarios (cf. Figure 13) for the evolution of changes extracted from the dynamics model of Poland's coal region development conditions. As presented in the dynamics model, not all mobility processes, unstable and resultant, can be considered co--correlated and projecting the likely future transition of coal regions.

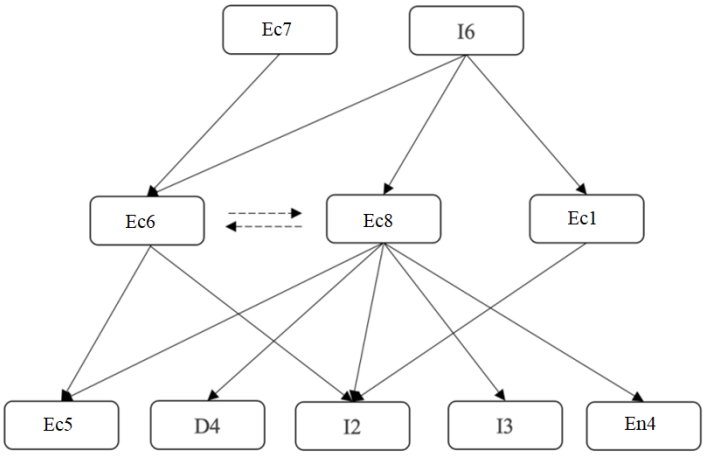

Figure 13. Coal region development determinant dynamics model

Source: own study.

Poland's coal region development determinant dynamics model forces us to settle the fundamental question related to the essence of the possible and probable scenarios. It can be seen that we are dealing with two processes initiating

change sequences, namely, a negative economic process which, if consolidated, will determine further transition (or, in principle, the stopping of economic modernisation processes), and a positive institutional process determining new economic and competence opportunities. The consequence of these scenarios is the transition of the interrelated economic, demographic, institutional and environmental-spatial aspects.

Scenario A. Increasing investment and network backwardness of business and science

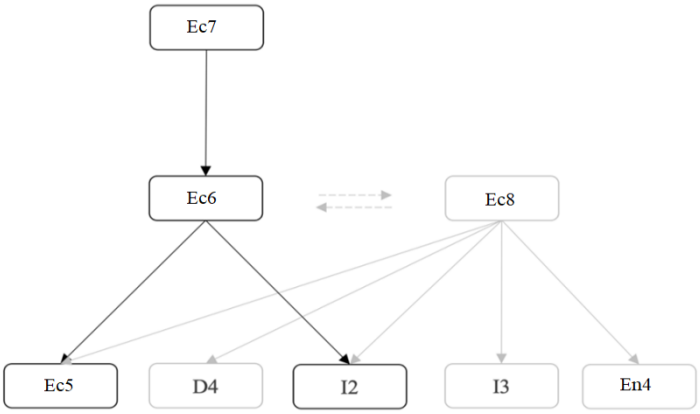

Figure 14. Development condition scenarios for Poland's coal regions – scenario A

Source: own study.

In Scenario A (cf. Figure 14), coal regions are exposed to **further marginalisation of international competitiveness of businesses due to low investment levels and lack of business-science cooperation**. In consequence, the absence of a solid economic base in the transforming regions does not facilitate dealing with the phenomenon of economic and social poverty. Due to the interrelated processes of low innovativeness of enterprises and insufficient systemic support for the development of creative, green and digital economy industries, there will be a persistent "suspension" of the transition processes initiated within these regions, pollution burden of the environment and a marginalisation of disadvantaged groups. This scenario is a negative one, wherein the public intervention mechanisms of the *European Green Deal* programmes have not worked out well. Coal regions wherein the economic situation is relatively the most difficult, are particularly exposed to such developments. Indeed, the effectiveness of the pro-development activities of local authorities generating investment projects

that condition new social, environmental or economic opportunities turns out to be severely limited not only by the deepening low economic power level, but also by the lack of exogenous incentives for the development of these regions.

Scenario B. New just transition development dynamics

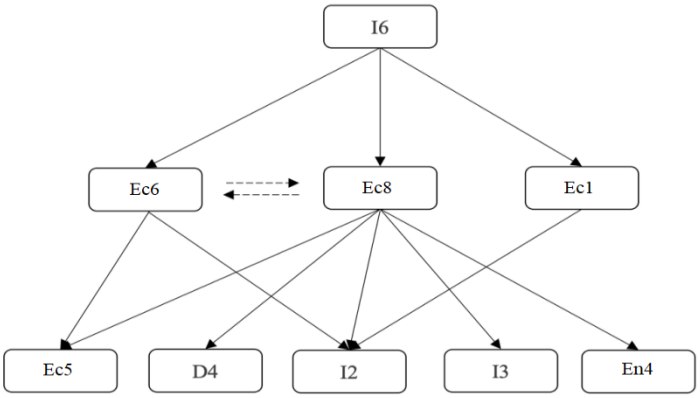

Figure 15. Development condition scenarios for Poland's coal regions – scenario B

Source: own study.

Under scenario B (cf. Figure 15), coal regions have the **opportunity to gain a new opening and a strong development stimulus through dedicated support programmes in the perspective of the *European Green Deal***. This scenario assumes that economic processes underpinned by prospective changes in industries, including transitions towards a green, digital and creative economy and meeting labour market expectations in terms of competences and occupations in, among others, medicine, energy, Industry 4.0 or ICT, will be supported in terms of investment. The consequence of such activities is more than just a reduction in the risk of disadvantaged groups in coal regions being marginalised or a reduction in the economic and social poverty in these regions, it also means new opportunities for local governments, the economic situation of whom is stabilised owing to smaller social transfers, higher revenues and access to EU funds. Local economic environments thus are gaining the opportunity to complete the transition process commenced in the 1990s. The living environment is improving as a consequence of reversing the degradation of the urban fabric and a reduction in the environmental burden through, among other things, low-emission gases and dust.

4. Strategic recommendations for programming just transition in Poland – central and regional levels

Adam Drobniak

Given the postulate of achieving high usability of the conducted research, proposals for strategic recommendations for the programming of just transition within Polish coal regions have been formulated. The recommendations are the result of the research and analysis conducted in the study, and relate, notably, to causal impulses of the energy transition, the concept of just transition, contemporary concepts of programming regional development, a synthetic diagnosis of Polish coal regions (together with the identification of their specifics using a portfolio approach), conclusions from interviews conducted with just transition stakeholders and their strategic stakes, and, finally, scenarios of external conditions affecting the potential future situation in coal regions formulated in the course of foresight thinking.

Finally, strategic recommendations were formulated at two levels, taking into account the context of just and energy transition programming in Poland, the interpenetration of territorial and sectoral transformation processes in particular. The first relates to the **national/central level**, which focuses the postulated intervention on the central level (e.g., legislative and information issues, institutional support, changes in State Treasury companies) and on all coal regions. This type of proposed intervention is central-sectoral in nature and targets solutions that are feasible at the government level. The second tier of the proposed strategic recommendations relates to coal **region level** and includes solutions that are feasible at the regional level, meaning that they are better tailored to the specificities of individual territories. It should also be emphasised the principles of subsidiarity was applied in proposing this approach to formulating strategic recommendations for the transition of Poland's coal regions, i.e., national and regional.

Central level

Adam Drobniak, Paweł Churski, Rafał Muster, Alicja Zakrzewska-Półtorak, Marcin Baron, Agnieszka Rzeńca, Łukasz Trembaczowski

Implementing energy transition-related changes, including green economy solutions in a way that ensures a just transition, especially within Poland's coal regions, requires a bold vision, a multidimensional, multi-stakeholder, as well as a sectorally and territorially coordinated approach. Above all, however, a dialogue between the stakeholders in this transition proves necessary.

The widespread use of RES-related activities – saving energy, water, raw materials and promoting green transport – is already taking place in Western European countries. Incorporating these in Poland presents fundamental civilizational challenges for the entire Polish society and national economy. However, postponing this change in time will lead to the widening of the development gap between Poland, EU countries and world leaders in the green revolution. The gradual decrease in the cost of low-carbon technologies, RES in particular, which has been taking place over the last two decades, results in the progressive availability of such solutions. In such conditions, abandoning, postponing or minimising the green transition will result in a significant weakening of the competitiveness of Poland's economy in the future, not only in terms of its cost position, but also in terms of living conditions, investment and settlement attractiveness [Krzysztofik, 2012] and the country's image.

The breakthrough technological change driven by green economy solutions (e.g., RES, passive construction, eco-transport, circular economy, water management, green infrastructure and spatial development) combined with the digital economy, in order to be socially accepted and become a stimulus for the advancement of the country's economic development, requires a comprehensive approach towards this process from the following perspectives: social, economic, spatial and related to development programming at the national level. Priorities on which to focus efforts and resources include: (A) A new social contract; (B) New sources of economic development; (C) New development spaces; (D) New institutional capacities and an integrated approach to development programming (cf. Figure 16). From the perspective of just transition, the overall goal remains to seek to improve the socio-economic situation of those incurring the energy transition costs, together with the creation of new development paths.

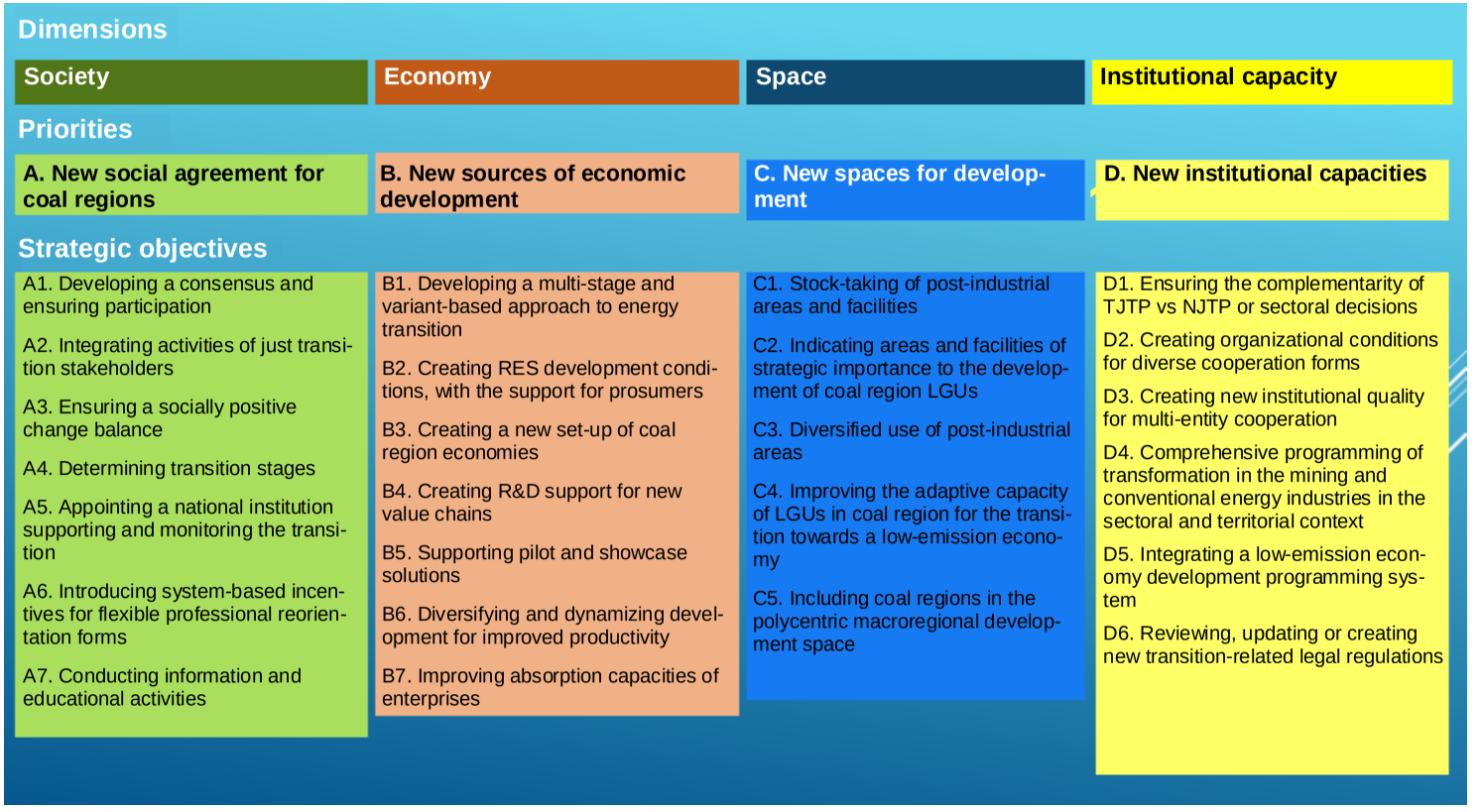

Figure 16. Domestic-level just transition programming: dimensions – priorities – strategic objectives

Source: own study.

