



ENTRANCES

ENergy TRAnSitions from Coal and carbon: Effects on Societies

D4.2 Krakow Metropolitan Area Case Study Report



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Authors

Aleksandra Komorowska (Instytut Gospodarki Surowcami Mineralnymi i Energią PAN, Poland)
Wit Hubert (Instytut Gospodarki Surowcami Mineralnymi i Energią PAN, Poland)
Wojciech Kowalik (Instytut Gospodarki Surowcami Mineralnymi i Energią PAN, Poland)
Dominik Kryzia (Instytut Gospodarki Surowcami Mineralnymi i Energią PAN, Poland)
Lidia Gawlik (Instytut Gospodarki Surowcami Mineralnymi i Energią PAN, Poland)
Monika Peplowska (Instytut Gospodarki Surowcami Mineralnymi i Energią PAN, Poland)
Eugeniusz Mokrzycki (Instytut Gospodarki Surowcami Mineralnymi i Energią PAN, Poland)
Ryszard Uberman (Instytut Gospodarki Surowcami Mineralnymi i Energią PAN, Poland)
Tomasz Mirowski (Instytut Gospodarki Surowcami Mineralnymi i Energią PAN, Poland)

Contributors

Tristram Barrett (Leibniz Institute of Ecological Urban and Regional Development, Germany)
Giovanni Caiati (K&I, Italy)
Katja Heinisch (Halle Institute for Economic Research, Germany)
Christoph Schult (Halle Institute for Economic Research, Germany)
Oliver Holtemöller (Halle Institute for Economic Research, Germany)
Daniel Škobla (Centre of Social and Psychological Sciences, Slovakia)
Nachatter Singh (University of A Coruña, Spain)

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Contact

Instytut Gospodarki Surowcami Mineralnymi i Energią Polskiej Akademii Nauk (IGSMiE PAN)
(Mineral and Energy Economy Research Institute of the Polish Academy of Sciences)
Lidia Gawlik
email: lidia.gawlik@min-pan.krakow.pl
website: <https://min-pan.krakow.pl/>

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Lead Organisation: Instytut Gospodarki Surowcami Mineralnymi i Energią Polskiej Akademii Nauk (IGSMiE PAN), Poland

ENTRANCES project

Project coordinator: Ricardo García Mira (University of A Coruna, Spain)

Project email: info@entrancesproject.eu

Project website: <https://entrancesproject.eu/>

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Abbreviations

CCT	Coal and Carbon Territory
CET	Clean Energy Transition
CHP	Combined Heat and Power
ENTRANCES	ENergy TRANsitions from Coal and carbon: Effects on Societies
ENTSO-E	European association for the cooperation of Transmission System Operators for Electricity
EU	European Union
GDP	Gross Domestic Product
IGSMiE PAN	Instytut Gospodarki Surowcami Mineralnymi I Energią Polskiej Akademii Nauk (Mineral and Energy Economy Research Institute of the Polish Academy of Sciences)
JASPERS	Joint Assistance to Support Projects in European RegionS
JRC	Joint Research Centre
KMA	Krakow Metropolitan Area
LMA	Labour Market Area
MAF	Multidimensional Analytical Framework
NACE	European Classification of Economic Activities
NGO	Non-Governmental Organisation
NUTS	Nomenclature of Territorial Units for Statistics (fr. Nomenclature des Unités territoriales statistiques)
PAR	Political Administrative Region
PEP2040	Poland's Energy Policy until 2040
RF	Research Focus
RQ	Research Question
SSH	Social Sciences and Humanities
STEN	Standard Ten
WP	Work Package

1 Executive Summary

This case study report presents the results of the ENTRANCES project (ENergy TRANSitions from Coal and carbon: Effects on Societies) for the Krakow Metropolitan Area (KMA). The multidimensional analytical framework comprises socio-cultural, socio-psychological, socio-economic, socio-political, socio-technical, socio-ecological, and gender-related aspects of the clean energy transition in the region. The report is organised as follows: Section 1 presents the goal and research background of the project; Section 2 describes the methods applied in the study; Sections 3-6 provide and discuss the results of the study; Section 7 offers concluding remarks about the transformation process in the KMA.

Section 3 analyses the coal and carbon territory by providing an overview of the KMA region, including its historical development, and ecological and environmental situation. The list and discussion of the strain situations mapped within the examination of the socio-cultural component are presented, and stress vectors and strains resulting from the focus group research are identified. The inhabitants point out the unequal treatment between people living in Krakow and the communes surrounding the city. The urban-centre narrative is emphasised. The other tension is unequal access to transition support since most information and applications are available online and are difficult to access by people exposed to digital exclusion. Section 3 presents the investigation of the socio-psychological aspect indicating the middle level of regional place attachment, resilience and optimism, decarbonisation impacts, coping strategies and the life satisfaction of region inhabitants.

Section 4 examines the socio-economic aspect. It presents the current economic situation and key determinants of economic development in the carbon territory region, the labour market area, the political administrative region, the country and the European Union. Among the economic indicators, labour productivity, working-age population, share of employed persons, and gross domestic product are analysed. The section also provides insight into the sectoral structure in all of the studied regional units, examines income distribution and analyses gender dimension. The economic indicators are higher for Krakow compared to other regions, indicating the greatest percentage of retail, IT, finance, and real estate sectors as key contributors to the sectoral growth.

Section 5 investigates the energy transition in the political administrative region. The political system in Poland is presented. The in-depth analysis of the decarbonisation process, public participation and clean energy transition in the Lesser Poland province provides a context for socio-political, socio-technical and socio-ecological components. The results show the greater involvement of local policymakers in the transformation process compared to national governments. Moreover, more grassroots initiatives are observed at the local level, particularly in Krakow. The impact of societal involvement resulted in the introduction of the first anti-smog law in Poland, in which using solid fossil fuels in households and public buildings is banned. Although the law is supported by more respondents asked in the study, they draw attention to the exclusive process of its shaping and the limited involvement of people exposed to energy poverty.

Section 6 presents four territorial challenges identified by the case study team, the coping strategies adopted so far to deal with them, gender-related aspects of the challenge and coping strategies as well as a discussion of the challenges based on the research result obtained with the multidimensional analytical framework. The challenges are as follows: intensive development of the

region, intensive building on existing green areas, the consequences of being pioneers of decarbonisation in the country, and the conflict between Krakow and surrounding communes.

Finally, it can be concluded that the energy transition takes different forms depending on the region because the needs and interests of the city (CCT region) and province (PAR region) vary significantly. The most advanced level is observed in Krakow, where regulations banning the use of fossil fuels in households and public buildings have been introduced since 2019. The city is a leader, including on the national scale, in introducing innovative solutions aimed at reducing emissions. The other communes of the province were obliged to introduce the anti-smog law by 2023. However, the most recent energy crisis caused by the invasion of Ukraine by Russia reopened the discussion about this deadline. This being the case, the decarbonisation of households can be postponed to 2024.

The current geopolitical situation could also delay the clean energy transition of the power sector. Currently, the main fuel used to produce electricity and district heating is coal and strategies of the key power companies assume to switch coal to natural gas. However, taking into account the recent gas supply issues, the course of the transformation is questionable.

With this in mind, it can be concluded that, although energy policies should have long-term goals, the implementation of acts and coping strategies should have greater adaptability. The regulations and framework should address the current issues and propose solutions to the decarbonisation challenge in light of the emerging problems. In addition, the changes should be more transparent and available to society. The increasing awareness and involvement of individuals about transformations should not be stopped by inconsistent regulations and a weak flow of information.

CHAPTER 1

INTRODUCTION

1 Introduction

The project ENergy TRANSitions from Coal and carbon: Effects on Societies (ENTRANCES), which is a three-year project funded by the European Union's Horizon 2020 research and innovation programme, addresses the Social Sciences and Humanities (SSH) aspects of clean energy. ENTRANCES is coordinated by the University of A Coruña and is conducted by a consortium of 14 European partners, including universities, research institutes, networks and umbrella organisations.

ENTRANCES' overall goals are the development of a theoretically-based and empirically-grounded understanding of cross-cutting issues related to the social aspects of the clean energy transition in European coal and carbon intensive regions and formulating a set of recommendations able to tackle these issues. The project investigates the challenges facing carbon intensive regions in transition hinging on the idea that the transition to clean energy should not be considered only as a technological change or an industrial shift but also as a complex and multidimensional process that affects the daily life of local communities. In this regard, the project understands the impacts of the clean energy transition on coal and carbon intensive regions in terms of the potential activation or strengthening of the de-territorialisation process, i.e. the process of the progressive weakening of ties between a community and its territory, and conversely as an opportunity for triggering their re-territorialisation.

One of the key aspects of the project was thus the development of 13 regional case studies dedicated to just thirteen European coal and carbon intensive regions in transition.¹ All the case studies were based on the application of the same Multidimensional Analytical Framework (MAF) within the project to grasp the multi-faceted aspects of the de/re-territorialisation processes ongoing in the regions. This report is devoted to the case study of the Krakow Metropolitan Area (KMA) that was developed by the Mineral and Energy Economy Research Institute of the Polish Academy of Sciences (IGSMiE PAN).²

The region is one of the most polluted regions in Poland and Europe in terms of air quality. The main sources of air pollution are solid fossil fuels used in households (particularly in communes located close to Krakow), public buildings, local heating plants, and power plants. It should be noted that some households use low-quality coal or even rubbish for heating purposes which is a consequence of the energy poverty phenomenon. The share of domestic heating emissions in the concentration of pollutants in the region is as follows: 55% of all particulate matter size 10 µm (PM10), 50% of all particulate matters size 2.5 µm (PM2.5), and 71% of benzo(a)pyrene. Although the local policymakers have taken numerous measures in Krakow to improve air quality, emissions problems are still present.

The report is structured into five chapters: Chapter 2 presents the **conceptual, methodological framework** adopted for the development of the case study, including information on how the Krakow

¹ <https://entrancesproject.eu/project-deliverables/>

² IGSMiE PAN stands for *Instytut Gospodarki Surowcami Mineralnymi i Energią Polskiej Akademii Nauk* (the Mineral and Energy Economy Research Institute of the Polish Academy of Sciences in Polish)

Metropolitan Area has been operationalised in different interrelated units of analysis. Chapter 3 is focused on **the analysis of the Krakow Metropolitan Area Coal and Carbon Territory**, i.e. the territory heavily dependent on fossil-fuel-based industries or the extraction of fossil fuels themselves, with the lenses of the socio-cultural and socio-psychological dimensions. Chapter 4 provides an overview of the **socio-economic situation** of the region. Chapter 5 covers the **analysis of the Clean Energy Transition** underway at the regional level through the lenses of the socio-political and socio-technical dimensions. Chapter 6 presents the main **territorial challenges, associated coping strategies and gender-related aspects** and discusses them in the light of all the dimensions included in the study (i.e. socio-economic, socio-cultural, socio-psychological, socio-political and socio-technical dimensions). Finally, some conclusions formulated by the case study team complete the Krakow Metropolitan Area case study report.

The report also includes four annexes.

CHAPTER 2

CONCEPTUAL AND METHODOLOGICAL FRAMEWORK

2 Conceptual and methodological framework

2.1 Case study objective(s) and organisation

2.1.1 The case study objective(s)

The case study objective can be better understood in light of the research questions of the ENTRANCES project.

What are the principal socio-economic, socio-technical, socio-ecological, socio-cultural, socio-political, socio-psychological, and gender-related challenges facing coal and carbon intensive regions in transition? What coping strategies have emerged in recent years?

What variables have been the most influential in the appearance of the *de-territorialisation* process and how do they interact? What kinds of strategies are the key determinant of success in terms of *re-territorialisation*?

What policies or a combination of policies would be most appropriate to recover the ties of the territory and community in coal and carbon intensive regions while fostering their transition toward clean energy?

The three questions as a whole, define the logical itinerary of the project, which starts from an in-depth description of the current situation of the regions (RQ1), moves to search the *causes* of the de/re-territorialisation process (RQ2), and identifies a set of *policies* for fostering the re-territorialisation of the regions (RQ3).

The main aim of the regional case studies is to answer the first research question (RQ1) of the project in all the regions involved in the project, thus also in Krakow Metropolitan Area. Moreover, the secondary aim of the case studies is to provide the empirical basis for answering the other two research questions, related to the causes of de/re-territorialisation processes (RQ2) and the set of policies needed to activate re-territorialisation (RQ3). However, two such questions will be answered in the next phases of the project through case comparisons (RQ2) and case-related scenario building and policy co-creation (RQ3).

To describe the challenges and coping strategies faced by coal and carbon intensive regions in transition across different dimensions of change, the main aim of this document is to report the answers that the research has found concerning the case of the Krakow Metropolitan Area.

2.1.2 Structure of the case study: multiple foci and units of analysis

To deal with the complex research question presented above (RQ1) the ENTRANCES case studies have been structured into multiple foci and units of analysis. This articulated approach is necessary to enhance the clarity of the study and avoid conflation of the concepts concerning the challenges and the coping strategies of the coal and carbon intensive regions in transition. In this regard, all the ENTRANCES case studies, thus also including the case study of the Krakow Metropolitan Area, have been articulated into three research foci and three corresponding units of analysis.

- **RF1: Territorial Change in the Coal and Carbon Territories (CCTs).** The project decided to focus its analysis of challenges and coping strategies on the territories that are more exposed to the

decarbonisation process. To this aim, the concept of the Coal and Carbon Territory (CCT) was developed. CCTs are the territories in which the “coal and carbon” features are represented as a distinctive part of the local identity or are a key asset for the income and employment opportunities of the local community. It is worth noting that, in many cases, the CCTs are not administrative regions. The focus on territorial change in the CCTs has been considered the “fulcrum” or the “core” of the ENTRANCES case studies.

While RF1 helps clarify that the research is focused on the territorial challenges and coping strategies of the CCT, the dynamics of de/re-territorialisation of this territory cannot be fully understood if not in the light of the other two research foci and related units of analysis.

- *RF2: Structural Change in the Labour Market Area (LMA).* The case study has investigated the change in the socio-economic structure over the last three decades. This is an essential dimension for understanding the underlying dynamics that affected and that still affect the CCT at the structural level. To investigate structural change, the *Labour Market Area (LMA)* was established as a secondary unit of analysis. The Labour Market Area was defined as the area including the Coal and Carbon Territory in which a bulk of the labour force lives and works.
- *RF3: The clean energy transition in the Political Administrative Region (PAR).* If RF2 investigates medium- and long-period dynamics that affect the CCT, the focus on the clean energy transition ensures that the research considers the incipient change triggered by the purposive transformation of the energy system that is promoted to deal with climate change. Such objectives have been recently accelerated through the European Green Deal. In each regional case study, the clean energy transition has been observed at the level of the Political Administrative Region (PAR), i.e. the administrative region encompassing the Coal and Carbon Territories more closely associated with governing the energy transition through a directly elected legislature and also the local representative of the country government nominated by the Prime Minister.

These three research foci and related units of analysis, at least to some extent, overlap with each other. Despite that, they offer different and complementary perspectives in the study of coal and carbon intensive regions in transition. They jointly contribute to understanding the de/re-territorialisation dynamics ongoing in the coal and carbon territory.

The structure of the case study is mirrored in this report as Chapter 3 deals with Territorial Change in the CCT; Chapter 4 deals with Structural change in the LMA; and Chapter 5 deals with the clean energy transition in the PAR.

Box 1: The three units of analysis

Following the structure of the case study, three units of analysis have been delineated in the Krakow Metropolitan Area case as shown in Figure 1.

Figure 1 – Case delineation



Created with Datawrapper

Coal and Carbon Territory

Labour Market Area

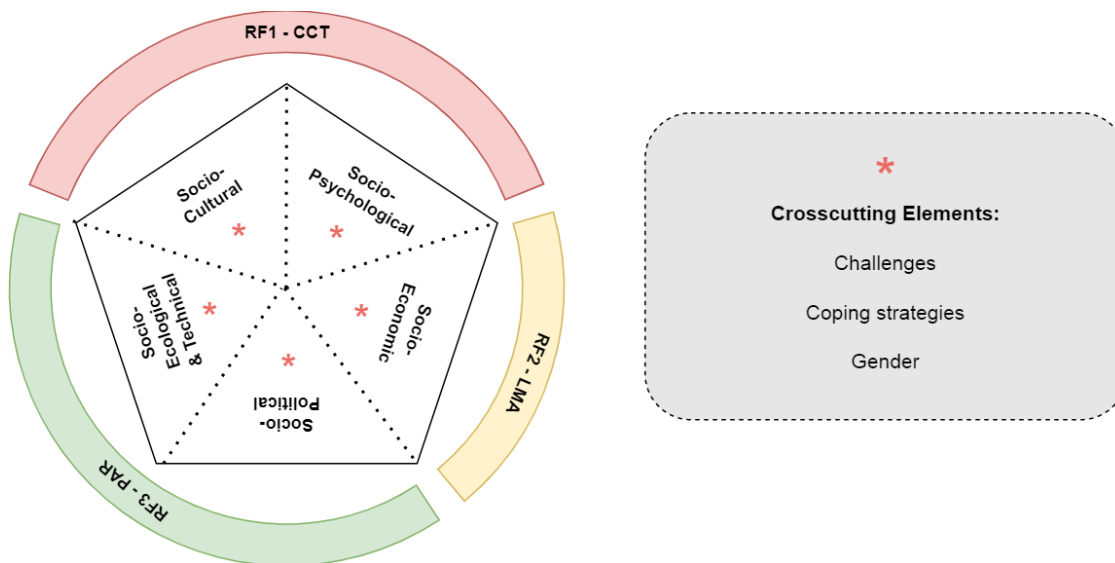
Political Administrative Region

The CCT has been defined as one municipality, named Krakow, PL213 according to NUTS classification (see Table 8). The Labour Market Area (LMA), relevant for the case study, consists of two subregions, including Krakow (PL213) and the Krakowski subregion (PL214). The key administrative unit for the case study is the Lesser Poland Province (PL21).

2.2 Overview of the Multidimensional Analytical Framework

For studying the complex and multidimensional dynamics characterising the processes of territory in transition, ENTRANCES embraces theoretical and methodological pluralism – a perspective in which the adoption of different scientific approaches is not considered as a problem but as an asset – as its research strategy and it relies on a process of knowledge integration (Isgren et al., 2017). In this regard, the project yearned for adopting multiple approaches without losing their distinctive ontological, epistemic, theoretical, and methodological features (Olsson and Jerneck, 2018). Therefore, a multidimensional analytical framework (MAF) has been adopted. The multidimensional analytical framework is articulated in five components – each relying on a set of specific concepts and methodology – and three cross-cutting elements, as shown in Figure 2. It also shows how the components relate to the above-mentioned research foci and units of analysis.

Figure 2 – Overview of the multidimensional analytical framework: research foci, components and crosscutting elements



In the following subparagraphs, all the different components will be shortly described with their overall approach, the concepts and the methodology adopted. Two final sub-paragraphs will be dedicated to a synoptic table, showing the main features of all the components together, and to the cross-cutting elements.

2.2.1 Socio-cultural component

Domain of enquiry

The socio-cultural component relies on the assumption that a territory – even an informal one as the CCT – is a form of social organisation. The component maps whether and in which way the socio-cultural changes associated with globalisation – such as migrations, technological advancement, financial flows, climate change, etc. – are provoking “stress” in the territorial organisation of the CCT. In this respect, the component interprets stress as a pressure to change for the territorial organisation rather than as the psychological stress produced by socio-cultural factors. The component relies on a theory of the “stress-strain” element of social organisations (Bertrand, 1963), which is devised to analyse change and stability dynamics “in action” in a certain organisation, in our case, in the CCT. The core of the theory is simple but insightful: when conflictual or contradictory needs, ideas or processes arise, processes of disorganisation take place inducing stress on the organisation which therefore necessitates some sort of adjustment. At the same time, the theory helps us in understanding the stability (or resiliency) of the territorial organisation as all the organisations can tolerate a certain amount of stress. The component identifies the social forces that are exercising pressure at the structural level, the resistance to change – i.e. conflicts or strains generated as a response – as well as change and stability dynamics in the territorial organisation.

Concepts

Stress-strains. The theory is based on the articulation of the “stress-strain” pair. Stress is an element inherent to the social structure in a given institutional or organisational field that cannot be observed per se but manifests itself in “strains” of different types such as conflicts, tensions, ambivalences,

etc. Therefore, the “strains” can also be interpreted as the manifestation of the stress in action at the structural level.

Strain situation. This is the operational concept adopted for identifying and studying on an empirical basis the stress-strain element in the CCT. Three main types of strain situations have been considered: situations of conflicts or disputes (both within and outside the territory), situations of impasses or contradictions, and situations of dependence and related uncertainty. The strain situations are therefore the unit of observation of this component.

Stress vector. This can be defined as a social process that activates stress in the territorial organisation. Stress vectors (or stressors) vary over a wide range of characteristics: with regard to their origins, which can be from either within or outside; with regard to intensity, as some pressure to change can be stronger than others; with regard to duration, as some stress-strain can be temporary or contingent while other can be long-lasting in society; with regard to their direction, as each stress vector pushes the territory in a certain direction of change.

Change, resistance to change and ambivalences. The dynamics of change, resistance to change and ambivalence in the CCT are described following four different dimensions of change: the territorial trajectory, by analysing continuities or ruptures; the territorial boundaries, by analysing the distinctiveness or alignments of the territory; the territorial governance, by analysing endogenous or exogenous governance; by territorial symbols, by analysing both territorial stigma and territorial myths.

Methodology

The analysis of stress-strain was based on focus group mapping (or participatory mapping) of the strain situations in the CCT. The focus group was composed of local key informants who disclosed their local knowledge of the strain situations generated by a variety of globalisation-related factors. The data collected were transcribed and processed into a consistent set of strain situations. An analysis across all the mapped strain situations allowed us to identify stress vectors, recurring strains and change-stability dynamics characterising the CCT.

