



THE PLACE OF ŚLĄSKIE VOIVODESHIP (POLAND) IN THE GREENING SPACE OF FLOWS

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Abstract. The study assess the position of the Śląskie Voivodeship in the European space of flows. The main objectives are: (1) to examine the regional position in the interregional space of flows, and (2) to assess this position in terms of the decarbonisation processes planned under the European Green Deal policy. In order to do this, the strengths and weaknesses of the region were identified, the flows potentially vulnerable to the restructuring process of the region's coal-based economy were recognised, and the extent and scale of the impact of decarbonisation on the region's economic situation was determined. An analysis of indicators such as intensity and concentration of flows places the region on the flow periphery, as the most significant flows are concentrated in Western and Northern Europe. One exception to this pattern is the transport of goods when measured in tonnes, which makes the region an important hub on a European scale. However, the most intensive flows link it with other Polish regions. Moreover the specificity of the Śląskie Voivodeship means that any effects of the European Green Deal will be particularly strongly felt, as it is among the regions experiencing the greatest negative impact of this policy on the economy and labour market.

Keywords: decarbonisation, European Green Deal, flows, international competitiveness of regions, low-carbon transition, position with(in) the space of flows, space of flows, Śląskie Voivodeship.

Introduction

Recent decades saw rapid changes in the socio-economic position of regions which, due to their mining and heavy industry, were the poles of industrialisation in the nineteenth and twentieth centuries. These changes began in highly developed countries, including in Western Europe, and then, after 1989, also affected transitioning economies. Initially, these developments were caused primarily by sectoral changes (the growing role of the service sector), new production systems (post-Fordism) and technological development. The processes of globalisation and access to alternative, cheaper fossil fuels were not without their significance. In Central and Eastern Europe (CEEC), the need for change stemmed from overemployment in the mining and heavy

industries. While the role of these industries went into decline, the regions of their concentration retained their overall strong position by attracting foreign investment in other industries (e.g. in the automotive industry; cf. Domański, 2001), including by leveraging the local availability of a relatively better-skilled workforce.

Over time, growing environmental challenges added to the existing a pool of change-inducing factors. Indeed, the idea of a low-carbon economy gained in importance after the global crisis of 2007-2008. Already symptomatic of this trend was 'Resource-efficient Europe', the priority of the Europe 2020 strategy, but it was the adoption of the European Green Deal (EGD) and the subsequent crisis on the energy markets linked to the Russian-Ukrainian conflict that sealed choices for the future of the EU economy which were aimed to maintain climate neutrality. Meanwhile, under the German Presidency in 2020, a Green Europe was adopted as one of the two meta-priorities of the new EU Territorial Agenda. On the other hand, awareness of the threats posed to some regions by the tenets of the 'Green Deal' resulted in the establishment of the Just Transition Fund designed to provide support for strictly defined territorial units of the European Union (EU).

A transition away from the traditional towards a new 'green' economy has brought with it a number of challenges to existing, often resource-intensive, economic systems. If competitive advantages are to be maintained, then the pursuit of the designated environmental priorities, with their focus on curbing the consumption of natural resources and increasingly bold measures adopted along the way, will require change that involves environmentally friendly solutions. Regions relying on traditional sectors, such as heavy industry, mining, and energy, may be particularly vulnerable to such developments (Michalak et al., 2020). Such regions are considered to be problematic and therefore requiring specific public intervention. Most studies exploring this area focus on a given region's internal economic situation, especially its labour market, without seeing its position across the space of flows. It can be argued, however, that territorial units should be seen through their networks of interactions with other regions on national, continental and global levels. The assessment of the position of a region in the space of flows would thus be a condition for assessing its resilience, understood as the sensitivity and adaptability of the system to external shocks (Drobnik et al., 2021).

The functioning of regions in the global economy is both associated with a diversification of their risks, as their integration in the system deepens, and with a reduction in their security levels, as they are affected by additional instability factors linked to the rapidly changing situation on other markets (Down, 2007). Hence, the advent of carbon transformation may be regarded as a shock to the region's economy affecting not only its social and economic realities, but also its population, capital, commodity and knowledge flows. Indeed, '[t]he space of flows structures and shapes the space of places (...)' (Castells, 2009, p. 161). On the other hand, without access to the space of flows, regions are marginalised and subordinated exclusively to the space of places (Bush & Oosterveer, 2007). In addition, a given region can trigger, via a system of interregional links, specific changes elsewhere in Europe and the world, such as labour supply, prices and demand for goods and services or a demand for research or capital.

For these reasons, industrial regions relying on mining and heavy industry should be considered in the broader context of their links with other regions. This approach could both help to identify the paths of risk spreading through the European regions, and provide an opportunity to identify alternative avenues for public intervention. So far, research into these areas has been hampered by the poor availability of interregional flow data, especially those collected under the international matrix system. This specific obstacle was targeted by the ESPON IRiE (Interregional Relations in Europe) project. The project analysed flows in 297 NUTS 2 units within the ESPON

space¹ examining parallel flows of goods, capital, people and knowledge. In this way it was possible to indirectly assess the effects of the changes not only in the regions studied, but also in a broader European perspective. The study also looked at scenarios triggered and outcomes produced within the system of connections by such external shocks as the introduction of the principles of the EGD.

Śląskie Voivodeship in Poland provides a particularly good example of a region affected by the EGD policy. It currently remains the largest coalfield operating within the EU, while maintaining a considerable footprint in the metallurgical industry. In 2021, Poland produced 96% of the EU's hard coal (55 million tonnes out of the total 57 million tonnes) and 5.5% of its steel, with the majority of the country's mines and metallurgical plants located within the Śląskie Voivodeship (Eurofer, 2022; Eurostat, 2022). The region was not just one of the Polish economy's most developed regions for decades, but it also stands to become one of the biggest beneficiaries of the Just Transition Fund programme in the future. For these reasons this study assess the position of the region in the European interregional space of flows. The main objectives of the study were to explore the position of industrialised Śląskie Voivodeship and to assess it in terms of the decarbonisation processes intended under the Green Deal Strategy. The strengths and weaknesses of the region in the system of European flows were identified, the flows potentially sensitive to the process of restructuring the coal-based economy in the region were recognized, and the scope and scale of the impact of decarbonisation of the region on the economic situation (Value Added and Employment) in the region and in other parts of Europe were determined. The paper concludes by assessing the outcome of the Green Deal scenario in terms of opportunities and threats to the region's demographic and economic situation. The special position of the Śląskie Voivodeship from the point of view of the structure of its economy and its vulnerability to decarbonisation policies is well known. However, the article provides new empirical knowledge on the size and structure of flows between this region and other NUTS 2 units in Europe. It also shows, for the first time, the scale of change in the region and in the system of flows that will occur as a result of the European Green Deal. It therefore proposes a new methodological approach to simulating the spatial effects of sectoral policies. Only by considering the region in the context of the space of flows can the effects of the decarbonisation of the economy be fully assessed. At the same time, the simulation of the results of the European Green Deal is an example of the practical application of flow analysis and thus its potential use in the territorialisation of European policies.

Subsequent sections include a short literature review (both on the EGD and on flows) and an introduction to the Śląskie Voivodeship and the methodology. These are followed by a discussion of the results (by types of flow) and the final conclusions, including a set of recommendations.

Literature background

The context: Green Deal and decarbonisation

EU has had a long history of climate policy legislation. Oberthür & von Homeyer (2022, p. 9) show that it began in the early 1990s in a purely informative role and that regulatory acts only follow after 2000. Climate governance in the EU has therefore come a long way, from the pricing of CO₂ emissions to implementing the socio-technological changes needed to implement such a comprehensive and socially sensitive policy (Voicu-Dorobanțu et al., 2021; Boasson & Tatham, 2022; Oberthür & von Homeyer, 2022).

¹ The 27 EU member states plus Iceland, Switzerland, Norway and Liechtenstein, as well as the United Kingdom (now outside the ESPON area).

The EGD is the EU's new development strategy underpinned by commitments to achieve climate neutrality by 2050. Its implementation will require a correct alignment of all the EU's sectoral strategies and policies as well as legislation (Czapiewski et al., 2022). The EGD spans all sectors of the economy from agriculture to energy to transport to construction. Its main objective is to transform the EU into a modern, resource-efficient and competitive economy. The EGD consists of the following 'key actions' (EC, 2019a; CBI, 2021):

- Climate ambition: by 2030, the EU's greenhouse gas emissions should fall by at least 55% compared to the 1990 baseline, and by 2050 the EU is expected to reach net-zero greenhouse gas emissions.
- Clean, affordable and secure energy.
- Industrial strategy for a clean and circular economy.
- Sustainable and smart mobility.
- Greening the Common Agricultural Policy (including through the Farm to Fork strategy).
- Preserving and protecting biodiversity.
- Towards a zero-pollution ambition for a toxic free environment.
- Mainstreaming sustainability in all EU policies.
- The EU as a global leader (an example for other countries).
- Working together – a European Climate Pact.

It should be underscored that the EGD is still a growth strategy that also requires taking into account a high level of environmental protection (Sabato & Fronteddu, 2020). The EGD funding is to come partly from the funds allocated for investments under the NextGenerationEU recovery plan and funds from the seven-year EU budget (EC, 2019b).

The EGD strategy involved the adoption of various framework documents on the transition to a zero-emission economy, which are to be transposed into implementation documents and programmes, recommendations and regulations, shaping the way the private sector operates. From the perspective of the Śląskie Voivodeship and its position in the system of flows, the European Industrial Strategy (EIS), adopted in March 2020, is a document that seems to be particularly important. It places emphasis on the development of a digitised, environmentally-friendly and competitive economy of the future (EC, 2020a; Smol, 2022). The COVID-19 pandemic has highlighted the importance of building economic resilience and, according to the EIS, resilience is to be based on the diversification of international partnerships, industrial alliances and the monitoring of strategic dependencies (EC, 2020a). This provides another context where a study of the space of flows in Europe seems valuable.