Social aspect – a new social agreement for coal regions is a priority

In the coming decades, the *European Green Deal* will be associated in coal regions with significant change, not only technological and economic, but above all – social. Just transition means equal access to environmental resources (water, clean air, greenery areas), labour market, infrastructure and social services, eliminating development-related disproportions to ensure high quality of life and long-term development opportunities. In the case of coal regions, unless appropriate measures are taken to mitigate change and stimulate development, the energy transition to a low-carbon economy is likely to have the greatest negative effects on the labour market and on accessibility to infrastructure, hence, widening disparities and decreasing development opportunities in these areas. Such a significant change, from the perspective of the existing coal region economic base, obviously raises concerns and emotions among stakeholders of the process. Therefore, the strategic objectives in the social aspect focus on:

- **A1. Developing a consensus and ensuring participation** – stakeholders' concerns about the effects of the energy transition and its social consequences justify the need for a new, broad social agreement based on **working out a consensus between the social side, government, local government, business (the new RES sector and traditional industries), the scientific sector, business environment institutions, and NGOs**. Energy transition is a process spread over time, which includes, with a view to Poland's energy security, co-existing dispersed (RES technology) and centralised (traditional technologies) energy supply systems and the stakeholders associated with them. Effective use of **participation mechanisms** enables the formulation of expectations and doubts expressed by each party, plays a conciliatory and educational role enabling the identification of strategic stakes and minimizing risks, and is a basic condition for social inclusion to develop acceptable solutions in the form of a national just transition strategy. The lack of participatory mechanisms and stakeholder cooperation will result in polarised positions and exclusively sectoral arrangements, making it essentially impossible to achieve a socially just energy transition.
- **A2. Integrating the activities of just transition stakeholders in coal regions and at the national level** – the current activities of local government units and ministries, the Platform for Coal Regions in Transition, international institutions (e.g., World Bank, EIB, WWF), NFEPWM, energy clusters, the mining and conventional energy sector, universities, R&D institutions,

technology parks, the business sector and special economic zones, trade unions, industry associations and NGOs, take far dispersed forms of cooperation in the relation to energy transition. The integration and coordination of the just and energy transition stakeholders, including the creation of a platform for the exchange of information, knowledge and experience, and to consult solutions at the national level, become essential for the development of a broad new social agreement. Cooperation in the field of just and energy transition, taking place to a greater or lesser extent at coal region level, should develop over time into a national organisation within a network structure.

- **A3. Ensuring a socially positive balance of changes** – a leading priority of the new broad social agreement is the pursuit of a socially positive balance of technological and economic changes that is reflected in a responsible distribution of costs and benefits, according to the 1:1+ principle, i.e., the loss of value in traditional industries should be compensated by the creation of at least equivalent value in new activities. The pursuit of a consensus and the application of the 1:1+ principle appear to be the basic conditions for **minimising the phenomenon of the geography of discontent**, which poses the greatest threat to the transition within Poland's coal regions. These areas are mostly characterised by "negative lock-in", meaning a distrustful approach to change and resistance to it in the social aspect, resulting from the hitherto stable functioning of traditional economic structures. Mitigating such phenomena requires involving all stakeholders in the creative processes, and not only in liquidation activities. Just transition is an environmentally, economically and socially sustainable process that should be well managed and should ensure the achievement of decent work, social inclusion and poverty eradication [International Labour Organization, 2015]. This process may also include energy transition. **However, just transition should not be replaced by energy transition, and by treating the latter more as a priority and an economic aspect of the changes** taking place under a wider, multifaceted transition process, especially in areas heavily dependent on the monopoly of mining and energy activities, i.e., coal regions.
- **A4. Defining transition stages** – the implementation of A1-A3 targets requires the definition of a clear time frame for the transition towards a low-carbon economy at the national level. The current arrangements of the strategic documents by various ministries are inconsistent in this matter. The lack of such arrangements leads to the incoherence of the decarbonisation process due to the natural inertia of social, economic and political forces interested in preserving the current *status quo*. In today's changing geopolitical circum-

stances, the rate of the decarbonisation process should be variant-based, i.e., built upon different balances of social (e.g., coal region absorbability of the human capital released by the mining and conventional power sectors, mining-related industries and related sectors), and economic (e.g., determining the profitability of extraction from deposits in individual mines) premises, as well as premises related to the country's energy security (e.g., the rate of technological change in terms of diversification of energy sources). The decision on the scale and of decarbonisation taken at central level must not adopt a DAD (decide-announce-defend) formula, but should be open to public discussion (announce-discuss-decide) using a participatory formula. A participatory decision increases the change of the process to be a success. It involves the sharing of responsibility among stakeholders who will come up with a compromise solution. This solution may run the risk of producing less ambitious time frames for coal phase-out, albeit being socially acceptable.

- **A5. Establishing an institution to support and monitor just and energy transition processes**, with such tasks as conducting diagnostic research and strategic recommendations related to the transition, supporting coal regions in the transfer of information, knowledge and best practices, providing strategic and technical assistance related to the development of transition projects, establishing partnerships and alliances for building new value chains (including matchmaking partners from such sectors as local governments, traditional industry, R&D institutions, education, new RES sector, BEIs), as well as advising on decision-making processes at national level. An institution of this kind could play the role of a coordinator of territorial and sectoral change processes.
- **A6. Introducing system incentives for the benefit of flexible forms of reorientation** of people associated with the mining and conventional power sectors, mining-related industries and related sectors. The ability of coal region economies to quickly absorb people leaving their jobs in the aforementioned sectors, assuming that a large part of their competences can be applied in the new energy sector, especially in the post-pandemic era, is very limited. The assumption of a complete "traditional industries – new industries" substitution seems very risky, even in the case of relatively economically diverse and internationally integrated value chains (albeit often at the level of primary products) of several Śląskie province coal regions. Moreover, each of the Śląskie, Dolnośląskie, Łódzkie, Wielkopolskie, Małopolskie or Lubelskie province coal regions have different economic characteristics, including industry structure, levels of economic and institutional development, as well as employment level, which differently affect the ability of their economies to absorb people leaving traditional sectors. Mitigating the aforementioned

problems requires systemic changes within the labour market, which are only possible at the central level. For example, this is a reference to regulations related to supporting people leaving traditional sectors, who are still employees and in transition, as well as labour market instruments targeted at families, including female employees of traditional sectors. Future labour market measures in coal regions should be directed towards labour market activation of those leaving traditional industries, and not just a cash severance scheme. Such is an objective very difficult to achieve given the experience of the mining reform implemented in Poland in the late 1990s, which also assumed the possibility of social benefits for retraining. Given the related past experience, it is fair to say that these benefits received very little interest: "In 1998, 24.9 thous. people decided to take the mining social package, of whom 10.1 thous. received unconditional cash severance payments of PLN 44 thous. gross. Only 145 people accepted social benefits for retraining" [Tkocz, 2001: 172]. Developing professional activation models requires, as a first step, research related to: (1) persons leaving hard coal/lignite mines and conventional power generation whose age will not allow them to receive pension benefits; (2) employees of peri-mining companies who will lose their jobs as a result of restructuring processes; (3) professionally inactive wives/partners of miners (a possible change in the place of work of a husband/partner employed in mining may result in a significant reduction in household income levels).

- **A7. Conducting information and education activities targeting coal region communities** – from the perspective of the local communities and the workers for whom the plants being shut down constitute the main source of income, global climate goals often remain incomprehensible and unjustified. Therefore, in order to disseminate the assumptions of a socially just energy transition, it is crucial to change the narrative and information message (addressing the needs of people living in coal regions, developing education and vocational reorientation, creating healthy lifestyles, building social ties, shifting from passive to active social attitudes, convincing people of low-carbon economy benefits, and of the impact of inadequate air quality on health). Previous studies of accountability frameworks indicate a greater acceptance of just transition policies and tools when communicating simultaneously the need for reform due to economic reasons, as well as regulation for environmental reasons [Mayer, 2018]. Therefore, the information activities conducted at the national level need to take into account both the economic situation of mining and the requirements of EU climate policy. It is necessary to make the expectations of stakeholders to be realistic as to possible forms of support [Bukowski, Śniegocki, Wetmańska, 2018], which is largely determined by a clear and consistent information message.

Economic aspect – new sources of economic development

The implementation of green economy solutions should be perceived not as a threat, but as a new stimulus for the economic development of the country and the nation's coal regions that allows improvement in its economic productivity (including a qualitative change in its value chains) and, consequently, enables the country to escape the middle income trap [Aiyar et al., 2013]. As a result of such a perceived transformation, coal regions can become showcase examples of low-carbon industrial centres responding to the idea of creating so-called 'super laboratories' of European industrial transition[22]. Strategic objectives building on this priority at national level include:

- **B1. Developing and implementing a multi-stage approach towards energy transition**. Given the current approx. 70% share of coal in the country's energy mix, the transition of the conventional power generation sector towards increasing the share of RES in the nearest perspective, i.e., by 2030, from the point of view of maintaining Poland's energy security and stability requires a phased and variant approach (especially in the era of recent geopolitical changes). It becomes necessary in this regard to develop an **energy transition variant road map**, together with an evolutionary model energy sources diversification (towards RES) and variant forecasts of Poland's energy mix by 2030, 2040 and 2050. The latter should take into account the improvement of energy efficiency, diversification of supplies of primary energy carriers, diversification of the structure of heat and electrical energy generation, RES use dynamics, coexistence of dispersed and centralized energy sources, but also the limitations and short-term shortages of access to coal resulting from the geopolitical situation.
- **B2. Creating conditions for RES development with support for prosumers** – energy transition, if it is to have a "just" nature, should develop a **governance model and a market mechanism**[23] to encourage individuals, energy cooperatives, housing cooperatives and communities, energy clusters, micro-, small- and medium-sized enterprises, local governments, as well as existing energy producers to join the accelerated use of RES. The new governance model and market mechanism should create equal conditions for stakeholders to access RES, taking into account their competitive position. Its

[22] The proposal was included in a report drawn up by a panel of the European Initiative for Decarbonisation, set up by the European Commission's Directorate-General for Research and Innovation.

[23] Including the resolution of issues related to the mechanism for setting an energy off-take price that ensures RES project financing.

extreme forms, e.g., preferring only incumbent energy producers or giving privileges only to the emerging new RES sector, will not create the conditions for a just transition. If the energy transition is to be just, the concealed negative practices of current RES development must be eliminated.