2.2.2 Socio-psychological component

Overall approach

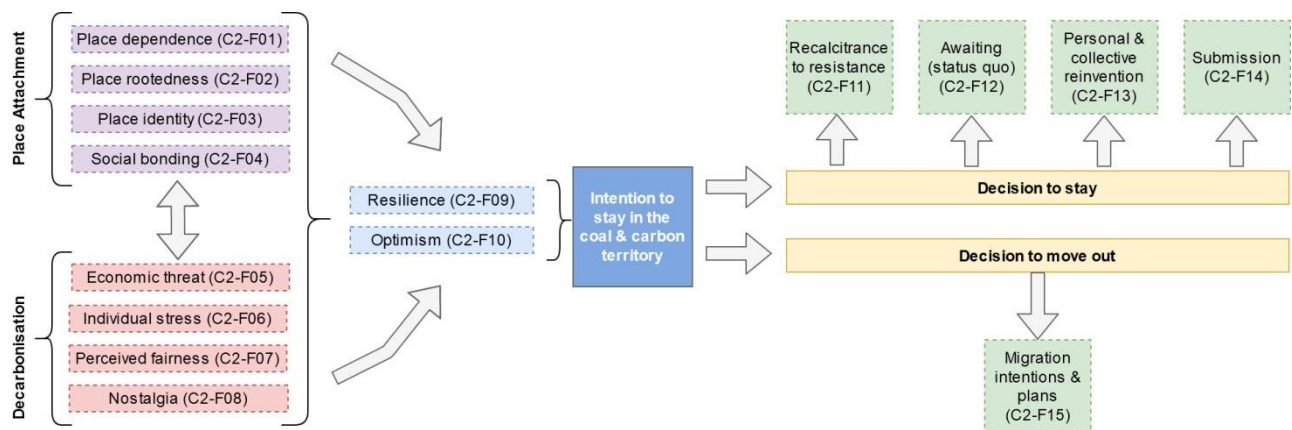
The socio-psychological component studies the socio-psychological impacts of the closure of coal mines and carbon intensive units, i.e. the decarbonisation process, on the lives of individuals living in the CCT. The component moves under the assumption that the economic, social, and political uncertainties caused by the closure of mines and coal-based industrial units may be a strong source of stress, uncertainty, and internal conflicts for the local population, as it not only constitutes an existential threat to their way of life and their primary source of livelihood but it may also appear in a dissatisfactory relationship with the territory. The component investigates how place attachment is threatened by stress, uncertainties, and deprivation induced by the decarbonisation process, and what are the main coping strategies adopted by the citizens living in the different coal and carbon territories.

Concepts

Place attachment. The concept of place attachment has been used by scholars to understand the bonds humans share with the physical environment. Leveraging on an integrated model of place

attachment (Raymond et al., 2010), the component articulates place attachment in four dimensions: a) place dependence, reflecting the functional dimension; b) place rootedness, reflecting the cognitive dimension; c) place identity, reflecting the symbolic dimension; d) social bonding, reflecting the emotional dimension. *Resilience*. The term resilience, in psychology, refers to positive adaptation in the face of stress or trauma (Luthar et al., 2000). In the socio-psychological component, the study of resilience is used for achieving a more comprehensive understanding of the response adopted by individuals to the challenges faced by the citizens more directly exposed to decarbonisation in the coal and carbon intensive regions in transition. *EVLN approach*. The possible coping strategies of citizens are identified in this component based on the “Exit, Voice, Loyalty, Neglect” (EVLN) theory, initially proposed by Hirschman (1970) to study responses to decline in firms, organisations, and states (EVL theory). The theory affirms that when dissatisfaction is experienced – in our case in territorial belonging – there are a few possible and interrelated coping strategies from the individuals. The above-mentioned concepts have been organised in a single model composed of several factors, organised in different areas, marked with different colours in Figure 3.

Figure 3 – Overview of the factors in the socio-psychological model



Starting on the left, Place Attachment and Decarbonisation factors reflect how the two joint processes of de-territorialisation and de-carbonisation are being perceived by the citizens inhabiting the CCT. On the opposite side of the picture, there are the outcomes (i.e. the dependent variables) that the model tries to explain. In the centre, resilience acts as a “moderator” as individuals with high resilience are more able to cope positively with decarbonisation-induced stress.

Methodology

The socio-psychological component was surveyed through a structured self-report online questionnaire consisting of 90 items representing 17 socio-psychological constructs (i.e. the different factors of the above-mentioned model). Most of these items and latent constructs are taken from other studies, where different researchers have applied and tested them in different contexts. All the items have been assessed by the respondent using scales.

2.2.3 Socio-economic component

Domain of enquiry

The socio-economic component focuses on structural change in the economy, i.e. the reallocation of economic activity across different economic sectors (Herrendorf, et al., 2014) and regions. Structural change can lead to a change in a region's economic, financial and demographic composition. The component is thus focused on a descriptive analysis of technological progress, demography, economic inequality, employment and economic activity based on various data sources over the last three decades. The socio-economic component focuses on the Labour Market Area but also relies on the other units of analysis as a reference and as a comparison.

Concepts

In the socio-economic component, ten different factors are taken into consideration. All the factors are investigated mainly from a quantitative perspective. The clean energy transition leads to structural change, which has an impact upon the demography (C4-F01). Furthermore, it has direct implications for the depletion of coal reserves (C4-F02), the expansion of alternative energy sources (C4-F03), direct employment and production (C4-F04) in the coal industry and carbon intensive industry, indirect employment and production (C4-F05) effects on other industries. Investments into the stock of capital (C4-F06) will respond to regional economic development. Furthermore, the clean energy transition can change economic inequality (C4-F07), energy security (C4-F08), technological progress (C4-F09) and migration patterns (C4-F10).

Methodology

For the socio-economic component, an extensive set of data was collected from national sources, mainly national statistical offices and Eurostat.

2.2.4 Socio-political component

Domain of enquiry

This component analyses the narrative battles for the interpretation of decarbonisation and energy transition in the Political Administrative Region of the case study. The component identifies which are the actors that are forming different “constituencies”: the constituency designing the transition, the constituency coping with the transition, and the constituency opposing the transition. Through analysing the narratives of such actors, the component investigates how the constituencies understand the benefits and losses from the decarbonisation process. Finally, the component shows the inclusion and exclusion dynamics resulting from technological change in the region.

Concepts

The socio-political component relies on the theory of *Technological Dramas* (Pfaffenberger, 1992). This approach understands technological shifts – such as decarbonisation – as technological dramas, i.e. a narrative battle among different actors to determine the meaning and implications of the technology. A technological drama is a discourse of technological “statements” and “counterstatements”, in which there are three recognisable processes: i) technological regularisation; ii) technological adjustment; iii) technological reconstitution. The three processes can be described as follows:

- *Technological regularisation*, a design constituency tries to impose change, i.e. to appropriate the technological process so that its features implicitly embody the political aim of altering the power relation.
- *Technological adjustment*, the impact constituency – the people who lose when a new technology is introduced or when a technological shift is ongoing – engage in strategies that try to compensate for the loss of social prestige or social power.
- *Technological reconstitution*, the impact constituency tries to reverse the meaning of the technology imposed through regularisation. In a different manner to technological adjustment strategies, the strategies related to technological reconstitution attack the foundation of technical regularisation, and activate a self-conscious “revolutionary” ideology aimed at producing a symbolic inversion and anti-signification of the technological regularisation process.

Methodology

The socio-political component was based on the semantic analysis of public statements and counterstatements of different social actors about the energy transition and coal phase-out. The analysis was carried out at the level of the PAR and was focused on statements and counterstatements of key regional stakeholders in the public debate.

2.2.5 Socio-ecological and technical component

Domain of enquiry

The socio-ecological component provides an overview of the capacity available in the case study region to shape its decarbonisation pathway. The focus on the transformative capacity allows us to discern how far a region is actually able to deviate from its current (carbon intensive) path towards sustainable outcomes.

Transformative capacity is understood in this context as an evolving collective ability to conceive of, prepare for, initiate and perform path-deviant change towards sustainability within and across the multiple complex systems that constitute the regional or urban area undergoing a clean energy transition (CET). As a systemic capacity, it is not attributable to any single actor but rather results from the interactions and orientations of multiple actors in the regional or urban economic development system involved in shaping its decarbonisation pathways. The diagnosis of transformative capacities thus enhances knowledge of key capacities hindering or facilitating purposeful transformation, ultimately permitting them to be addressed as part of capacity development activities.

Concepts

Transformative capacity is strongly influenced by the governance of the regional decarbonisation or clean energy transition in question. Three **governance and agency** components are critical to the ability of a regional development apparatus to foster the transformability of a system: the inclusiveness and multiformness of governance arrangements (C1); polycentric and socially embedded transformative leadership (C2); the empowerment and autonomy of relevant communities of practice (C3). These elements are preconditions for the transformability of a system; there needs to be connectivity and responsiveness built into governance, effective leadership able to bring people together around a vision, and actors empowered to experiment and innovate. These three attributes must be developed by stakeholders in **capacity development processes** to enhance their

transformative potential, including enhancing understanding of the systems of which they are a part (C4), engaging in participatory visioning and alternative design scenarios (C5), experimenting with novel solutions to social needs (C6) and ensuring that these innovations can be embedded (C7). Ideally, this can be seen as a learning loop, where system(s) understanding helps inform visions and pathways, which in turn orients experimentation, with successful innovations being embedded and better system understanding resulting from this process. These processes should be fed back into governance through social learning (C8) as well as the effective involvement of actors at different scales (C9) and levels of agency (C10).³

Methodology

These components were assessed by way of mixed quantitative-qualitative interviews with various stakeholders engaged in the CET. The aim was to obtain and contrast differential stakeholder assessments of transformative capacities. A diverse set of stakeholders were interviewed, representing public, private, third and civil society actors. Respondents were asked to assess statements corresponding to each measure of transformative capacity according to whether and how much they agreed or disagreed with the statements.⁴ They were then asked to elaborate their answers in open follow-up questions, which were subsequently transcribed, coded and analysed.

2.2.6 Synopsis of the five components

The features of the conceptual side of the Multidimensional Analytical Framework are summarised in the synoptic table reported in Table 1.

Table 1 – Synoptic table of the five components of the MAF

Component	Research focus	Unit of analysis	Domain of enquiry	Unit of observation	Methodology
Socio-Cultural	Territorial change	Coal & Carbon territory	Stress strains in the territorial organisation	Strain Situations	Focus group mapping
Socio-Psychological	Territorial change	Coal & Carbon territory	Place attachment, Decarbonisation, Resilience and Coping	Citizens	Online Survey
Socio-Economic	Structural change	Labour-Market Area	Change in the socio-economic structure	The area as a whole	Quantitative data collection
Socio-Political	The clean energy transition	Political Administrative Region	Narrative battles to determine the meaning and “appropriation” of the energy transition	Statements & Counterstatements	Text research
Socio-Ecological & Technical	The clean energy transition	Political Administrative Region	capacity available in the region to shape its decarbonisation pathway	Multilevel System interaction	Semi-structured interviews

³ For full elaboration of transformative capacity and its components, please refer to Wolfram (2016, 2018, 2019).

⁴ Possible responses were: 1 – completely disagree; 2 – somewhat disagree; 3 – neither agree nor disagree; 4 – somewhat agree; 5 – fully agree; don't know.

2.2.7 Cross-cutting elements

The three cross-cutting elements of the Multidimensional Analytical Framework, i.e. challenges, coping strategies and gender, are nurtured and can be better understood in the light of each and all the components of the MAF.

Challenge: In the case study we focus on the challenges faced by the CCT, i.e. from the perspective of the CCT. A challenge can be defined as composed of two elements: (i) a current situation (as the territory makes sense of it); (ii) the specific desired outcome(s) of a process intended to change that existing situation. Note that a challenge is a social construct as the sense of the current situation only exists in a given social context (i) and that the outcome is desirable by the territory itself (ii). Depending on the state of awareness of the territory, the degree of clarity and definition of the challenges may vary a lot. In this respect, depending on the cases, the territorial challenge(s) may be rather vague or it may be well structured (e.g. in the latter case, also including indicators to assess the success in achieving the challenge).

Coping strategy. A coping strategy is defined here as the strategy adopted to successfully cope with a territorial challenge. For each challenge, there can be several coping strategies. Depending on the case, two or more coping strategies may be coordinated with each other, but they may also be in contrast and competition with each other. A coping strategy can be articulated in (i) a vision or orientation for the territory; (ii) a set of actions undertaken to fulfil the vision.

Gender dimension. The gender dimension highlights how a challenge may differently affect men and women, and how gender differences might be relevant to the adopted coping strategies.

2.3 Activities

2.3.1 Desk research

The case study started with a desk research activity. The desk research was aimed at (i) delineating the case study across its three units of analysis (CCT, PAR, LMA); (ii) collecting relevant dates and basic information on the region; (iii) collecting information needed for the implementation of the five components (including a stakeholder analysis at the PAR level). The desk research enabled the analysis of a wide set of sources, including documents and reports, available data sets, previous research and studies, policy documents and others. The results of the desk research have been collected in a state-of-the-art report.

2.3.2 Focus groups (socio-cultural component)

Focus groups support qualitative measurement on research issues in which an inter-subjective agreement is needed, and for these issues, different types of actors had to be invited. The analysis focused on the territorial stress induced by globalisation in the CCT. As “territorial stress” is not directly observable, following the socio-cultural component guidelines, the focus group aims at mapping the “strain situations” (i.e. conflicts, impasses, etc.) and related impacts in the CCT.

The focus groups were conducted online in May 2022, using Microsoft Teams and Miro Platform. The primary purpose of the focus group was to identify strain situations shaping the historical and current development in the Krakow Metropolitan Area case study. The focus group consisted of eight

participants, including three women. The focus group represented all three categories of stakeholders: community leaders, knowledge keepers, and memory keepers.

2.3.3 Survey data collection process (socio-psychological component)

The survey data collection in the KMA case study was carried out using CAWI (Computer Assisted Web Interview) method. The study was performed from 9 to 23 August 2021. The questionnaire was prepared in a dedicated survey data collection system provided by an external company to provide a controlled random sample of the regional target population with as little selectivity bias as possible. The region corresponding to the CCT was selected as the area for the survey. Due to the need to identify respondents living in specific areas (administrative units) within the case study, a question verifying the respondents' place of residence was added at the beginning of the questionnaire. The sampling strategy used in the study was based on a quota approach and frequency distributions for two variables (gender – female and male, and age divided into 3 categories – 16-34; 35-54; 55+). The realised sample is representative of CCT in terms of both variables indicated above. The selection of particular respondents was made from the base of the largest research panel, Ariadna, in Poland, which has over 300 thousand registered and verified users with established identity. Information about the study and the invitation was sent out by the Ariadna National Research Panel team via e-mails to the registered members of the panel of over 300,000 people. The sample included people who, at the beginning of the questionnaire, declared living in a geographical area overlapping with the CCT.

The final total number of surveys was 234, including 124 women. All data was collected in accordance with GDPR and the project's data management plan. All data was collected anonymously. The raw data is located on the company hard drive of IGSMiE PAN. The processed data is stored on the local server of A Coruna University.

2.3.4 Socio-economic data (socio-economic component)

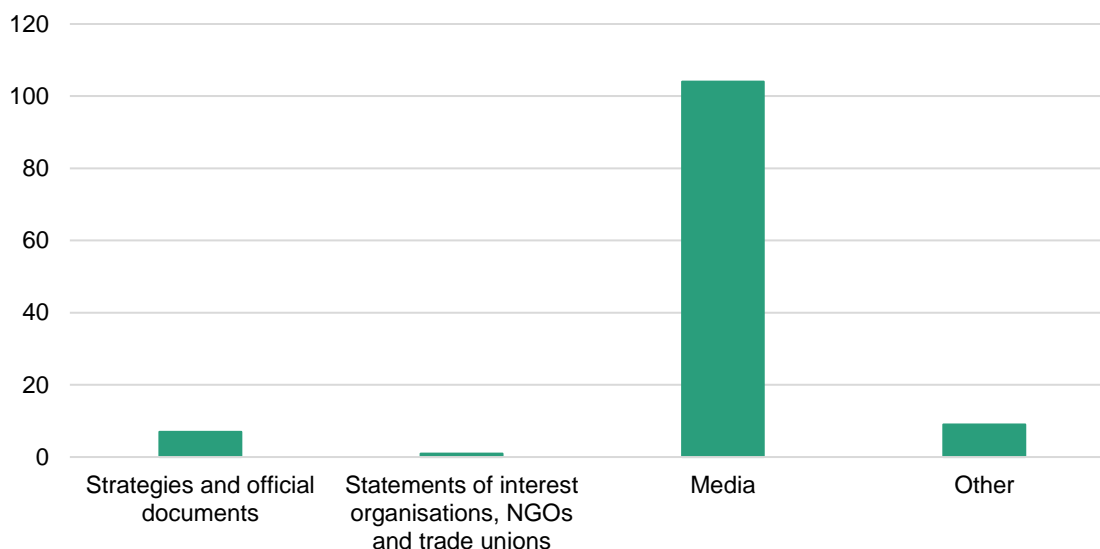
Socio-economic data has been collected from national sources, particularly the Central Statistical Office. Furthermore, Eurostat data has been used to provide an overview of the region's economic, financial and demographic composition based on a descriptive analysis. The period covered ranges from 2000 to 2019 and was focused on (i) carbon intensive data; (ii) demographic data; (iii) economic data; (iv) public finance data. The data were collected for the three units of analysis, CCT, PAR, and LMA as well as for upper levels (NUTS2 region), country and European levels. Sector-specific and region-specific peculiarities were located and processed. The data will be used further for comparative analysis and macroeconomic modelling and simulation.

Additionally, data on electricity generation from coal-fired units were collected from databases published by the Polish Transmission System Operator, the Polish Energy Market Agency, the European Association for the cooperation of transmission-system operators for electricity (ENTSO-E) and websites of the Polish power companies. Currently, adequate socio-economic data at the CCT level is at an unavailable level to address the respective research question. In the future, more granular sector-specific data is required to improve the analysis and the derived policy implications.

2.3.5 Text analysis (socio-political component)

Several **sources for the text analysis** have been investigated, covering the **period** from January 2016 to September 2021. Figure 4 shows the different types of sources for the text analysis and the number of articles for each class.

Figure 4 – Types of sources for text analysis



Note: The number of articles used to analyse local discourse, narratives and the field of power is shown for each source type.

Source: own representation.

To carry out the study on how the decarbonisation of the economy from coal influenced the socio-political aspect of coal and carbon intensive regions, the text research method was chosen. This method was applied to the Krakow Metropolitan Area. Legal conditions causing changes in the decarbonisation process arise at all administrative levels of the country. Some decisions are initiated by central authorities, which are then implemented at the Province level by the Head of Province and his offices. Some decisions are initiated and made at the local level. The analysis of the texts has been narrowed down to the discourse at the local level by appropriately selecting texts in local media.

The first steps of the research process included discursive domain delineation (research keywords selection and selection of press titles and stakeholders whose communication was analysed) and a preliminary collection of texts (207 texts relevant to the energy transition process were collected).

The sources can be described as follows:

Strategies and official documents: The main official document presenting the energy strategy is *Poland's energy policy until 2040* (PEP2040), published by the Ministry of Climate (2021). The document outlines the main goals and strategies of the Polish power system, including energy transition towards low-emission generation.

Programmes of the political parties, policy papers and statements of interest organisations, NGOs, and Trade Unions: Documents and policy papers (including resolutions, and planning documents)

introduced in the CCT region, mainly for banning fossil fuels in Krakow, the improvement of energy efficiency and the reduction of air pollution.

The media: Regional and local newspapers and internet-based e-papers, including:

- a. Dziennik Polski (newspaper),
- b. Gazeta Krakowska (newspaper),
- c. Gazeta Wyborcza – Krakow (newspaper),
- d. Nasze Miasto – Krakow (newspaper),
- e. krowoderska.pl (local information portal),
- f. www.krakowwpigulce.pl (local information portal),
- g. www.krknews.pl (local information portal),
- h. www.lovekrakow.pl (local information portal).

Informal statements and postings have not been included in the text analysis. The analysis focuses on the public and policy debate regarding the energy transition towards a low emissions economy. We exclude informal statements and postings because of their low representativeness for the general public and policy debate.

Social Media: have not been included in the text analysis. The statements of NGOs and other stakeholders published in social media were also published in official sources and interviews in media sources that were analysed in the study. Consequently, we exclude social media because of their low representativeness for the general public and policy debate.

2.3.6 Semi-structured interviews (socio-ecological and technical components)

Mixed quantitative-qualitative interviews with various stakeholders engaged in the CET have been conducted. The aim was to obtain and contrast differential stakeholder assessments of transformative capacities. The stakeholders represented public, private, trade unions, higher education, science, non-governmental organisations, research institutions and civil society actors. Respondents were asked to assess statements corresponding to each measure of transformative capacity.

The interviews were carried out by the Mineral and Energy Economy Research Institute of the Polish Academy of Sciences (IGSMiE PAN) researchers. One researcher was responsible for recruiting. Two researchers conducted interviews. The entire team worked on the adaptation of the methodological guidelines and the recruitment strategy. The interview was conducted by online meetings on the MS Teams platform. During the interview, the researcher filled out the questionnaire which was coded on MS Forms. Each researcher was responsible for recording the interviewee's most important responses (via MS Forms). For this purpose, it was possible to use the recording of the meeting. E-mail and telephone were used in the recruitment phase. Interviews were partially transcribed. The most relevant and selected answers were translated into English. All interview partners accepted the use of their data. All personal data were kept separate from the content, and the interviews were stored in personalised clouds that only the research team could enter. As the questionnaire was rather long and complicated, the interviewer provided detailed explanations to the questions.

Finally, for the KMA case study, seven interviews were collected, and three of the interviewers were women. All interviews were conducted between 21 February 2022, and 20 April 2022.

2.3.7 Data reporting, interpretation and the case study report

The broad set of research activities carried out for the development of the case study required extensive data processing and reporting activity. For each of the above-mentioned components, a short report describing the data collection procedure as well as a dataset were produced. This allows making the collected data available to the public in the future in accordance with the FAIR principles. All the data collected have been interpreted by the case study team with two complementary approaches: through a component-focused interpretation (see Chapters 2–4); in the light of a holistic understanding of the case (see Chapter 5). The results of such interpretation are reported in the next chapter of the case study reports.