Among the objectives pursued by the EGD is a 'clean' energy agenda which involves the decarbonisation of the energy system. The energy sector is to build its future on renewables supplemented by a rapid withdrawal of coal and the decarbonisation of gas. At the same time, the EU's energy supply must be both secure and easily accessible to consumers (EC, 2019b). For this to happen, it will be necessary to ensure a full integration of the European energy market and the taking care of its internal connectedness. Thus the issue of flows between European regions again arises (Czapiewski et al., 2022).

It is worth mentioning that the EGD is but one of many existing strategies in a more general green deal, one of the most important concepts for the worldwide implementation of sustainable development. Green deal strategies are launched at the national (e.g. US, UK and South Korea), regional (EGD) and international (Global Green New Deal on behalf of the United Nations) levels (Smol, 2022).

The EGD is an ambitious, large-scale and long-term undertaking with a significant impact on the economic realities in Europe and the rest of the world. One example of this worldwide impact is that besides higher sustainability standards in primary production and industrial processes, the EGD will require non-EU based small and medium-sized enterprises to provide more detailed information about the products they export to EU (CBI, 2021). For this reason, attempts to forecast the impact of the Green Deal strategy on various areas of life have been the subject of numerous research studies (Jacobson et al., 2019; Pietzcker, Osorio & Rodrigues, 2021; Hainsch et al., 2022; Koasidis et al., 2022; Loewen, 2022).

The COVID-19 pandemic has slowed down the implementation of the EGD and other similar strategies, which had to be modified and adapted to new challenges (Smol, 2022). This has opened up space for the post-COVID recovery designed to make the European economy greener, as this is what is supposed to make it more resilient to shocks and better suited to current and upcoming challenges (EC, 2021). The 'greening' of Europe and the achievement of the EGD's objectives may benefit from some of the behavioural change resulting from the pandemic, such as reduced commuter traffic due to the spread of remote working (Cassetti et al., 2023).

Climate change, the harmfulness of pollution and the depletion of natural resources have convinced the world it must move away from coal. On the other hand, according to Bergamaschi (2020, p. 1), '[t]here is No Green Deal without a Just Transition'. Additionally, there are many challenges to the implementation of the EGD resulting from different environmental, social and economic conditions (Schumacher, 2020; Smol, 2022). The transition to a low-carbon economy should be sustainable, and this requires a general public consensus (Filipović et al., 2022). Indeed, the delivery of the carbon transformation envisaged by the EGD will require a deep restructuring in areas where the economy is based on coal mining. However, without financial and institutional support, the burden of decarbonisation would be unevenly distributed with the last few 'coal' regions bearing most of the costs, including social ones (Moesker & Pesch, 2022). In order to mitigate the social impact of phasing-out coal, a financial toolkit, known as the Just Transition Mechanism, has been introduced to support coal regions. A just transition is defined as a transition to a climate-neutral economy which preserves the well-being of the local population. This applies primarily to ensuring continuity of employment for the workforce of carbon-intensive sectors (e.g. the mining industry and coal-based power utilities) and care for the environment (Moesker & Pesch, 2022; ST, 2022; Eurofound, 2023). The Just Transition Mechanism for 2021-2027 is based on three pillars (EC, 2020b):

- The Just Transition Fund (JTF; €7.5 billion, generating €30-50 billion from investments).
- A dedicated just transition scheme under InvestEU (€45 billion from investments).
- A public sector loan facility with the European Investment Bank backed by the EU budget (€25-30 billion from investments).

Unfortunately, as noted by Pianta & Lucchese (2020), although the allocation of JTF funds to be targeted at specific regions should reduce resistance on the part of the member states most affected by this problem, the lack of a linkage with the EU's cohesion policy and the currently uneven development of clean-technology industries may lead to a deepening of spatial injustice across Europe.

Flows: conceptual and empirical approach

The scientific and methodological foundations of modern analyses of spaces of flows date back to the mid-twentieth century (Zipf, 1946; Stewart, 1948), but modern understanding of the concept has been outlined by the work of Castells (1996, 1999). According to his definition, a space of flows is 'the material organisation of time-sharing social practices that work through flows' (Castells, 1996, p. 147). The factor that distinguishes the space of flows from the conventional space of places

is the movement that links the individual elements of the space in a network of relations characterised by continuity and taking place in real time (Castells, 1996; Stalder 2003). The technological infrastructure of a space of flows consists of information, telecommunication and transport systems (Castells, 1999). At a time of advancing globalisation, the spatial and functional structures of territorial units cannot be accurately captured without an analysis of international flows (Komornicki et al., 2021). However, spaces of flows are difficult to study due to their complexity, dynamic nature, and the relevant statistical databases which are poorly synchronised and riddled with errors. ‘The resulting ignorance of the system leads to erroneous scientific diagnoses and often also to misguided investments’ (Komornicki et al., 2021, p. 14).

As European regions drive towards an ever-deeper integration, the study of interregional flows seems to offer particularly useful insights. The degree of integration of individual areas affects their level of development, which in turn determines changes in the sets of opportunities and threats to various EU territories. All these issues make interregional relations a key driver of regional economic, social and sustainable development and consequently also the foundation of several European policy initiatives, such as the cohesion policy, regional development strategies and trade policy (Velasco Echeverría et al., 2022). Thus, determining the position of a region in the interregional system of flows is important for that region’s development.

Researchers have now transitioned from viewing the regional space as purely a space of places to one where a space of places and a space of flows coexist. The relationships between the ‘objects’ of this new space are complex, as they include both cooperation and competition (Jin et al., 2021). In Poland, the idea of the parallel existence of competition and cooperation (synergy) was at the roots of the concept of a networked metropolis, which was proposed in the experts’ version of the National Spatial Development Concept (Korcelli et al., 2010). The main forms of interaction in the space of flows include (Fig. 1): flows of population (migration, commuting, tourism), flows of goods and services – trade (Jin et al. (2021) calls them ‘material flow’); flows of capital (capital funds, FDIs, remittances), and flows of information and technology (scientific cooperation, R&D, patents).

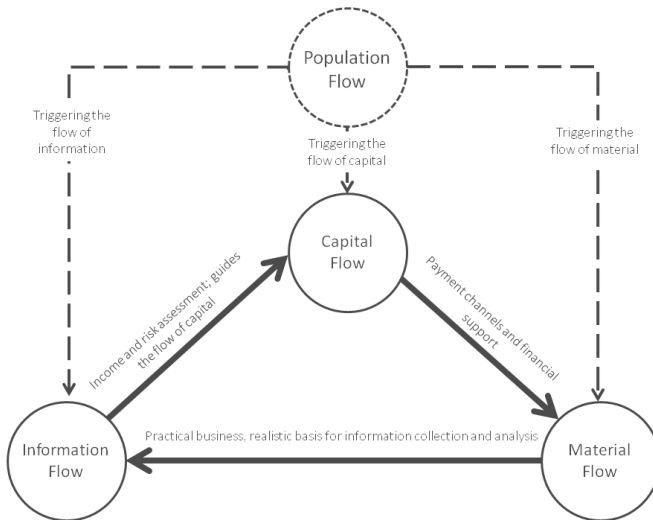


Figure 1. The relationship between types of flows
Source: Jin et al. (2021, p. 11).

Whether a given type of relationship between areas develops at all depends on multiple factors. A new and interesting trend in regional research looks at the scale and intensity of such links between regions and their spatial patterns. On the one hand, whole systems of links are examined in search of patterns of relations between them. On the other hand, regions are assessed in terms of their rank within the space of flows, such as when looking for competitive advantages.

Studies of flows of people between regions focus mainly on the flows of migration and of tourists. European research into migration flows has been limited to the national level, looking at both flows and their effects, while the regional level has been missing (Komornicki et al., 2021). Much attention has been paid to the issue of immigration into the EU from other parts of the world (e.g. Sirkeci, Cohen & Can, 2012; Fassman & İçduygu, 2013; Maddaloni & Moffa, 2019) and to migrations between the pre-2004 EU and the new member states (e.g. Kahanec, Zaiceva & Zimmermann, 2009; Barrell, Fitzgerald & Riley, 2010; Fic, 2013; Glorius, Grabowska-Lusińska & Kuvik, 2013). In the context of the EGD and decarbonisation, the intensification of migration flows fuelled by increased immigration from the new member states, as found by these studies, could be explained by structural unemployment resulting from the closure of mines and other mining-related workplaces (Spencer et al., 2017; Oei, Brauers & Herpich, 2019; Baran, Szpor, & Witajewski-Baltvilks, 2020; Oei et al., 2020; Reitzenstein et al., 2022).

As regards tourism flows, extensive studies have been devoted to visitor arrivals and revenues from tourism, but there are evident gaps in research into the structure and evolution of these flows (Shao et al., 2020; Cerić et al., 2021). A different picture emerges from research on people flows achieved through the analysis of individual modes of passenger transport (Schwarze & Spiekermann, 2022). It does produce a precise quantitative representation of the links but provides no insight into the motivations behind the trips. Therefore, the flows of people through each of the means of transport may as well be reflecting any one of the tourist, migratory (visits of relatives and friends), and economic (business trip) connections.

Research on interregional flows of goods can be divided into two strands: 1) embedded or produced in the context of input-output tables and 2) studies outside of the input-output table context (Llano, Pérez-Balsalobre & Gallego López, 2021). The oldest studies of the first strand come from Leontief (1941), Isard (1951) and Ullman (1957), who built the earliest interregional input-output models. The design of an input-output model requires knowledge of bilateral flows connecting pairs of regions and productive sectors in a given system (Llano, Pérez-Balsalobre & Gallego López, 2021). This concept was subsequently built upon by other researchers who conducted studies on the origin-destination flows of individual regions for each sector at the subnational level (Polenske, 1980; Batten, 1983; Hewings & Jensen, 1987; Jiang, Dietzenbacher & Los, 2012; Almazán-Gómez et al., 2019; Temursho, Oosterhaven & Cardenete, 2020). The other strand encompasses research estimating the flow of goods in the origin-destination relationships using statistical data on freight and passenger transport (e.g. McCallum, 1995; Combes, Lafourcade & Mayer, 2005; Hillberry & Hummels, 2008; Redding & Sturm, 2008; Garmendia et al., 2012; Agnosteva, Anderson & Yotov, 2019). Typically, these studies would be confined to a single country and would focus on any of the following issues: the border effect, the relationship between intra-regional and interregional flows, and the impact of geographical frictions on trade. There is a body of research, albeit much slimmer, on the flows of trade between regions divided by national borders (e.g. Nijkamp et al., 2004; Gallego & Llano, 2014, 2015) and on flows of services, which themselves belong to flow of trade (Helpman, 1984, 1985; Markusen & Venables, 2000; Markusen, 2002; Christen & Francois, 2010; Llano et al., 2021).