- **B3. Creating a new "composition" of coal region economies** based on green economy, digital economy and smart specialisation industries. The implementation of low-carbon technologies, in order to become an impulse for new sources of economic growth for Poland as a whole and its coal regions, should be considered in a broader context, i.e., inclusive of all sectors of green economy, which, apart from RES, also include passive construction, water and wastewater management (blue infrastructure), spatial management (including post-industrial areas), green infrastructure and circular economy [Nowakowska, Grodzicka-Kowalczyk, 2019], and low- or zero-carbon transport. The search for synergies linking the above industries with **smart regional specialisations** and digital economy solutions is also important in relation to this process. Such links are a prerequisite for the emergence of spillover effects related to innovations created within smart specialisations and/or in green and digital economy industries. They also foster the right "composition" of regional economies. In order to identify and support existing and potential complementarities from the central level, such a view of the development programming process, however, requires not only a regional, but also a broader national view of the entire "composition" of economic structures.
- **B4. Creating R&D facilities for new value chains** of green and digital economy. New sources of economic growth require not only the reorientation of value chains in traditional industries, but above all, the creation of **new national and regional value chains in green and digital economy industries (mainly RES, passive construction, circular economy and electromobility)**[24]. The search for market niches and the creation of such value chains of at least national potential is justified in terms of economic development. Energy transition will apply to the whole of Poland, but embedding key links of the new value chains in the coal regions, especially links related to the creation of solutions (R&D units, research and implementation centres, clusters, etc.) will contribute to a fair mitigation of the traditional sector transition costs. These effects will be all the better if the right "composition" of the regional economy conditioning spillover effects can be achieved. This requires, above all, undertaking diagnostic analyses of the profile of existing and postulated

[24] For example, Eastern Wielkopolska: H2Lab Hydrogen Application Centre and the first hydrogen stations in Poland; development of the "Green Energy – Konin" cluster.

R&D units, as well as of the spillover effects generated by the potential implementation of new green and digital economy solutions in coal regions. Obtaining a national or international competitive advantage in terms of native green and digital economy value chains is currently a considerable challenge (highly unfavourable level of asymmetry exist in the conditions for creating and implementing solutions in relation to, for example, Western European countries). Technologically advanced countries, which have been intensively implementing and promoting green and digital economy solutions for at least the past decade, rely on their own value chains and have been stimulating R&D activities in this area for years. Hence, there is a risk that Poland's coal regions, and more broadly, all of Poland's regions, may become mere consumers of their products. An escape route from this situation may be establishing various links (scientific, business, social) with entities from countries with advanced green economy value chains, while intensifying domestic research in this field. Networking of knowledge-exchange contacts is essentially a condition for seeing and economically exploiting market niches in the green and digital economy.

- **B5. Supporting pilot – showcase green and digital economy solutions**. The transition to a low-carbon economy requires, given the current affordability of green and digital economy technologies, the introduction of mechanisms to stimulate demand for such solutions. This includes the introduction of various types of financial support (PIT reliefs, PIT and CIT exemptions, subsidies, revolving instruments such as low-interest loans, warranties and sureties, increased share of eligible costs) for natural persons, the SME sector, enterprises, housing cooperatives and communities, cooperatives and energy clusters. Funds for the implementation of the proposed instruments (repayable and non-repayable) should come from various sources, including: JTF, Modernisation Fund, Investment Fund, NFEPWM, World Bank, EIB [European Investment Bank, 2020], Innovation Fund, Cohesion Fund/ European Regional Development Fund, InvestEU and the Pandemic Emergency Purchase Program.
- **B6. Diversifying and stimulating developments to enhance productivity** – in the economic context, the main criterion for supporting coal regions, which already exhibit the characteristics of lagging-behind regions relative to the EU space, should become the stimulation of their economic development, including productivity improvement. This can be achieved by seeking and capitalising on opportunities to create new value chains in the green and digital economy industries. However, given the potential decline of employment in

the mining and conventional power generation sectors (and related industries), the support for smart specialisations already existing in the regions and the localising of digital economy activities (including the Internet of Things with the development of 5G networks) to stimulate dormant and partially lost specialisations not directly related to energy in order to provide the coal regions with **new competitive advantages**, also become important. These advantages should be territorialised [Nowakowska, 2013; 2015] based on the specific potentials and opportunities of a given coal region. Alternatives to imitating activities from other regions are transfer, modification and adaptation of existing solutions. New competitive advantages should translate into new development paths, including those based on **related and unrelated variety**. Related variety can result from the **development of related sectors**, e.g., the use of IT competences found in the mining sector to program automated production and data handling processes in other sectors. Unrelated variety is often a consequence of successfully **attracting external investors to the region to allocate capital to new industries**, or of **developing local entrepreneurship**. Strategically orienting the region towards increasing sectoral-industrial diversity in the long term is also in the interest of the state, since it enables a flexible and evolutionary redeployment of assets and human capital from declining, to newly emerging industries on a national scale.

- **B7. Improving the absorptive capacity of companies** – due to the significant asymmetry of the conditions under which modern green and digital economy technologies have emerged (high-tech sectors and regions), in relation to the conditions existing in the carbon regions (low tech), the national process of generating innovation and creating national value chains in this field can be an extremely difficult task, requiring a long time horizon. Shortening this development gap is basically only possible based on improving the absorptive capacity (knowledge, competence, experience, openness to change) of domestic companies in relation to the rapid transfer, necessary modification and adaptation of available innovations in the field of green and digital economies.

Spatial aspect – new spaces for development

The new social agreement and the new sources of economic development should find expression in the material sphere related to the coal region space. Changes taking place in the social and economic aspects should be reinforced

"visually", directly reflecting the tangible effects of the transition and the image of the coal regions. The strategic objectives for the spatial aspect include:

- **C1. Stock-taking of brownfield sites and facilities**, i.e., those used by the mining sector, conventional power generation and related industries. The scale of brownfield sites and facilities, as shown in chapter II of the study, especially in coal regions, is significant, as the decommissioning processes of traditional industries started there in the 1990s. However, both the actual scale of brownfield sites and their pollution level have not yet been fully recognised [Bondaruk, Kruczek, Uszok, 2021]. A number of problems relation to data access were encountered in the course of conducting analyses to approximate this issue for the purposes of the present study. The lack of such recognition at the national level and of that of individual coal regions significantly reduces the transition rate of these areas. Therefore, the first step towards reclaiming brownfield sites should be their detailed stock-taking (national database of brownfield sites), followed by geochemical and geotechnical investigations indicating potential directions for their development.
- **C2. Identifying brownfield sites of strategic importance to the development of LGUs in coal regions** – given the scale of activity of traditional industries in coal regions, which is reflected by the estimated area of brownfield sites, it must be noted that their recovery and reuse should be executed in stages. Priority should be given to **identifying sites and objects of strategic importance** from the perspective of industrial heritage, importance within the urban layouts of communes, strategic projects (e.g., cultural zones, technology hubs, new technology districts, low-carbon economy demonstrators) and proximity to residential areas or recreational areas, including green and blue infrastructure. The reuse of such land should be delegated to interested LGUs (if they show interest in doing so), as only these entities have a holistic view of the territory and the necessary regulatory competences for integrated territorial planning. However, the implementation of this type of programme requires decisions at the national level that are associated with a "green light" for the transfer of post-industrial property by State Treasury companies to interested local governments. This primarily involves the development of appropriate legal regulations, including procedures for the transfer of brownfield sites.
- **C3. Diversified use of brownfield sites** – the reuse of brownfield sites (excluding sites of strategic importance for the development of LGUs in coal regions, cf. C2) should proceed in diversified directions, including: (1) use by

current owners (mining and conventional power sector) as locations of RES solutions (e.g., PV farms, production of RES components)[25]; (2) use by current owners (mining and conventional power sector in cooperation with special economic zones and/or LGUs) to create new economic spaces by establishing special economic zones, economic activity zones, industrial or industrial and technology parks (so-called "economic transition zones"); (3) in the case of the remaining post-industrial areas, providing them with a recreational function that improves the quality of life of the inhabitants, taking into account the strengthening of their potential for green and blue infrastructure, and in the case of particularly contaminated areas, applying protective, isolating measures. Achieving this objective involves the preparation of appropriate legal regulations at national level for the economic reuse of brownfield sites by their current owners for the purposes of RES, as well as for establishing special economic zones, economic activity zones and recreational functions.

- **C4. Increasing the adaptive capacities of LGUs in coal regions in terms of a transition towards a zero-carbon economy** – local government units, if they do not undertake actions mitigating the effects of coal phase-out, while creating new values, may mostly be exposed to the effects of limited activities of traditional industries in the long term (e.g., increased unemployment, outflow of inhabitants, need to revitalise post-industrial districts, decrease in PIT and CIT revenues, decrease in property tax and mining fee revenues). Support for LGUs in the processes of transition towards a zero-emission economy should be directed at: (1) improving energy efficiency by recovering and utilizing waste heat, and modernising facilities (municipal buildings) in terms of energy efficiency and management; (2) supporting innovative approaches to energy storage and supply (e.g., local systems); (3) increasing RES-based prosumer energy; (4) combating low emissions sources; (5) eliminating institutional and financial barriers by creating regulatory space (legislating) and resources for individualising solutions. The aforementioned directions require the creation of an appropriate legal environment at national level to foster the development of open data infrastructure; energy networks (including district heating infrastructure); sustainable transport (including zero-emission transport); circular economy (including sewage sludge management); passive construction (energy efficiency of buildings should become a priority in the construction sector). In addition to legal regulations, strategic arrangements in this area at the national level are also necessary. These

[25] Properties related to closed mines, stabilised waste dumps and landfills, backfilled water reservoirs, storage areas, technical and production facilities.

should be contained in relevant updates of the National Regional Development Strategy or the National Urban Policy.

- **C5. Integrating coal regions into the polycentric development of macro-regions** – the scale of socio-economic challenges for Poland's coal regions in relation to the transition towards a low-carbon economy, taking into account employment rate and the value of mining and conventional power assets, is the highest it the EU. In this context, the intervention viewed solely from the perspective of JTF will prove insufficient. Bearing in mind the European experience in programming the territorial development of second-tier urban centres (which are predominant in Poland's coal regions), it is necessary to apply **development planning instruments at the interregional level, which are based on the polycentric urban region concept**. The implementation of this concept in relation to coal regions may take the form of linking (infrastructural and strategic) cities from coal regions with urban centres currently acting as growth leaders in neighbouring regions. The objectives of building such infrastructural and strategic links include mitigating the negative social effects of enacting technological changes; providing faster exchange of knowledge, information, human capital, goods and investments; and improving communication accessibility. Strengthening polycentricity within the interregional system of Poland (e.g., Dolnośląskie – Śląskie – Małopolskie provinces) will foster the flow of production factors, increase the competitiveness of the national economy and enable coal regions to be more rapidly integrated into the circuit of economy 4.0 and into the coverage of metropolitan areas. Such polycentric development systems are already in place in the economic domain, which is best confirmed by the volume of average daily vehicle traffic on the A4 motorway between Wrocław – Katowice and Kraków [Drobniak et al., 2021]. However, rational programming of interregional development bands requires a national perspective on defining the basic contexts of such spatial organisation, i.e., strategic and economic (e.g., in terms of a shared vision of development and economic specialisations), cultural (e.g., in terms of a shared sense of belonging to a polycentric region) and functional (e.g., in terms of transport, energy and mass transit infrastructure).

Institutional aspect – new institutional capacities

In the institutional aspect, a fundamental prerequisite for the effective programming and implementation of interventions in accordance with the objectives of just transition is their proper territorialization. Its essence involves recogniz-

ing the specificity of the territorial capital [Camagni, 2008] of each territory, which, it is worth noting, is not a simple sum of resources located in a given place, but forms a synergic system of mutually penetrating factors. The essence of development territorialization is based on perceiving a territory not in terms of "space – place", but rather "space – actor" [Jewtuchowicz, 2013]. It is thus a space that is permanently occupied, developed and controlled by its inhabitants, that is not limited only to its physical characteristics and related resources that can constitute development factors [Chojnicki, 1989]. The uniqueness of space defined this way, which is the basis of the concept of territory, is determined, in addition to its resources, by relational and functional elements that create networks of interpersonal and inter-institutional links, determining the rooting of development within a given place. It is a space going beyond its physical nature; a space created by a specific society with its history, culture, knowledge, skills, as well as institutions and relationships networks [Pietrzyk, 2004]. Therefore, "the territory becomes a product-commodity of actors located within its boundaries, connected by common relations and activity goals", creating an environment for further development processes [Nowakowska, 2013: 69-70]. In the institutional aspect, the programming of just transition within such a complex configuration of correlations between the specificities of Poland's coal regions and, moreover, the sectoral, national, international context, has been directed towards the creation of new institutional capacities and planning coordination.