CHAPTER 3

ANALYSIS OF THE CARBON INTENSIVE TERRITORY

3 Analysis of the Carbon Intensive Territory

3.1 Overview of the carbon intensive territory

3.1.1 Historical development

Krakow (CCT region of the KMA) is one of Poland's oldest cities. It is the second largest city in Poland and one of the most important cultural and scientific centres. In the past, the city belonged to the Hanseatic League, which brought together the most important trading centres in Europe until 1795. Krakow was formally the capital of Poland and, until 1611, the seat of the rulers of the Polish state. The post-war period saw strong territorial and population development in the city. In 1951, Nowa Huta, which according to the original plans was to be a separate city, was incorporated into Krakow.

Apart from its rich history, numerous monuments, universities and cultural institutions, Krakow has also been an important industrial centre for centuries. The traditions of Krakow's industry date back to the mid-19th century. The turn of the 19th and 20th centuries marked the beginning of the development of the large-scale factory industry, and it developed the most after World War II. The largest investment of that period was the Lenin Smelter, the city's largest industrial facility. It was also the biggest emitter of air pollution and had the highest odour intensity in the region.

The city's atmosphere was also polluted by the Solvay Soda Works and Bonarka Chemical Works, which also existed in the pre-war period and were later developed. These plants have now been decommissioned, and large-scale retail and office buildings have been built on their sites. Other plants operating in Krakow include the Cement Works in Pleszów, Armatura Krakowska, Polfa and many others. Sectors such as metallurgy (Sendzimir Steelworks – a part of the former Lenin Smelter), chemicals, pharmaceuticals, tobacco, machinery, clothing, food, electrical engineering, printing, leather and footwear industries developed in Krakow. Just outside Krakow, in Skawina, the Aluminium smelter was established after the war, which for decades was one of the main sources of pollution in the KMA area. The most troublesome was the electrolysis plant operating at the smelter. After numerous protests, it was closed in 1981. Nowadays, the Skawina smelter operates with much more modern technology, so its impact on the environment is less compared to the past. The special economic zone established in 1998 within the area of the city has attracted companies from the IT sector, e.g. Motorola, IBM, and Cisco.

There is one public generation unit in Krakow; it has a thermal capacity of 1,118 MWt, and an electrical capacity of 460 MWe. The unit produces electricity and derived heat that are distributed in the Krakow region. In the context of carbon emission, the power plant produces approx. 1.1 Mg CO₂/MWh. The total volume of CO₂ emitted in 2019 amounted to 1.6 million Mg. It is also worth mentioning that there are two combined heat and power (CHP) plants operating in the Skawina area, which supply district heating to the KMA.

The most energy-intensive industry was a smelter located in Krakow. The smelter was established in 1954. In the 1970s, the company employed over 40,000 people and produced over 6.7 million steel per year. Steel production was based on coke that was produced in the same location. In the 1990s, the most environmentally burdensome branches of the plant were closed. Changes in the global market and environmental costs led to a reduction in the workforce to 3,500 in 2018. In May

2019, the mill owner, ArcelorMittal Poland, decided to extinguish the blast furnace and steel plant due to high electricity prices, the costs of carbon certificates and a global slowdown in the steel market.

Around Krakow, in communes belonging to the KMA, more than 50% of households still use hard coal to heat their houses. The decommissioning of old coal-fired boilers has been ongoing in these municipalities since 2015. In 2017, over 7,000 boilers were replaced in the KMA, of which 6,114 were in Krakow. In 2018, over 16,000 boilers were replaced in the entire Lesser Poland Province, of which 4,256 were in Krakow. The overriding objective was to eliminate low emissions by eliminating sources of PM₁₀, PM_{2.5} dust and benzo-a-pyrene emissions. The CO₂ emissions are not considered in regional emission balances because the household sector and the sector of small and medium-sized fuel customers (small and medium-sized enterprises, farmers) are not included in the non-ETS sector.

The post-war history of the KMA can be divided into six key phases that were identified and reconstructed during the fieldwork. These phases reflect what our informants consider to be the most important periods for the Krakow Metropolitan Area.

These phases are synthetically described as follows:

- First phase – the first decade of the post-war period (1945–1955): The first years after the Second World War were associated with the reconstruction of the country, including the economy and industry. Many plans were made at that time to establish new industrial centres, mainly heavy industry, which could be quickly converted to military production in the event of another war. At that time, metallurgical plants called Lenin Steelworks (1953) and Aluminium Smelter in Skawina (1954) were opened in the Krakow agglomeration.
- Second phase – the main phase of the Polish People's Republic (1956–1989): In the first decade of the People's Republic of Poland, a decision of the central authorities continued the expansion and nationalisation of industry, in line with the centrally planned economy. Many new workplaces, mines and processing plants were established during this period. At the same time, mass protests of workers resulting from social discontent and huge shortages of basic products broke out periodically. Further strikes took place in 1956, 1968, 1970 and 1976, among others. However, they did not bring the expected results. At the same time, it is worth noting that after several decades of activity that was harmful to people and the environment, it was possible to close down the electrolysis department at Aluminium Smelter in Skawina in January 1980. The decision, won during the Solidarity movement, was a manifestation of civic opposition and the first significant success of the emerging environmental movements in communist Poland. Subsequent mass protests led to the imposition of martial law on 13 December 1981, which lasted until 22 July 1983. Increasing economic problems and growing social resistance led to the 1989 breakthrough.
- Third phase – the Polish Round Table Agreement and its consequences (1989–1990): Roundtable arrangements, political transformation and the establishment of institutions related to environmental protection and management.
- Fourth phase – the first dozen years of the Third Polish Republic (1991–2003): The 1990s were associated with the implementation of the free market economy, which had serious consequences for society and the national economy. A large number of Krakow's industrial plants were restructured, privatised or liquidated at that time. Some moved their operations outside the

KMA. The first programme for the decommissioning of individual boilers in households in Krakow also started at that time. During this time, a large number of such installations were successfully liquidated.

- Fifth phase – Poland as a member of the EU, Development of the business and IT sector in Krakow (from 2004–onwards). The dynamic development of the KMA in terms of tourism and a significant increase in the attractiveness of the city in terms of investment. Establishment of business centres hosting organisations from shared services, business process outsourcing and IT sectors. Between 2000 and 2015, there was also a period of increased investment in the thermal modernisation of residential buildings.
- Sixth phase – Action for clean air and elimination of low emission sources (2015–onwards). The second decade of the 21st century started a debate on air quality in Krakow. Mass protests by residents and non-governmental organisations led to the introduction of the Anti-Smog Resolution in 2017 – a ban on burning coal and wood in Krakow (from 2019). At that time, a programme to eliminate sources of low emissions from individual boilers was also established.

In addition, the respondents also identified key moments (milestones) that had a significant impact on the direction and dynamics of the region's development.

- 1950s – The Aluminium Smelter in Skawina and the Lenin Steelworks were established, and air-quality problems were growing.
- 1953 – It was decided to develop district heating, a revolution changing the source of heat supply in Krakow, previously simple individual installations with very low efficiency. Start of work on introduction of district heating system; infrastructure started to be developed.
- 1989–1991 – Round table arrangements, political transformation and establishment of institutions related to environmental protection and management.
- 1990–2000 – The first programme to eliminate individual boiler houses was funded by the United States. During this time, quite a number of such installations were decommissioned.
- 2015 – The introduction of eco-design requirements for boilers up to 500 kW.
- 2017 – Maintaining the Anti-Smog Resolution: the rate of boiler replacement was stopped, and this Anti-Smog Resolution was challenged. The issue was that the President had to sign a law (Environmental Protection Law) that would have made it possible to uphold the resolution. There was a clash of arguments between the mining lobby and the anti-smog lobby. Eventually, the law was signed and a period of a rigid plan to move away from solid fuels has been in place since 2017.
- 2016-2019 – Clean Air Programme, which was a low emission elimination programme.
- 2019 – ban on burning solid fuels in Krakow.
- 2020 – plans to install heat pumps at the ends of the network.
- 2022 – hyperinflation of prices of electricity and fuels.
- From 2023 – ban on boilers below class 3.

3.1.2 Ecological and environmental situation

The environmental impact is defined in this section as any change to the environment (adverse or beneficial) resulting from the operation of heat and power plants situated in Krakow and the consumption of solid fossil fuels in adjacent communes (the emissions from adjacent communes

have an impact on the environment in Krakow because Krakow is located in a valley and the majority emissions flow to the city).

The power generation unit located in Krakow and households mainly influences air quality. The power plant emissions are under control and have to meet European requirements in maximum concentrations of individual pollutants. Additionally, the level of carbon emissions is also regulated by CO₂ European Emission Allowances. The case is very different if the household sector is considered. The fuels consumed by individuals are regulated only in Krakow. Regulations for adjacent communes are not yet legally binding. Therefore, coal, wood and even waste are consumed there. The low emission (emission from chimneys of households, up to 40 m) is the main source of air pollution with dust (PM₁₀ and PM_{2.5}) and benzo(a)pyrene.

One of the key challenges in Krakow is an improvement in air quality. Although the introduction of Anti-Smog Resolution contributes to positive changes, the effect remains insufficient. Poor air quality is still observed, especially in the winter months. The challenges require decisive measures toward changes in regulations not only in adjacent communes but also at the level of the entire province or country. However, the ecological challenges are related to social and economic challenges. Low incomes, high heat and energy costs, and low energy efficiency in buildings result in the energy poverty phenomenon in some households. Polish statistics indicate that about 10% of households (3.35 million people) are being affected by the problem. Consequently, the ecological challenges cannot be viewed in isolation but as a complex issue at many various levels. Among the main challenges are the introduction of new regulations, the operation of programmes related to boiler replacement in households, the introduction of support mechanisms dedicated to the people that are exposed to the risk of energy poverty, and the implementation of measures to raise awareness about the risks related to the poor air quality.

The electricity and heat consumed in Krakow are mainly produced in heat and power plants situated in Krakow and Skawina. Both of them are hard coal-fired units. The total hard coal consumption amounted to 4,491 thous. Mg in 2019. The hard coal was mainly consumed in the following sectors: power plants and combined heat and power (CHP) plants (48.6%), industry and construction (27.7%), and small consumers sectors (19.8%). The small consumers sector consists of agriculture (1.0% of total hard coal consumption in Poland), households (17.3%), and other consumers (1.4%). The hard coal was also consumed in public thermal plants (2.9%), heat-only boilers in public power plants (0.9%), and autoproducing thermal plants (0.1%). Among the power plants and CHP, the greatest volume of hard coal was consumed in Krakow (787 thousands Mg) (PGE, 2020) and Skawina (130 thousands Mg) (CEZ, 2020). According to the European climate policy and the newest Polish documents, the hard coal consumption in the entire country should be noticeably decreased in the near future. Consequently, it is expected that local units will be refurbished in the coming years.

Due to its geographic location in the basin, the location of industrial plants within the KMA and the predominant heating methods in housing (classless coal and wood-fired boilers), Krakow has suffered from air quality problems for decades. The topic became very high-profile in the second decade of the 21st century with the proliferation of air quality measuring devices and access to reliable and up-to-date data. There were days when Krakow was in the top three cities with the highest daily levels of harmful substances in the air in Europe and one of the ten with the highest smog in the world. Mass protests and a number of grassroots initiatives led to the introduction of a

law in Krakow, and later in the entire Lesser Poland province, aimed at changing the situation. At the moment, Krakow's air quality is improving.

In 2016 Anti-Smog Resolution in Krakow was introduced. From 1 September 2019, only gaseous fuels or light fuel oil may be used in fuel combustion installations in Krakow. The types of installations listed by the Anti-Smog Resolution as allowed to use in the city are district heating and local air or liquid heaters (space heaters, stoves, fireplaces and others). The regulations also apply to heat generation for non-heating purposes and are not limited to private buildings. Thus, they also embrace the occasional use of fireplaces, heating of outbuildings, public institutions, greenhouses, catering facilities, and others. Consequently, all solid fossil fuels (coal, biomass) are prohibited. It should be noted that the Anti-Smog Resolution does not restrict district heating and electricity (produced in the hard coal-fired power plants), heat pumps, and photovoltaic and solar collectors.

One of the executive documents of the strategy and the Anti-Smog Resolution is the Air Protection Programme for Krakow. The document has imposed new obligations on the city government in the context of actions aimed at improving air quality. At the regional level (CCT, Krakow), the Krakow Metropolitan is the main stakeholder which develops a strategic frame. One of the priority objectives related to decarbonisation is "High quality of life in the associated communes". Socio-cultural component

3.1.3 Summary of results

The analysis of the socio-cultural component of the decarbonisation process in the Krakow Metropolitan Area is based on the results of two four-hour focus group sessions, during which, strain situations were identified and described from a historical and regional perspective.

List of the strain situations mapped

A total of 26 strain situations were mapped in the focus group. Table 2 provides an overview of the strain situation mapped, classifying each strain situation in relation to (a) the type of strain situation; (b) areas of change and related stress factors; (c) position in space; (d) position in time.

Table 2 – List of the strain situations mapped

	Name	Type	Area	Factors		Geo	Time
				1st	2nd		
1	Stench in the Płaszów region	Exo conflict	Finance	F11		Płaszów (part of XIII district in Krakow)	2017
2	Intensive development of green areas	Exo conflict	Finance	F11		Krakow	2000
3	Clean Air Programme	Endo conflict	Finance	F10	F06	Krakow	2015-2019
4	Imposition of heat supply in the form of district heating	Dependence	Finance	F09		Krakow	1954
5	Waste incineration plant	Exo conflict	Finance	F09		Nowa Huta (district in Krakow)	2009

❧	Name	Type	Area	Factors		Geo	Time
				1st	2nd		
6	Anti-Smog Resolution	Impasse	Finance	F10		KMA	2016
7	Establishment of a paid parking zone	Impasse	Finance	F09		Krakow	2010
8	ArcelorMittal steelworks closure	Dependence	Finance	F13		Nowa Huta (district in Krakow)	2019
9	Moving industrial enterprises outside Krakow	Dependence	Finance	F13		Krakow	2010
10	Housing associations – heat allocation meters	Dependence	Techno	F17		Krakow	2010
11	Air quality monitoring technologies	Dependence	Techno	F17	F16	Krakow	2016
12	Digitalisation of the application process for subsidies and boiler replacement	Dependence	Techno	F16		Krakow	2016
13	Collection of surplus energy into the grid	Dependence	Techno	F16		Krakow	2016
14	Gas boiler problems	Endo conflict	Multiple	F09		Krakow	2000
15	Increased number of tourists as well as economic and educational immigrants	Impasse	Ethno	F04	F03	Krakow	2004
16	Erosion of social relations in neighbourhood communities	Endo conflict	Ethno	F03	F01	Krakow	2004
17	Unpreparedness to accommodate increasing numbers of residents	Dependence	Ethno	F03		Krakow	2004
18	Reversed trend of people moving to Krakow (due to clean air) after years of moving out of Krakow due to smog	Dependence	Ethno	F05		Krakow	2017
19	Introduction of clean transport zones and paid parking zones	Exo conflict	Ethno	F03		Krakow	2022
20	Tensions between young and old	Endo conflict	Ideo	F15		KMA	2016
21	Populism of science centres	Dependence	Ideo	F14		Krakow	2018
22	Uneven and inconsistent distribution of costs associated with clean air measures	Endo conflict	Ideo	F15	F14	Krakow	2016
23	Anti-Smog Resolution with a timetable for the removal of individual types of heat sources	Exo conflict	Ideo	F06		Krakow	2017
24	Breaking supply chains during a pandemic	Dependence	Nature	F19		KMA	2020
25	Inconsistency of climate action in the context of urban development	Exo conflict	Multiple	F11	F18	Krakow	2007

	Name	Type	Area	Factors		Geo	Time
				1st	2nd		
26	Decisions at the EU level on changing energy sources vs the geopolitical situation	Dependence	Multiple	F09	F18	KMA	2015

Sources: ENTRANCES Focus Group Discussion.

Note: The factors refer to the socio-cultural factors, dynamics and patterns identified by the ENTRANCES project in Deliverable 1.2.

Distribution of the strain situation in the geographical map

Out of the 26 strain situations mapped, almost all (23) cannot be localised in a specific point of the map as they are related to the whole KMA area. These strain situations are represented in the lower left corner of the map below (see Figure 5). Strain situation no 1 is placed in Płaszów (part of XIII district in Krakow), 5th and 8th strain situations are placed in different parts of Nowa Huta district.

Figure 5 – Distribution of the strain situations in the geographical map



Sources: ENTRANCES Focus Group Discussion

Distribution of the strain situations in the time map

Error! Reference source not found. shows the starting year of the strain situations mapped and the duration of the strain situation.

Table 3 – List of strain situations

Years	Phase	Strain Situation	Duration (years)
1945–1955	1 – The first decade of the post-war period	1953: Imposition of heat supply in the form of district heating (≈04)	Until today
1956–1989	2 – Main phase of Polish People's Republic	No strain situation mapped started in this period	-
1989–1990	3 – The Polish Round Table Agreement and its consequences	No strain situation mapped started in this period	-
1991–2003	4 – The first dozen years of the Third Polish Republic	2000: Intensive development of green areas since (≈02)	Until today
		2000: Gas boiler problems (≈14)	Until today
2004–onwards	5 – Poland as a member of the EU, Development of the business and IT sector in Krakow	2004: Increased number of tourists as well as economic and educational immigrants (≈15)	15
		2004: Erosion of social relations in neighbourhood communities (≈16)	2004–until today
		2004: Unpreparedness to accommodate increasing numbers of residents (≈17)	2004–until today
		2007: Inconsistency of climate action in the context of urban development (≈25)	2007–until today
		2009: Waste incineration plant (≈05)	2009–2015
		2010: Establishment of a paid parking zone (≈07)	2010–until today
		2010: Moving industrial enterprises outside Krakow (≈09)	2010–until today
		2010: Housing associations – heat allocation meters (≈10)	2010–?
2015–onwards	6 – The coal phase-out	2015: Decisions at the EU level on changing energy sources vs the geopolitical situation (≈26)	2015–until today
		2016: Clean Air Programme (≈3)	4
		2016: Anti-Smog Resolution (≈06)	1
		2016: Air quality monitoring technologies (≈11)	2016–until today
		2016: Digitalisation of the application process for subsidies and boiler replacement (≈12)	2016–until today
		2016: Collection of surplus energy into the grid (≈13)	2016–until today
		2016: Tensions between young and old (≈20)	2016–until today
		2016: Uneven and inconsistent distribution of costs associated with clean air measures (≈22)	2016–until today

Years	Phase	Strain Situation	Duration (years)
		2017: Stench in the Płaszów region (≈1)	3
		2017: Reversed trend of people moving to Krakow (due to clean air) after years of moving out of Krakow due to smog (≈18)	4
		2017: Anti-Smog Resolution with a timetable for the removal of individual types of heat sources (≈23)	6
		2018: Populism of science centres (≈21)	1
		2019: ArcelorMittal steelworks closure (≈8)	2
		2020: Breaking supply chains during a pandemic (≈24)	2020–until today
		2022: The introduction of clean transport zones and paid parking zones (≈19)	2022–until today

Sources: ENTRANCES Focus Group Discussion.

Note: The factors refer to the socio-cultural factors, dynamics and patterns identified by the ENTRANCES project in Deliverable 1.2. The symbol ≈ stands for strain situations.

Tracing the time map, it can be seen that the challenges and strain situations associated with the region in the collective memory are located after the breakthrough of 1989 and the transformation of the political system in Poland, in particular, since the beginning of the 21st century. Most of the mapped strain situations can be placed on the timeline as long-term or sequential processes. They are associated with two parallel trends.

The first is the dynamic development of Krakow as an urban centre and one of Poland's most important cities with a high rate of investment in business centres and the IT sector. This situation entails population growth and a scramble for land for residential investment. The second trend is related to the growing public awareness of the consequences of air pollution and a greater understanding of the factors that affect the quality of city life. Against this backdrop, tensions are increasingly arising between the city's residents and those living in neighbouring municipalities and towns, e.g. with regard to parking zones, the entry of cars into the city centre or restrictions on permitted home heating fuels.

3.1.4 Interpretation

Stress vectors

For each of the factors considered in the research – which identifies a class of possible stressors in the territory – a set of specific stress vectors (i.e. actual change process producing stress in the territory) can be identified by analysing the strain situations mapped. While the strain situations have been represented using the “strain” symbol (≈), the stress vectors will be coded in progressive order and marked using another special symbol (↗).

The data collected allows the conclusion to be drawn that the region has been most influenced by the long-term processes connected first with the transformation of the political system in Poland in 1989 and then with Poland's accession to the European Union in 2004. Both of these phenomena resulted in Krakow becoming a fully urban centre, an attractive European metropolis competing for

new investment with previously better positioned Western European cities. Thanks to its very good universities and highly qualified staff, its convenient geographical location, the relatively cheap labour force and its well-developed transport infrastructure (proximity to the east-west motorway, airport, and major railway junction), the KMA quickly attracted a lot of investment from high-tech industries, which resulted in a steady influx of new residents. The city's boundaries grew by absorbing the surrounding villages or by creating housing estates out of suburban areas. Such rapid growth inevitably brings about a sudden clash between the rural and working-class communities and the old and new inhabitants of the KMA, working in the new knowledge-based sectors of the economy, with different needs, aspirations and lifestyles. The new, mainly young, inhabitants of the KMA have become proactive in their local community, pursuing their own interests. At the same time, there is still a high proportion of so-called 'old' residents in the urban and peri-urban areas, connected to traditional industries, including labourers and manual workers and also often agricultural and peri-agricultural contractors. Within these long-term processes, many divisions and differences are crystallised related to different aspirations and worldviews, the evaluation of urbanisation processes, the conflict between young and old or between urban and new suburban dwellers and old inhabitants of villages near Krakow or the digital exclusion and the unequal distribution of the costs of the energy transition resulting in energy poverty among some KMA inhabitants.