In Poland, studies of internal flows of goods were initiated by Chojnicki (1961). More recently, regional-level research has been looking at the context of foreign trade. These studies included parallel analyses of both industry and geographical export structures (e.g. Komornicki, 2000; Rogacki, 2001; Umiński, 2012; Maćkowiak, 2013; Szejgiec-Kolenda & Duma, 2020), which allowed global threats to local economies to be identified. In addition, studies of the flows of goods helped identify relations with specific partners and the role of intermediaries (Szejgiec-Kolenda, 2018).

Capital flows usually coexist with other types of flows, as remittances or capital investments accompany migrations themselves, while FDIs, loans, or knowledge flows (investments in research projects) come with the flows of goods. For this reason there is not much published research on capital flows as such (Buckley & Ruane, 2006; Choi & Seiger, 2020; Jin et al., 2021; Yang et al., 2022). Moreover, according to Hall et al. (2017), studies on change in energy systems have largely neglected the role of capital markets even though a shift towards low-carbon economies is bound to require large amounts of investment. Yet such systemic change can have serious repercussions on investment patterns and the stability of financial systems (Lachapelle et al., 2017; Semieniuk et al., 2021). Recently, a noticeable change has been identified in investment behaviour as climate-awareness and low-carbon emissions have been incorporated into the profiles of investment portfolios (Gomez Echeverri, 2018), thus increasing the importance of climate risk for institutional investors (Benz et al., 2020). According to Sartzetakis (2020), three types of climate-related financial risks have been identified in the literature: 1) physical risks (extreme events, e.g. floods); 2) risks of liability (for damage suffered by a party); and 3) transitional risks (resulting from the process of adaptation to the requirements of a low-carbon economy and to investors' expectations). It is also emphasised that the impact of FDIs on the quality of the environment in the FDI host countries can be either beneficial or detrimental. It is actually believed that FDIs tend to predominantly target heavy industry and therefore degrade the host countries' environment and contribute to an increase in CO₂ emissions (Hamid et al., 2022). Conversely, where the investments are placed in 'clean' industries, CO₂ emissions decrease.

In general, when it comes to capital in the process of decarbonisation, we are dealing with what is referred to as a moral economy, while Singh & Chudasama (2021) use the term 'regenerative and conscious capitalism'. As the tightening of climate-related regulations progresses, we demand that investors, who have traditionally been seeking maximum profit, take action to divest fossil fuel assets (Braunstein, 2022) in favour of low-emission technologies in what is known as 'morally good projects' (Langley et al., 2021). This has given rise to a new trend of research analysing business models that go beyond just the economic dimension and consider also social and environmental issues (Gomez Echeverri, 2018). Green finance is the concept of a financial sector responsible for delivering sustainable growth and in particular for protecting the environment (Lee et al., 2023). In green finance, investors would follow trends produced by the growing environmental awareness of European public opinion (Benz et al., 2020).

Information and technology flows or knowledge flows' refer to knowledge movements across people, organisations, places and time, depicting changes, shifts and applications' (Chauvel, 2017, p. 1). While Krugman (1991) holds that knowledge flows are invisible and therefore impossible to measure, over recent decades researchers have put forward a number of ways to record, measure and analyse them. Knowledge flows may be related to human flows through the migration of specialists and migration for educational purposes, but their study often employs patent citations (Jaffe, Trajtenberg & Henderson, 1993; Thompson, 2006; LeSage, Fischer & Scherngell, 2007; Fischer & Griffith, 2008; Paci & Usai, 2008; Li, 2014; Figueiredo, Guimarães & Woodward, 2015; Van der Berge, Bolhaar & Van Elk, 2017; Llano et al., 2021; Diemer & Regan, 2022; Rezaei & Kamali, 2022). Patent

citations track knowledge flows because they 'leave a trace': they provide details of the geographical location of the inventive process and help to observe the diffusion of knowledge, measuring the impact of individual patents on other patents (Llano et al., 2021; Diemer & Regan, 2022).

Interregional flows of knowledge can also be studied through the analysis of real active knowledge carriers, which include people, economic entities and institutions either physically moving between regions or virtually exchanging components of knowledge (Cardoso & Piskorek, 2021). Just like patents, knowledge carriers also leave traces, e.g. in the form of travel, communication, or budget transfers (Maggioni & Uberti, 2007). Knowledge carriers can be analysed in a number of ways, such as by examining research partnerships, student mobility, or connections on the Internet (including on social media, e.g. Diemer & Regan, 2022). The role of higher education is also important as it constitutes a node of flows of knowledge on a local, European and global scale (Cardoso & Piskorek 2021; Cardoso, Uyttebrouck & Dąbrowski, 2021).

Interestingly, while research demonstrates that geographical distance is indeed important for knowledge flows (Paci & Usai, 2008; Maggioni and Uberti, 2007; Van der Berge, Bolhaar & Van Elk, 2017), its significance has declined in recent years (Griffith, Lee & Reenen, 2011) and is lower than for other types of flows (Rosik et al., 2022). According to Maggioni & Umberti (2007), the flow of knowledge benefits from similarity of the regions involved. The proximity of regions can be geographical, but also functional or sectoral. Small distances in space have a positive effect on the centrality of the knowledge flow network, which is associated with the spill-over effect from strong regions to neighbouring regions (Cardoso & Piskorek, 2021). This means that being in the sphere of influence of a strong region represents an asset that leads to benefiting from greater opportunities to build research partnerships and from intensified knowledge flows, thus raising the region's position in the system of flows (Maggioni & Umberti, 2007; Cardoso & Piskorek, 2021). Networks of knowledge flows have a strong tendency to polarise (Breschi & Cusmano, 2004), so it is very difficult for regions that are not the main players to gain in importance and increase their position. This is important for the competitiveness of regions, since flows of knowledge constitute an important factor favouring innovation capacity, organisational improvements, and the production of new knowledge (Fan & Lee, 2009; Użienė, 2015).

In the current space of flows, a region's position is determined by its relationships with its surroundings, i.e. by a system of economic and social interactions with other regions (Castells, 1996). What is needed to properly identify its position is not just the volume and structure of flows, but also the system's vulnerability to changes caused by external factors. This makes it possible to assess the region's resilience and vulnerability to unexpected external shocks or policy changes. This, in turn, allows one to make predictions of the scale of territorial impact of events such as the implementation of the EGD (Czapiewski et al., 2022).

Further considerations start with an observation that regions in the world economy are increasingly perceived as 'regional-enterprises', i.e. independent participants of international competitive relations (Brykova, 2006, p. 33). In the context of regional development, competitiveness could be defined as the ability to adapt to changing conditions so as to maintain or improve the region's position in the competition between regions (Marszał & Markowski, 1998, p. 134). Processes taking place within regions show high variability. In the static approach a region's competitive position is its place in the global economy, while in dynamic terms, i.e. the change of position over time, the 'competitive capacity' is examined (Góralski & Lazarek, 2009). In this context, the competitiveness of a region is a measure of its ability to identify, develop and protect the local competitive advantages (Brykova, 2006). The phenomenon of competitiveness is not universal and there is a value-judgement ring to the term itself which invites the construction of various rankings and compar-

isons (Żmuda & Molendowski, 2016). According to Brykova (2006, p. 52), the international competitiveness of a region derives from its ability to promote high labour productivity and a high standard of living of the local population, thus ensuring its long-term status as a region with high competitiveness, while the capacity itself is based on the efficient use of available resources.

The transition to low-carbon is bound to affect the international competitiveness of regions. This is explained by the fact that processes involved in the restructuring of coal regions lead to a complete change in the regions' economic structure, and that decarbonisation will trigger far-reaching economic and societal changes, some of which may be difficult to predict (Rybarz, 2021; Semieniuk et al., 2021). It is therefore necessary to define new targets based on new industries and new energy sources (Kiewra et al., 2019). Importantly, however, decarbonisation can be a source of both opportunities and threats to growth. Due to the so-called spillover effects or indirect effects, it will affect not only bodies directly related to the mining industry, but also those that support the activities of this industry (e.g. manufacturers of machinery and equipment for mining and service providers for the mining industry) (Frankowski & Mazurkiewicz, 2020). As a consequence, some sectors will need to rapidly increase their relative market share, others will necessitate a transformation of their technological base, while still others, namely high-carbon industries, will become uncompetitive, will shrink and potentially disappear altogether (Semieniuk et al., 2021). Thus, the impact of decarbonisation on the relative positions of individual regions within the European space of flows may be limited to one specific region or a group of regions potentially expanding interregional disparities whose effects can be mitigated through strategic actions.

To sum up, the interregional flows analysed in this paper may result in a change of the region's competitive position. In addition, both the regional space of flows and the low-carbon transition interact with each other in two ways: a) individual types of flows can determine whether the process of restructuring the regional economy is a success or failure; and b) the decarbonisation process will transform the space of flows within the regions (flows of people, trade, capital and knowledge). The extent and strength of mutual influence will depend on the current competitive position of a given region, the domestic economic and social structures, and the way climate change is managed (cf. Fig. 2).