The effective implementation of a new, broad social agreement, the creation of new economic development sources based on green and digital economy solutions, and the creation of new development spaces require appropriate institutional competences and an integrated approach towards planned changes. Therefore, the strategic objectives in this aspect include:

- **D1. Ensure the complementarity of Territorial Just Transition Plans (TJTP) with the National Just Transition Plan (NJTP)** or sectoral arrangements. As demonstrated in the study, Poland's coal regions, due to their different demographic, economic, spatial, environmental and institutional situations, cannot be treated identically, i.e., by applying the same solutions in terms of goals, directions, instruments and projects related to the implementation of both just and energy transition. This consequently implies a different scale and specificity of social, economic, spatial and institutional problems. Therefore, **place-based** [Barca, 2009] and **place-sensitive policy-based** [Rodrígues-Pose, 2017; Churski et al., 2018] approaches towards Poland's coal region just transition programming therefore prove to be a necessity.

This understanding of interventions enables, above all, the optimal use of territorial resources and development conditions within the just transition process, i.e., basing development on specific and endogenous resources, internal economic links and social ties or local identity. Secondly, it allows for the differentiation and adaptation of public intervention at the local/regional levels (i.e., the adaptation of policy objectives and instruments, procedural and institutional arrangements, and the level and methods of financing pro-development undertakings) to the specific needs of particular areas and stakeholders. From the point of view of equitable transformation programming, this means that ***Territorial Just Transition Plans*** **(TJTP) should be prepared under the bottom-up approach at the level of coal regions (NUTS3)** or, as in the case of the Śląskie province, where almost the entire province consists of coal regions, at the NUTS2 regional level. The proposed positioning of the TJTP at the regional level also allows for a better integration of the priorities, objectives, measures and projects embedded in the operational programmes and developed by the regions for the 2021-2027 programming period. Achieving such a level of integration would be considerably hindered (if at all possible) with the creation of a single joint national programme, as a very wide range of stakeholders – both at the level of the relevant NUTS3 local authorities (a requirement of the JTF regulation) and the authorities of the relevant provinces (the need to integrate the TJTP with regional programmes and strategies, as well as ensuring their complementarity, including financial) – would make this undertaking extremely risky at the national level. A complementary element in relation to the TJTP should be the *National Just Transition Plan* (NJTP), which, as noted in the introduction to this section of the study, should be sectoral (the just transition process including the traditional sector, i.e., State Treasury companies that remain under national level responsibility), and utilize pilot-innovation (initiation of showcase flagship transition projects based on the activity of the R&D sector, which is also the responsibility of the state, enterprises and local governments) in nature. Importantly, the absence of a national level of intervention in just and energy transition will lead to a discord between the "pro-green" activities initiated at the regional level and the desire of the traditional sector to maintain the *status quo* (as a response to not being included in the process). The findings undertaken in the TJTP and NJTP should also be reflected in the updates of regional and urban development policy planning documents at the national level, i.e., in: *National Spatial Development Concept 2030*, *National Regional Development Strategy 2030*, *National Urban Policy*, strat-

egies for development of macro-regions. This is a condition for the integration of intra- and inter- approaches towards programming of the country's territorial development.

- **D2. Creating organisational conditions for various forms of cooperation** – building new and reinforcing existing institutional capacities should follow an integrated manner, i.e., linking the national, regional, subregional and local levels of state and local government administration with the business sector, business environment institutions, social organisations and the scientific sector. Due to the territorial aspect of just transition aimed at coal regions, their hitherto "thin" institutional capacity (thin regions) should be expanded (thick regions) towards well-developed competences related to green and digital economies. Building this kind of institutional capacity related to just transition requires providing the organisational, legal and financial conditions for **various forms of cooperation** (public-public, public-social, public-private, networks, associations and formal partnerships, organisational units within local governments and government institutions). Also important in this process is the strengthening of competences, which should be seen as a prerequisite for effective self-organisation that determines adaptation and absorption capacity in coal regions. The development of organisational competences will foster the effective and coordinated implementation of the TJTP and NJTP (including their better coordination with other funding sources).
- **D3. Creating a new institutional quality for multi-stakeholder cooperation** – creating the organisational conditions for cooperation is the first step in establishing multi-stakeholder cooperation. However, this cooperation should, due to the complexity of just and energy transition processes, lead to the generation of added value interpreted in terms of social dialogue, new solutions, transfer of experience, and creation of strategic transition projects. Monitoring and evaluation of actions taken are also needed. The processes of both just and energy transition will not end by 2027, as the EU itself points out, by introducing a time horizon of strategic thinking for a low-carbon economy until 2050 [Szlachta, Zaleski, 2021]. The EU is interested in offering further aid in this regard in the next decade of the 21st century. Providing analytical and conceptual input (content) for just transition should therefore be considered essential. The role of such institutional support should be played by multi-sectoral think tanks, universities and R&D sectors working together with stakeholders of the process. This is a prerequisite for high quality content input and qualitative discourse.

- **D4. Comprehensive programming of transformations in the mining and conventional power sectors in the sectoral and territorial contexts** – the success of energy transition depends on the creation of a variant-based programme for the transition of the mining and energy sectors and related industries, defining, among others, transition scenarios, variant timetables for reducing the extraction and use of fossil fuels, traditional industry activity diversification directions, and competence-wise support for the personnel switching from mining, conventional power and related industries, to other sectors. A **scenario-based energy transition analysis**, involving the use of indicators and defining their desired values should be considered necessary. Such an approach enables dynamically (i.e., depending on changes in the socio-economic situation) optimizing energy transition measures at sectoral level. In the European perspective, changes to the Emissions Trading Scheme (ETS) will be important, in particular, through increasing the linear reduction factor and limiting the allocation of free allowances. The decision to include building emissions in the ETS will also have important consequences for energy transition. Energy transition scenarios should take into account such indicators as, among others, primary energy solid fuel consumption, coal-fired electricity generation, installed capacity of coal-fired power plants, and CO_2 emissions from the power generation sector. It is reasonable to build on existing research, analysis and simulations in the field of coal phase-out of the economy conducted by, among others: the Intergovernmental Panel on Climate Change (IPCC); the International Energy Agency (IEA); and the Climate Analytics (CA) research centre. It is also worthwhile for the scenario-based transition analysis to take into account the scale of green transition challenges (e.g., the impact on the employment rate, the size of assets related to the raw material and energy sector, the problem of reclaiming post-industrial sites). In the context of Poland's coal regions, the financial resources secured in the JTF for mitigation measures and creating new development impulses by 2030 are insufficient. This is all the more so, as some of the coal regions are outside the JTF accessibility criteria (Zgorzelec district, Lublin subregion). Moreover, the JTF does not cover additional energy regions strictly related to conventional power plants or coking plants (such as the Opole, Krapkowice, Kozienice or Ostrołęka districts). When preparing a variant-based transition analysis at the national level, the JTF funds should therefore be treated as a stimulus for socio-economic and environmental mitigation of the technological change associated with the implementation of RES solutions and green economy, which **should be reinforced with other**

available European and national funds [Szlachta, Zaleski, 2021], e.g., among others, funds from the European Regional Development Fund, European Social Fund, InvestEU, EIB (loan instrument for the public sector)[26], NFEPWM (priority programmes financed from the Modernisation Fund).

- **D5. Integrating the low-carbon development programming system** – the challenge related to just and energy transition processes is also reconstructing the country's development planning system (at all levels of development management) towards a close link between the socio-economic context and the spatial and environmental context. An important link in the integrated development planning system should be a mandatory (based on an integrated approach) energy transition plan/strategy at the coal subregion, regional and national level, constituting foundations for activities (together with a variant--based analysis of the energy transition, cf. D4). Such decisions should be strategic and operational in nature, and define a regional and national energy transition pathway through broadly involving the representatives of different stakeholder groups creating energy independence. Existing acts on energy, gas and heat supply and plans, such as the low-carbon economy plan and climate change adaptation plans, do not meet the expectations that are associated with building a low-carbon economy. They are narrow in scope and limited to short-term investment solutions or a catalogue of possible measures. There is a lack of a holistic, integrated approach to building a low-carbon economy on a local, subregional and regional scale in the long term. However, given the potential socio-economic consequences of the energy transition in coal regions, it should be noted that it is also important to suggest the role that the mining conventional power generation and related industries should play within this process. The transformation of the mining and conventional power generation sectors is not only a sectoral change, but above all, a systemic, strongly territorially oriented one. **It requires comprehensive and complementary actions, and an integrated political approach**. In order to build a low-carbon economy, there is a need to integrate and coordinate actions taken in different institutional settings and to reinforce territorial partnerships. The approach should be holistic, taking into account the energy system as a whole, as well as its individual components (energy generation, distribution and consumption) together with the related social, economic and environmental systems. It becomes necessary, therefore, to introduce stronger mechanisms of coordination between sectoral, horizontal and territorial poli-

[26] InvestEU and EIB resources make up Pillar II and Pillar III of the Just Transition Mechanism.

cies, and between different governance levels, i.e., to strengthen multi-level governance for just transition.

- **D6. Reviewing, updating or creating new legal regulations in the field of just and energy transition** in the context of eliminating barriers that prevent local governments, their associations and companies, cooperatives and housing communities, natural persons, enterprises, energy cooperatives and clusters, NGOs and BEIs, and the scientific sector from implementing pro-development activities in the field of green economy. Taking into account the scope of activities constituting the just transition process, it seems necessary to review the legal solutions, primarily related to: (1) RES, i.e., with regard to the activities of energy clusters and their participants, such as housing cooperatives; (2) electromobility and alternative fuels; (3) spatial planning and development; (4) construction law; (5) waste, e.g., labelling of packaging; (6) energy efficiency, support for thermal modernisation; (7) capacity market; (8) public procurement, e.g., selection of a bid taking into account the full project costs, i.e., operating costs, exemption of clusters with local governments as members from the Public Procurement Law; (9) transferring post-industrial lands and facilities to local governments; (10) applying for and settlement of European funds (including the provision of own contributions, which may be difficult under the crisis caused by COVID-19 and progressive centralisation); (11) promotion of employment and the labour market, as well as other provisions on supporting entrepreneurship to facilitate the energy, economic and social transition necessary to achieve the assumed just transition goals. It is also justified to consider the development of new legal regulations concerning, among others, the stimulation of prosumer energy generation in line with the development trends of local electricity generation and coal phase-out (e.g., in terms of increasing access to the prosumer system, virtual prosumer, discount system, duration of the support system, operation of energy storage facilities[27]). New solutions may also be needed in relation to the revitalisation of post-industrial areas (the current legislation is far from sufficient in this regard)[28]. Another issue remaining to be considered includes new tax solutions additionally favouring the development of innovation for green technologies in decarbonisation areas, especially in the field of revitalisation, which after 2023 refers solely to inhabited areas, the designation of

[27] Considering the provisions on: (a) ensuring grid neutrality, i.e., the level of distribution fees for both energy consumed and supplied; (b) mechanisms supporting energy storage viability.

[28] The need for new regulations concerns, among others, the revitalisation of brownfield sites not inhabited by residents – there is a statutory limitation of revitalisation (after 2023) to the *Communal Revitalisation Programme* only, wherein revitalisation is determined exclusively based on the social situation (social indicators) in a specific urban area, discarding reference to brown-field sites (economic indicators).

which is based on social indicators. Thus, the current provisions of the Revitalisation Act almost completely ignore the issue of economic revitalisation and the related economic, technical and often environmental indicators.