- The rise of the urban movement and urban-centred narrative (✓1)** – this type of narrative emphasises the key role of urban centres in regional development and the quality of living spaces. Against this backdrop, frictions are now increasingly frequent – mainly between residents of Krakow vs residents of neighbouring towns or old vs new residents. A sign of these tensions is the increasingly visible presence of urban movements, which are fighting for, among other things, the establishment of more paid parking zones for visitors (≈ 07) or the introduction of clean transport zones (≈ 19). The intention is that this will result in fewer cars from outside Krakow entering the city, especially older cars that generate more pollution. Urban movements are also trying to stop the often chaotic and over-intensive housing development in the KMA. Faced with the impotence or ill-will of the city authorities in stopping residential development on green spaces in the KMA, we are seeing more and more grassroots initiatives that seek to protect nature and the cityscape. Also, the fight against smog and the subsequent changes introduced in the region have been initiated by NGOs and informal civic groups. City residents are increasingly mobilising to protect the common good. Intergenerational frictions are also emerging against this background (≈ 20). Urban movements are mainly fuelled by young people, who have a very progressive mindset and would often like to change reality in a revolutionary way, for example, by introducing restrictions and bans on permitted home heating fuels (≈ 03, ≈ 23), placing restrictions on private transport, etc. Meanwhile, people from older generations have a slightly different perspective on these radical changes, often resulting from their worse financial situation.
- New vs old residents (✓2)** – The dynamic growth of the Krakow agglomeration causes a lot of friction between existing and new residents. As an important academic and historical centre, Krakow attracts large numbers of tourists and educational and economic migrants every year (≈ 15). There is also a trend of people returning to Krakow who moved away years ago due to poor air quality and a desire to live closer to nature. At present, Krakow is coping much better with smog than neighbouring municipalities, and in addition, intensive suburban development is generating new problems for suburban residents (≈ 18). This issue is linked to the previous

vector, in which the chaos of erecting residential buildings on green spaces was mentioned. The KMA, as a conurbation, is not prepared for such a dynamic increase in population (≈ 17), which can be seen not only in the increasing problems related to transport and traffic jams but also in the use of public institutions. In addition, such a dense and chaotic housing development, taking into account only the economic viability of investments, makes it increasingly difficult for the KMA to cope with climate change (≈ 25). This includes the problem of rainwater drainage, the development of polders and floodplains around the Vistula River or the increasing areas of concreted land. Huge housing estates on the outskirts of the city and a high turnover of residents in older neighbourhoods (e.g. due to the short- to medium-term renting of flats by students) are eroding social relationships within neighbourhoods (≈ 16).

- **Digital exclusion** (↗3) – As more and more activities move to the digital world, older, less educated people are being excluded from many areas of life. The problem of digital exclusion is considered here from the perspective of combating smog and air pollution in the KMA. One of the issues at stake is access to up-to-date information on air pollution levels (≈ 11), which are provided by apps based on readings from sensors located in the KMA. Not everyone is able to use these apps. The situation is similar with regard to the possibility of applying for funds for furnace replacement and thermal modernisation. Since 2016, the application process has been through registration via an online form (≈ 12). Not all groups are able to fill in applications using computers and the internet. Consequently, these groups are limited in their ability to benefit from discounts, subsidies and support.
- **The Matthew effect of accumulated advantage** (↗4) – described by Robert Merton, refers to the accumulation of advantage and mechanisms for perpetuating inequality. In the context of the KMA, it refers to situations in which energy transition support measures reach the better-off, while it is much harder for aid to reach those most in need. This is due to, but not limited to, the aforementioned digital exclusion of some social groups. At present, in order to obtain funding for the replacement of a heating source, it is necessary to have sufficient funds to make the required contribution. People who are better educated and have more financial resources could reach for a grant much faster and more efficiently back when it covered 100% of the costs (≈ 22). Moreover, residents in the municipalities and rural areas neighbouring Krakow cannot benefit from the subsidies for replacing boilers offered to the city's residents (100% and 80% subsidies), so they prefer not to take action on their own and wait for similar conditions to be offered in their localities (≈ 06). People recognise that, on the one hand, there is a fight for clean air by imposing restrictions on people, while on the other hand, one can see on a daily basis the lack of restrictions in chaotic development, the abuse of power in the use of cars, the renting of car parks for officials, etc. This gives rise to a sense of injustice and unequal distribution of costs. Moreover, people replacing their heating source were overwhelmingly connected to the gas network and replaced their old furnaces with modern gas boilers. The geopolitical situation has caused gas heating costs and electricity prices to rise by several hundred per cent, and the least well-off face the real problem of energy poverty (≈ 26). The issue of subsidies for photovoltaic panels is also problematic. People who could afford it installed PV and connected to the grid as prosumers. The technology is becoming cheaper, and more and more people can afford to use it, but transmission grids have limited capacity and the power system distributors are increasingly refusing to connect new installations to the grid (≈ 13).
- **Changes within the specialisations and dominant industries** (↗5) – within the KMA, there has been a significant change over the last two decades in terms of the industries and economic

sectors that have developed in the region. Krakow has for years occupied leading positions in rankings regarding investment attractiveness and business conditions for foreign investors. Krakow is a significant centre of modern business services (SSC, BPO, IT, R&D). There are 323 service centres employing nearly 78,000 people (23% share of the total sector employment) (Krakow, 2020). At the same time, industrial and manufacturing companies are withdrawing from the KMA area, closing or relocating their branches (≈ 08, ≈ 09). As a consequence, some people, especially production workers, are losing their jobs and are facing the necessity to commute to work outside Krakow or relocate. On the other hand, the COVID-19 pandemic showed a high dependence on industrial production, which is increasingly shifting to Asian countries. The pandemic has disrupted supply chains from Asia, where most of the components for individual renewable installations come from, significantly slowing down the replacement of obsolete high-emission boilers (≈ 24).

Stress-strain

Conflict and disputes. The analysis of the strain situations allows us to single out a set of recurring conflicts within the Coal and Carbon Territory. The first of the main conflicts is over the direction and shape of climate policy, which in the case of the KMA mainly refers to efforts to combat air pollution caused by the use of solid fuels for households heating and pollution from cars (≈ 03, ≈ 19, ≈ 20, ≈ 22, ≈ 23, ≈ 25). Some conflicts also arise from the activities of municipal waste and wastewater management facilities (≈ 01, ≈ 05) and from intensive residential development on greenfield sites (≈ 02).

Impasses and contradictions. The impasses mapped in the research are related mainly to the way in which the inhabitants perceive the consequences of the development of the Krakow metropolis. On the one hand, they broadly benefit from the positive effects of these changes, while on the other hand, they oppose the chosen sources of this development. These include attempts to monopolise the city centre as an area for residents (by introducing parking zones) (≈ 07) or tensions caused by a large number of tourists and economic and educational migrants (≈ 015). The impasse is also related to differences in support for the transformation by the city and neighbouring municipalities. Residents of neighbouring municipalities cannot benefit from the subsidies for the replacement of boilers offered to residents of the city (100 and 80% subsidies), so they prefer not to take action on their own and wait for similar conditions to be offered in their localities (≈ 06). However, such funding is in short supply, with the result that the effects of the fight against smog are significantly reduced. Air pollution flows into Krakow from neighbouring towns and villages.

Dependence and uncertainties. Through the analysis of the strain situations, we have identified different forms of stress by dependence and uncertainty. Firstly, there is a sense of dependency and uncertainty surrounding EU policy on energy transition (≈ 21, ≈ 26). In the face of the war in Ukraine and the resulting increase in fuel prices, the current process of removing solid fuel boilers and replacing them with cleaner gas boilers has meant that many people cannot afford to heat with the very expensive gas fuel. Other dependency tensions related to the feeling of residents in KMAs connected to the district heating network that they are losing control and empowerment over how and how much their homes are heated (≈ 04, ≈ 10). Uncertainty for some residents is also caused by the situation of industrial plants closing or relocating outside the KMA (≈ 08, ≈ 09). The narrowing of the regional economy was highlighted by problems in the COVID-19 pandemic when supply chains were disrupted and many investments stopped and some individual needs could not

be met with the commodities available on the market (≈ 24). Uncertainty and dependency also result from the digitalisation of further spheres of individual and social activity (≈ 11, ≈ 12). Uncertainty also results from the city growing too fast, especially in terms of the number of new inhabitants, and the consequences of this (≈ 13, ≈ 17, ≈ 18).

Strategies for coping with territorial stress. Despite all the strain situations ongoing in the area, no initiatives and strategies have been found devoted to coping with the stress itself. The research has found a lack of appropriate participatory mechanisms devoted to defusing, reducing or solving conflicts and a lack of mechanisms aimed at balancing power and reducing the dependency of the territory on national and regional policy-making. The only activities that are increasingly visible are the grassroots initiatives and the rise of urban movements that are vocal and effective in their fight for quality of life in the city, their fight for environmental protection and their efforts to publicise social problems resulting from, among other things, the energy transition process.

Change, resistance to change, and ambivalence

The analysis of the strain situations and the complementary information collected about the Coal and Carbon Territory allowed us to describe some key dynamics of change, resistance to change and ambivalence in the territorial organisation of the CCT. Such dynamics are briefly described below.

a. Territorial trajectory: between continuity and rupture

The first element concerns the ambivalence in the interpretation of territorial identity and visions of the territory in the future. The territory is seen primarily through the prism of its historical and cultural heritage and centuries-old university tradition. Heavy industry within the KMA began to appear after the Second World War with the successive plans for the industrialisation of the economy carried out by the communist authorities, and it was only as a consequence of the construction of the entirely new Nowa Huta working district and the launch of the Lenin Steelworks that industrial connotations began to enter into associations with Krakow. At the same time, these were not the most positive associations because of the ideological background behind the location of Nowa Huta next to Krakow. Nowa Huta was supposed to change the social structure of nearby Krakow and be a counterweight to a city with old traditions, hostile to the new government, which was a strong scientific and cultural centre with the highest percentage of the population having reached higher education. The steelworks and the new district became a permanent part of the territory's landscape and identity, although their industrial character never dominated the perception of the KMA. Over the past two decades, Nowa Huta and the area around the steel plant have become part of the cultural heritage, frequented by tourists. In the future, the steelworks area is expected to become a centre of innovation and a business zone.

b. Territorial boundaries: between distinctiveness and alignment

The closure of large industrial plants or their relocation outside the KMA has been gradual, so it has not provoked mass protests. In addition, the growing and carrying theme of air pollution and smog in the KMA facilitated the acceptance and even approval of the de-industrialisation of the territory. During this time, Krakow successfully promoted its image as an ideal city for investment by companies building business centres and the IT industry. In the future, the city plans to allocate post-industrial land for the creation of new business and residential districts. New visions for these areas

are emerging, focusing, for example, on efforts to comprehensively rework and change the image of Nowa Huta, a neighbourhood associated with the steelworks and a district inhabited mainly by metalworkers. The city is currently in the preliminary stages of implementing the Nowa Huta Przyszłości (Nowa Huta of the Future) project. Moreover, a multifunctional residential and business district is planned on the existing industrial sites around Lake Bagry and in the Rybitwy district.

c. Territorial governance: between endogenous and exogenous

As a very strong academic centre and a city with a unique history and cultural heritage, Krakow has had a privileged position for centuries. Even today, as the second largest city in Poland, it enjoys a high degree of autonomy. Many decisions taken at the local level require authorisation from the central government – this was the case, for example, with the Anti-Smog Resolution adopted by the local government. However, after several years of struggle, an important change in improving air quality was achieved, and the solutions implemented in the region served as a model for other regions. The KMA has had the opportunity over the past two decades to shape its image as a modern metropolis worthy of trust from investors. However, some decisions are still made centrally, such as those concerning supra-regional road infrastructure or the selection of managers of regional companies in which the state has a stake.

d. Territorial symbols: between myth and stigma

After 1989, there was a rather pronounced shift towards building the image of the KMA as a unique tourist attraction. At some point, however, with the accession to the European Union and the dynamic growth in the popularity of low-cost airlines, Krakow actually became a very popular city for low-cost weekend tourism, mainly centred around music clubs, pubs, etc. It was one of the most popular destinations for stag parties organised by western tourists. Initially, the revenue from this encouraged the city to continue to promote such an image. However, the problematic and conflicting nature of this type of tourism prompted the KMA to take steps to change its image. This process accelerated with the outbreak of the coronavirus pandemic. At the same time, the local authorities have successfully built an international image of the KMA as a territory characterised by innovation and high-quality human capital. Krakow is one of the most important university centres in Poland, which has certainly contributed to the city's position as one of the most attractive cities for investment, above all in the area of IT and business centres. Unofficially, Krakow is referred to as the Dragon Valley, in imitation of Silicon Valley in the USA.

Another stigma is that for years, the KMA has also had a problem with very poor air quality. Krakow's smog came to have such a strong association with the territory that jokes and popular internet memes began to circulate about it. The topic became very high-profile in the second decade of the 21st century with the proliferation of air quality measuring devices and access to reliable and up-to-date data. There were days when Krakow was in the top three cities with the highest daily levels of harmful substances in the air in Europe and one of the ten with the highest smog in the world. Mass protests and a number of grassroots initiatives led to the introduction of a law in Krakow, and later in the entire Lesser Poland province, aimed to change this situation. At the moment, Krakow's air quality is improving, although the lack of identical regulations in the KMA's neighbouring municipalities means that harmful substances from neighbouring towns and cities still find their way over the city during the winter months.

Looking at the current state of affairs, however, it can be concluded with regard to the above stigmas that the KMA has now almost completely dealt with both territorial stigmas, and the image of the territory is now free of the associations described above.

3.1.5 Gender Dimension

Although all descriptions of strain situations were tested for gender differences, the focus group decided in all cases that there were no differences between women and men in terms of concern.

3.2 Socio-psychological component

The transformation of the energy system and the decarbonisation process are expected to have a noticeable impact on the socio-psychological well-being of the inhabitants of coal and carbon intensive regions across Europe. In this component, we have measured the long-term and short-term impacts of the decarbonisation process on the socio-psychological well-being of the people and the de/re-territorialisation of the affected regions. It can provide crucial support to policymakers and investors, helping them to make informed decisions on immediate and appropriate measures and actions to retain the population and maintain the demographic, social and economic configuration of these regions in the coming decades, while achieving a sufficient level of decarbonisation.

Our main objective is to measure socio-psychological stress in the general population of the territories more directly challenged by the ongoing decarbonisation process, conventionally referred to in the project as the Coal and Carbon Territory (CCT). Through a quantitative survey, the project aims to create new knowledge about the impact of different decarbonisation policies implemented in the CCT on people's socio-psychological well-being and their coping strategies to deal with this transition.

3.2.1 Summary of results

Profile of respondents

In the case of the KMA, of the total of 234 respondents, 52.99% were women and 47.01% were men. This gender distribution approximately corresponds (with a deviation of 7.2%) to the share of both sexes in the total population of the region. In terms of age distribution, the majority of the respondents (98, 41.88%) belong to the 46–65 age group, followed by 70 (29.91%) respondents from the 31–45 age group, 45 (19.23%) from the 18–30 age group and the remaining 21 (8.97%) from the 65+ age group.

Education is an important characteristic affecting living standards and the labour market position. Among the respondents, 140 (59.83%) had university degrees, 85 (36.32%) completed secondary education, and 9 (3.85%) had completed some vocational training. As for the professional profile of the respondents, most of them worked in the service sector (116, 49.57%), followed by pensioners (36, 15.38%), unemployed (34, 14.53%) and industrial workers (22, 9.40%). A small number of respondents were either inactive (16, 6.84%) or public servants (10, 4.27%). There were no workers from the agricultural sector among respondents. Of the total number of respondents, only 2 (0.85%) were currently working in carbon intensive industrial units, and only 6 (2.56%) respondents had previously worked in these or similar industrial units.

In terms of marital status, almost half (108, 46.15%) of the total respondents were married and 46 (19.66%) were living with a partner. Of the remainder, 62 (26.50%) were single, 16 (6.84%) were divorced or separated and 2 (0.85%) were widowed. Of the total respondents, 85 (36.32%) were living with dependents (under 16 or over 65). The level of place attachment and the social bond with the local population depend to a large extent on the length of time spent in the region. People who were born in the region or who migrated when they were very young have more attachment to the place compared to newcomers. Of those surveyed, 134 (57.26%) were born in the KMA, followed by 98 (41.88%) born in other provinces of Poland, and only 2 (0.85%) were born outside Poland.

Table 4 – Respondent profile

Sample Size		234 Complete cases					
Gender	Males (110, 47.01%)				Females (124, 52.99%)		
Age	18–30 (45, 19.23%)		31–45 (70, 29.92%)		46–65 (98, 41.88%)		65+ (21, 8.97%)
Education	Primary (0, 0%)		Secondary (85, 36.32%)		University (140, 59.83%)		Professional (9, 3.85%)
Occupation	Industry (22, 9.40%)	Agricultur e (0, 0.00%)	Services (116, 49.57%)	Public Servants (10, 4.27%)	Unemploy ed (34, 14.53%)	Retired (36, 15.39%)	Inactive (16, 6.84%)
Working in Carbon Industries	Yes (2, 0.85%)				No (232, 99.15%)		
Worked in Carbon Industries	Yes (6, 2.56%)				No (228, 97.44%)		
Marital Status	Never Married (62, 26.50%)	With Partner (46, 19.66%)		Married (108, 46.15%)		Divorced/ Sep. (16, 6.84%)	Widowed (2, 0.85%)
Living with dependents	Yes (85, 36.32%)				No (149, 63.68%)		
Nativity	Born in KMA (134, 57.27%)		Born in other provinces (98, 41.88%)			Born outside country (2, 0.85%)	
Duration of Stay	0–5 years (1, 0.43%)		6–10 years (4, 1.71%)		11–20 years (8, 3.42%)		20+ years (221, 94.44%)

Sources: ENTRANCES survey data

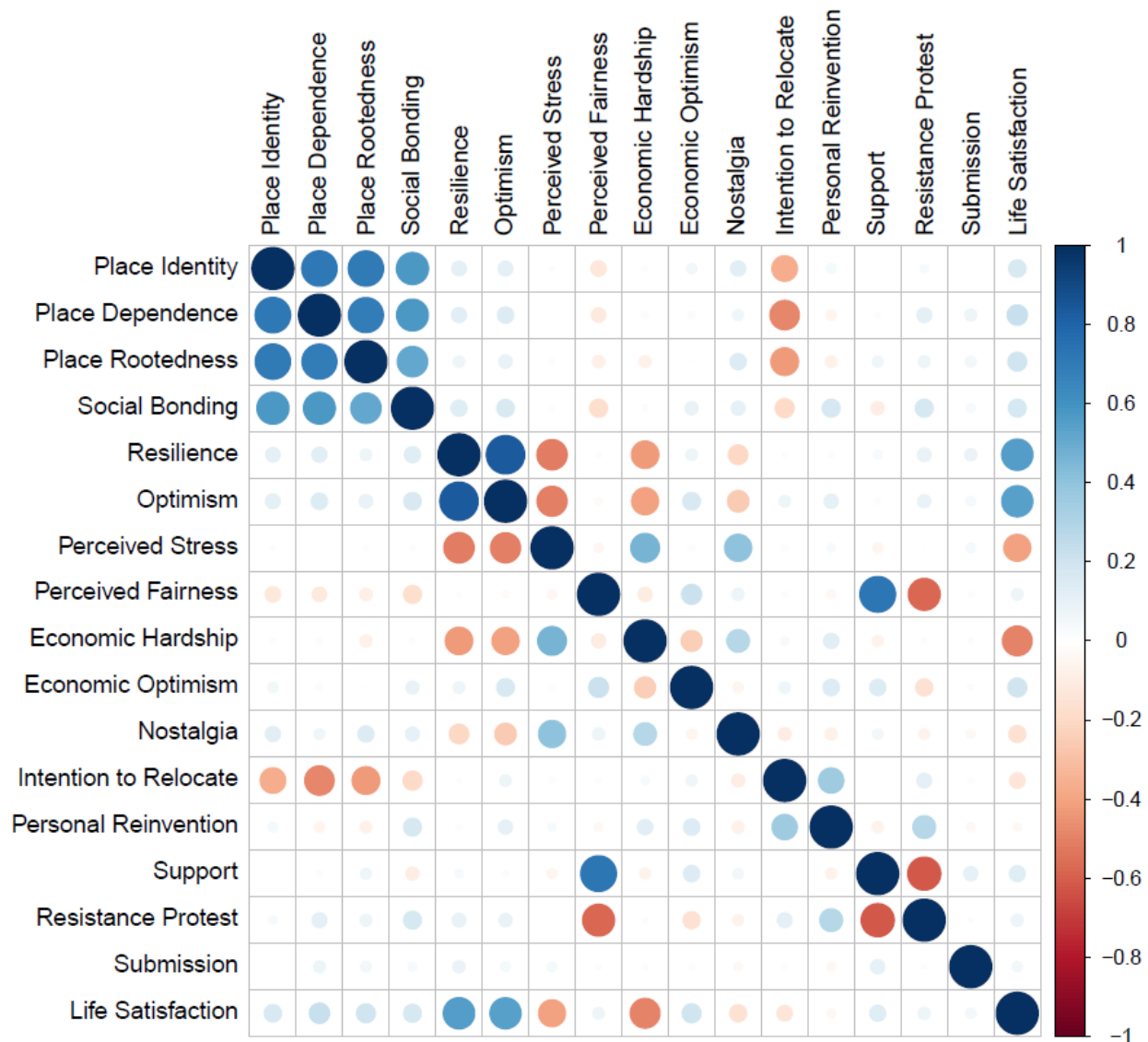
3.2.2 Interpretation

Correlation among different factors related to socio-psychological component

In the KMA, we claimed a strong positive correlation between the different elements of place attachment, that is, Place Identity, Place Dependence, Place Rootedness, and Social Bonding (Figure 6). Identity of Place, Dependence on Place, and Rooting in Place show a moderate negative correlation with Intention to Relocate. We also found a strong positive correlation between the factors Resilience and Optimism, and the factors Perceived Fairness and Support. Both moderators show

a negative correlation with the Perceived Stress factor. In terms of coping strategies, there is a strong negative correlation between the factors Support, Resistance and Protest. This is evident and provides a measure to verify the reliability of the responses. Similarly, there is a strong negative correlation between the factors Perceived Fairness and Resistance and Protest. The Resilience and Optimism factors show a strong positive correlation with Life Satisfaction, indicating that people with higher levels of Resilience and Optimism also have higher Life Satisfaction scores.

Figure 6 – Correlation among different factors related to the socio-psychological component



Sources: ENTRANCES survey data

Mean score with standard deviations for all constructs

Analysis of the averages for the individual scales used in the survey indicates a moderate level of the indicators used. This is the case for Place Attachment, where the mean values oscillate between 2.15 and 2.89, and only Social Bonding is rated better, although this dimension is not rated

particularly highly (3.12). The average level of Optimism and Resilience probably translates into relatively higher ratings for dimensions such as Perceived Stress and Economic Hardship. Interestingly, Economic Optimism was rated similarly high in this case. When looking at coping strategies, it can be noted that three strategies were rated highest: Resistance and Protest, Personal Reinvention and Intention to Relocate.