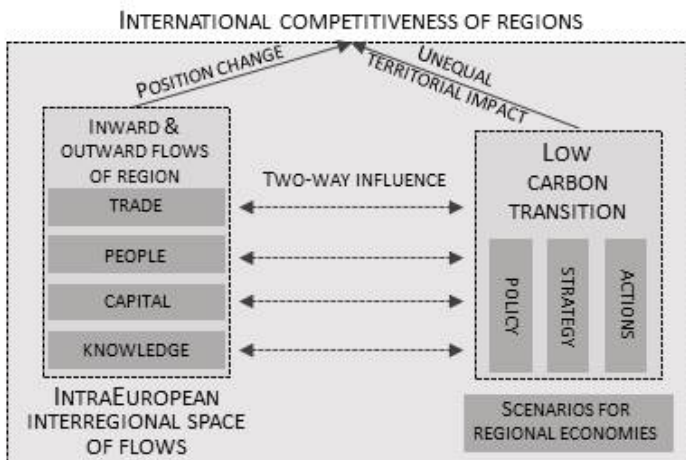


Figure 2. Space of flows, low carbon transition and global competitiveness: a concept diagram of relations and interactions

Source: own analysis.

Data, methods and study area

The material necessary to deliver the research objectives has been sourced from the data and results of the ESPON IRIE project carried out between 2020 and 2022. The aim of the project was ‘to generate interregional data and find new territorial evidence on interregional relations (...). to feed the debate on the potential impact of policy decisions, external shocks and territorial cohesion policies’ (Velasco Echeverría et al., 2022, p. 11). The types of flows covered included: trade (goods, services and freight transport by mode of transport), people (migration, tourism, labour and passenger transport by mode of transport), capital (FDIs, remittances and loans) and knowledge (Erasmus students, Horizon 2020 networks and patents). The project produced EUREGIO-2017 input-output tables, as well as assessing, balancing at country level, analysing and outlining the relationships between flows at regional (NUTS 2) level. The study period spanned the years 2010-2018.

Data

The study of the Śląskie Voivodeship’s position in the space of flows was based on secondary data obtained in the IRIE project. The region’s rank was determined by looking at selected flows of goods, population, capital and knowledge between regions (NUTS 2) according to the 2016 classification (297x297 cells) (Velasco Echeverría et al., 2022).

Flows of trade were separated into flows of goods and flows of services. The goods trading data set includes flows of goods broken down into 4 modes of transport (road, sea, rail and air) and 14 different sectors based on the NST-2007 classification (IRiE, 2022). The flows of services were based on the official data on country-to-country flows of services differentiated by sectors and years (IRiE, 2022).

Flows of people consisted of migratory, tourist and passenger transport flows. The data matrix for these three types of flows was constructed using national statistical databases (NSIs) and Eurostat data, with any data gaps plugged using estimates based on the information available (IRiE, 2022). Passenger transport matrices were worked out for the three modes of transport: rail, sea and air. One specific subtype of migration flow, circular migration, i.e. daily movements of people to and from work, was excluded from this study. Although a commuting dataset had been produced in and made available under the IRIE, relevant methodological difficulties and the low reliability of the data ruled it out from further research.

Flows of capital included Foreign Direct Investment (FDIs) and remittances. FDIs are defined as an investment involving a foreign direct investor’s long-term relationship, including their enduring interest in and control of an FDI enterprise (which must be located in an economy other than that of the foreign direct investor’s) (IRiE, 2022). By contrast, remittance flows are defined as short-term capital flows and ‘refer to money movements that represent household income from foreign economies’ (IRiE, 2022).

Flows of knowledge were examined in three categories: patent citations, participation in Horizon 2020 (H2020) projects and Erasmus student exchanges. An H2020 database was generated for the period 2015-2020, i.e. when the H2020 Framework Programme was active, obviously setting this period apart from those of the other flow types (IRiE, 2022). It should be noted that data on the Erasmus+ programme by definition applies only to international flows. The database on student flows only spans the years 2010-2014.

Table 1. Characteristics of methods and data sources of selected flows analysed in this paper

Flow group	Flows	Unit	Data Source	Methodology	Report
Trade	Trade in goods	Monetary units (€)	BACI, Eurostat	Correspondence and distribution of region-to-region flows with reference to country-to-country flows	Llano, Pérez-Balsalobre & Gallego López (2021)
	Freight volume of goods	Tonnage	Eurostat	Mix of methods, such as data clearance, plausibility checks, aggregation (from ports and airports), spatial disaggregation, estimation of gaps	Schwarze et al. (2022)
	Trade in services	Monetary units (€)	WTO-UNCTAD/OECD (BATIS, TIS, TISMOS); Different indicators from IRIE Project: passengers, mobility, labour, freight.	Correspondence and distribution of region-to-region flows with reference to country-to-country flows, using information about modes of supply and indicators related to each. FIGARO database used as constraint for intra-national flows by country and sector	Llano et al. (2021)
People	Migration	Number of migrants	Eurostat, NSIs (including census and LFS data)	Techniques of estimation: gravity models, spatial-interaction models and log-linear model if data gap in statistical sources	Komornicki et al. (2021)
	Tourism	Number of tourists	Eurostat, WTO, NSIs (including census and LFS data)	Techniques of estimation: gravity models and temporal linear regression if data gap in statistical sources at country-to-country level; gravity models for particular countries while disaggregating towards region-to-region level	Cerić et al. (2021)
	Passenger	Number of passengers	Eurostat	Mix of methods, such as data clearance, plausibility checks, aggregation (from ports and airports), spatial disaggregation, estimation of gaps	Schwarze & Spiekermann (2022)
Capital	FDI	Monetary units (€)	AMADEUS	Aggregations of firm-level data, comparisons/smoothing processes with data from national organisations	Kallioras et al. (2021a)
	Remittances	Monetary units (€)	Eurostat, World Bank	Regionalisation methods based on country-to-country data	Kallioras et al. (2021b)

Knowledge	Patents	Number of patent citations	OECD databases: REGPAT and Citations; EPO (European Patent Office); PATSTAT data set; Other related datasets	Interconnection of patent datasets with complementary information (geolocation, names of institutions, Amadeus information on patent-producing institutions, etc.)	Llano et al. (2021)
	Horizon 2020	Number of project coordinators (sending countries)/ Number of project participants (receiving countries)	European Commission: CORDIS database	Aggregation of raw data tables of all H2020 organisations and projects by starting year (2015-2020)	Cardoso & Piskorek (2021)
	Erasmus students	Number of exchange participants	European Commission	Aggregation of individual flows by correspondence lists between codes of institutions, locations of institutions and NUTS 2 regions	Cardoso, Uyttebrouck & Dabrowski (2022)

Source: Velasco Echeverría et al. (2022, pp. 18-20), modified by authors.

Most flow matrices are based on publicly available databases with the exception of the FDI flows which are sourced from the commercial data provider AMADEUS. The most frequently used source of data included: Eurostat (flows of trade, people and remittances), European Commission (H2020 and Erasmus students), OECD (service flows, patents), UN agencies (WTO – tourism, World Bank – remittances), and others, such as the Bank of International Settlements (BIS) and the European Central Bank/European Data Warehouse (ECB/EDW) for loans. Data sourced from national institutions were of lower significance and they came from the national statistical offices (NSIs) (migration, commuting) or research institutes, such as the French CEPII (Centre d'Études Prospectives et d'Informations Internationales), which made available the BACI database. Detailed information on the methods of data processing for individual flows is described in Table 1.

The scenario analysis employed input-output tables developed for the EU and EFTA countries (EUREGIO-2017) by Almazán-Gómez et al. (2022a). The EUREGIO-2017 table expands the FIGARO multicounty framework (Remond-Tiendrez & Rueda-Cantuche, 2019), supported by EUROSTAT, at the NUTS 2 level, including the region-to-region flows for all analysed countries. For the qualitative analysis of the scenarios the study added expert opinions (from representatives of local authorities, trade unions, industry associations and academics) from the study regions, including the Śląskie Voivodeship (Czapiewski et al., 2022), collected at workshops held in the first half of 2022².

² The list of workshop participants is available on the ESPON IRIE website: https://gis-portal.espon.eu/arcgis/apps/sites/#/irie-hub/pages/egd_pl22

Methods

One method that the article deploys is the Secondary quantitative and qualitative Data Analyses (SDA). SDAs are studies in which data collected in another study are used to examine new hypotheses, to deepen existing analyses, or to adopt other analytical strategies (e.g. focusing on another unit) (cf. Hinds et al., 1997; Szabo & Strang, 1997; Ruggiano & Perry, 2019). In our SDA, we analyse and interpret the available research material in order to 1) synthesise the project's various individual areas of analysis, narrowing down the results obtained from the European space of flows to the position of a single region within this space (synthesis of results), and 2) examine these flows using a new approach that introduces circumstances following from the implementation of the low carbon strategy (new questions). As recommended by Johnston (2014) and Schlomer and Copp (2014), the study does take into account the limitations of secondary data analysis and of the data sets employed by critically examining the material analysed.

Interregional flow matrices were developed using a methodology tailored to the individual needs of each group of flows. Data sets on trade, people, capital and knowledge flows were used for the indicator analysis developed for the Śląskie Voivodeship, each time considering the region's position within the national and European interregional space of flows.

The final stage of the analysis includes scenarios measuring the impact of major external shocks, namely the EGD, on interregional relations as well as the impact of any change in the position of the regions within the system of flows, as well as identifying which measures adopted at the political level are best suited to mitigate the effects of such events (Velasco Echeverría et al., 2022). In the quantitative approach, a simulation was performed using sectoral flow and input-output tables to look at changes in the space of flows triggered by the introduction of the EGD (Czapiewski et al., 2022). The scenarios assume a complete elimination of hard coal and brown coal from energy production in the member states. Concretely, this case-study analysed the socioeconomic (changes in valued-added and employment), and environmental (changes in CO₂ emissions) impacts, when the elimination of the two fossil fuels. The study examined two distinct scenarios: type A, wherein coal phase-out is limited to electricity generation, and type B, which expands the phase-out to include domestic heating. This elimination is compensated for by a corresponding increase on the input side from alternative sources in other regions. In this regard, sub-scenarios were developed which hypothesis is related to 'who provides the energy that has stopped being produced?'. In sub-scenarios type 1 (A1 or B1) the total fall in energy production due to decarbonisation is compensated by green energies from all regions and countries; sub-scenarios type 2 compensates with green energies from EU27, and finally sub-scenarios type 3 compensates only with green energies from EU27 contiguous counties. According to the authors, the hypothesis proposed in type 3 scenarios, where energy can only come from the same country and from neighboring (contiguous) countries, is more plausible taking into account the European electricity market (Almazán-Gómez, Llano & Pérez, 2022b). Consequently, this work focuses only on sub-scenarios type 3.