Regional level

Wałbrzych subregion – Dolnośląskie province

Stanisław Korenik, Dorota Rynio, Alicja Zakrzewska-Półtorak, Piotr Hajduga, Alicja Kozak

Proposed values for the transition of the Wałbrzych subregion

Taking into account both the socio-economic situation and the location of the Wałbrzych subregion (post-restructuring "social stagnation", lack of perspectives, depopulation, re-industrialisation, location in a mountainous border area creating a peripheral space), the just transition process can be based on three values, namely, education and innovation, new industries related to green and blue infrastructure based on the abundant and rich natural resources, and activation and education of the community in the field of accepting changes towards a low-carbon economy.

An important role within the just transition process in this subregion, but more broadly, in the overall context of transformation, should be played by Wałbrzych as a city that integrates the southern local government units of the Dolnośląskie province around new development directions – indeed, more than 100 such units cooperated on the Sudety Development Strategy 2030 [Local Government Research and Development Centre, 2018]. The task of the leader is both the transfer of experience and a stronger integration of the LGUs of the Wałbrzych subregion (and, more broadly, the southern part of the province) around the just transition process.

Priorities and strategic objectives for the transition of the Wałbrzych subregion

Based on the contextual analyses conducted, particularly these related to previous experience, stakeholder surveys and development concepts, certain original strategic recommendations related to just transition programming for the Wałbrzych subregion have been presented.

Table 27. Strategic recommendations for the Wałbrzych subregion

Contexts	Social	Economic	Spatial and environmental	Institutional
Priorities	Human resources	Research, innovations and implementations	Post-industrial areas	Experience transfer
Strategic objectives	Social integration Creative and innovative attitudes, green economy acceptance Activating and integrating the local community around held resources associated with green economy Promoting and educating in the field of professional activation of milieus at risk of social exclusion	Triggering the creation of science and research entities with a research profile focusing on green economy and using digital technologies Creating the basics to disseminate digital and green economy solutions Education in the field of building an endogenous value chain based on the values of green and digital economies	Sustainable use of post-industrial areas as a new potential for subregional development (diagnostics, identification of opportunities) Permanent dissemination of benefits and values related to the use of post-industrial areas Use of rich endogenous natural resources from post-industrial areas	Creating the foundation for permanent alliances to support just transition and energy transition (also cross-border) Creating platforms (various social and spatial contexts) for exchanging knowledge, information and experience in the implementation of transition projects Continuous optimization of skills and competences in the field of creating and implementing various projects

Source: own study.

In the context of the specificity of just transition programming within the Wałbrzych subregion, the priorities are based on the strengths and challenges accompanying the socio-economic situation of the Wałbrzych subregion that are related to human capital and its specificity, its abundant and rich environmental resources, opportunities for creating and implementing innovations, the potential of its post-industrial areas and the exchange of experiences.

As a result, the identified objectives focus on the creation of human capital and its improvement in the context of the challenges, but also the requirements of green and digital economies in the necessary relationship with educating excluded people; the construction of value chains within this economy and the coordination of ongoing and planned projects for the sustainable development of post-industrial areas; and the construction of an alliance platform for the transfer of experience (including cross-border), as well as good practices and knowledge in the field of just and energy transition.

Zgorzelec district – Dolnośląskie province

Stanisław Korenik, Dorota Rynio, Alicja Zakrzewska-Półtorak, Piotr Hajduga, Alicja Kozak

Proposed values for the transition of the Zgorzelec subregion

Taking into account both the socio-economic situation and the location of Zgorzelec district (prominent border location, dominance of the mining and energy industries, large environmental changes, creation of a peripheral space), the just transition process can be based on three values, namely, education and innovation, new industries related to green and blue infrastructure based on environmental resources, and activation and education of the community in the field of accepting changes towards a low-carbon economy.

The cities of Zgorzelec (over 30 000 inhabitants) and Bogatynia (over 23 000 inhabitants), inhabited by more than a half of the district's population, should play important roles within the just transition process within this district, but more broadly, in the general context of the socio-economic transformation as they are centres of integration and opinion-forming around the new directions of the district's development. The fact that Zgorzelec and the German city of Görlitz (a population of more than 60 thous.) have established the cross-border city of Zgorzelec/Görlitz (a total population of more than 90 thous.) should also be taken into account. This represents a potential opportunity for wider involvement of entities from the German side. Also important is the functioning of the Zgorzelec Cluster for the Development of Renewable Energy Sources and Energy Efficiency (ZKlaster), which is a civil-legal cooperative for the construction of a local electricity and heat market based on local renewable resources. In turn, the "Turów" Brown Coal Mine remains a significant change stakeholder in Bogatynia.

Priorities and strategic objectives for the transition of the Zgorzelec subregion

Based on the contextual analyses conducted, particularly that related to the current situation, stakeholder surveys and development concepts, original strategic recommendations related to just transition programming for the Zgorzelec subregion have been formulated.

Table 28. Strategic recommendations for the Zgorzelec district

Contexts	Social	Economic	Spatial and environmental	Institutional
Priorities	Human resources	Research, innovations and implementations	Post-industrial areas	Experience transfer
Strategic objectives	Integration and activation of the district's community Building a civil society Living conditions that meet the expectations of residents and the environment Improving the quality of human capital through actions aimed at education quality and access to higher education Creating attractive living conditions for the local community through using existing resources related to green economy	Creating the foundations for establishing science and research entities with a research profile focusing on green economy and on using digital technologies Education in the field of building an endogenous value chain based on the values of green and digital economies	Working out a comprehensive programme based on sustainable use of post-industrial areas Striving for a permanent restoration of endogenous natural resources in post-industrial areas and their use for local and cross-border development	Constructing advantageous institutional links with abroad (primarily the neighbouring regions in the Federal Republic of Germany and the Czech Republic) Creating platforms (various social--spatial and cross--border contexts) for exchanging knowledge, information and experience in the implementation of transition projects

Source: own study using Euroregion, Interreg [2021].

In the context of the significant issues related to the potential implementation of just transition within the Zgorzelec district, the priorities are based on the potential socio-economic values of the district. However, in addition to the internal local ones (such as the building of a civil society, environmental resources and material culture), the cross-border aspect of both the Czech and German expectations and the potential values of active cooperation must always be taken into account.

As a result, the formulated objectives refer to the creation of a civil society and its improvement as challenges, but also requirements of green and digital economies; the construction of new value chains in the context of sustainable brownfield development projects; and the construction of an alliance platform

for the transfer of experience, including, above all, the cross-border aspect. Such objectives are based on the exchange and improvement of good practices and knowledge in terms of current and potential future just and energy transition directions.

Lublin subregion – Lubelskie province

Wojciech Janicki, Grzegorz Iwanicki, Andrzej Jakubowski

Proposed values for the transition of the Lublin subregion

A characteristic feature of the Lublin subregion, which distinguishes it from other coal regions within Poland, is its direct proximity to the academic potential of the provincial capital (Lublin), although it should be stressed that the city of Lublin itself is not located within the boundaries of the Lublin coal region. Benefiting from the academic potential of five universities, two research institutes and the ECOTECH-COMPLEX Analytical and Programming Centre to shape the social reality in the new age is the most important of the opportunities available to the coal region, and it is science and education that the transition process should be based on.

The second of the key values is entrepreneurship. Compared to other coal regions, and in relation to Poland as a whole, the subregion comes off poorly. The Łęczyca district ranks fifth from the bottom in a table of 381 districts ranked according to the descending number of entities registered in the REGON system, which considered one of the simplest methods of measuring the level of entrepreneurship among the inhabitants. The result of 618 entities, against a national minimum of 550 and a maximum of 2 548, clearly indicates the need to effectively stimulate entrepreneurship among residents and create conditions for them to act independently.

Priorities and strategic objectives for the transition of the Lublin subregion

Studying the needs and opinions of stakeholders and analysing the situation in the subregion has made it possible to present the following strategic recommendations for the Lublin coal region – cf. Table 29.

Table 29. Strategic recommendations for the Lublin subregion

Contexts	Social	Economic	Spatial and environmental	Institutional
Priorities	Human resources	Research, innovations and implementations	Post-industrial areas	Experience transfer
Strategic objectives	Introducing changes to the educational system aimed at shaping entrepreneurial attitudes among the youth Stimulating entrepreneurship among adults and creating conditions advantageous for its development	Using financial tools to shape university research towards green economy Increasing outlays on R&D to accelerate the work on existing and new projects	Establishing the "Bogdanka" Special Economic Zone Using post-industrial areas to develop tourism and solar energy	Using the academic potential of Lublin to train engineering personnel to operate new technologies Drawing good examples of an effective transition based on the experience of these European regions that have successfully transformed
		Modernizing and adapting the industrial infrastructure to increase compatibility with the distributed network of energy producers		

Source: own study.

The social aspect should be recognized as the key strategic recommendation for the Lublin coal region. This stems from both the high research and teaching potential, and an exceptionally low human capital level at the same time. Therefore, the room for change is considerable.

Bielsko-Biała subregion – Śląskie province

Radosław Cyran, Piotr Rykała

Proposed values for the transition of the Bielsko-Biała subregion

Due to the highly developed institutional potential in terms of universities, research and development centres, business environment institutions, and natural and landscape assets, the just transition process in the Bielsko-Biała subregion

can be based on three values, namely, the location-wise attractiveness of the subregion based on the permanent presence of international companies, as well as new industries related to specialised services and the presence of high-tech industry (especially in the area of green and blue infrastructure); its natural and landscape assets; and its cultural assets for the development of recreational spaces.

Priorities and strategic objectives for the transition of the Bielsko-Biała subregion

Based on the conducted contextual analyses and stakeholder surveys, and worked out development concepts, the recommended priorities and strategic objectives for just transition programming within the Bielsko-Biała subregion are presented in Table 30.

Table 30. Strategic recommendations for the Bielsko-Biała subregion

Contexts	Social	Economic	Spatial and environmental	Institutional
Priorities	Human resources	Research, innovations and implementations	Ecology and development of recreational areas	Experience transfer
Strategic objectives	High-quality general, vocational and higher education and a training offer based on green and digital transition Available services in the field of social and health protection so as to encourage social integration	Developing innovation centres and green and blue economy implementation projects Developing ecotourism potentials	Developing leisure infrastructure based on green economy infrastructure Sustainable and multimodal local and regional mobility Increasing the energy efficiency of residential buildings, public utility buildings and enterprises	Exchange of knowledge and experience in the field of energy transition of the economy Improving administration personnel competences in managing energy transition projects

Source: own study.

The just transition programming priorities for the Bielsko-Biała subregion derive from the subregion's development potential, i.e., human capital, research, innovation and implementation, ecology and recreational area development, and transfer of experience. The proposed strategic objectives for each priority include adequately focusing human capital at different education levels on current challenges associated with green economy and process digitisation; preparing

implementation projects for green and blue infrastructure that will contribute, among other notions, to the development of leisure and ecotourism infrastructure, as well as the reduction of low emissions in real estate and public transport; benefiting from good practices in the implementation of energy transition projects.

Bytom subregion – Śląskie province

Małgorzata Czornik, Paulina Badura

Proposed values for the transition of the Bytom subregion

Despite the unfavourable demographic (high ageing rate), as well as economic (low employment rate) situation in the Bytom coal region, it exhibits strengths and values that can become just transition pillars – the development of new industries, job creation and the development of a stock of brownfield sites in new directions.

The specificity of the subregion is based on the existence of a peri-metropolitan zone (Tarnowskie Góry, Radzionków, Zbrosławice, Świerklaniec) around the two main post-mining cities (Bytom, Piekary Śląskie). Most areas in the northern zone are rural communes. Hence, the main challenge for the Bytom subregion includes generating a new vision for the development of the post-mining towns – in just transition, they should follow the path of implementing innovative industries that will further initiate a more dynamic economic growth in these cities. The zones around these cities will then be able to focus on supporting them with spatial resources and on developing a residential function for the subregion's residents.