Table 5 – Mean score and standard deviations for all factors

Factors/ Latent constructs	Sub constructs	Mean score	Standard deviation	Cronbach's Alpha
Place Attachment	Place Identity	2.15	0.86	0.94
	Place Dependence	2.70	0.97	0.91
	Place Rootedness	2.89	0.46	0.67
	Social Bonding	3.12	1.29	0.79
Moderators	Resilience	2.45	0.67	0.87
	Optimism	2.51	0.73	0.89
Decarbonisation Impacts	Perceived Stress	3.09	0.44	0.82
	Perceived Fairness	2.73	0.49	0.74
	Economic Hardship	3.11	0.85	0.93
	Economic Optimism	3.19	0.79	0.78
	Nostalgia	3.09	0.83	0.89
Coping Strategies	Intention to relocate	3.30	0.89	0.89
	Personal Reinvention	3.42	0.86	0.84
	Support	2.43	0.97	0.91
	Resistance and Protest	3.58	0.73	0.81
	Submission	2.97	0.56	0.48
Life Satisfaction		3.11	0.84	0.87

Sources: ENTRANCES survey data

Note: The factor mean is the average of all respondents' scores for each construct. A mean score close to 5 shows a higher value for all constructs, and a mean score close to 1 shows a lower value for all constructs. Cronbach's Alpha provides a measure of the internal consistency of a test or scales indicated (Cronbach 1951); it is expressed as a number between 0 and 1. Internal consistency describes the extent to which all the items in a test measure the same concept or construct and, thus, it is connected to the inter-relatedness of the items within the test. The alpha score below 0.7 is not acceptable.

Regional differences in mean scores for different factors

Below is the Z-score and standard ten (STEN) for all 17 sub-constructs for the Krakow Metropolitan Area region, and how it can be seen that for some indicators, respondents from the KMA region scored higher compared to the other ENTRANCES case studies. In the factor related to Decarbonisation Impacts, respondents scored higher for the sub-constructs related to Perceived

Fairness (6.78) and Perceived Stress (6.08), while for Coping Strategies, higher scores were obtained for Intention to Relocate (6.56), Support (6.48) and Personal Reinvention (6.12).

Table 6 – Z score and STEN for all factors

Factors/Latent constructs	Sub constructs	Z-score	STEN
Place Attachment	Place Identity	-0.38	4.74
	Place Dependence	-0.09	5.32
	Place Rootedness	-0.30	4.90
	Social Bonding	-0.35	4.80
Moderators	Resilience	-0.45	4.46
	Optimism	-0.52	4.60
Decarbonisation Impacts	Perceived Stress	0.26	6.02
	Perceived Fairness	0.64	6.78
	Economic Hardship	0.07	5.64
	Economic Optimism	0.11	5.72
	Nostalgia	0.23	5.96
Coping Strategies	Intention to Relocate	0.53	6.56
	Personal Reinvention	0.31	6.12
	Support	0.49	6.48
	Resistance and Protest	-0.45	4.60
	Submission	-0.57	4.36
Life Satisfaction		-0.63	4.24

Sources: ENTRANCES survey data

Note: The Z-score provides an indication of how far from the mean a data point is; more technically, it is a measure of how many standard deviations below or above the population mean a raw score is. The STEN scores (Standard Ten) shows results using a simple standardized scale from 1 to 10 that have a normal distribution. They have a mean of 5.5 and a standard deviation of 2 and are then rounded to the nearest integer. To interpret the STEN scores, all case studies will focus on STEN scores below 4 (which should be interpreted as low compared to the case studies as a whole) and above 6 (the high scores). All STEN scores around 5 show that the case study is not very different from the other ENTRANCES case studies.

Gender dimension

Gender is one of the important dimensions of our study. Three significant differences between men and women were found. Women had significantly lower values in resilience (men: 3.65, women: 3.46, $p < 0.05$). Women showed higher levels of Perceived Stress (men: 2.67, women: 2.85, $p < 0.05$) as well as Economic Hardship (men: 2.94, women: 3.27, $p < 0.005$). Thus, the data suggest that, in economic and psychological terms, women are more concerned about the consequences of decarbonisation processes. The rest of the 17 sub-constructs are not significantly different between men and women.

Table 7 – Gender differences in the mean scores for all constructs

Factors/ Latent constructs	Sub constructs	Mean score		T-test (df)	P-values
		Men	Women		
Place Attachment	Place Identity	3.782	3.901	-1.068	0.287
	Place Dependence	3.225	3.363	-1.089	0.277
	Place Rootedness	3.519	3.570	-0.623	0.534
	Social Bonding	2.914	2.855	0.345	0.730
Moderators	Resilience	3.648	3.460	2.162	0.032
	Optimism	2.929	2.852	0.702	0.483
Decarbonisation Impacts	Perceived Stress	2.697	2.864	-2.045	0.042
	Perceived Fairness	3.364	3.379	-0.144	0.885
	Economic Hardship	2.938	3.268	-3.004	0.003
	Economic Optimism	2.868	2.766	0.978	0.329
	Nostalgia	3.116	3.071	0.417	0.677
Coping Strategies	Intention to Relocate	2.730	2.667	0.534	0.594
	Personal Reinvention	2.509	2.640	-1.159	0.248
	Support	3.573	3.577	-0.030	0.976
	Resistance and Protest	2.439	2.401	0.386	0.700
	Submission	3.045	3.008	0.513	0.608
Life Satisfaction	Life Satisfaction	2.929	2.852	0.702	0.483

Sources: ENTRANCES survey data

Note: Mean-score indicates the mean score for all constructs. Mean score close to 5 shows a higher value for all constructs and mean score close to 1 shows a lower value for all constructs.

3.3 Conclusion

The study of the socio-cultural and socio-psychological aspects of the energy transition and decarbonisation used data collected through surveys and focus group interviews conducted among the residents and key stakeholders of the Krakow Metropolitan Area. During the focus group research, it was possible to identify 26 stressors which, in the opinion of the participants, have left their mark on the history of the region. Based on these, it was possible to identify several key stress vectors and recurring situations creating tensions. These relate to aspects such as: a) a prominent urban-centred narrative; b) tensions between new and old residents; c) the impact of digital exclusion on opportunities to benefit from transition support, and the resulting (d) uneven distribution of the costs of the energy transition; e) the changing profile of industries and sectors operating in the region. No gender-differentiated influences were identified. Looking at mediascapes, it can be concluded that for the first ten to fifteen years of the 21st century, KMAs have been marked by a very clear negative set of associations. Today, however, both of these issues have improved considerably, and the Krakow Metropolitan Area region is now relatively unaffected by territorial stigma. What constituted territorial stigma was related to two issues:

- The city for cheap party tourism
- The city with the highest smog

The KMA has now almost completely dealt with both territorial stigmas and the image of the territory is now free of the associations described above. What is more, one of the emerging new symbols of the KMA is the reference to innovation and high-quality human capital. In terms of emerging visions, the focus research highlighted efforts to comprehensively rework and change the image of Nowa Huta district. The city is currently in the preliminary stages of implementing the Nowa Huta Przyszłości (Nowa Huta of the Future) project. Moreover, a multifunctional residential and business district is planned on the existing industrial sites around Lake Bagry and in the Rybitwy district.

The study also analysed the impact of the decarbonisation process on the social and psychological well-being of the inhabitants of the Krakow Metropolitan Area. For this purpose, we conducted a survey on a sample of 234 residents. The sampling strategy used in the study was based on a quota approach and on frequency distributions for two variables (gender: female and male; and age divided into 3 categories: 16–34; 35–54; 55+). The realised sample is representative of the CTT in terms of both variables indicated above.

The results of the research revealed that the residents obtained scores close to the middle of the scale on almost all constructs (Regional Place Attachment, Resilience and Optimism, Decarbonisation Impacts, Coping Strategies and Life Satisfaction). It is worth noting that the respondents obtained relatively higher scores in coping strategies in the sub-constructs Resistance and Protest, Intention to Relocate as well as Personal Reinvention. Interestingly, for these dimensions, Intention to Relocate and Personal Reinvention, the results obtained for KMA were higher than they were for the results obtained in other case studies.

Only in the case of three dimensions did we notice significant differences between men and women. Women obtained higher scores for Perceived Stress, Economic Hardship and lower scores than men when it comes to Resilience.

CHAPTER 4

SOCIO-ECONOMIC SITUATION

4 The socio-economic situation

4.1 Introduction to the socio-economic situation

This chapter provides an overview of the socio-economic situation of the region. Important factors for economic development are population dynamics, labour force, capital stock and technological progress.

We refer to the three different delineations of the region, namely the Coal Carbon Territory (CCT), Labour Market Area (LMA) and Political Administrative Region (PAR), as described in the Introduction.

The socio-economic component focuses on structural change in the economy, i.e. the reallocation of economic activity across different economic sectors and regions. Structural change can lead to a change in a region's economic, financial and demographic composition. This report provides a descriptive analysis of technological progress, demography, economic inequality, employment and economic activity based on various data sources.

4.2 Determinants of economic development

An important indicator of economic development is real gross domestic product (GDP) per capita.⁵ Real GDP per capita (Y/N) can be decomposed into three components – labour productivity (Y/L), employment rate (L/E) and share of the population in working age (E/N):

$$\frac{Y}{N} = \frac{Y}{L} \times \frac{L}{E} \times \frac{E}{N} \quad (1)$$

where Y is real GDP, N population, L employed persons and E working-age population.⁶

Labour productivity (Y/L) depends on technological progress and capital intensity (Solow, 1956; Solow, 1957). In addition to private investments, also investments into the public capital stock influence the development of labour productivity. The public capital stock is important for the growth trajectory of a region (Baxter & King, 1993). Technological progress depends on research and development (Romer, 1990; Jones, 2005; Lucas Jr, 2009). Further, technological progress also depends on human capital determined through individual qualifications (Uzawa, 1965; Lucas Jr, 1988; Mankiw, et al., 1992).

The economic overview of the CCT, LMA, and PAR region in comparison to the national and EU28 results is shown in Figure 7. The economic overview includes, in particular, the labour productivity,

⁵ Gross domestic product is not created to measure welfare. It measures the transaction value of goods and services over a specific period (see Eurostat 2014, p. 146). Other measures such as mortality, leisure and inequality show a high cross-country correlation with GDP (see Jones and Klenow 2016). Therefore, GDP is a good proxy for welfare despite its apparent shortcomings. Nevertheless, one should use various indicators to finally assess the welfare of a region (see Fleurbaey 2009).

⁶ The population in working age refers to the persons aged 15-64 years. Expected effects of legislated pension reforms will increase the participation rate of older persons in the future.

population, the working-age population, the share of employed persons, GDP per capita, and GDP in total.

Labour productivity has a similar pattern in the case of CCT, LMA, PAR and the country – a similar level was observed before 2016, and then the index decreased slightly (Figure 7a). Since 2016, an increase in labour productivity has been observed at all levels analysed. The greatest values are in the CCT region. Values in the LMA region and the country are similar, whereas the values in the PAR regions are the lowest. This results from the high share of non-industry areas at the provincial level. Although an increase is observed from 2016, labour productivity is still significantly below the EU28 level.

The changes in the number of the population indicate that the number of people living in CCT, LMA, and PAR has been increasing since 2000 (Figure 7b). The number of people has increased by 1.6% in CCT, by 7.1% in LMA, and by 5.3% in PAR. This trend is also observed in the EU28 where the growth of the population is 5.2%. The population only decreased at the country level. The number of people living in Poland in 2018 was lower by 0.7% compared to 2000. Consequently, the results indicate a positive development with respect to the socio-economic factors in the CCT, LMA and PAR.

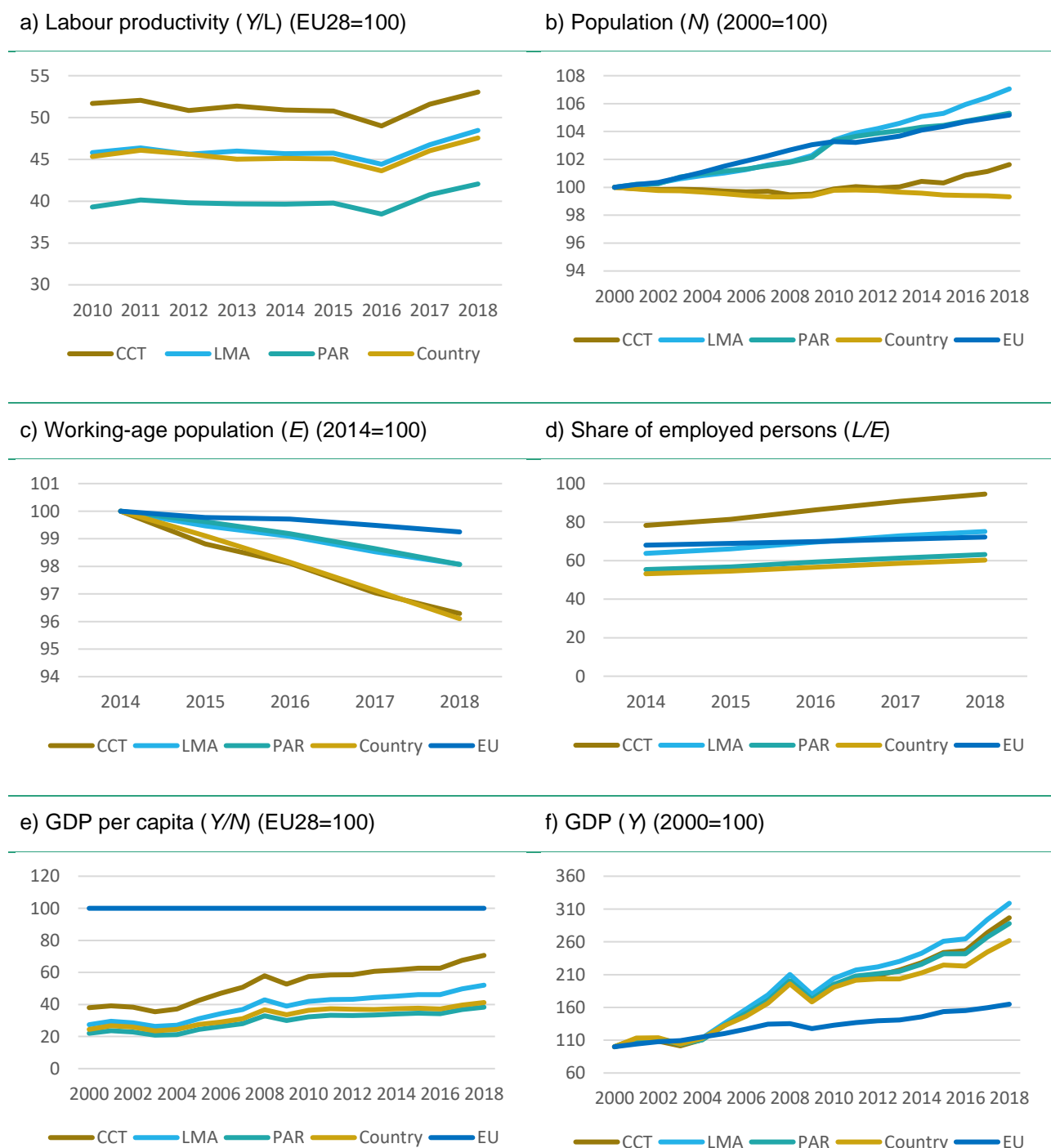
The working-age population in CCT, LMA, PAR, and Poland has been decreasing stronger than in the EU28 (Figure 7c). The largest decline, with about 3.9% compared to 2014, has been observed at the national and CCT level. The values in LMA and PAR are similar. Consequently, the working people in Poland are younger compared to the EU. However, changes in Poland have had greater dynamics. Given values from 2014 as a benchmark, the decrease in 2018 is 0.8% in the EU28, 1.9% in LMA and PAR, 3.7% in CCT, and 3.9% in Poland.

The share of employed persons in Poland has been increasing in all regions examined (Figure 7d). This share increased from 78.3% in 2014 to 94.6 in 2018 in CCT, from 63.8% to 75.1% in LMA, from 55.4% to 63.2% in PAR, from 53.2% to 60.3% in Poland, and from 68.0% to 72.2% in EU28. The increase observed in CCT was 20.8% compared to 2014 and much stronger than the increase at the EU28 level (6.2%).

GDP per capita (Figure 7e) and total GDP (Figure 7f) have been increasing since 2000. GDP per capita is very similar in Poland and the PAR. It is at a significantly lower level compared to the EU28 level, i.e. about 60% lower to EU28. However, GDP per capita in the CCT was 30% lower than the EU28 average in 2018, and in the LMA – 48%,

The changes in total GDP in Poland are significantly larger compared to the EU28. The EU28-GDP has increased by 64.9% since 2000, whereas in the CCT by 196.6%, in the LMA by 218.9%, in the PAR by 187.8%, and in Poland by 161.8%. The difference in dynamics results from the economic conditions in Poland in 2000 that were worse than in other EU28 countries and provided a lower benchmark for assessing the growth in 2018 compared to the EU.

Figure 7 – Economic overview



Sources: National and regional statistical office of Poland and Eurostat

Note: Labour productivity is shown from 2010 due to availability of regional data. Real gross domestic product is not available on a regional level. Therefore, the figures always refer to nominal figures.

4.3 Sectoral structure

Overall gross value added in the CCT amounted to 14.8 million EUR in 2018. The total amount is based on a contribution of about 0.1% from agriculture, 26.6% from mining and utilities, manufacturing, and construction, 33.7% from retail and information technology, 9.3% from finance and 34.4% from other services.⁷ Compared to the EU28, the sectoral composition indicates a higher share of retail and information technology. The sectoral pattern at the CCT has been rather stable since 2000, while at the EU28 level, the share of services has increased, and the percentage of manufacturing has decreased (Figure 8a–b).

Figure 8c presents changes in electricity production in a coal-fired power plant located in the CCT and changes in the number of employees in this generation unit. In 2015, 1.69 TWh of electricity were produced, whereas in 2019, it was 1.41 TWh (a decrease of 16.6%). The number of employees was reduced from 264 to 236 (10.6%).

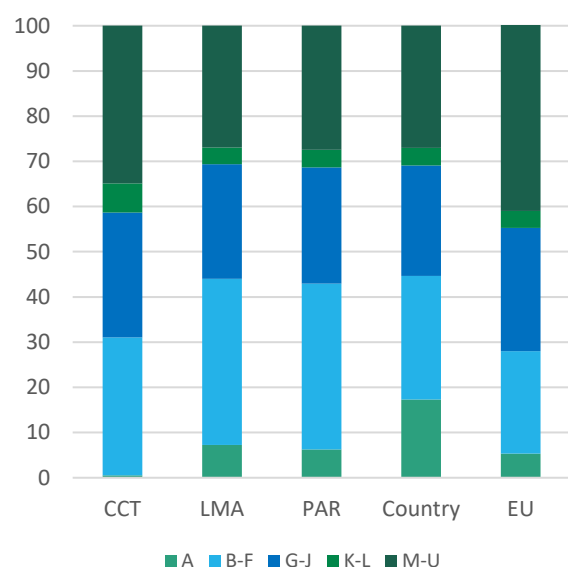
The growth decomposition is outlined in Figure 9. Sectoral growth (dY/Y) is decomposed into labour productivity growth ($d(Y/L)/(Y/L)$) and labour growth (dL/L). The growth contribution by each sector (i) is the initial share of the sector (Y_i/Y) in the year 2000 multiplied by the sectoral growth rate between 2000 and 2018 (dY_i/Y_i). The sectoral growth has positive values at all levels (CCT, LMA, PAR, Country, EU) for each sector, except for the agriculture sector in CCT (in that case, the labour productivity growth has negative values, and labour growth is too small to cover them).

In the CCT, the highest sectoral growth is observed in sectors K–L (sectors of finance, real estate and other professional services), in the LMA, PAR, country, and the EU28 – sectors G–J (retail and IT) and M–U (other services). Figure 9f shows that the mining and utility sector has the highest share in the total sectoral growth only at the country level. In the CCT, the main contributors are other services, similar to the EU28 level. The key components of the LMA and PAR are the retail and IT sectors.