It is worth bearing in mind that the quantitative analysis does not take into account certain important issues linked to the elimination of coal, such as: technological aspects of the elimination of coal, possible changes in the electricity demand and generation of individual countries, modifications of alternative energy sources, and any limitations in the regional generating capacity. Then, the qualitative approach analysed the results of a workshop with key stakeholders from the Śląskie Voivodeship, whose knowledge and insights were used for qualitative analysis and the revision of scenarios. Meetings with experts were held in several regions of Europe to verify the scenario analysis. The meeting for the Śląskie Voivodeship took place on March 11, 2022, at the University

of Economics in Katowice. Representatives of the local authorities, the R&D sector, the academy, local trade unions and non-governmental organisations shared their observations on the effects of the EGD policy in the region, ongoing activities linked with decarbonisation and on the importance of the various flows for the region and for its position in the European system. The experts focused mainly on the unknowns related to the implementation of the EGD and the risks that decarbonisation may bring.

Study area

The Śląskie Voivodeship (PL22) is the region with Europe's highest share of employment in mining, the highest level of urbanisation, but also the poorest environmental indicators (IRiE, 2022).

Much of Poland's industrial potential is concentrated in the region, as evidenced by the value of GDP generated in the region (11.7% of the GDP in 2020). The region maintains the highest share of employment in the industry and construction sectors among all voivodeships. Industry (NACE sections B, C, D, E) accounted for 31.2% (2020) of the gross value added generated in the voivodeship.

The region hosts the majority of the mining companies operating in the hard coal sector (PGG, JSW, Węglokoks, Tauron Wydobycie). Currently, PGG is the largest producer of hard coal in Europe. In 2019, 24 out of 27 Polish hard coal mines were located within the region (Frankowski & Mazurkiewicz, 2020). Over 80% of Poland's mining municipalities not only are located in the region (UMWŚ, 2003); but also and they are concentrated in its central part.

After the collapse of the centrally planned economy in Poland and the opening-up to global markets, Polish coal lost its competitiveness (inter alia due to technological backwardness, high mining costs, and the privileged status of the employees) (Rybarz, 2021). In 1996, the Katowice Special Economic Zone was established, the aim of which was to attract new investors and mitigate the effects of mining restructuring and colliery closures. Currently, mining and mining-related activities operate alongside other industrial sectors, including automotive, chemical, metallurgy, logistics, ICT and knowledge services, as well as cultural, entertainment and recreational businesses (Frankowski & Mazurkiewicz, 2020).

Although the first mine closures and mining sector restructuring efforts began in the early 1990s, right after Poland's political transformation, this did not mean the end of this process. In the years 2000-2019, coal production in the Śląskie Voivodeship fell by half (Bukowski & Śniegocki, 2022). During this period, employment in the mining sector dropped by 46% as the industry embarked on a two-stage restructuring process. The first stage happened in the years 2001-2006 in connection with Polish accession to the EU and the need to improve profitability, during which 34,000 jobs were shed; while the second, caused by the global crisis and falling coal prices, followed in the years 2013-2017 and saw a reduction of another 30,000 jobs (Bukowski & Śniegocki, 2022).

Śląskie Voivodeship is a region where, in addition to numerous economic and social transformations, profound demographic changes are also taking place. As a result of the closure of mines, the Silesian conurbation experienced depopulation (Krzysztofik & Runge, 2010). The difficult demographic situation in the region is aggravated by its unfavourable migration balance. While the region had already started to lose residents due to emigration to Germany in the socialist period (from the 1970s), this decline was compensated by an internal migratory influx in response to the demand for labour from the region's heavy industry (Frankowski & Mazurkiewicz, 2020). Mass departures from Śląskie to Germany also meant that many residents of the former Katowice Voivodeship now have relatives or friends in Germany (Kijonka, 2013). Between 1995 and 2020, the region's population fell by 11% to 4.4 million residents in 2020, i.e. 11.6% of the total population of Poland, but remained the second most populous voivodeship in the country.

The focus on heavy industry and the general concentration of industrial plants directly affects the quality of the Śląskie Voivodeship's natural environment. The region features a diverse range of land uses, including both highly valuable natural areas and land which is badly degraded as a result of the exploitation of raw materials (Lorek, 2016). The voivodeship also has the highest population density in Poland at 358 people per square kilometre, which is more than three times the national average (2020).

The region is one of the six Polish regions that stand to benefit from the Just Transition Fund. Taking account of global trends and the current situation in Europe, the role of hard coal in the economy of the Śląskie Voivodeship will continue to decrease. The transition to a low-carbon economy is already one of the main challenges for the region (Kiewra et al., 2019). The regional authorities and local stakeholders have noticed this trend and are taking into account this transition and environmental issues in their activity. In the vision of the latest Development Strategy for the Śląskie Voivodeship '*Zielone Śląskie*' (Polish for 'Green Śląskie') (UMWŚ, 2020), the region is intended to become a modern European region with a competitive economy as a result of responsible transformation, providing development opportunities for its inhabitants and offering a high quality of life in a clean environment.

Results

The position of the Śląskie Voivodeship in the system of flows

Trade

Goods with a total value of €522.2 billion were exported from the Śląskie Voivodeship to other ESPON regions in the years 2010-2018 (ranking it at 40th place among 297 NUTS 2 units in 2018). In the same period, goods worth €457.9 billion were imported (44th place in 2018). The goods were traded primarily within Poland and predominantly with neighbouring voivodeships. Flows between Śląskie and Moravskoslezsko (CZ08) were also highly significant, as were inflows from Lombardia (ITC4) and Arnsberg (DEA5). Overall, the voivodeship had trade links with 246 NUTS 2 units (IRiE, 2022).

The region, like Poland as a whole, ranks particularly strongly in tonnage of freight. The flows of goods along this route ranked number one in the ESPON area (792.7 thousand kT of outflows and 542.2 thousand kT of inflows in the period 2010-2018) and had rail freight links with 128 other regions. The largest traffic flows of goods by rail were carried to and from the neighbouring voivodeships and those located on the Baltic coast. International rail flows were much less important: the only major foreign partners were the Oberösterreich region (AT31) and the neighbouring Moravskoslezsko (CZ08).

With regard to the transport of goods by road the region ranks 12th in Europe in terms of volume of inflows (1216.3 thousand kT in 2010-2018) and 18th in terms of outflows (1226.6 thousand kT). The most intensive flows of goods by road take place between the Śląskie Voivodeship and other Polish regions, primarily with the neighbouring Małopolskie (PL21), Łódzkie (PL71) and Opolskie (PL52) voivodeships. Internationally, the top place of the region with the most flows belongs to the Moravskoslezsko (CZ08). Overall, goods were exchanged by road with 159 other regions, which is a very good result on a European scale.

In air transport the Śląskie Voivodeship is clearly a less significant region. It ranks 47th in terms of the volume of cargo arriving by air (146.9 thousand kT in 2010-2018) and 55th in terms of outflows (96.6 thousand kT). It had 17 connections with other regions. In contrast to land transport,

international flows are more important for air transport than domestic ones. The largest volumes of goods transported by air travelled between the Śląskie Voivodeship and the regions of Leipzig (DED5) and Köln (DEA2) and the province of Liège (BEL33).

In the system of service flows, the region ranks relatively high in Europe, although lower than in the network of the flows of goods. The outflows of services in the period 2010-2018 were worth €951.1 billion (47th place in 2018), while the inflow was 457.9 billion (92nd place). Domestic flows of services dominated, especially with the neighbouring Małopolskie Voivodeship (PL21).

People

The Śląskie Voivodeship maintained migration links with almost all of the ESPON regions during the study period. The strongest ones of these are with the neighbouring Małopolskie Voivodeship (PL21), Berlin (DE30) and regions in western and southern Germany (DEA1, DEA2, DEA5, DE71, DE21). Between 2010 and 2018, 478,500 immigrants arrived in the region (57th place in 2018), while 579,100 people left (62nd place). Therefore, it would be difficult to put the Śląskie Voivodeship at the forefront of regions of migration in Europe, or even in Poland, or in terms of the weighted migration intensity index (measured as the share of total migration in the population of a given region (Rosik et al., 2022). Indeed, the region's index value of 2.59% remains well below the 6% or more found in regions of Hungary, Romania, Great Britain, southern Germany or the neighbouring Opolskie Voivodeship (PL52).

The region is much less important in the European system of passenger transport flows than in the transport of goods. In the ranking of rail inflows and outflows, it occupies the 102nd (179.8 million passengers in 2010-2018) and the 99th place (180.5 million passengers), respectively, among the analysed regions. Domestic transport provides by far the dominant links, while international flows are of negligible importance.

Furthermore the region ranks low in passenger air transport with just above 13.5 million passengers exchanged with other regions (82nd place). Unlike passenger rail transport, passenger flights are mainly international. The most important are connections with Bedfordshire and Hertfordshire (UKH2), Arnsberg (DEA5), Darmstadt (DE71), as well as with tourist destinations such as Canarias (ES70), Malta (MT00), Greece (EL42, EL43, EL62) and Cataluña (ES51).

Tourism flows was another analysed segment of population flows. In the years 2010-2018, the Śląskie Voivodeship was visited by 48 million tourists (67th place in 2018), while 44.3 million tourist departures were recorded in the same period. The top regional destinations of the region residents were other Polish voivodeships (PL21, PL51, PL91), while internationally it was Croatia (HR03). The spatial distribution of the sources of tourist flows to the region looks quite interesting. It is most often visited by tourists from Czechia (Moravskoslezsko (CZ08) – 1st place in terms of the average number of tourists in 2010-2018, followed by Jihovýchod (CZ06, CZ07), Praha (CZ01), other Polish regions (mainly the Małopolskie (PL21) and the Warszawski stołeczny (PL91)) and Slovakia (SK02, SK03).