Priorities and strategic objectives for the transition of the Bytom subregion

Taking the context into account, based on the conducted stakeholder surveys, and the development concept prepared, the following key recommendations for just transition programming for the Bytom subregion are put forward (cf. Table 31).

Table 31. Strategic recommendations for the Bytom subregion

Contexts	Social	Economic	Spatial and environmental	Institutional
Priorities	Cultural identity	Innovation and entrepreneurship	Green areas	Local government
Strategic objectives	Revitalizing the urban spaces and post-industrial facilities, with particular attention to the city centre, for the benefit of its residents Supporting and strengthening the cultural identity associated with the industrial history of this region Developing the city's recreational infrastructure and cultural offer dedicated to its residents and tourists	Activities supporting and encouraging local entrepreneurs in undertaking economic initiatives Promoting cooperation with scientific institutions within the subregion and promoting joint accomplishments Creating conditions for the development of new industries, including providing support for business entities and supporting the development of modern business services	Using agricultural land as a base for renewable energy development Taking care of particular natural values and the well-being of greenery areas in the subregion, and reclaiming degraded lands Using the potential of agricultural land to promote eco-farming and recreational tourism (including agritourism)	Assisting the local government in making decisions through instruments supporting local entrepreneurship, new investors and any initiatives in line with the just transition process

Source: own study.

The priorities for the Bytom subregion were created in four contexts, i.e., social, economic, spatial-environmental and institutional. With these in mind, it was determined that the subregion's main strengths are a strong cultural identity, innovation and entrepreneurship (especially within the local environment), a multitude of green spaces, and support for the local government in its initiatives. Thus, the objectives corresponding to the identified priorities are building a new, attractive image of the city based on the cultural identity of the subregion's inhabitants; support for local entrepreneurs in economic initiatives; the creation of a favourable environment for the development of new industry (including services); the use of green areas, especially agricultural areas, to focus the local economy on ecological solutions (renewable energy, organic farming, agritourism);

and emphasis on close cooperation and support on the part of the local government to encourage and facilitate activities in the context of just transition.

Gliwice subregion – Śląskie province

Marek Magdoń, Jakub Miracki

Proposed values for the transition of the Gliwice subregion

The Gliwice subregion is characterised by it having a good economic situation (with a large number of large enterprises highly diverse in terms of sectors and a strong economic zone), the academic profile of the subregion, and a well-developed network of BEI services. Therefore, the just transition process is proposed to be based on values related to the high competence and entrepreneurial attitudes of the inhabitants, the cooperation of businesses with scientific centres and R&D institutes, and the involvement of all stakeholders in the transition process.

Priorities and strategic objectives for the transition of the Gliwice subregion

Based on the contextual analyses conducted, stakeholder opinion surveys and development concepts, original strategic recommendations related to just transition programming for the Gliwice subregion have been compiled and presented in Table 32.

Table 32. Strategic recommendations for the Gliwice subregion

Contexts	Social	Economic	Spatial and environmental	Institutional
Priorities	Human resources	Innovation and competitiveness	Quality of life	Cooperation between business and BEIs
Strategic objectives	Changing social attitudes and broadening knowledge in the field of entrepreneurship and economics Changing social attitudes and broadened knowledge in the field of environmental	Development towards circular economy Developing new technologies and innovations, also related to the use of energy from renewable sources	Revitalizating and developing post-industrial facilities and areas Developing the needed infrastructure for renewable energy sources Developing water supply and sewage networks	Development of new trends and specializations related to the subregion's economy Creating conditions for an effective implementation of innovative industrial solutions

Table 32 cont.

	and ecological conservation Adapting the education process to labour market requirements and for the purposes of generating opportunities for creating local economy sustainable development directions	Creating conditions for the establishment and development of new enterprises, and the development and improvement of competitiveness exhibited by existing enterprises	(taking into account modern water supply network monitoring systems) Developing the blue and green infrastructure	Creating conditions for cooperation between the scientific community, businesses and local governments in the field of just transition

Source: own study.

Given the specificity of the just transition programming context in the Gliwice subregion, the priorities for this process were embedded in the potentials inherent to the subregion, i.e., human capital and its qualifications; innovation and competitiveness of the local economy; facilities and post-industrial areas; as well as high scientific and research potential and a well-developed network of services provided by business environment institutions. Therefore, the identified main strategic objectives concern the transformation in stakeholder awareness towards the use of green economy solutions combined with the adaptation of the educational process, as well as the creation of conditions for the establishment and development of technologically advanced, innovative and competitive enterprises that take into account solutions in terms of alternative energy sources and circular economy; the development of blue and green infrastructure and other solutions favouring the improvement of the quality of life for the subregion's inhabitants that incorporate the potential of post-industrial sites; the creation of conditions for the cooperation of the scientific community, businesses and local governments in the area of just transition.

Katowice subregion – Śląskie province

Adam Drobniak, Piotr Rykała

Proposed values for the transition of the Katowice subregion

With regard to the specifics of the Katowice subregion (an institutionally and economically developed urban area with significant resources of human and creative capital), the just transition process can be based on three values, namely,

science and innovation; new industries associated with digitalisation and green and blue infrastructure; and social inclusion resulting from a relatively high level of acceptance of changes towards a low-carbon economy.

Katowice should play a special role in the just transition process, not only in the Katowice subregion, but more broadly, in the overall context of the transition, as it is a city with significant experience in the implementation of transition projects of strategic importance, and it operates on an international scale, especially through industrial development. The role of the leader is both to transfer experience and to include other cities in the Katowice subregion that are still heavily dependent on traditional industry (Mysłowice, Ruda Śląska) in the just transition processes.

Priorities and strategic objectives for the transition of the Katowice subregion

Based on the contextual analyses conducted, stakeholder opinion surveys and development concepts, original strategic recommendations related to just transition programming for the Katowice subregion have been compiled − Table 33.

Table 33. Strategic recommendations for the Katowice subregion

Contexts	Social	Economic	Spatial and environmental	Institutional
Priorities	Human resources	Research, innovations and implementations	Post-industrial areas	Experience transfer
Strategic objectives	Profiling and popularizing education in the field of digital and green economy Initiating cooperation between the education sector (primary, vocational, secondary) in the field of digital and green economies	Expanding university and research institution profiles with digital and green economy subjects Showcase implementations in the field of green and digital economies Initiating new digital and green economy value chains	Sustainable use of post-industrial areas as a new potential for urban development (diagnostics, identification of opportunities) Implementing showcase solutions related to reuse of post-industrial areas	Local and international alliances supporting just and energy transition Effective platform for the exchange of knowledge, information and experience in implementing transition projects

Table 33 cont.

	Creating educational opportunities for communities at risk of social exclusion		Applying nature-based solutions (NBS) to minimize adverse environmental effects originating from post-industrial area remediation	Improving administration personnel competences in managing transition projects and multi-entity cooperation

Source: own study.

Given the specific context of just transition programming in the Katowice subregion, the priorities for this process were embedded in the potentials inherent to the subregion, i.e., human capital and its qualifications; research combined with innovation and implementation; the potential of post-industrial sites; and the transfer of experience. Consequently, objectives related to increasing the quality of human capital in response to the needs of the digital and green economy, combined with the creation of educational opportunities for excluded individuals; the creation of value chains within digital and green economy (starting with implementation research) should be enhanced; preparation of pilot projects in the field of brownfield development in a sustainable manner and benefiting from Katowice's affiliations to create alliances to transfer experience, good practices and knowledge in the field of just and energy transition.

Rybnik subregion – Śląskie province

Florian Kuźnik, Artur Ochojski

Proposed values for the transition of the Rybnik subregion

The just transition vision for the Rybnik subregion should particularly adopt the following as its foundation. These values include natural, landscape and cultural values in the development of residential and recreational spaces; an industrial and entrepreneurial culture combining traditions of work in large industrial enterprises with technical university knowledge and skills; the location-wise attractiveness of the subregion based on the permanent presence of international companies; as well as social, business and local government acceptance of economic transition, including energy transition in the subregion.

Priorities and strategic objectives for the transition of the Rybnik subregion

The formulation of these strategic recommendations for just transition programming within the Rybnik subregion was made possible by analysing the context, stakeholder surveys and the development concept adopted (cf. Table 34).

Table 34. Strategic recommendations for the Rybnik subregion

Contexts	Social	Economic	Spatial and environmental	Institutional
Priorities	Intellectual capital	New energy, new industries	Post-industrial areas	Integration of territorial investments
Strategic objectives	New secondary education directions related to a professional requalification system New university and technical university majors (in consultation with local government and economic milieus of the subregion)	Developing new RES-based energy in spatially concentrated forms, as well as distributed, prosumer energy New logistic zones and hubs strengthening business territorialization in the region	Pro-development regeneration of shut-down mining areas/urban zones Revitalization of degraded and post-mining areas Improving the value of greenery areas Infrastructural investments in areas considered as prospective	Revitalizing water courses and full organization of the water/sewage and waste management in the subregion Expanding pedestrian and bicycle lanes in cities and rural areas Developing public e-services

Source: own study.

Just transition programming in the Rybnik subregion relates primarily to the social and economic sphere. On the one hand, it requires a good social climate for change, and thus, adequate intellectual capital, while on the other, it must take into account the directions for the reconstruction of the "coal and coal--related" economic base in that offers a future to all generations of the subregion.

As in the case of the Tychy subregion (similar employment rate in the mining and mining-related sector), the objectives indicated herein with respect to raising the quality of intellectual capital should be treated as horizontal, also in relation to the institutional – local governmental aspect of the changes.

Proposed values for the transition of the Sosnowiec subregion

Bearing in mind the peculiarities of the Sosnowiec subregion (characterised by a relatively developed economy and institutional infrastructure with a high human capital potential), the just transition process can be based on three values, namely, modern industries using green and blue infrastructure and electromobility technologies; the transition of conventional power into renewable energy; and new transition spaces that improve the quality of life of the subregion's inhabitants.

Priorities and strategic objectives for the transition of the Sosnowiec subregion

Based on analysing the context, studies of the stakeholder's opinion and the development concepts, Table 35 provides a list of recommended just transition priorities and objectives.

Table 35. Strategic recommendations for the Sosnowiec subregion

Contexts	Social	Economic	Spatial and environmental	Institutional
Priorities	Human resources	Research, innovations and implementations	Post-industrial and degraded areas	Experience transfer
Strategic objectives	Popularizing education for the purposes of developing modern electromobility and green economy sectors Preparing an educational offer for modern industries (including electromobility and green economy sectors)	Implementing studies associated with transforming the energy sector toward a low-carbon economy and RES Transitioning traditional industries (metallurgical, coke and chemical) towards low emissions	Creating new functions for post-industrial areas and facilities Reclaiming particularly contaminated/polluted areas through testing new environmental technologies Revitalizing post-industrial and degraded areas	Establishing institutions responsible for multi-entity cooperation in the field of just transition Cooperation and exchange of experience between private and R&D entities under transition projects

Table 35 cont.

		Development of the *automotive* industry in the field of electromobility Creating showcase transition spaces in cities		

Source: own study.

Given the specificity of the subregion, the proposed strategic objectives have been based on its potentials, i.e., human capital; research combined with innovation and implementation; the potential of post-industrial and degraded areas; and the transfer of experience. The proposed objectives aim to adequately prepare and direct human resources to surmount transition-related challenges, including the development of modern industries; to accelerate the transition of the energy sector and traditional industry towards a low- and zero-carbon economy through the use of RES; the development of the automotive industry and the creation of transition spaces; recommissioning post-industrial and degraded areas and providing them with new functions; fostering cooperation and exchange of experience related to the just transition process.