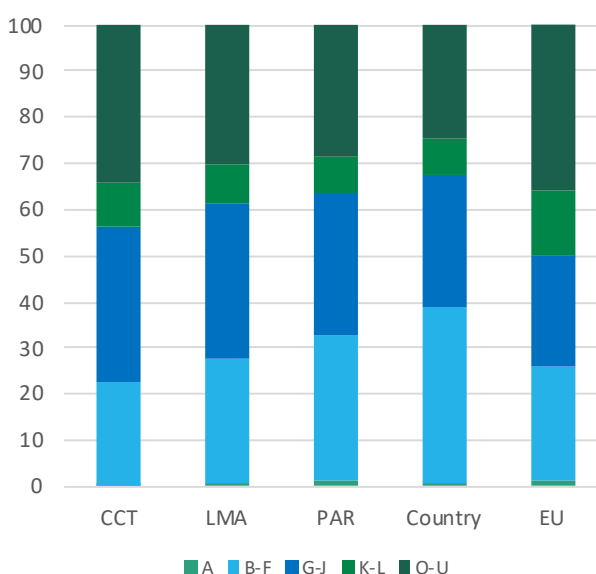
⁷ All sectors follow the European Classification of Economic Activities (NACE), Eurostat (2008)

Figure 8 – Sectoral structure

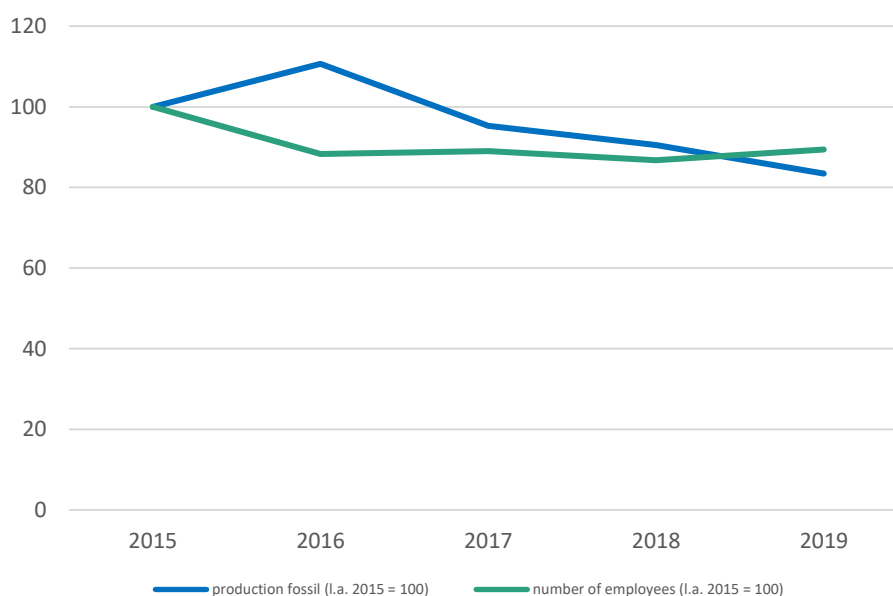
a) Gross value added in 2010 (in percent)



b) Gross value added in 2018 (in percent)



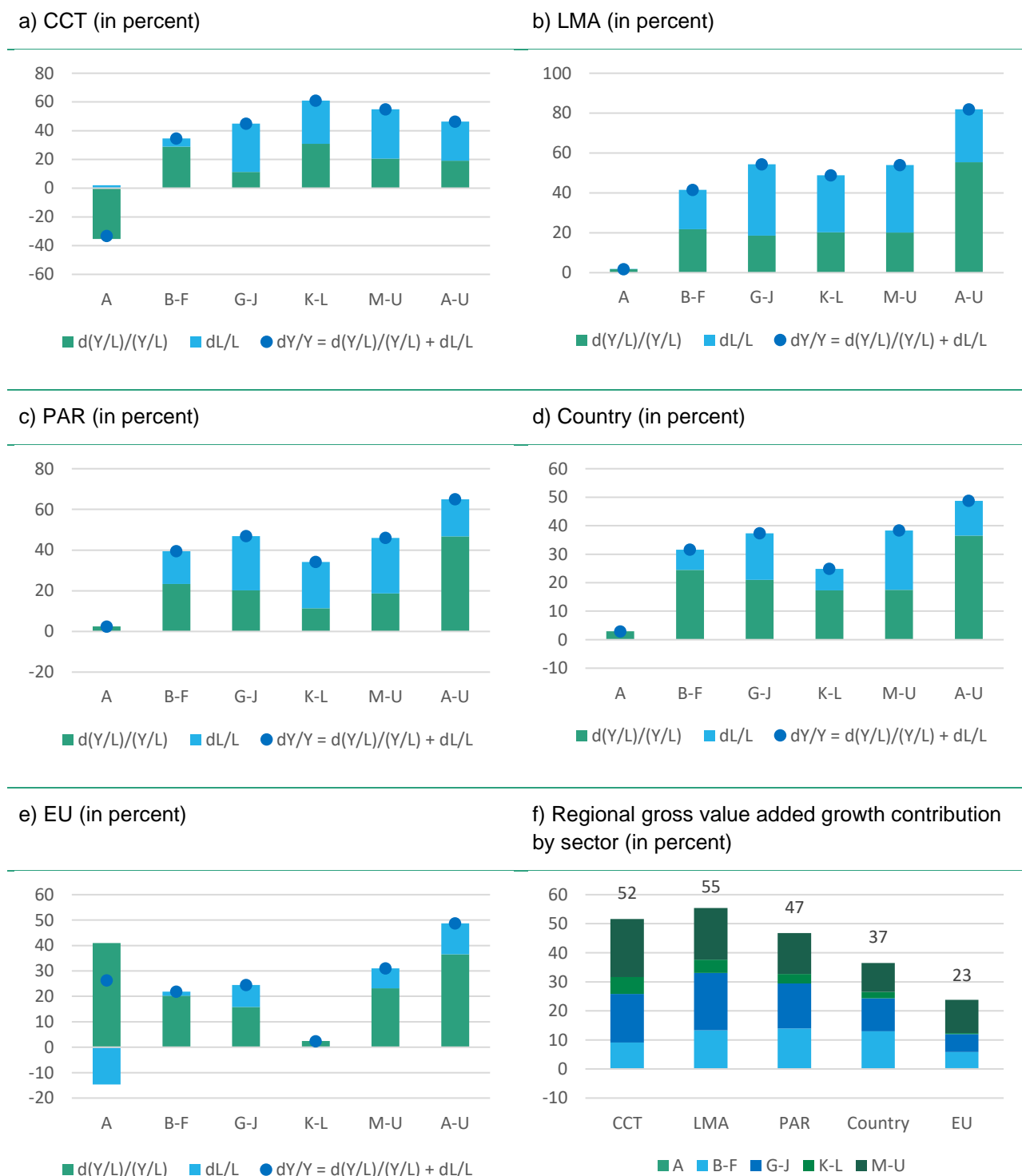
c) Carbon intensive industry overview



Sources: National and regional statistical office of Poland and Eurostat, data published by carbon intensive companies

Note: The sectors are classified by: A – Agriculture, Forestry and Fishing; B–F – Mining and Utilities, Manufacturing and Construction; G–J – Retail and IT; K–L – Finance, Real Estate and other Professional Services; M–U Other Services (Eurostat 2008).

Figure 9 – Growth decomposition (2018–2000)



Sources: National and regional statistical office of Poland and Eurostat

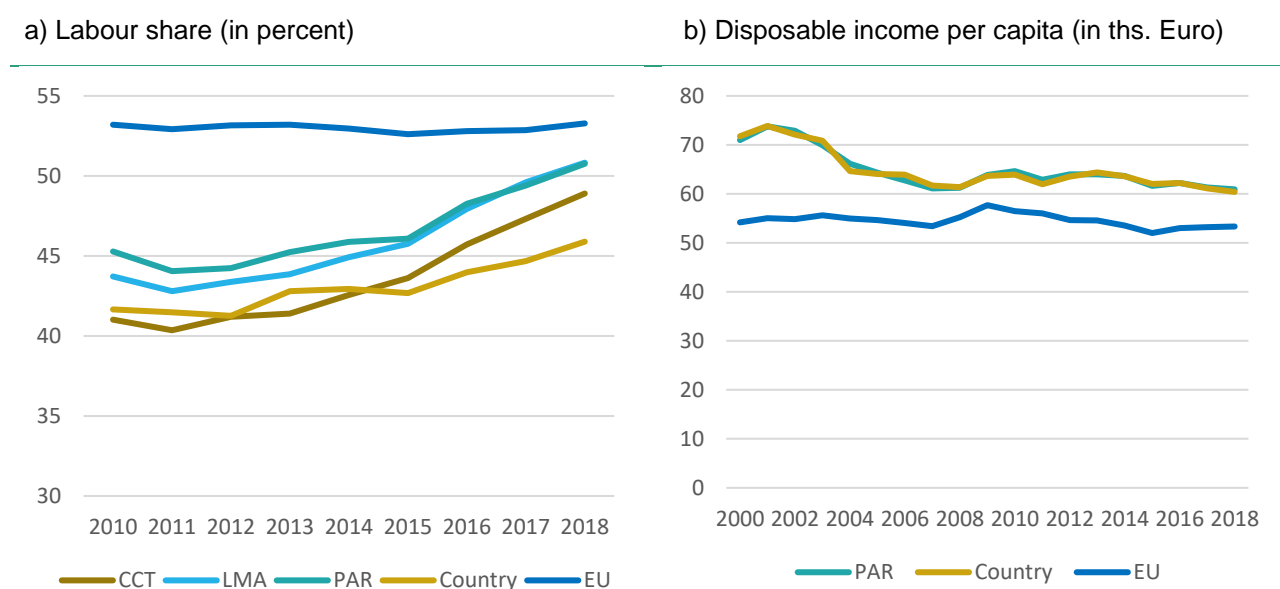
Note: Sectoral growth (dY/Y) is decomposed into labour productivity growth ($d(Y/L)/(Y/L)$) and labour growth (dL/L). The growth contribution by each sector (i) is the initial share of the sector (Y_i/Y) in the year 2000 multiplied by the sectoral growth rate between 2000 and 2018 (dY_i/Y_i). Abbreviations for the sectors are provided in **Error! Reference source not found.**

4.4 Income distribution

On the sub-national level, harmonised data for income distribution on a household or individual level is not available for all European case studies. However, it is possible to analyse the development of the functional income distribution in the region. The income approach states that GDP in a region is the compensation of employees (labour income), the gross operating surplus, mixed-income (e.g. compensation of owners), taxes on production and imports minus subsidies on production.⁸ Figure 10a depicts the labour share defined as labour income divided by the total gross value added as a key economic indicator for income distribution (between labour income and capital income).

Labour share in the CCT was below the European, LMA and PAR share and over the national percentage in 2018 (Figure 10a). Note that the labour share in the UE was stable in 2010–2018, whereas in CCT, LMA, PAR and Poland, it increased by 19.2, 16.3, 12.1 and 10.2%, respectively. However, the trends in disposable incomes per capita are opposite (Figure 10b). It decreased by around 6% from 2010 and 15% from 2020 at the PAR and country level, respectively.

Figure 10 – Income distribution



Sources: National and regional statistical office of Poland and Eurostat

Note: Labour productivity is shown from 2010 due to the availability of regional data. Labour share is the labour income divided by the total gross value added. Disposable income per capita is presented at the level of PAR, country and EU due to data availability.

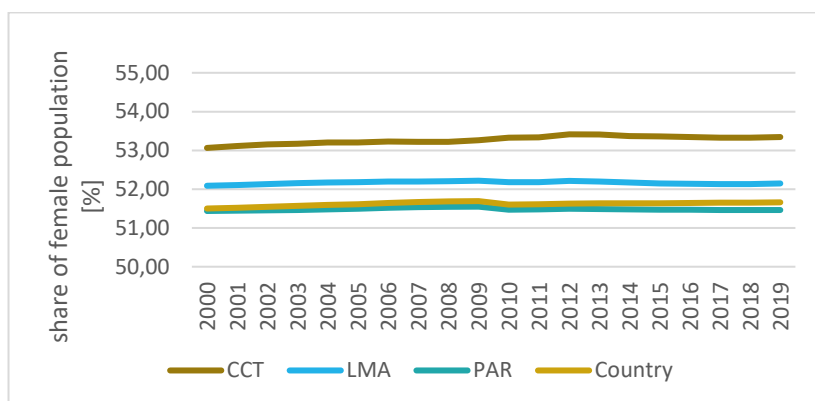
⁸ https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Income_approach

4.5 Gender dimension

The Krakow Metropolitan Area was chosen as an example of a carbon intensive region mainly due to its poor air condition and coal-fired power plant in the CCT region. However, data availability did not facilitate collecting information about the proportion between men and women employed in this power plant.

Figure 11 shows the share of the female population in the CCT region from 2000 to 2019. It can be observed that the level is similar in this period, regardless of the unit of the analysis (CCT, LMA, PAR, country), and it is around 53% in the CCT, 52% in the LMA, 51% in the PAR and at the country level.

Figure 11 – Share of the female population



4.6 Conclusion

The economic overview conducted within the study indicates that labour productivity in the CCT region is the highest among all units analysed. This results from the highest concentration of the labour market in the region that is the capital of the province. The population is growing, which is the result of the inflow of people to work and universities to the CCT region. This is also confirmed by an increase in the share of employed persons. The study shows that the working people in Poland are younger compared to the average of the EU28. The GDP in Poland is much higher compared to the EU28. However, it is worth noting that economic conditions in Poland in 2000 were worse than in other EU28 countries and provided a lower benchmark for assessing the growth in 2018.

The sectoral structure in the CCT has not changed much from 2000. The highest share is still observed in the retail and IT sectors as well as finance, real estate and other professional services. This means that the percentage of the mining and utility sector has not made the greatest contribution to the growth of the region. The growth decompositions show that the sectors of real estate and other professional services are key contributors to the CCT.

Although the labour share in all units has been increasing since 2010, the disposable income per capita has been decreasing in the PAR and the whole country. Due to the lack of available data, there is information about the trends in CCT and LMA regions.

CHAPTER 5

ANALYSIS OF THE ENERGY TRANSITION IN THE POLITICAL ADMINISTRATIVE REGION

5 Analysis of the Energy Transition in the Political Administrative Region

5.1 Overview on the energy transition policies

5.1.1 Political system and context

In Poland, the three-tier administrative division has been operating since 1999. The division includes:

- Communes (*gminy* in Polish) – 2,478 units
- Counties (*powiaty* in Polish) – 314 units
- Cities with a county status (*gmina na prawach powiatu* in Polish) – 66 units
- Provinces (*województwa* in Polish) – 16 units

In 2005, the NUTS classification was introduced in Poland. The classification includes:

- Macroregions – grouping provinces (NUTS 1)
- Regions – provinces or parts of a province (NUTS 2)
- Subregions – grouping counties (NUTS 3)

The Polish political regime is based on the subsidiarity principle. It means that all social and political issues should be dealt with at the most immediate (or local) level, consistent with their resolution. Communes and counties are organisational units of local self-government.

5.1.2 Decarbonisation process

The national energy policy assumes that half of the installed capacity in the power system will be based on zero-emission sources by 2040. In the Polish power system, the energy transition towards a net zero-carbon power system implies the phase-out of a significant number of coal- and lignite-fired units. Therefore, in addition to the decarbonisation of the electricity system as well as district heating systems and individual heating devices, the Polish government plans to provide adequate support primarily to the coal sector (coal mining and related industries) and citizens at risk of energy poverty. The support for the mining sector means new workplaces from the EU Just Transition Fund. Moreover, support for the residents affected by energy poverty means financial support for replacing obsolete coal-fired boilers and subsidies for utility bills.

Currently, the Ministry of Climate and Environment is the main authority responsible for decarbonising the economy. Supervision of the mining and power sectors is the responsibility of the Ministry of State Assets, from which the government's mandate officer for energy transition and coal mining has been nominated. The Government Prime Minister's Representative for Clean Air has also been appointed. He is responsible for reforming the government's programme for the thermal upgrading of residential buildings and replacing old solid fuel boilers with environmentally friendly heating sources that meet emission and energy efficiency standards.

There are key documents that transfer the responsibilities in the energy transition context to local levels (e.g., the Law on Renewable Energy Sources, the Law on Environmental Protection, Energy Policy of Poland until 2040). The documents impose new requirements on the administration of provinces and communes in the context of, among others, an increase in the share of renewable generation, and improving air quality and energy efficiency in the household and public utility sectors.

Although not yet so directly defined, the responsibility for the decarbonisation policy will lie with the provincial Marshal. The local law resolutions that directly or indirectly affect local communities in decarbonisation are the Anti-Smog Resolution and the Air Protection Programme. Currently, there are no bodies directly dealing with the decarbonisation process at regional or local levels.

5.1.3 Public participation

Participatory processes linked to the issue of energy transition can be divided into several different forms. The first is related to formal public consultations, which have been and are still carried out by local government units, with the City of Krakow and the Marshal's Offices at the forefront. Over the last 8–10 years, the loudest and most debated topic has been the anti-smog law prohibiting the burning of solid fuels in heating furnaces in Krakow, and later also in the entire province.

In the course of works on the anti-smog law, a number of panel meetings and discussions were held, as well as formal public consultations. This was a space for action for several key groups lobbying for or against the proposed law.

Representatives of the Krakow Smog Alert civic movement were strong supporters. The main opponents were industry associations, mainly associated with the production and trade of coal, coal-fired boilers and fireplace manufacturers. Apart from participation in public consultations and lobbying among politicians and councillors of different political groups, the above-mentioned groups conducted agitation activities using local and sectoral media, as well as social networking sites.

The last of the identified forms of civic participation in the issue of energy transition were grassroots civic movements, which marked their presence in the public debate mainly by organising marches and protests in public spaces. It is worth mentioning that this type of activity was in principle only the domain of those supporting the emerging Anti-Smog Resolution.

Consequently, two forms of public participation could be recognised in the region analysed: political participation aimed at influencing the setting of agendas and decision-making, and policy participation aimed at influencing policy implementation.

5.1.4 Clean energy transition (CET)

Despite the decarbonisation of the power sector, to date, actions related to reducing coal consumption, energy efficiency improvement, and RES in Poland have been undertaken. They are financed with funds from international (mainly EU), national and regional sources. The primary goal is to build a low-carbon economy and improve energy efficiency. Individual initiatives focus on several key areas, such as renewable energy sources, energy efficiency improvements in businesses, thermal upgrading of public and residential buildings, low emission reduction and low-emission transportation.

Municipalities that participate in the LIFE Programme (including Krakow and adjacent communes) could establish an eco-advisor in their offices. The eco-advisor helps the local community decide whether to change their coal-fired boiler for an environmentally friendly alternative, install solar collectors, photovoltaic panels, heat pumps, or others. One of the conditions of participation in the LIFE Programme was developing the “Low-Emission Economy Program”. This document must contain plans and measures in the context of, for example, renewable generation and energy efficiency improvements.

Clean energy transition is also the subject of the Krakow Strategy up to 2030. The document presents the objectives in the following aspects: (i) reduction of low-stack emissions by the elimination of all coal-fired boilers, (ii) continuation of the program supporting the poorest residents, (iii) intensification of the cooperation between Krakow and the province, particularly surrounding communes, (iv) reduction of inflow emissions, (v) reduction of transport emissions by increasing public transport and other forms of environmentally friendly mobility, e.g. bicycles and electric scooters, etc. One of the executive documents of the strategy and Anti-Smog Resolution is the Air Protection Programme for Krakow. The document has imposed new obligations on the city government in the context of actions aimed at improving air quality.

At the regional level (CCT, Krakow), the Krakow Metropolitan Area is the main stakeholder, which develops a strategic frame (Krakow Metropolis Association 2021). One of the priority objectives of official documents related to decarbonisation is "High quality of life in the associated communes". They promote the transition to a low carbon economy through the following activities, (i) energy retrofitting of public and residential buildings, smart energy management and use of RES, (ii) improvement of air quality, and (iii) supporting sustainable multimodal urban mobility through supporting sustainable metropolitan transport.

The greatest level of advancement of the CET is observed in the household sector as a consequence of the introduction of the Anti-Smog Resolution. The document has imposed the requirements for new sources in the context of pollutant emissions. However, these requirements are different for Krakow and different for other communes of the Lesser Poland Province. Since 1 October 2019, there has been a total ban on coal and wood in boilers and fireplaces in Krakow. Regulations in other municipalities are less strict and are mainly biding in the long term.

Although district heating in Krakow is also produced in coal-fired units, the replacement of coal boilers with district heating in households results in a decrease in carbon emissions. This is the result of the higher net efficiency of devices installed in power plants and carbon filters used in these units. The information presented by the power company owning the power unit shows that they are going to switch fuel from coal to natural gas as a temporary solution to low-carbon generation. Considering the description proposed by Rotmas et al. (2001), the clean energy transition in KMA presents the features of the acceleration stage, but its dynamics varies for different sectors. The household and industry sectors and their decarbonisation are more advanced, whereas the large-scale power and heat sectors are still around the take-off stage.

5.2 Socio-political component

5.2.1 Summary of results

Issues, statements and conflicts

The key document presenting the stages of coal phase-out is the Energy Policy of Poland until 2040. The document establishes the framework of energy transformation in the entire country based on three main pillars: just transition, a zero-emission energy system and good air quality. Although the national documents present objectives for hard coal consumption (the reduction of coal consumption in electricity production to 56% by 2030 and 38% by 2040), there is no timeline of phase-out for particular power plants, including power generation units located in the KMA region. At the local

level, the Krakow Strategy up to 2030 and the Anti-Smog Resolution provide the fundamentals for the energy transition.

The text analysis of Krakow media facilitated the identification of several issues related to decarbonisation. The most important conflict – somewhat muted after the entry into force of the ban on burning solid fuels in Krakow – is the issue of reducing smog from burning these fuels in households and public buildings in order to improve air quality in the region. Another conflict concerned the closures of the smelter. The entity emitted carbon dioxide and harmful gases and dust. However, the “Nowa Huta” smelter provided a lot of workplaces.

Defining constituencies

Constituency 1: Technological regularisation (IMPOSE)

- European Union and its agencies
- Regional government and public administration
- Academics and researchers
- Non-governmental organisations
- Sellers and operators of natural gas
- Suppliers of renewable installations

The technological regularisation constituency is formed by the coalition of the European Union and its agencies (European Commission, JASPERS, JRC), who are actively involved in the processes, and the national and local governments.

The Marshal's Office of the Lesser Poland province is leading in activities in the context of coal and carbon transition. The support of this office is focused on building a development strategy for the region and individual cities of the Lesser Poland Province based on national legislation (in particular, the Act on Renewable Energy Sources and the anti-smog law) and on the local level, developing assumptions for the Anti-Smog Resolution for the Krakow and Lesser Poland Province. The other important administration body is the Office of the City of Krakow. They carried out an inventory of coal sources from 2013 to 2015 that resulted in the introduction of regulations on replacing coal boilers and tiled stoves in Krakow. The office actively participated in the decision-making processes regarding the expansion of the district heating and gas network as part of the transition away from the use of coal by individuals and in public buildings.

Scientific research in the context of coal and carbon reduction mainly focuses on air quality, sources of air pollution, the possibilities of preventing smog formation and its impact on the health and lives of citizens. The key Krakow research teams conduct their studies in the following scientific units: AGH University of Science and Technology, Jagiellonian University, Krakow University of Technology, Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, and the University of Agriculture.

The non-governmental organisations in Krakow play an important role in the formation of the ecological and environmental consciousness of residents. They have been involved in activities related to improving air quality and phasing out solid fossil fuels. The key NGOs in the region are as follows: the Krakow Metropolis Association, the Krakow Smog Alert, the Polish Ecological Club Association, and the Krakow Climate Panel.

An active entity in coal withdrawal in Krakow is Polska Spółka Gazownicza SA (Polish Gas Company). The decommissioning of coal-fired boilers, fireplaces, and stoves in Krakow has allowed this company to increase its share in the city's retail natural gas customer market. A similar role in this process was played by the Municipal Thermal Energy Utility of Krakow SA, which participated in the replacement of coal-fired equipment and connecting buildings to the district heating system. With the support of prosumer RES installations, the Columbus Energy company in Krakow has developed dynamically, installing PV installations in combination with a heat pump and energy storage to provide a modern alternative to traditional forms of heating.