Capital

In the years 2010-2018, the Śląskie Voivodeship received almost eight times more in FDIs than it invested in other regions (€7941 billion against €1053 billion). This placed it 176th among the source regions and 72nd among target regions (out of 297 regions overall). Therefore, taking into account the relatedness criterion for incoming foreign direct investment (FDIs), the region can be classified among the 'incoming FDI ESPON-wide relative hubs', i.e. a group of regions of the topmost relative absolute FDI receivers, and the bottommost connected, absolute, and influencing FDI receivers.

Most of the CEEC area belongs to this cluster (except for capital-city regions). As for outgoing intra-regional FDIs among European countries, the region was a member of the group of 'outgoing FDI dependents', i.e. the topmost dependent FDI senders, and the bottommost connected, absolute, and influencing FDI senders (IRiE, 2022).

The region was in the group of regions with the highest number of interregional connections). In total, 161 regions sent FDIs to the Śląskie Voivodeship in the period under review and the region was in the group of regions with the highest number of interregional connections. In Poland, this performance is comparable with the Warszawski stołeczny (PL91), Dolnośląskie (PL51) and Wielkopolskie (PL41) voivodeships, all of which had been known for years as attractors of investment capital. In the region, investors are more often represented in industrial processing, utilities and the energy industry (Frankowski & Mazurkiewicz, 2020). Elsewhere in Europe, comparable results were achieved by such economically powerful regions as Lombardia (ITC4) and Cataluña (ES51).

Although the number of regions in which funds from Śląskie have been invested is definitely lower than that which sent their FDIs to the region (51 regions), it is still higher than the Polish regional average (except for the 3 regions mentioned above). The largest outgoing flows were targeted at Lombardia (ITC4), Piemonte (ITC1) and Île de France (FR10). As a consequence, the region records an FDI imbalance towards inflows at 88% of the total flow (weighted intensity), which is typical for most regions in Poland (and different to rich European regions).

With the large number of regional links for inflowing-FDI, none of the regions is a key (dominant) partner (network selectivity). This produces a more distributed pattern of sending regions thus reducing the economy's exposure to capital withdrawal and with the inflows to the Śląskie Voivodeship totalling € 117.17 billion this accounts for only 10.2% of total FDIs. The situation is different in the case of outgoing FDIs where the main recipient region (Moravskoslezsko – CZ08 in Czechia) accounts for 61.5% of the total.

In the case of capital ties related to either migration or travel for work, almost €7.2 billion in remittances flowed into the region (16th position in 2018) and only €1.4 billion flowed out of the region (148th place). Just as in the case of the FDIs, there is a clear disproportion between inflows and outflows. For this reason the region was qualified in the cluster of the 'incoming remittance ESPON-wide hub' composed of the 30 topmost absolute and net receivers of remittances in Europe (NUTS in France, Spain, Portugal and Romania)³.

The region received the highest worth of remittances among all NUTS 2 in Poland (intensity). The largest proportion of these came from Germany: from Berlin (DE30), Oberbayern (DE21) and western regions, such as Düsseldorf – (DEA1) and Darmstadt – (DE71). What is more, nearly 20% of the total German remittances to Poland (interregional balance) were received within the region, thus creating a strong concentration of ties along this vector. At the same time, in relative terms (weighted intensity), the region's high inflow to total remittance ratio (84.2%) was comparable to that in other CEEC regions, except for Czechia and Slovakia (i.e. countries with strong emigration after the opening of Western European markets as a result of integration with the EU).

³ It should be stressed, however, that these data concern only flows in EU and EFTA countries, so remittances to Ukraine, for example, are not included, which, perhaps, as in other regions, would close the gap between inflows and outflows of remittances.

Knowledge

The region ranks low in the European system of knowledge flows, which is also a problem faced by most regions belonging to the countries that joined the EU after 2004 (Rosik et al., 2022). In 2018, the Śląskie Voivodeship ranked 192nd in the inflow of patents to the voivodeship (116 citations in 2010-2018) and 181st place in the list of outflows (272 citations). The spatial structure of regional connections in the knowledge flow network differs significantly from other flows, as distances in physical space are not significant. In the period 2010-2018, the patents most used in the region came from Murcia in Spain (ES62), Cheshire in the United Kingdom (UKD6), Stuttgart (DE11) and Weser-Ems (DE94) in Germany. On the other hand, flows in the other direction mainly took place between the region and the Hampshire and Isle of Wight (UKJ3) region and domestically with the Łódzkie (PL71). Patent citations from the region were also relatively frequent in the Mazowieckie (PL92), the Małopolskie Voivodeship (PL21), Prov. Antwerpen (BE21), Stuttgart (DE11) and Tirol (AT33).

The position of the region in the system of knowledge flows is even weaker in the context of the Horizon 2020 partnership (H2020). In the years 2015-2020, entities from the region coordinated 39 projects under the H2020 partnership, which ranked the region 287th out of 297 territories. On the other hand, the voivodeship's participation in the programme looks better; as entities from the region participated in 112 projects, which translated into 151st position. Coordinating bodies from the Śląskie Voivodeship which participated in the H2020 partnerships developed their best links with Attiki in Greece (EL30), Comunidad Valenciana (ES52) and Comunidad de Madrid (ES30) in Spain, Hovedstaden in Denmark (DK01), the Brussels-Capital Region (BE10), Lazio in Italy (IT14), as well as with other regions in Poland: Lubelskie (PL81), Świętokrzyskie (PL72) and Warszawski stołeczny (PL91). On the other hand, bodies from the region most often participated in the H2020 partnerships coordinated from Región de Murcia in Spain (ES62) and from West Central Scotland (UKM8).

The final area of knowledge flows considered here is student exchange under the Erasmus programme, which can be a measure of the attractiveness of the regional academic centres. In the period 2010-2014, 4589 students from the region's universities took part (63rd place among 297 regions in 2014). In total 1782 students came to universities in the Śląskie Voivodeship (122nd position). Students from the region most often chose universities in Spain (ES11, ES52, ES61), Portugal (PT17) and in the region of Puglia (Italy) (ITF4), Midtjylland (Denmark) (DK04) and the Moravskoslezsko (CZ08) across the Czech border. On the other hand, students from Spain were the number one among those choosing to come to the region's universities for student exchanges.

Summing up the importance of the various flows for the region, it turns out that the movement of population is the crucial one. These flows have a long history of emigration to Germany going back to before the collapse of the communist system and continuing until today, especially after Poland's accession to the EU, which is important. Domestically, trade flows (including those resulting from industrial specialisation) and capital flows stand out the most. The region's knowledge flows remain inconspicuous against other CEEC regions. Most flows may be sensitive to the implementation of the EGD, including some to a relatively greater extent than in other Polish regions (Table 2). This means that the coal transformation process, although 'imposed' from the top by EU policy, may be either an opportunity or a threat. An opportunity would be to use the EGD and the Just Transition Fund to further restructure the region's economy towards 'green' technologies by leveraging the strength of the current economic base and the available workforce. The threats stem largely from the prospect of competing for resources with other regions over a period of time that may be too short for adequate capital reallocation. This competition will play out both domestically and internationally, which places even more emphasis on the preparation of all bodies interested in participating in the transformation process.

Table 2. Characteristics of flows in the Śląskie Voivodeship

Flow area	Type of flow	Overall assessment		The importance of flow in the context of the Green Deal
		General	In comparison to European regions	
Trade	Trade in goods	<ul style="list-style-type: none"> • Very important for the economy of the region. • Highly dispersed business relations, many partners. • Exports higher than imports. 	<ul style="list-style-type: none"> • One of the leading regions in Poland in terms of the intensity of flows of goods, relatively high importance in the European system of flows. • Flow rates similar to urban regions in countries that joined the EU after 2004, but significantly lower than similar regions in Western Europe. 	<ul style="list-style-type: none"> • A reduction in flow intensity leading to lower income for local business and a heavy impact on the region's economy. • Possible change in the send-receive balance due to the halt in coal exports: imports overtake exports.
	Freight of goods	<ul style="list-style-type: none"> • The 'dominant' flow: transport of goods is key to the region's economy. • High importance of distance: the vast majority of goods are transported by land to regions located a relatively short distance away, for the most part within the same country. Air transport to more remote regions. • Strong links with the Baltic Sea regions: goods transported onward by sea. 	<ul style="list-style-type: none"> • The highest ranking in the intensity of transport by rail and above-average by other means of transport, both in Poland and in Europe. • Relatively high number of partners and low dependence on a single partner. 	<ul style="list-style-type: none"> • Coal plays crucial role in the overall transport of goods to and from the Śląskie Voivodeship leading to a significant reduction in the ranking in the system of flows. • The loss of jobs related to the handling and transport of coal can further contribute to lower flow intensities. • Reduction of road freight flows due to high emissions.
	Trade in services	<ul style="list-style-type: none"> • The strongest relations with other Polish regions, while foreign relations of little importance. • Numerous low-intensity relationships with many partners crucial for the region's resilience to crises in the services market. • A big imbalance in favour of outflows over inflows. 	<ul style="list-style-type: none"> • Average rank in the European space of flows. • Indicators typical of similar regions in member states that joined the EU after 2004. 	<ul style="list-style-type: none"> • The service sector gains from the decline of industry. It may lead to an increase in the importance of service flows in the region's mix of flows, but not necessarily an increase in intensity.