Tychy subregion – Śląskie province

Florian Kuźnik, Artur Ochojski

Proposed values for the transition of the Tychy subregion

The socio-economic processes and activities observed within the Tychy subregion (the rate of demographic change and the economic situation) should become an indication for a change vision within the just transition framework, in relation to which the following values should be recognized as fundamental. These include integrating local communities with a strong identity and high educational aspirations; providing a new post-coal industrial fabric; excellence in specialised services, including metropolitan services; providing sustenance of natural assets accompanying recreation, weekend tourism and heritage assets as part of the cultural and sentimental offer; awareness in the field of economic transition, including energy transition direction; encouraging acceptance of and ability to benefit from the digital offer enhanced by smart public management

(e-services) and business systems; well-composed business, residential and public spaces; regional integration – the subregion as part of an agglomeration becoming a metropolis; and enhancing openness to the world and infrastructural connectivity with the global environment.

The city of Tychy should play a leading role in the just transition process since it has some experience in implementing transition projects of strategic importance, especially in the field of energy and transport infrastructure. As a leader, the city should create the foundations for a partnership-based model of project development with other centres forming a settlement system and developing the economic fabric of the subregion.

Priorities and strategic objectives for the transition of the Tychy subregion

The conducted context analyses, stakeholder surveys and development concepts enabled formulating the following strategic recommendation in the field of just transition programming for the Tychy subregion (cf. Table 36).

Table 36. Strategic recommendations for the Tychy subregion

Contexts	Social	Economic	Spatial and environmental	Institutional
Priorities	Creative, innovative and entrepreneurial milieus	New industries and new quality services	Areas requiring regeneration and revitalization	Territorialization and business networking
Strategic objectives	New specialities of local business New professional competences Living environment and public spaces	Promoting distributed and prosumer energy for companies, farms, households, public/ municipal units Large, concentrated wind, PV etc. systems by power corporations New spatial concentrations of the local businesses Weekend tourism, recreation and free-time	New, zero-energy/ passive residential areas and revitalizing old residential complexes, including ones of high cultural heritage value Providing public spaces with green and circular economy infrastructure – such as bicycle lanes, pedestrian passages, linear parks, recreational post-mining areas	New, strong clusters organized around branded subregional products Developing the Tychy KSEZ

Source: own study.

The just transition programming for the Tychy subregion should take into account both its own (local government and economic) experience and the search for partnerships with business environment entities in neighbouring subregions, the Katowice subregion (university fabric) in particular. New personnel and the institutionalisation of the economic fabric development require continued development of public spaces and orienting transition processes on energy industries and new creative activities.

The proposed objectives, related to the enhancement of the quality of human capital in response to the required strengthening of the economic fabric, public services transition processes, and the strengthening of public awareness in terms of just transition should be treated as horizontal, also in relation to the institutional context of change.

Bełchatów Transition Area – Łódzkie province

Aleksandra Nowakowska, Agnieszka Rzeńca

Proposed values for the transition of the Bełchatów subregion

The Bełchatów area is characterised by its good economic standing. For the last two decades it has been an "island of prosperity" in the Łódzkie province. Its area records the highest income of all inhabitants in the region (higher than average in the regional capital Łódź) and exceptional economic stability. In addition, the growing presence of large companies of national and international coverage, the high dynamics of external economic investments and the good labour market situation create conditions for a "new opening" in the history of the Bełchatów area.

Building the well-being of the inhabitants and neutralising the negative effects of the transition, as well as creating a modern, diversified and resilient economy should constitute the foundations of the just transition process. An endogenous approach, based on entrepreneurship and the use of specific territorial capital, should become the key development mechanism. It will be crucial for the just transition process to target and support climate-neutral economy (CE, RES) development processes and to use significant post-mining areas for testing and implementing innovative forms of reclamation and development.

Priorities and strategic objectives for the transition of the Bełchatów subregion

Original strategic recommendations related to just transition programming for the Bełchatów Transition Area have been presented based on the contextual analyses conducted, stakeholder opinion surveys and development concepts.

Table 37. Strategic recommendations for the Bełchatów Transition Area

Contexts	Social	Economic	Spatial and environmental	Institutional
Priorities	Creative society with high labour market competences	Innovative economy stimulating the development of green markets (industry, services)	Attractive space with a high ecosystem service value	Strong institutional environment, and territorial inclusion and cooperation
Strategic objectives	Developing strong human and social capital, and the welfare of the residents Attractive and entrepreneurial society Modern education and digital skills for the economy and transition area environment Cultural heritage and identity of the subregion	Creating an entrepreneurial and innovative economy striving for climate neutrality Diversified and innovative economy New, green economy sectors (low-carbon economy, circular economy, green economy) R&D facilities for the purposes of modern energy	Regenerating and re-naturalizing the environment using innovative solutions Enhancing environment resistance to climate change Remediating and reclaiming post-mining areas Creating the area's environmental potential (biodiversity, low retention)	Partnership, economic cooperation and development of business environment institutions Subregion centre for civic education and supra-local cooperation Modern and partner-friendly public institutions (*governance*) Improving the debate and local activity (with strong participation of local stakeholders)

Source: own study.

Just transition should provide a developmental stimulus not only for the transition area under analysis, but also for the entire Łódzkie province. It should also create an opportunity to build new economic sectors/industries and new developmental trajectories while restoring the environmental values and assets, and involving all stakeholders in the transition process.

Consequently, the authors proposed exposing the need to build an innovative and climate-neutral economy stimulating the development of green markets (industry, services). Moreover, attention was paid to bottom-up and multifunc-

tional socio-economic development and the creation of spaces for the entrepreneurship of local residents to grow. In addition, regeneration and re-naturalisation of the natural environment, increasing the biodiversity, implementation of innovative solutions, methods and technologies in the field of climate change adaptation are becoming important areas of just transition processes. The transition of the Bełchatów area should also focus on creating a high level of human and social capital, on building dense social and economic relations, as well as a strong identity and well-being of the inhabitants.

Western Małopolska – Małopolskie province

Krzysztof Gwosdz, Sławomir Sitek, Krzysztof Wiedermann

Proposed values for the transition of Western Małopolska

The particular challenges of transforming Western Małopolska are related to its location on the border with Śląskie province, which simultaneously means the subregion's peripheral nature as part of the Małopolskie province. This necessitates close coordination of the activities with the local government authorities of the neighbouring province, which the subregions remain functionally linked to. Cooperation and coordination are among the overriding values required in such circumstances.

The subregion's transition should focus on environmental values that have a direct impact on the quality of life. Its outcome should be built on creating a good living space. However, there must be a parallel economic diversification that strengthens and broadens the economic base of the region and creates new functions therein.

Functional polycentricity should be pursued in the spatial context. Western Małopolska does not have a single dominant centre and is a region with diverse affiliations. Forming its polycentricity should balance the area and create an opportunity for specialisation based on experience and endogenous competence. The success of such activities requires mitigating the adverse social and economic transition effects, which are to encourage undertaking actions and are supposed to be implemented with social approval.

Priorities and strategic objectives for the transition of Western Małopolska

The characteristics of Western Małopolska and the leading values of the transition allow the formulation of priorities in each of the four aspects. These components are interlinked to form a bundle of complementary courses of action (cf. Table 38).

In the social aspect, the emphasis is on improving the quality of life. The strategic objectives focusing on improving the environment, but also on raising the quality of education and social infrastructure. This corresponds closely to the spatial and environmental aspects. The economic priority is to strengthen the endogenous potential. Creation of a diverse and competitive economy based on a strong RES sector and related industries should be the objective. It proves important to create a model economic activity zone, oriented towards SMEs, with its infrastructure incorporating pro-climate, including zero-carbon, solutions. A prerequisite for economic change is to strengthen the economic activity of the population that is strongly associated with social objectives. The strategic objective is focused on the implementation of public policies that will limit the negative effects of the transition.

Table 38. Strategic recommendations for Western Małopolska

Contexts	Social	Economic	Spatial and environmental	Institutional
Priorities	Quality of life	Economic potential, new and innovative industries	Post-industrial areas and facilities	Subregional cohesion and cooperation
Strategic objectives	High quality of the living environment High quality of the educational offer Developing the social infrastructure	Creating a diverse and competitive economy based on a strong RES sector and related industries Reinforcing the economic activities of the residents Mitigating the adverse social and economic transition consequences	Promoting solutions supporting the recycling of post-industrial areas within the spatial and investment policy Green linear infrastructure: nodes and corridors promoting the use of post-industrial landscapes and strengthening functional and spatial integration	Effective multi-level cooperation that takes into account the strong relation between the Western Małopolska region and the Śląskie province Creating a subregional spatial structure with polycentric complementarity

Source: own study.

In the spatial and environmental aspect, the priority is the just transition process of post-industrial areas and facilities. The strategic objectives are related to the creation of an appropriate spatial policy, promoting solutions to reduce environmental pressures and increase spatial order. These actions are intended to foster the recycling of brownfield sites. It is recommended to introduce innovative functional and engineering solutions related to the remediation of brownfield sites. Spatial accessibility should be enhanced in order to strengthen functional links through the development of road infrastructure connecting the subregion with the core area of the Katowice conurbation and the Bielsko-Biała agglomeration.

In the institutional aspect, the recommendations aim to develop the subregion's internal cohesion, taking into account the strong links between the Śląskie and Małopolskie provinces. The intent is to support the processes of creating local partnerships between individual municipalities and other stakeholders in the process, aimed at achieving long-term strategic goals. This will require the strengthening of synergies between the leading urban centres through, among others, a regional investment policy aimed at a polycentric spatial structure of the subregion.

Eastern Wielkopolska – Wielkopolskie province

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Proposed values for the transition of Eastern Wielkopolska

With regard to the characteristics of endogenous resources and the transition of the local economy to date, the core values within the just transition of Eastern Wielkopolska include striving to become a leader in the green transition of the energy industry based on innovating manufacturing and energy application consumption that will change the way the region is perceived; broad and active participation so as to create a country-unique cooperation platform to implement the idea of effective and sustainable transition of the local economy with respect for the natural environment; and social inclusion, taking into account the need to guarantee decent and qualified jobs for all residents, while reducing the scale of internal spatial disparities in terms of living standards and conditions.

Konin plays a special role in the just transition process within the analysed coal subregion as it is a subregional growth centre. Its cooperation as the capital of the township and land district with the other three district, namely, Turek, Koło and Słupca, where lignite mining and processing plants are or were located, is crucial for the effective achievement of the adopted objectives and for making the idea of a zero-emission, innovative economy that ensures the expected level and living conditions in Eastern Wielkopolska, a reality. It is important that other urban centres involved in this process, which serve as district capitals (Turek, Koło and Słupca), strengthen their economic base and central functions, and increase the degree and scope of their influence on the local environment. This action will strengthen the relationships that create the grounds for the formation of urban functional areas, and which enable effectively reducing the scale of internal spatial disparities in the well-being and living conditions of the area's inhabitants.

Priorities and strategic objectives for the transition of Eastern Wielkopolska

Based on the conducted contextual analyses, stakeholder opinion surveys and development concepts, original strategic recommendations related to just transition programming for the Konin subregion have been compiled and are presented in Table 39.

Table 39. Strategic recommendations for Eastern Wielkopolska

Contexts	Social	Economic	Spatial and environmental	Institutional
Priorities	Human resources	Green economy innovations and implementations	Post-industrial areas and tourism-related developments	Local participation and cooperation
Strategic objectives	Using the qualifications and skills of the human capital within new economic specialisations of the subregion by creating conditions for broadening and changing education	Energy (r)evolution towards green energy through the development of renewable energy sources and distributed energy, development of hydrogen technologies and building a zero-carbon energy sector resilient to climate change	Regenerating the natural environment through development of degraded areas, restoration of proper hydrographic conditions within the area impacted by mines, and the progress of new functions, including	Increasing the activity and cooperation of inhabitants so as to implement joint actions, including the implementation of the green and digital transition idea Developing the social services,

Table 39 cont.