Constituency 2: Technological adjustment (COPY)

- Heat and power companies
- Carbon intensive industry companies

PGE Energia Ciepła SA is the main power generation company in Krakow. Their hard coal-based heat and power plant supplies the city with district heating (72.2% of total heat consumption in Krakow) and almost the total volume of electricity consumption. In March 2021, the Office of the City of Krakow signed a 2-year agreement to purchase so-called "green electricity". The agreement was signed with the other power generation concern (ENEA SA) that owns its renewable generation units in the north-western part of Poland. PGE also assumes in its strategy the switch of fuels from coal to natural gas in the coming years.

Constituency 3: Technological reconstitution (RESIST)

- Coal merchants
- The Lesser Poland Guild of Carpenters and Related Professions
- Farmers

Coal merchants, who sell hard coal of different sorts and other types of fuel, such as briquette, chunk wood, and wood pellets, are also stakeholders in decarbonisation in the region. There are nine large coal sellers associated with the Chamber of Polish Coal Sellers in the Lesser Poland Province, including one business entity in Krakow. The coals sold by these companies are mainly produced in the mines of the Polish Mining Group (PGG) or imported from eastern directions.

The Lesser Poland Guild of Carpenters and Related Professions is affiliated with the Lesser Poland Chamber of Crafts and Enterprise associated with the occupational group making wood stoves and fireplaces. The ban on the use of solid fuels in Krakow has meant that there are no jobs for them in the city. Consequently, they are indirectly affected by the decarbonisation of the city and they aimed to stop the introduction of anti-smog regulations.

Farmers operating in the administrative area of Krakow, who had greenhouses, tents for planting crops, and installations for drying fruit, vegetables, grain and other agricultural products, also have to deal with the ban on using solid fuels. The fuels most commonly used by these farmers were fine coal and wood (due to their price and lack of requirements for combustion installations) and were against the anti-smog law.

Constituencies, the local field of power and outcomes

Currently, supporters of the decarbonisation postulate the introduction of similar bans in the communes surrounding Krakow and the entire province. They are arguing, inter alia, that although

the improvement of air in Krakow is visible after the ban of solid fossil fuels in the city, further progress in this regard will not be possible. Krakow is located in a valley, thus the smog from adjacent communes accumulates and causes air pollution in spite of the ban in the city. Opponents of the ban on burning solid fuels are several groups of stakeholders whose businesses are based on coal – coal traders, sellers and contractors of stoves and fireplaces – as well as a part of the society for whom replacing the heating and cooking source is a financial problem and troublesome as it is connected with necessary renovations. There is a significant group of opinion leaders arguing that smog and emissions are caused by other sources rather than domestic stoves, such as transportation, building up natural corridors that cause stop airing, or even devices such as leaf blowers.

Another conflict is related to the decisions made by the owner of the steelworks in Krakow to shut down the blast furnace for economic reasons (high fuel prices and emission charges). This resulted in a series of strikes and objections from the steelwork workers who were to lose their jobs. However, the trade unions reached an agreement that allowed the payment of compensation for the dismissed workers of the steelworks, which calmed the conflict.

From time to time, topics related to global climate change appear. The prevailing belief is that these changes are a threat to us and steps should be taken to limit them, but there are narratives that this is not true and that: scientists' theses are stretched; there are stakeholders who made this topic a way of life and fame; the EU's climate policy brings losses to the member states only, and will not help the climate, some EU countries favour this view as it will allow them to gain a competitive advantage over other countries less dependent on fossil fuels.

The issues related to the reduction of smog in the city were the main subjects of note in the local media. After the dispute has been partially resolved, the problem of decarbonisation remains vivid with regard to the Krakow CHP plant, which uses hard coal as fuel. The media has reported plans to switch the fuel to natural gas in the unit. However, a problem with gas availability has arisen after Russia's invasion of Ukraine. The heat and power plant (based on hard coal) supplies hot water and heat to a very large part of the city. What is more, as part of the move away from burning solid fuels in households, there has been a significant increase in interest in connecting more apartment blocks to the district heating network.

5.2.2 Interpretation

The energy transition is a subject of heated debate. Ultimately, however, after several unsuccessful attempts, the supporters of the ban on solid fuel burning in the city won the conflict. The conflict over the proposed ban on the burning of solid fuels in rural areas was somewhat silenced by the publication by the government of the document "Poland's Energy Policy until 2040", which announced that the ban on solid fuels burning in all cities in Poland would apply from 2030, and in rural areas from 2040.

Although the national document is aimed at the elimination of coal consumption in households in cities by 2030, local policymakers introduced their internal law and banned using solid fossil fuels significantly earlier. The Lesser Poland Province, as the first province in Poland, introduced the Anti-Smog Resolution, imposing obligations on the individual communes. The resolution presents a detailed timeline for the elimination of solid fossil fuels in the region. In Krakow, coal has been prohibited in households and public buildings since 2019. Apart from the resolution, the municipality

introduced a range of related support programmes which allowed individuals to replace their obsolete heating sources with new alternatives or district heating.

The results of the text analysis in Krakow pointed out the increase in social awareness of environmental issues. It is worth noting that the media described numerous grassroots initiatives aimed at the improvement of air quality, the increase in the percentage of low emission transport, and – in general – the acceleration of the transformation towards an inclusive green economy.

5.2.3 Gender dimension

Women's social movements are not an actor involved in the energy transformation of the KMA region. None of the identified stockholders carries out activities related to the position of women and their rights. In the list of identified stakeholders who are involved in the process of energy transition in the KMA, there are organisations in which women hold significant positions.

Analysis of collected text documents indicates the dominance of the male-dominated narrative. In the course of coding the performing actors, a strong overrepresentation of the statements of men can be observed. For example, out of 188 coded actors, only 31 were identified as women.

5.3 Socio-ecological and technical component

This section provides an overview of the transformative capacity of the region to shape its decarbonisation pathway. The focus on the transformative capacity allows us to discern the extent to which a region is actually capable of deviating from its current (carbon intensive) trajectory towards sustainable outcomes. The transformative capacity is understood in this context as an evolving collective ability to conceive of, prepare for, initiate and perform path-deviant change towards sustainability within and across the multiple complex systems that constitute the regional or urban area undergoing a CET. As a systemic capacity, it is not attributable to any single actor but rather results from the interactions and orientations of multiple actors in the regional or urban economic development system involved in shaping its decarbonisation pathways. The diagnosis of transformative capacities thus enhances knowledge of key capacities hindering or facilitating purposeful transformation, ultimately permitting them to be addressed as part of capacity development activities. Wolfram (2016) identifies ten interdependent components to assess the transformative capacity of a region. These components are selected based on a literature review. Transformative capacity is strongly influenced by the governance of the regional decarbonisation or clean energy transition in question. Three governance and agency components are critical to the ability of a regional development apparatus to foster transformability of a system: the inclusiveness and multiformity of governance arrangements (C1); polycentric and socially embedded transformative leadership (C2); the empowerment and autonomy of relevant communities of practice (C3). These elements are preconditions for the transformability of a system: there needs to be connectivity and responsiveness built into governance, effective leadership able to bring people together around a vision and actors empowered to experiment and innovate. These three attributes must be developed by stakeholders in capacity development processes to enhance their transformative potential, including enhancing understanding of the systems of which they are a part (C4), engaging in participatory visioning and alternative design scenarios (C5), experimenting with novel solutions to social needs (C6) and ensuring that these innovations can be embedded (C7). Ideally, this can be seen as a learning loop, where system(s) understanding helps inform visions and

pathways, which in turn orient experimentation, with successful innovations being embedded and better system understanding resulting from this process. These processes should be fed back into governance through social learning (C8) as well as the effective involvement of actors at different scales (C9) and levels of agency (C10). These components were assessed through mixed quantitative and qualitative interviews with various stakeholders engaged in the CET.

5.3.1 Summary of results

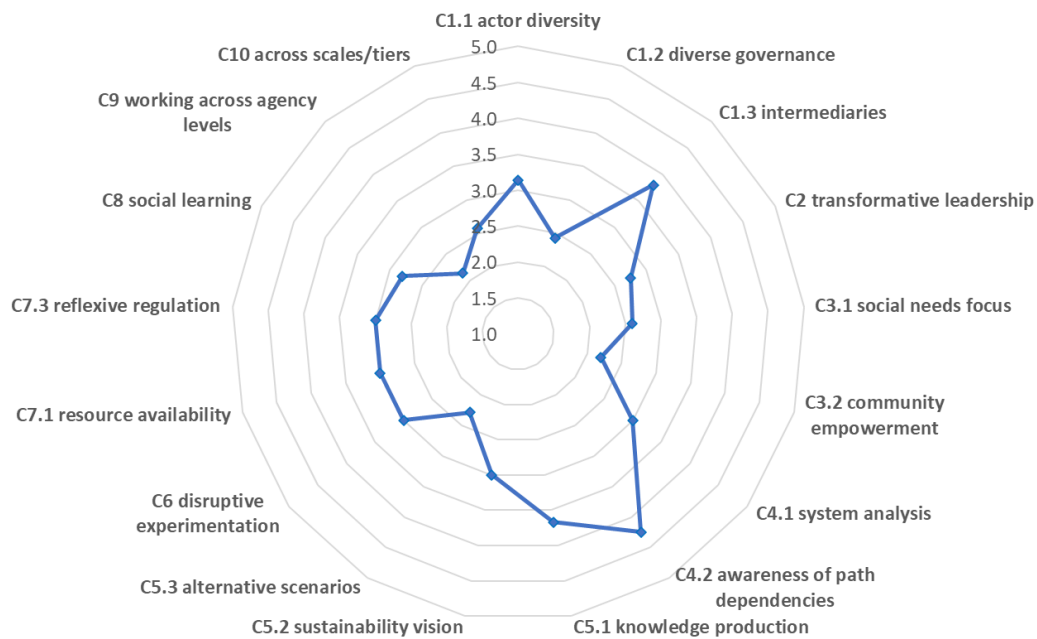
Overall assessment

Figure 12 presents the averaged quantitative results of the estimates of transformational capacity and potentially made by informants during the interviews. These results should be treated with caution due to the small sample size, and thus the large impact of the extreme values presented by individual interviewees on the presented averages. Seven respondents represent four stakeholder groups: two of them represent the public sector, one represents the private sector, two come from the civil society sector, and two from the third sector.

Analysing the chart, it is possible to draw cautious conclusions about the transformational potential of the Krakow Metropolitan Area. The general conclusion emerging from the results obtained on the ten assumed dimensions is that the vast majority of the averaged indications lie in the middle of the scale. The lowest rated dimensions are those that relate to the autonomy, empowerment, and legitimacy of broad stakeholder groups in decision-making and the implementation processes related to the energy transition. These include dimensions such as C9 (2.1 – average on a scale of 1-5), which refers to the active involvement of a wide range of social actors, including individuals and households, as well as groups, organisations, networks, and society to move the energy transition forward; C3.2 (2,2) concerning community empowerment and C1.2 (2,4) pertaining to diverse governance. An extensive justification for such low indications is provided in the qualitative part of the report.

Among the low-rated dimensions is also the one relating to the presence of alternative paths and possible options for the energy transition. According to the informants, the assumptions are, on the one hand, very general, and, on the other hand, assume a single perspective on the implementation of the process. This situation greatly limits the possibility of seeking alternative solutions and creates a situation of the dependence of many social actors on a single, top-down imposed course of action. This is reflected in the relatively highly rated interdependence of various elements of the social system (C 4.2) and their impact on slowing or complicating the transformation process.

Figure 12 – Stakeholder assessment of transformative capacity



Source: Based on ENTRANCES interviews conducted for the case study

5.3.2 Interpretation

Governance and agency

C1. Inclusive and multiform governance

This factor examines the participation of stakeholders and inclusiveness of governance, the diversity of governance modes and network forms, and the effectiveness of intermediation. In the KMA, the energy transition is designed by the national and local governments as well as the active participation of citizens. Respondents identified large organisations as intermediaries, which at the same time provide the main axes of policymaking and are also platforms (hubs) for other actors.

The poor or those exposed to energy poverty are considered to be the main group excluded from the deliberative process. Although they are very often the subject of policies, they were pointed out as absent from the discourse by interviewees. There was little involvement of the people affected by the transition in decision-making. The adopted way of managing the transformation process, especially in the context of including various stakeholder groups, is rated very low by most interviewees. What emerges from the statements is a picture of rather chaotic and uncoordinated activities, which at different levels of the organisation (from central to local) are not consistent with each other. There is a lack of a more holistic approach that takes into account the entire complexity of the consequences and challenges facing the energy transition.

In conclusion, it can be said that the current way of managing the transition processes is chaotic and is hardly based on the flow of information and knowledge between different actors and levels of government. Communication is mainly one-way, from top to bottom, and any consultation or agreement of positions is residual, sometimes even apparent.

C2. Transformative leadership

This factor asks about individuals in the public, private, and civil society sectors who lead through articulating shared visions, motivating engagement, and shaping collaborative processes. The average level of transformation-oriented leadership is one of the lowest-rated dimensions and has a high degree of estimation agreement among the informants taking part in the study.

Although the region has its own political leader, there is a lack of strong leadership in the decarbonisation process. The lack of a main decision-making centre is also observed at the national level. According to some respondents, the problem is not so much the diffuse type of leadership but its complete absence. Informants point out that at the national level, there is no single clear leader capable of coordinating the entire legislation and implementation process of the energy transition. Even if it is possible to identify central units attempting to set the tone for activities in the area in question, their influence is low due to very limited political legitimacy. Moreover, most coping strategies have been implemented as consequences of the European climate and energy policy or grassroots incentives.

C3. Empowered and autonomous communities of practice

This factor identifies to what extent resources and conditions of autonomy are provided for communities of practice to meet social needs as part of the clean energy transition. In terms of perceived social needs, respondents mainly highlighted problems related to energy poverty. Access to economically acceptable energy sources was identified as a basic social need for residents. However, respondents indicated that the level of protection for people threatened by high energy prices is insufficient. There have also been more strident assessments of energy policy as being disconnected from the needs of society.

When it comes to the autonomy of action and the empowerment of different stakeholder groups, there are two main positions represented by the informants. While all of them give a relatively low assessment of support, they give different reasons for this assessment. The first group indicates that further requirements and obligations are imposed on municipalities to implement energy transition processes, while at the same time, these municipalities are insufficiently equipped with measures, mainly financial resources. The second group of informants indicates that grassroots initiatives, including citizens and non-institutionalised groups, have the least autonomy in action and, above all, access to resources.

Capacity development processes

C4. System(s) awareness and memory

This factor investigates if and how systems analysis is used to understand change dynamics and path dependencies in relation to the clean energy transition. The respondents pointed out that the weakest understanding is in the socio-economic area and the technical aspect in terms of defining what we qualify as renewable energy sources and what we do not. Small and medium-sized enterprises and some administrative representatives were indicated as areas where attitudes (including the cognitive component) are far from being ready for a transformation. The awareness is higher in industry, in particular in large power companies, local governments and central administration.

The subfactor of recognition of path dependencies is one of the most highly rated dimensions by the informants participating in the survey. Thus, it can be concluded that the participants are highly

aware of the extent to which systemic interdependencies in institutions, regulations, infrastructure, societal values, etc, are potential obstacles to change. In addition to regulations, the work of the guidelines, according to informants, depends on (but is also limited by) factors of a social nature. The point is that there is a lack of understanding and knowledge among the people of the region, and more broadly the country as a whole, about the real benefits of transformation processes, as well as directly seeing the negative consequences of using fossil fuels.

C5. Sustainability foresight

This factor examines the role played by sustainability foresight, i.e. participatory visioning and alternative scenario designs in the region. The implementation of knowledge at the operational level, understood as opening up the discourse to multiple actors, poses some difficulties. Although different perspectives are taken into account during the preparation of strategies, they were not included to the same extent at the level of implementation policies. During the interviews, there were also clear suggestions that knowledge production is dependent upon research-commissioning bodies. In other words, some interviewees point to the lack of scientific independence of some knowledge providers.

In the opinion of the informants, the current transformation vision does not provide enough support to the different stakeholder groups due to its generality and ambiguity. Respondents also indicate that the prevailing vision was not developed with the participation of all stakeholders. More than the collective development of possible action scenarios, all arrangements were based on the implementation of top-down decisions, often using political tools. It can be assumed that the current transformation vision is not a particularly motivating factor for most informants. The lack of a sense of influence on the direction and possible ways to implement the transformation process means that most stakeholders do not identify with this vision, and it does not drive their actions.

However, it should be emphasised that in this part of the study, the interlocutors made assessments based on the memory of the implementation of anti-smog policies. The assessments made only in part concern the broader decarbonisation policy, which also appears in the other studies conducted in the KMA region.

C6. Disruptive experimentation

This factor examines the practical experimentation of communities and also other actors (business, research, government) with novel solutions. The interviewees did not identify many examples of testing solutions related to policies. Experimental policies or testing solutions were present only in the field of reducing low-stack emissions, not for climate policies. Krakow is one of the most innovative cities in Poland. The National Fund for Environmental Protection and Water Management program for multi-family buildings and other support mechanisms were introduced for the first time there. In Krakow, these included the intensive cleaning of dust from the streets, the periodical switching off of certain streets, the introduction of bus lanes for cars with four passengers on board, public bicycles, no car zones, etc.

There was also a dissenting opinion indicating that many of the solutions implemented were only pilots. If a politician sometimes doesn't know how to solve a problem, they suggest a pilot, indicated one from the respondents.

C7. Innovation embedding and coupling

This factor investigated the effectiveness and availability of innovation in the region and address the issue of whether the innovations considered above under experiments have supportive conditions

and can actually be embedded or just occur as an experiment and then nothing further happens. Access to resources is rated by informants at an average level. All informants noted that their rating was based on perceived deficiencies in very specific areas or sectors. There was also one comment indicating that the lower the level of management, the lower the access to resources.

Respondents also highlight inadequacies in terms of knowledge and access to experts, such as support for different sectors and industries undergoing transition. Although there are more and more financial resources, a lack of knowledge resources, well-educated people with experience, and good is observed.

Regarding the issue of legislation to support the transition process, the interviewees positively assessed the legislative changes concerning the reduction of low emissions and air pollution. In the area of boiler replacement, boiler emission standards have been introduced. In the area of renewable energy sources, laws on prosumers have been implemented.

The provision covering the broader context of the energy transition and the framework guidelines for decarbonisation is much worse. Some informants indicate that regulations are often counter-productive. It also happens that their manner of interpretation changes throughout their duration, making it difficult to plan and realise long-term goals.

Relational factors

C8. Reflexivity and social learning

Social learning is required to feed the outcomes of the learning processes detailed above back into the articulation of governance, leadership, and community empowerment, e.g. through monitoring system change and collective reflexivity. Interviewees were ambivalent about assessing the feasibility and quality of the ongoing monitoring of climate policy implementation. The interviewees pointed to a number of measurements that were carried out, but no coherent picture emerges of the state of the transition, particularly in terms of its effectiveness and relationship to strategic objectives.

The respondents took the position that current energy sources, levels of greenhouse gas emissions, mining and power plant workers, and technical conditions of power plants are currently well monitored, but there is a lack of monitoring on what will replace coal and gas and what will ensure energy security. Currently, there is no possibility to monitor the transformation on an ongoing basis. Only information and raw data on the effects of actions (clean air, capacity in renewable generation, etc.) are available. There is a lack of professional corporations in the area of transformation.

C9. Cooperation across human agency levels

This factor stands for how respondents elucidated their answers to describe whether capacity development (C1-8) addresses multiple levels of agency in public, private and civil society sectors, including individuals, households, social groups, organisations, networks (of individuals, groups, etc.) and society.

The general level of involvement of various social actors is assessed by the informants as the lowest of all the dimensions analysed during the interviews. The groups mentioned by the informants are excluded from decision-making processes or ignored in the planned activities and the strategies are very diverse, and in principle. Depending on the sector from which the individual informants come, different social actors excluded from the transformation process are indicated.

Some of the respondents mentioned inhabitants and employees of the energy sectors as excluded social actors in the transformation process, whereas the others highlighted farmers and small and medium enterprises. The interviewees agree on the exclusion of the energy poor, the indigent, and clients of social welfare centres.

C10. Cooperation across political-administrative levels

This factor examines the efficiency of cooperation across political-administrative levels. According to the respondents, a key area of cooperation between politicians and administrations is the relationship between ministries and local governments. The flow of knowledge and data should be the least disrupted at this level.

Unfortunately, this level of cooperation receives the lowest rating from interviewees. It is at the interface between regional governments and ministries that information flows are most disrupted. The strongest coordination is observed at the EU-Country level, whereas the weakest is at the Country-Region and Region-Municipal level. There needs to be a chain of dialogue in which each administrative level should be included.

5.3.3 Gender dimension

Women's social movements are not an actor involved in the energy transformation of the KMA region. None of the identified stakeholders carries out activities related to the position of women and their rights. In the list of identified stakeholders who are involved in the process of energy transition in KMA, there are organisations in which women take up significant positions (universities, research institutes). Key stakeholders (policymakers, energy agencies, companies, civil society) in which women take leadership positions were a minority in the studied area.

Gender issues are not related to the transition specifically addressed in coal phase-out strategies in the KMA region. Social justice and inclusion addressed in coal phase-out strategies in the KMA region are reduced to only the energy poverty problem. In particular, they were accepted in the context of shielding programs for households with the lowest incomes, which the new regulations forced to switch from coal boilers to natural gas alternatives.

5.4 Conclusion

The analysis of the energy transition in the Political Administrative Region allowed us to identify the key difference between Krakow (CCT region) and the rest of the province. Although the general energy policy is designed at the national level, local governments have their autonomy. The Anti-Smog Resolution introduced in the KMA region is a good example of autonomy because the document only obliges inhabitants of this province to stop using solid fossil fuels in low-class and non-class boilers in their households in the coming years. The issue had been a subject of heated debate over the last ten years, but ultimately the supporters won the conflict, and the law came into force.

In this part of the study, the interlocutors (leaders of the transformation) largely base their assessments on the experience resulting from the implementation of anti-smog policies. Their assessment of the energy transition is largely based on the politics of moving away from burning solid fuels. Nevertheless, it can be translated into broader energy policies and sustainable transition.