	Migration	<ul style="list-style-type: none"> • Strong historical ties with Germany. • Intensive migration flows, but relatively low importance of long-term migration between the Śląskie Voivodeship and other Polish regions. • Emigration slightly higher than immigration. 	<ul style="list-style-type: none"> • High intensity compared to other Polish voivodeships, quite high rank in the European flows. • The excess of outflows over inflows, even if only slight, is unique among countries that joined the EU after 2004. 	<ul style="list-style-type: none"> • Increase in economic emigration and a decrease in immigration due to job losses in the mining sector leading to a change in the net migration (send-receive balance). • Increase in flow intensity, especially in relation to Western European regions (incl. Germany), resulting in an increase in the importance as a sending region. • An increase in the intensity of emigration among people of working age leading to a change in the age structure, a decrease in the rate of natural increase, a change in the demographic structure and, consequently, the depopulation of the region.
People	Tourism	<ul style="list-style-type: none"> • Inflows mainly from neighbouring regions (including from across the Czech and Slovak borders), large outflows to other Polish regions and to Jadranska Hrvatska (HR03). • Very low weighted intensity points to a secondary role of tourist flows in the region's economy. • Tourist inflows are crucial for 'non-coal' areas of the region (city of Częstochowa and the Beskidy Mountains) • Short reach of rail passenger transport, mostly limited to Poland. • Air transport mainly to tourist destinations, such as the Canary Islands (ES70) and Greece, and to large hubs, such as London and Frankfurt. Low importance of domestic flights. 	<ul style="list-style-type: none"> • Average ranking in the European system of flows, low importance in European tourism. • Average position and average integration with the European system of flows. • Indicators comparable to most Polish regions. 	<ul style="list-style-type: none"> • Decrease in outflow due to reduced income of residents. • A need to find new, non-carbon related sources of income, potentially including tourist inflows through increasing the region's tourist attractiveness.
	Passenger	<ul style="list-style-type: none"> • Foreign capital is an important element of the regional economy. • Strong spatially diverse source regions for FDI. • FDI from Śląskie Voivodeship highly spatially focused on a partner from Czechia 	<ul style="list-style-type: none"> • Above-average ranking vs Polish regions in both FDI inflows and outflows. • FDI inflows comparable with other CEEC regions. 	<ul style="list-style-type: none"> • A growing importance of rail passenger transport with rail perceived as a green mode of transport. • A reduction of tourist outflow intensity may lead to shrinking air passenger connections and a reduction in the intensity of flows.
Capital	FDIs	<ul style="list-style-type: none"> • Strong, historically determined links with German regions (migration and sustained strong family ties). 	<ul style="list-style-type: none"> • Above-average ranking vs Polish regions in both FDI inflows and outflows. • FDI inflows comparable with other CEEC regions. 	<ul style="list-style-type: none"> • A need for foreign equity partners to refocus the economy towards industries of the green economy while making use of its current specialisations. • FDI outflows require a reassessment of the profitability of investments in key economic sectors taking into account the EU's new paradigm of growth.
	Remittances	<ul style="list-style-type: none"> • Strong, historically determined links with German regions (migration and sustained strong family ties). 	<ul style="list-style-type: none"> • Above-average position vs. Polish and other European regions. • Clear leader among European regions with regard to the inflow of remittances. 	<ul style="list-style-type: none"> • Low impact; may indirectly lead to a relative increase in the contribution of remittances to household budgets as a result of turbulences on the regional labour market. • Increased remittances as a result of economic emigration related to the increase in the unemployment rate in the region.

Knowledge	Patents	<ul style="list-style-type: none"> • Low intensity of patent flows with a small number of partners. • Unlike most flows, there is neither any dependence on distance nor a predominance of flows within Poland. 	<ul style="list-style-type: none"> • Very low importance for the European system of patent flows, typical of other regions of Central and Eastern Europe. 	<ul style="list-style-type: none"> • A need for innovative solutions to develop alternative energy sources, emissions reduction and other aspects related to the decarbonisation of the region can positively affect the innovativeness of the R&D sector and an increase in patent flows.
	Horizon 2020	<ul style="list-style-type: none"> • Low intensity of participation in H2020 partnerships with a small number of partners. • As with patent flows, and unlike most flows, there is no dependence on distance and no predominance of flows within Poland. • The Śląskie Voivodeship tends to be a project participant, rather than the leader. 	<ul style="list-style-type: none"> • Very low importance in the European system of knowledge flows, typical of other regions of Central and Eastern Europe. 	<ul style="list-style-type: none"> • Decarbonisation and the introduction of the green economy in the region is a major challenge for the research and development sector. There are reasons to intensify cooperation with researchers from other regions on projects connected to the broadly understood greening.
	Erasmus students	<ul style="list-style-type: none"> • Strong connections to Southern Europe (Spain, Italy). • A large number of connections (mainly outflow). • Outflow over inflow 	<ul style="list-style-type: none"> • Low ranking in the student exchange network. • Relatively low intensity and weighted intensity rates compared to other European regions. Average or lower than neighbouring regions. 	<ul style="list-style-type: none"> • The changing of the profiles of the regional universities, largely focused on the mining-based economy, to profiles involving careers and the operation of a greening Europe may increase their attractiveness to and inflow of foreign students. • The growing need for education leading to a non-mining profession may cause an outflow of students and greater interest in exchange with other universities.

Source: own study based on IRIE (2022).

The Śląskie Voivodeship vs. other European regions and decarbonisation simulations

In terms of decarbonization, the EGD aims to achieve global objectives, specifically in reducing CO₂ emissions. Nevertheless, the implementation of such actions has direct and indirect impacts at the local level. The impact of the implementation of the EGD shows high spatial variation which depends on the economic structure and trade flows.

As mentioned, two different decarbonisation scenarios were the focus of the study: the A3 scenario includes the withdrawal of coal from electricity generation alone; while type B3 scenario which expands the phase-out to include domestic heating (see section 'Methods'). Both scenarios have effects in areas where power is generated from alternative sources and in their immediate vicinity (Almazán-Gómez, Llano & Pérez, 2022b). In both scenarios, the count of regions where socioeconomic impacts yield a net positive outcome is considerably greater than the count of regions with negative socioeconomic balances (net losses in GDP and employment). Nevertheless, the net negative socioeconomic impacts are considerably more intense than the positive ones, resulting in an adverse overall outcome in which Europe experiences a net loss of GDP and employment. This trade-off, however, results in a substantial reduction in CO₂ emissions.

The clearest positive economic impacts of decarbonisation will be seen in those non-mining regions of Poland, Bulgaria and Romania that are neighbouring areas of the mining regions that will lose the most. The largest positive environmental effects, measured by a decrease in CO₂ emissions, are much more spectacular and reach values of up to 30-50% in Bulgaria, Slovenia, Romania and Czechia.

As a consequence of scenario A3, the replacement of coal with alternative energy sources has a direct impact on the coal mining industry, leading to decreases in both value-added and employment within this sector. These reductions are not compensated by the increased production of green energy in the affected mining regions. Consequently, these regions experience an overall negative socioeconomic impact. Specifically, the negative effects of the EGD will have the most detrimental effect on Central and Eastern European regions in Poland (mainly the Śląskie Voivodeship PL22), Bulgaria (Yugoiztochen – BG34) and Romania (Sud-Vest Oltenia – RO41). Their economy is largely based on hard coal and lignite and primarily on the extraction of these resources. Interestingly, however, the negative effects observed in the most EGD-affected regions of Poland, Romania and Bulgaria also generate positive effects in their neighbouring regions. This is a consequence of the assumption that any decrease in coal energy inputs in some regions will be offset by an increase in alternative energy inputs generated in other regions of the same country and in neighbouring countries. The adverse and favourable effects occur within groups of countries and interact with each other, as neighbouring economies tend to have close regional sectoral links (Almazán-Gómez, Llano & Pérez, 2022b). Particularly noteworthy are the significant decreases in CO₂ emissions in regions neighbouring the areas that are most negatively affected by decarbonisation, such as Czechia.

There are some differences between the two scenarios analysed in the study, mainly related to the intensity of the decarbonisation effects. Scenario A3 foresees no impact of the withdrawal of coal from power generation on the economy and employment of those EU regions that are not adjacent to the regions most negatively affected by decarbonisation, i.e. Śląskie (PL22), Sud-Vest Oltenia (RO41) and Yugoiztochen (BG34). In regions neighbouring these negatively affected ones, on the other hand, there will be benefits, but they will be relatively small: value added will increase by a maximum of 0.23% and employment by less than 0.8% in the regions that will gain the most, i.e. in Dolnośląskie (PL51), Świętokrzyskie (PL72), Lubuskie (PL43), Severozapaden (BG31) and Yu-

zhen tsentralen (BG42). Smaller-scale declines in value added and employment are also expected in eastern Germany, northern Bohemia, four Polish voivodeships (Małopolskie (PL22), Lubelskie (PL81), Łódzkie (PL71) and Zachodniopomorskie (PL42)) and individual regions of Greece (EL53), Romania (RO41, RO42), Slovakia (SK02), Spain (ES12) and Bulgaria (BG32, BG41). The decline in just the value added will also occur in several regions of the UK, but they should not be affected by a decline in employment. Scenario A3 also foresees a change in CO₂ emissions in all European regions, although not all are expected to decrease. A slight increase (to 0.32%) is forecast in Germany, Lithuania, Estonia, Cyprus, Malta, Liechtenstein, in almost all of Switzerland and in some regions of the United Kingdom and Norway. In the rest of Europe, decarbonisation of power generation is expected to bring down emissions. The most drastic drops, reaching almost 54%, concern Czechia, Slovenia and Bulgaria (Table 3).

Table 3. The five regions most affected by the implementation of the EGD – ‘Scenario A: Decarbonisation of Power generation’

Employment		Value added		CO ₂	
Region	Change	Region	Change	Region	Change
Sud-Vest Oltenia (RO41)	-0.57%	Yugoiztochen (BG34)	-1.15%	Vzhodna Slovenija (SI03)	-53.41%
Yugoiztochen (BG34)	-0.48%	Śląskie (PL22)	-0.44%	Yugoiztochen (BG34)	-47.51%
Śląskie (PL22)	-0.45%	Sud-Vest Oltenia (RO41)	-0.35%	Severozápad (CZ04)	-46.52%
Severozápad (CZ04)	-0.32%	Łódzkie (PL71)	-0.29%	Severozapaden (BG31)	-45.59%
Łódzkie (PL71)	-0,25%	Lubelskie (PL81)	-0.27%	Moravskoslezsko (CZ08)	-40.44%

Source: own analysis based on IRiE (2022).