	Profiling and popularizing education in the field of digital and green economy Creating conditions for the development of cooperation between the education sector (primary, vocational, secondary) in the field of digital and green economy Creating educational opportunities for communities at risk of social exclusion	Promoting zero--emission and energy--efficient transport, industry and construction Creating conditions for the development of a diversified and innovative economy with developed entrepreneurship and expanding research and development work, technologies and innovations related to new specialisations of the subregion; ensuring opportunities for the internationalisation of enterprises and the promotion of the subregion to facilitate the initiation of new value chains of digital and green economies Fulfilling the circular economy idea through promoting sustainable industrial production, sustainable consumption and bioeconomy development	tourism developments Adapting to climate change through increasing water resources and improving their quality, protecting and restoring biodiversity and natural retention within the landscape, and reducing the consequences of extreme events, including adaptation of urbanised areas to climate change Improving transport accessibility, including through the creation of road routes adapted to the needs of the subregion's transition, and the development of a railway system that guarantees efficient internal and external subregional links	taking into account the needs of those affected by the transition towards climate neutrality and improving the standard of living and living conditions of the inhabitants Strengthening the competences of the administration personnel in creating conditions for the development of public participation in implementing measures aimed at achieving the goals of green and digital transition

Source: own study.

Given the specificity of the just transition programming context within the analysed coal region, its priorities have been embedded in the potentials inherent to the subregion, i.e., human capital and its qualifications; innovation and implementation of green energy; the potential of brownfield sites; and strengthening the tourism offer using local environmental resources and local participation and cooperation.

Consequently, objectives related to strengthening the quality of human capital in line with the needs of the green and digital transition and the need to protect disadvantaged groups; creating conditions for innovation and implemen-

tation enabling the development of green energy as a new specialisation of the coal region; taking action in the field of natural environment regeneration and management (taking into account the challenges of the post-mining and post--industrial area reclamation) and the need to build conditions for sustainable tourism development with the use of environmental resources; applying experiences and strengthening local participation and cooperation for the benefit of a transition towards climate neutrality.

Conclusions

Adam Drobniak

The goal of the conducted analyses was an attempt at collecting and organizing knowledge, experience and studies related to just transition, and formulating strategic recommendations for Poland's coal regions. The multifaceted, but also synthetic approach towards the issue of just transition programming in Poland, enabled gaining insight into and organising the most important stimuli and concepts related to the introduction of changes on a regional level; reviewing the experience in the implementation of transition projects; capturing the specificity of each of the coal regions of Poland (demographically, economically, spatially, institutionally and environmentally); formulating preliminary scenarios of environmental trends affecting the future of such regions; and identifying the stakes of just transition strategic stakeholders. Ultimately, these results have become grounds for formulating a number of strategic recommendations for just transition programming at domestic and regional levels.

Taking into account the complexity of the subject matter undertaken, the Authors fully share the opinion that the advocated broader recognition of the issue of just transition covering Poland's coal regions (in the context of technological, social, economic and environmental change) from the diagnostic, prognostic, and normative perspectives, with the participatory involvement of stakeholders in this process, is still valid. The presented research results contained herein shall be treated as an introduction to a further and broader discussion on the sectoral and territorial transition that should take place in Poland's coal regions.

The driving stimulus behind considering just and energy transition is the environmental pressure that has been growing for decades, manifested in international declarations and policy documents related to, among others, *Agenda 2030*

[United Nations, 2015], the *Paris Agreement* [United Nations Climate Change, 2015] and the *European Green Deal* [European Commission, 2019b]. In strictly economic and technological terms, just and energy transition entails a reorientation towards a green economy [Brand, 2012] that is focused on changing the relationship between the economy and ecosystems that will form the foundations for the operationalisation of sustainable development. The emphasis being place upon a green economy that is related to human economic activities, compared to the previous perception of the economy, shifts the focus to environmental risk reduction, indexes ecological rarity and the renewable with regard to environmental resources. The sole decisive issue is incorporating environmental aspects into all sectors of the economy.

The turn towards green economy should come with well-prepared social changes, which, in the context of a narrowly conceived just transition, mean minimising the costs of the "green revolution", including the provision of new jobs for current workers in traditional resource-based and related industries, in particular. However, the just transition concept can and should be perceived in a significantly broader manner (distributive and procedural just transition) than just through from the labour market perspective. Just transition should also refer to the creation of new development paths in coal regions or areas dependent on traditional industries. Therefore, in regions of this kind, just transition implies the need for a far-reaching structural reform, if these places are to upkeep their role as growth centres. It is important to emphasise that a shift towards a green economy does, however, mean disrupting the current *status quo* of economic activities and the labour market. Providing access to new skills and new jobs, as well as stimulating new development paths are all remedies for the geography of discontent that can emerge in regions with strong links to the fuel and energy sectors − and which can effectively hinder green transition.

The transition from the notion of restructuring, fashionable in the 1990s, i.e., the restoration of profitability as the outcome of a structural adjustment process [Kuźnik, ed., 2003], to the transition category, represents an opportunity to better integrate the social factor in the context of the upcoming changes. However, excessive focus on the technological aspect of energy transition (energy mix, energy efficiency) may bring about social costs equally serious as in the case of excessive concentration on the economic context (costs, benefits, profitability), as was the case with restructuring. Therefore, upon programming technological changes related to green economy industries (such as RES, circular economy, passive construction, low-carbon transport, green and blue infrastructure) or digitisation, it is required to consider the role that employees of traditional industries, together with their families, local communities, and the traditional industry

sector with related industries should play within this process. This is all the more so because, as demonstrated, the traditional sector and coal-related industries within Poland's coal regions nationally-significant positive economic potential, being a natural consequence of their previous development path.

There are 13 coal regions in Poland. They are located in six provinces, namely, the Dolnośląskie, Lubelskie, Łódzkie, Małopolskie, Śląskie and Wielkopolskie. In total, these regions account for more than 20% of the GDP, more than 20% of all jobs, and carry approximately 20% of the nation's population. Thus, their current social and economic significance for the country is very high. Unfortunately, in the environmental context, these regions, in addition to the issue of post-industrial sites (including degraded areas), also "supply" more than 40% of our country's total CO_2 emissions. Most coal regions are concentrated within the Śląskie province, which has been almost entirely covered by European Commission support in the form of the Just Transition Found. This is also the largest coal-related region in the EU. However, serious transition-related problems and challenges are evident in almost every coal region analysed. Their peculiarities are related, among other issues, to economic monoculture, unsatisfactory development of BEIs, depopulating and ageing communities, peripheral location, and the settlement structure based on small- or medium-sized towns with lower development dynamics and relatively weaker links with the global economy. Such a situation makes these places particularly vulnerable to the costs of the "green revolution" − notably at the start of the transition.

Each of Poland's coal regions needs an individual approach to programming just and energy transition. Significantly less negative social and economic effects of the transition will be experienced in institutionally strong, well--diversified regions with an urban character, such as the Katowice or Gliwice regions, or those where the current scale of mining employment is small, such as the Bielsko-Biała region. The situation will be very different in regions characterised by a low urbanisation level, weak institutional development or a rural or small-town character, such as Bełchatów, Lublin or even Eastern Wielkopolska. *De facto*, the energy transition process has already begun in the latter region and, in the face of the protracted lack of JTF support related to the prolonged negotiations on the National Reconstruction Plan, it is already generating serious social problems in the local labour market. The transition will be even more different in the Wałbrzych region, where the last mine was closed in mid-1990s and where the effects of the social and economic collapse at the end of the last century are still felt.

In addition to just and energy transition programming at the level of individual coal regions (territorial aspect), solutions are also required at the national

level (sectoral aspect)[29]. The latter mainly refer to an extensive social agreement establishing, among other notions, the rate of the change process with all stakeholders; the scope of the transition of traditional sectors; the initiation of new value chains through cooperation between enterprises, BEIs and LGU; sorting out brownfield-related issues; the introduction of legislative changes primarily related to the energy market and its participants, the labour market, education and spatial planning.

At the national level, the prerequisite for the success of just transition of a political and sectoral nature is to "turn on the green light" for the transformation of the sectors related to mining and conventional power generation, with their simultaneous involvement in the transition to a low-carbon economy. Unfortunately, for almost a decade, with few exceptions [Ministry of Climate and Environment, 2021], there has been no decisive decision-making motion on this matter at the national level. The current geopolitical situation (war in Ukraine, embargo on Russian coal and gas, energy crisis) has even halted the first activities of the traditional sector towards a low-carbon economy and coal phase-out. Indeed, recently, there has been a reverse movement towards increasing coal mining and preserving old energy generation structures – this being justified by ensuring the country's energy security. This is a move that is difficult to understand even for trade union communities, who during their July 2022 protest, demanded revision and verification of the long-consulted social agreement with the mining sector related to phasing out mines by 2049 (Social Agreement of 28 May 2021). Such a move could lead to less JTF resources allocated to just transition, as the condition for its activation was, highly respected by the EU, to ensure coal extraction reduction in Poland's coal regions.

The delays associated with energy transition in Poland, the change in the geopolitical situation, the difficulty in successfully implementing just transition and, above all, the social and economic scale of the coal regions make the transition a topic of high political risk. Potential piecemeal failures, which are inevitable given the current poor level of technological and institutional preparedness for the transition to low-carbon economy, pose a risk of serious social protests, real labour market problems, marginalisation of some coal regions and excessive social stratification. The complexity of and diversity of the contexts and various strategic stakes of different just and energy transition stakeholder groups raise a number of dilemmas that are worth addressing and resolving before proceeding with the implementation of such processes, which are very important to the na-

[29] The specific nature of Poland means that the vast majority of the fuel and energy sectors remains under the responsibility of State Treasury companies.

tion's coal regions and the country as a whole. Following the British, Spanish and German experiences, there is also a need for an institutional solution to coordinate the exchange and transfer of knowledge of successful transition projects that have provided opportunities to create new activities in coal regions that would constitute development prospects for the next generations. The lack of an entity gathering transition-related knowledge that monitors the process, and stimulates communication and cooperation between R&D – enterprises – LGUs – NGOs – national level, may result in partial and uncoordinated solutions. Should such an entity not be created, this, in turn, will mean that in the coming decade we will witness the emergence of hybrid transition spaces in coal regions, i.e., a patchwork of places where new green economy solutions, supported by European funds, will coexist with dying traditional industry.

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In the years 200-2004, he was employed at the District Labour Office in Tychy (started as a job agent, and later as a Job Agency Department manager). He was awarded his *doctor habilitatus* title in 2016, based on a series of publications entitled *Procesy zachodzące na rynku pracy – ze szczególnym uwzględnieniem województwa śląskiego. Diagnoza kategorii defaworyzowanych na rynku pracy [Labour market processes – with particular emphasis on the Śląskie province. Diagnosing categories disadvantaged within the labour market]*. Coordinator and participant in numerous research projects involving analyses of processes occurring within local and regional labour markets. In the years 2009-2010, he was an expert for the Provincial Labour Office in Katowice, working on a project of monitoring the regional labour market. Author of seven published reports on labour market research and over 100 articles on the labour market and human resources management issues. Between 2011 and 2018, he served as secretary of the Commission for the Studies on the Future of Upper Silesia at the Polish Academy of Sciences. Member of the Polish Sociological Association and the Polish Social Policy Association.

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This book documents the importance of EU structural intervention in coal regions, both at European and Polish level, recorded not only at national but also at regional level. The role of the European Union in conceptualizing public intervention in coal regions is crucial. Poland is the most important country of such structural change. A very important conclusion from the conducted research, which should be highlighted, is the significant diversity of these thirteen Polish coal regions. This calls for an individualized and decentralized approach to the challenge of transforming individual coal regions. In the outlined context, I positively assess the authors' approach to difficult topics with significant added value in the theoretical and empirical sphere, marking the new cognitive frontier.

Professor Jacek Szlachta – the book reviewer

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