The B3 scenario results exhibits more significant declines and gains in value added and employment compared to the A3 scenario. It is important to note that in this scenario, the coal mining sector would completely disappear, resulting in a direct impact: all regions will lose all the GDP and employment associated with this sector. As before, the positive effects on Value-Added and employment arise from the increase in green energy production to offset the complete disappearance of coal. Then, the withdrawal of coal from both power generation and heating means that the ‘winner’ and ‘loser’ regions of scenario A3 are joined by new ones, and the share of regions that will not feel any major social or economic effects of decarbonisation is significantly reduced. Hungary, Italy, the Netherlands, Slovenia, Croatia, Estonia, most regions of Germany and individual regions of Spain, Portugal, Ireland, France and Norway join the group of gainers. Regions losing out in scenario A3 include Wielkopolskie (PL41), the Ruhr, northern Greece, northern Norway and Ireland, Asturias (ES12) and regions in southern Scotland, northern England, Wales and neighbouring regions. As regards the environmental benefits of a reduction in CO₂ emissions, the largest reductions of almost 50%, as in scenario A3, are projected in Czechia, Slovenia and Bulgaria.

Socioeconomically, in absolute terms, Śląskie Voivodeship is the most affected region. The A3 scenario leads to reductions in Value-Added of 222 million euros and 8,400 jobs, while in the B3 scenario these figures increase to 1,638 million euros and 52,500 jobs. In relative terms, the Śląskie Voivodeship is among the regions experiencing the greatest negative impact of the EGD on the economy and on the labour market in both scenarios considered. The simulation showed that the decrease in value added for the voivodeship is over 1% in scenario A3, and it increases to 3.24% in scenario B3. Only two regions (BG34 and RO41) will be hit harder (in relative terms) by the adverse economic effects of Europe’s decarbonisation policy than the Śląskie Voivodeship. The forecast of the social costs of the EGD are even worse, with a 2.8% loss of jobs being the highest

in the entire ESPON area. These estimates are confirmed by the study by Alves Dias et al. (2018), which also indicates the Śląskie Voivodeship as the region most exposed to the negative social effects of decarbonisation measured in job loss (Table 4).

Table 4. The five regions most affected by the implementation of the EGD – ‘Scenario B: Decarbonisation of Power generation and the end of coal heating’

Employment		Value added		CO ₂	
Region	Change	Region	Change	Region	Change
Śląskie (PL22)	-2.80%	Yugoiztochen (BG34)	-3.64%	Vzhodna Slovenija (SI03)	-53.36%
Sud-Vest Oltenia (RO41)	-1.58%	Śląskie (PL22)	-3.24%	Severozápad (CZ04)	-46.81%
Łódzkie (PL71)	-1.54%	Dytiki Macedonia (EL53)	-2.02%	Yugoiztochen (BG34)	-45.85%
Yugoiztochen (BG34)	-1.47%	Łódzkie (PL71)	-1.92%	Severozapaden (BG31)	-43.89%
Dytiki Macedonia (EL53)	-1.37%	Sud-Vest Oltenia (RO41)	-1.44%	Moravskoslezsko (CZ08)	-40.77%

Source: own analysis based on IRIE (2022).

Discussion and Conclusions

The study of the position of the Śląskie Voivodeship in the European space of flows in the context of the challenges related to the EGD yielded several conclusions of a more general nature:

- The Śląskie Voivodeship is among the most important Polish regions active in relations with other regions. However, the scale of its participation in the space of flows is below par for its GDP, and even more so for its demographic potential.
- Mining, the basis of international economic relations in the past, has now been supplanted in this role by other industries, especially the automotive industry. Nevertheless, mining-linked relations continue to shape the region’s connections with other NUTS 2 units in Poland.
- The decline in the importance of economic ties related to mining was to some extent compensated by an increase in migration-related interactions resulting from the outflow of labour to Germany.
- Some of the patterns of relations are geographically influenced. These include intensive flows of economic material and people linking the regions with its neighbours across the Czech border. In the case of tourism, the relatively good (compared to other Polish regions) accessibility of the Croatian Adriatic coast turns out to be an important factor.
- Despite the moderate intensity of the established system of various types of connections and flows, it may foster a just transformation in the region while the economy is being decarbonised. The helpful factors could include the existing connections within other branches of the economy, good connections within the general European transport systems (legacy from the development of infrastructure for the transport of raw materials), and the historically shaped social ties with Germany and with Czech regions.
- On the other hand, the region’s low participation in European flows of knowledge can be particularly problematic. This is confirmed by the finding that what transformation potential the voivodeship has is associated with leveraging other sectors of traditional industries rather than with a modern knowledge-based economy based on tapping the resources of a creative workforce. This latest area might be a candidate for public intervention (including support for the education system).

- Input-output simulations demonstrated that the threats to the region's economic position and to the number of jobs that will be associated with a departure from a hard coal-based economy are the Europe's highest. At the same time, the regional effects of the efforts to control CO₂ turn out to be limited.

Moreover, the experts noted the pivotal role of mining for the region's society and of the sector's contribution to the identity of the region and of its inhabitants after centuries of coal-related tradition and the crucial impact it had on the urbanisation of Śląskie. They argued that this might cause a certain mental block against decarbonisation as a move potentially perceived as a threat to the culture and values of the local population. Nevertheless, they were aware that the direction set for changes in the environment towards climate neutrality and a structural transformation of the power generation sector was necessary and irreversible (IRiE, 2022).

Understanding of these measures runs deeper since they aren't new. Indeed, the local coal sector has been shedding jobs and output since unprofitable mines started to close in the early 1990s. Therefore, it is the social sphere, rather than the economy or the energy sector, that is treated by regional authorities as one of the biggest unknowns in shaping the future of the region in the EGD scenario. An added concern is that real household incomes may shrink due to job losses and rising prices (Semieniuk et al., 2021). This may mean that measures involved in Just Transition could turn out to be crucial for an effective implementation of the EGD policies and for a relatively smooth decarbonisation of the region (Czapiewski et al., 2022; IRiE, 2022).

The occurrence of the largest estimated decline in regional employment is associated with the scale unseen anywhere else in Europe to which mining influences the regional creation of jobs. According to the estimates of Mandras and Salotti (2021), in 2018, about 200,000 people were employed in mining throughout the EU, of which almost 108,000 in Poland. These results are consistent with those of Almazán-Gómez et al. (2022b) forecasting a net negative balance of 52,500 jobs in Śląskie Voivodeship, if there is a complete disappearance of coal. Moreover, thousands of people work in professions indirectly related to coal, namely jobs in the supply chains for coal mining and coal-fired power plants. Mining in the Śląskie Voivodeship generates jobs not only within the region, but also in other areas due to trade flows related to coal. This is why decarbonisation may have a truly drastic impact on the economy, including employment in the region and the closure of mining in the Śląskie Voivodeship may affect employment in other regions that are linked by a network of trade flows and participate in common supply chains. It is estimated by Alves Dias et al. (2018) that by the year 2030 up to 41,000 workers in the region may be at risk of losing their jobs. In addition, workers who are out of work in mining may have problems with re-employment if they are not retrained to work in other industries, which is a time-consuming and costly process. In this context, Just Transition is bound to be crucial for minimising the social costs of eliminating coal. Despite decarbonisation, the region's well-developed energy sector can still remain an engine of regional development. Power plants using alternative sources could provide re-employment for properly retrained coal sector workers. Indeed, electrical and mechanical expertise, together with work experience in harsh environments and occupational safety, are highly valued in the renewable energy industry (Alves Dias et al., 2018).

From the stakeholder perspective, political decisions are associated with many unknowns. Examples of issues raised included the carbon tax (the higher it is, the fewer opportunities to improve the region's competitiveness), the shape and continuity of the EU's emissions trading system, or any modification of the assumed mine closure dates following the reduction of coal imports following Russia's aggression against Ukraine. In the opinion of the meeting participants, coal may

become a transitional fuel and, with the use of modern technologies, be used for several decades, which could lengthen the process of the inevitable decarbonisation (IRiE, 2022).

The experts noted that energy transition under the EGD would not only affect the mining sector and reduce emissions (thus contributing to environmental protection), but would also bolster global competitiveness because the historical dependence on mining in coal regions has limited their growth potential in other sectors (Alves Dias et al., 2018). Another issue is linked with the predicted growth in demand for cheap and clean energy, while the infrastructure of companies from the Śląskie Voivodeship tends to be old and often not adapted to new standards. Therefore fears were expressed that there would be problems with access to energy as it has been overwhelmingly generated using the region's ubiquitous hard coal. Energy policy is a sectoral policy within the responsibility of national administrations on which regional policy has very limited influence. Local authorities are pushing a hard factor 'green economy' in any new regional development strategy as they want to take a step forward in preparing for the inevitable changes (IRiE, 2022).

The EGD involves not only decarbonisation, but also a comprehensive reconfiguration of the region's economy and large-scale structural changes. As a result of these processes, sectors related to the 'green economy' (such as renewable power, circular economy, and low-carbon transport), will have to quickly increase their relative production/market shares. Other sectors, on the other hand, will either have to completely transform their technological fundamentals, or will shrink, or even disappear altogether (e.g. activities related to the extraction and distribution of fossil fuels, including coal, and manufacturing sectors where fossil fuels are an important input in the production process) (Semieniuk et al., 2021). For a region to succeed in the new green reality, it must build new relationships in the principal sectors of the 'green economy', which for the Śląskie Voivodeship, with its existing network of flows, is bound to become a huge challenge (IRiE, 2022). The region is relatively poorly networked and has a low degree of integration with the European space of flows. Low participation in the network of knowledge flows is particularly problematic, pointing to problems with innovation and knowledge resources, both deemed necessary for a successful transformation.

A solution mitigating the potential adverse change in the ranking of the Śląskie Voivodeship in the system of flows would be to create new green jobs and business opportunities through the use of industrial heritage and the creation of new, competitive industries and services. For these measures to be effective, an appropriate strategy and close cooperation between relevant bodies are necessary. Smart and effective reclamation of brownfield mining areas will be crucial to mitigate their adverse impact on the environment and to contribute to the development of the local economy (Alves Dias et al., 2018). Attractive new facilities, such as leisure centres or museums, could be built on the reclaimed sites attracting greater tourist flows and boosting the region's participation in the overall system of flows.

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