The analyses of the interviews conducted within the study indicate that the decarbonisation process is ongoing and faces numerous problems and challenges in the region. First, some groups are excluded from the process of shaping local strategies. We were informed by the interviewers that there is a lower involvement of the citizens affected by the transition in decision-making, in particular, the poor or those exposed to energy poverty. Second, there is no flow of information between all levels of governance in the country, province and communes. Third, a lack of strong and transformation-oriented leadership is observed in the region.

Experiments seem to be a chance for effective transformation. Worryingly, however, few stakeholders are able to point to the importance of this implementation model. However, the availability of knowledge is appreciated. Both in terms of the number of sources and the availability of data. Some, however, note the risk of a lack of research independence.

However, increasing social awareness and knowledge of the causes and potential consequences of ongoing transformation is observed among the inhabitants. The growing number of grassroots initiatives (including active Youth Strike for Climate) show that more and more people want to have an impact on their local environment and be a part of the transition. The strong position of decarbonisation constituencies is evidenced by the strong support for maintaining the provisions of the resolution of the Lesser Poland Regional Assembly, even in the face of the current energy crisis.

CHAPTER 6

CHALLENGES, COPING STRATEGIES & GENDER

6 Challenges, Coping Strategies & Gender

6.1 Challenge 1: Intensive development of the KMA

6.1.1 Challenge description

In recent years, Krakow and the Krakow Metropolitan Area have been experiencing a large increase in investments in the area of residential real estate. This tendency is opposite to demographic trends in the ageing Polish society (Krakow remains the city with the best demographic forecast). This process is accompanied by an increase in the number of inhabitants, simultaneous suburbanisation and the density of existing housing estates. The demographic growth of the KMA causes the following stressors:

- an increase in passenger vehicle traffic causing traffic jams, higher low emissions (in particular secondary emissions), an increase in noise, a lack of parking spaces
- estate development on green areas
- conflicts between old and new residents.

Current situation

Krakow, as one of several cities, has a positive demographic forecast. The growth is projected to be moderate and is expected to peak in 2025 (742,398 inhabitants (Krakow, 2021a)). However, these values do not include a few factors. First, the power of suburbanisation is underway, which is connected with the intensified development of municipalities adjacent to Krakow. Second, these data exclude migration processes. All calculations did not include, for example, a wave of immigration from Ukraine. This process was strengthened by the geopolitical situation (War in Ukraine). It is estimated that as of February 2022, 177,000 people migrated to this region, which is nearly 19% of the KMA population.

Desired outcome

Sustainable development of all districts of the city and an increase in indicators of the quality of life and satisfaction of residents is the desired outcome. Krakow, as a growing city, is not the leader in any of the rankings of quality of life. For example, in the ranking of one of the national media websites, it is rated low for, among others, the offer of the real estate market (Polityka, 2018). The pollsters also do not point to the highest assessments of the quality of life (Urbnews, 2015).

6.1.2 Coping strategies

Coping strategy 1: New transport policy

In June 2016, Krakow City Council adopted the "Transport Policy for 2016–2025" as the basic document defining the directions of transport development. This document was in line with the "Strategy for the development of transport in Poland until 2020 (with a perspective until 2030)". The reference point for transport policy was also the "Low-Emission Economy Plan for the Municipality of Krakow". The three main strategic objectives that define the current transport policy concern: (i) improving the safety of all road users, particularly including vulnerable transport users; (ii) reducing the harmful impact on the natural environment and living conditions of residents; (iii) improving transport accessibility within the city.

Coping strategy 2: Availability of landscaped green and recreational areas

From 2015 to 2020, Krakow acquired 105 hectares of plots for greenery. The city has developed a map that shows where in Krakow, at a distance of 300 meters from a given point, there are green areas, and where this amount is insufficient. There are currently 50 parks in Krakow. As part of the investments in Towns and Cities selected in The Civic Building, the so-called micro parks ("pocket parks") are gaining popularity.

Coping strategy 3: Promotion of KMA citizenship – new taxpayers in Krakow

Since 2011, Krakow has been running the "Pay taxes in Krakow" campaign. The program is swallowed from 2018 by the Krakow Card, giving discounts and preferences in public transport, cultural institutions and access to selected goods and services. The collected data shows that in 2021, about 658 thousand people paid PIT in the city, and 25 thousand did it for the first time (Krakow, 2021b). The city's strategy is an element of the financial policy responding to the growing deficit of public finances and allows the conducting of public policies, including decarbonisation programs.

6.1.3 Gender dimension

None of the above policies covers the equality policy. However, it should be noted that the stream of migration to the KMA associated with the War in Ukraine causes a strong feminisation of this national minority.

6.1.4 Discussion

The respondents asked within the study pointed to the strong growth of cities and the consequences that this brings. In particular, the shrinking of green areas and problems with the ventilation of the city were emphasised. The selection of interlocutors probably meant that the subject of transport was not discussed, and stressors from this area were not indicated.

6.2 Challenge 2: Shrinking of urban Greenspace

6.2.1 Challenge description

Current situation

For over a decade, construction in Krakow has been developing very quickly. Krakow is at the forefront of cities with the largest increase in the number of apartments being delivered. Between 2009 and 2019, the number of flats per 1,000 inhabitants increased by 21%, from 426 to 517. Only Wroclaw (26%) and Gdansk (23%) recorded better results.

The resources of modern office space in Krakow are still increasing. Currently, they amount to 1.64 million square meters, and this is the second largest result in the country after Warsaw. In June 2022, 157 thousand square metres of offices were under construction and the vacancy rate was 15.6% (LoveKrakow, 2022).

The dynamic growth of investments meant that the biologically active area decreased between 2006 and 2021 from 76.1% to 71.3% (KRKNews, 2021). In November 2020, the Scientific Council of the Institute of Nature Conservation of the Polish Academy of Sciences adopted a resolution in which it

appeals to the authorities of Krakow to gradually enlarge green areas and not deplete existing ones (IOP PAN, 2020).

6.2.2 Coping strategies

Coping strategy 1: City policy on the green areas exposing

In 2015, Krakow City Council appointed a new unit: the Municipal Greenspace Authority. The unit was created to take care of almost all green areas in Krakow, such as parks, forests (excluding the Wolski Forest), greens and squares, and river boulevards.

The Supreme Audit Office (NIK) report indicates that in the years 2015-2020, 550 "green" investments worth PLN 160 million were made in Krakow, which is the largest share (2.1%) in total expenditures of all of the 19 analysed cities.

Coping strategy 2: Increasing the share of land covered by local plans

Data for April 2022 shows that 7.29% of Krakow is covered by local spatial development plans. According to the report of the Supreme Audit Office (NIK), this is the highest result from the large Polish cities. Next in the ranking is Gdansk (65.4%) and Wroclaw (59.8%) (NIK, 2022).

Coping strategy 3: PR activities on residents' opinions on sustainable development of the city

The city tries to conduct an information policy in which it promotes the natural values of the city. For example, the Centre for Environmental Education and many points of nature education are being established. The city has twice submitted (2022 and 2024) an application to the competition for the title of European Green Capital.

The Department of Communication conducts information campaigns on planning topics and promotes green initiatives in the KMA, for example, in the local press, there are articles sponsored by the City Hall under the title "Concreting the city — facts and myths".

6.2.3 Gender dimension

This stressor and the resulting policies do not concern gender equality issues.

6.2.4 Discussion

In accordance with the current legal status, the city authorities have the ability to secure green areas and protect the ventilation of the city with appropriate provisions contained in planning documents. Unfortunately, the protection of green areas through new spatial plans violates the interest of the land owners in the city. This means that this process is highly politicised and vulnerable to strong pressure (lobbying) from investors. The primary solution may be to change the provisions of the main planning document, which is the "Study of conditions and directions of spatial development". Despite the fact that the city ordered an analysis of the aerosanitary condition and developed the concept of the city's ventilation system and air regeneration, none of them has been included in the current planning documents.

6.3 Challenge 3: Krakow as a pioneer of decarbonisation activities and related errors

6.3.1 Challenge description

Current situation

KMA is an area of dynamic transformation processes and strong agglomeration development in many transformation activities, Krakow is a pioneer and innovator on the scale of the whole country. The activities that were first initiated in Krakow include:

- Designation of the first lane for bus transport.
- 2008: the first tram tunnel in Poland as an element of the Krakow Fast Tram.
- 2009: the first public bikes in Poland (100 bicycles located in 12 base stations).
- From January 2023, the first clean transport zone is to operate in Krakow. In 2019, a pilot solution took place in the Kazimierz district.
- The first resolution in Poland prohibiting the combustion of solid fuels was adopted and implemented. The decision on the ban was preceded by the whole process: protests of residents, lobbying of environmental groups (the Krakow Smog Alert was established), inventory of furnaces, analysis of effects, analysis of the costs of changes in energy carriers, implementation of protection programs.

Desired outcome

According to many commentators, Krakow, as a pioneer of certain solutions in the field of transformational policies, bears the costs associated with the early adoption of solutions. Many actions are met with protests from residents because information about the consequences of the introduced changes is not available. For example, the pilot project for a clean transport zone was put on hold after three months of validity. Also, some solutions related to the so-called "Krakow Shield for Mobility" (a number of activities in the field of transport policies corresponding to changes in patterns during the COVID-19 Pandemic) were cancelled. It should also be noted that currently, Krakow is one of the few large Polish cities that does not have a public bicycle system.

6.3.2 Coping strategies

Coping strategies 1 – The involvement of inhabitants in testing new solutions

Implementing solutions through a small-scale experiment. There is greater social acceptance for testing activities. An example was the local admission of passenger vehicles with full passenger attendance on bus lanes. The experiment was conducted on one communication route.

Coping strategies 2 – The participation of citizens in processes of decision making

Increasing the engagement of citizens by introducing new standards for public consultation. Currently, a resolution of the Krakow City Council is in force, forcing the professionalisation of consultation processes. The permanent introduction of participatory budgeting (Citizens' Budget) as a tool to increase citizens' engagement is also important.

6.3.3 Gender dimension

None of the above coping strategies covers equality policies.

6.3.4 Discussion

During the interviews and as part of the FGI meetings of the ENTRANCES project, the respondents did not demonstrate the importance of scaling transformational activities. The majority of respondents did not recognise the importance of conducting experiments as a form of policy implementation.

However, the respondents highlighted the importance of the heterogeneity of groups and categories of residents in the deliberation process. According to most interlocutors, representatives of various interest groups take the floor in shaping policies. The importance of greater activation and the empowerment of various groups of residents at all stages of the transformation processes was also stressed.

6.4 Challenge 4: Conflict between Krakow and adjacent municipalities – low-emission policies

6.4.1 Challenge description

Current situation

The results of the research indicate that one of the main causes of the current air pollution is the unfavourable location of Krakow, which makes it susceptible to the accumulation of pollution from the neighbourhood. The main source of air pollution during the period under review was heating with solid fuels outside the city (Danek et al., 2022).

In the municipalities adjacent to Krakow, 23,000 non-class boilers fired with coal and wood are in use (data from the Krakow Metropolis Association for Polish Smog Alert). The dynamics of exchange (e.g. 2,412 in 2020) indicate that the process of the liquidation of non-class hearths will take several more years. The results call into question the effectiveness of the resolution of the Lesser Poland Regional Assembly, which orders the replacement of all class 3 and 4 boilers by the end of 2026.

Significant emitters are also internal combustion vehicles entering Krakow from neighbouring municipalities. Every day, a total of 246,000 vehicles enter Krakow. Approximately 40,000 pass through the city in transit traffic. Among these cars, about 16,000 move through the city centre.

Desired outcome

Coordinated actions are needed between Krakow and neighbouring municipalities to improve air quality throughout the Krakow Metropolitan Area. One of the strategic actions should be institutional support for accelerating the program of replacing coal-fired boilers in municipalities adjacent to Krakow.

Coping strategies 1 – Support for neighbouring communes

Institutional support program for furnace replacement in neighbouring municipalities. Krakow will support municipalities in improving the efficiency of using funds intended for the fight against smog, e.g. the Clean Air Programme. Pressure on neighbouring municipalities is exerted, for example, by the activities of the Krakow Metropolis Association.

Coping strategies 2 – Adaptation of local policies to the emerging energy crisis

The Krakow Smog Alert, in its press releases, warns that if the rate of the replacement of coal furnaces does not accelerate, it is possible to sue municipalities for pollution. The possibility of using the legal route is to be an attempt to exert pressure on the authorities of neighbouring municipalities (Smoglab, 2021). The Municipality of Krakow and environmental organisations (including the Krakow Smog Alert) are lobbying to maintain the provisions of the Anti-Smog Resolution for the entire Lesser Poland Province. The crisis in the energy carriers market caused a lot of activity of organisations opposing programs eliminating sources of low emissions in the Province.

Coping strategies 3 – Clean Transport Zone

The Clean Transport Zone is a means of limiting the number of cars entering the city. The 6th program of the ban on the entry of vehicles that do not comply with emission standards is prepared. The draft resolution assumes that from January 2024, diesel cars below the EURO 3 standard and diesel below the EURO will not be able to enter the very centre of Krakow. However, from January 2030 only vehicles with the standards EURO 5 and EURO 6b (diesel) will be permitted to enter the centre. The project is to be supported by the expansion of the agglomeration railway and the Park and Ride parking system. In 2024, the northern bypass of the city is to be completed and thus the ring of expressways around the city will be realised.

6.4.2 Gender dimension

None of the above coping strategies covers equality policies.

6.4.3 Discussion

The environmental conflict between Krakow and its surroundings has a long tradition. The emissions of Huta Skawina or Nowa Huta (treated by many Cracovians as a separateness of the city) caused conflicts as indicated by the participants of focus groups. Currently, the place of conflict between the municipalities and Krakow is based on the problem of low emissions. The respondents paid attention to the tensions caused by the emission of furnaces or the entry of vehicles from the agglomeration. The researchers did not connect this problem with the process of the suburbanisation of the city.

6.5 Conclusions

The KMA region is analysed mainly in terms of policies implemented by the city of Krakow. It is there that the most decarbonisation solutions have been implemented in recent years. The main challenges include the intensive development of the city with residential construction and office buildings. Unfortunately, this process causes shrinkage of green areas, a decrease in bioavailability and problems with ventilating the city. In order to continue the project of improving air quality, cooperation at the level of the Krakow Metropolis is needed. The ban on burning solid fuels (coal and wood) in Krakow, which has been in force since 1 September 2019, has not brought an improvement that eliminates the number of days of exceeding air quality standards. To achieve further results, it is necessary to cooperate with neighbouring municipalities where the replacement of boilers is too slow. There is also a need for solutions promoting low-emission transport, especially among residents coming to Krakow for professional, educational or tourist purposes. The situation requires leaders in the KMA to take further innovative actions on a national scale. Despite the mistakes associated with the pioneering of activities, Krakow is forced into experimental activities.

The above objectives are difficult due to challenges diagnosed in the project, such as:

- There is a lack of strong leadership for the transformation.
- There is a lack of representation of the interests of the poorest; although they are affected by politics, their votes are not taken into account in the preparation of documents.
- Requirements are imposed on municipalities and they are not provided with funds for their implementation.

CHAPTER 7

CONCLUSIONS

7 Summary

The case study report aimed to analyse and discuss the analysed socio-cultural, socio-psychological, socio-economic, socio-political, socio-technical, socio-ecological, and gender-related aspects of the clean energy transition in the Krakow Metropolitan Area, identified as a carbon intensive region. The methods of desk research, focus groups, survey, quantitative macroeconomic modelling, text research and semi-structured interviews were applied to provide solid foundations for the drawing of conclusions about the transformation process in the region.

The study of the socio-cultural and socio-psychological components results in the identification of the following key stress vectors and situations creating tensions in the region. First, the inhabitants indicate the strong urban-centred narrative focused on Krakow instead of the surrounding communes (city vs suburbs). Second, tensions between new and old residents are observed, which is the result of intensive residential and office development of the green areas of the city. Third, the problem of digital exclusion influences access to transition support since most applications and information are available mainly online these days. Finally, the costs of the energy transition are unevenly distributed between all actors. The results do not show significant differences between responses of men and women. Looking at the territorial stigma, there were the stigma of being a destination for cheap parties and the city with the highest smog. Currently, it can be concluded that the region is relatively unaffected by it due to the introduction of the anti-smog regulations, promoting the change of the image of Krakow, and the coronavirus pandemic.

Taking into account the social and psychological well-being of the inhabitants, it can be concluded that scores relating to the regional place attachment, resilience and optimism, decarbonisation impacts, coping strategies and life satisfaction are close to the middle of the scale. The results show differences between men and women in three of the analysed dimensions: for perceived stress and economic hardship, women obtained higher scores, and for resilience, they received lower scores in comparison to men.

The analysis of the socio-economic aspect provided insight into the current state of the region in comparison to the country and the EU28 average. Krakow has the highest labour productivity among the considered regional units due to the high concentration of the labour market and capital. Krakow is also a city with a growing population in which working people are younger in comparison to the EU28. People inflow to the city because there are numerous universities, workplaces, and an encouraging environment in which to live.

Looking at the GDP trends, higher dynamics are observed in Krakow, the KMA region, and Poland in comparison to the EU28. However, apart from the improvement in the economic situation, the country was in worse economic conditions in 2000 than the developed European countries, providing a lower benchmark for the assessment of GDP growth. The sectoral structure in Krakow has been similar since 2000, with the highest share of the retail, IT, finance, and real estate sectors. The contribution of the mining and utility sector was much lower than the aforementioned sectors. The wage gap is a general problem in Poland. However, the data availability did not allow us to compare the differences in the wages of men and women and examine the level of the gap in different sectors in the region. Krakow is mostly inhabited by women (around 53%). The percentage is expected to be higher in the years to come due to a large influx of women from Ukraine since the war started.

The examination of socio-political aspects shows the greater involvement of local policymakers in the transformation process compared to the national governments. The national government often introduces documents that implement documents of European coping strategies in the context of the energy transition, whereas the local resolutions respond to the grassroots initiatives. Moreover, the provincial government is dependent on the current ruling party and also stands in opposition to the city administration.

Socio-technical and socio-ecological components indicate that stakeholders assess the anti-smog regulations as inclusive, fair and balanced. However, they perceive the process of shaping policies as excluding since there was little involvement of the people affected by the transition in decision-making, in particular, the poor or those exposed to energy poverty. Although the transformation process and its impact on the air quality and environments are evaluated positively, the administration and flow of information are perceived as chaotic and inconsistent. The problem, which was often emphasised in the study, is the lack of strong leadership in shaping decarbonisation policies at the local and national levels.

The region faces four main challenges, including intensive and unsustainable development (1), which includes the shrinking of the green spaces (2), consequences of being a pioneer of decarbonisation in the country (3), and conflict between the city and adjacent municipalities (4). The local governments undertake the following coping strategies to address these issues. They develop local strategies, transport policies, and programs to encourage citizens to pay their taxes in the region. They also create conditions to increase the involvement of inhabitants in the sustainable development of the Krakow Metropolitan Area.

Finally, it can be concluded that the energy transition takes different forms depending on the region since the needs and interests of the city (CCT region) and province (PAR region) vary significantly. The most advanced level is observed in Krakow, where regulations banning the use of fossil fuels in households and public buildings have been introduced since 2019. The city is a leader – also at the national scale – in introducing innovative solutions aimed at reducing emissions. The other communes of the province were obliged to introduce the anti-smog law by 2023. However, the most recent energy crisis caused by the invasion of Ukraine by Russia reopened the discussion about this deadline. This being the case, the decarbonisation of households can be postponed to 2024.

The current geopolitical situation could also delay the clean energy transition of the power sector. Currently, the main fuel used to produce electricity and district heating is coal and strategies of the key power companies assume a switch from coal to natural gas. However, taking into account the gas supply issues recently, the course of the transformation is questionable.

With this in mind, it can be concluded that, although energy policies should have long-term goals, the implementing acts and coping strategies should have greater adaptability. The regulations and framework should address the current issues and propose solutions to the decarbonisation challenge with consideration to the emerging problems. In addition, the changes should be more transparent and available to society. The increasing awareness and involvement of individuals about transformations should not be stopped by inconsistent regulations and a weak flow of information. The analysed case study, therefore, emphasises the importance of the dilemma of whether the institutional system should show greater adaptability to changing conditions in the energy market, or

whether it should focus on the durability and predictability of the framework for all actors of the ongoing transformation.

8 References

- Baxter, M. & King, R. G. (1993). Fiscal policy in general equilibrium. *American Economic Review*, 83, 315–334. <https://www.jstor.org/stable/2117521>.
- Bertrand, A.L. (1963). The stress-strain element of social systems: a micro theory of conflict and change. *Social Forces*, 42(1), 1–9. <https://doi.org/10.2307/2574939>.
- CEZ. (2020). CEZ Skawina technical data. <https://www.cezpolska.pl/pl/cez-w-polsce/spolki-grupy-cez-w-polsce/cez-skawina-s-a/dane-techniczne>.
- Cronbach L. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*. 16, 297–334. <https://doi.org/10.1007/bf02310555>.
- Danek et al. (2022). Danek, T., Weglinska, E. & Zareba, M. The influence of meteorological factors and terrain on air pollution concentration and migration: a geostatistical case study from Krakow, Poland. *Scientific Reports*, 12, 11050. <https://doi.org/10.1038/s41598-022-15160-3>.
- European Commission (2021). The 2021 Ageing Report, Economic & Budgetary Projections for the EU Member States (2019-2070), Institutional Paper 148. <https://doi.org/10.2765/84455>.
- Eurostat (2008). NACE Rev. 2 Statistical classification of economic activities, Luxembourg: Office for Official Publications of the European Communities. <https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-ra-07-015>.
- Eurostat (2014). Essential SNA: Building the basics. <https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-gq-14-008>.
- Fleurbaey, M. (2009). Beyond GDP: The quest for a measure of social welfare. *Journal of Economic Literature*, 47(4), 1029–75. <https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-gq-14-008>.
- Herrendorf, B., Rogerson, R. & Valentinyi, A. (2014). Growth and structural transformation. *Handbook of Economic Growth*, 2, 855–941. <https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-gq-14-008>.
- Hirschman, A. O. (1970). Exit, voice, and loyalty: Responses to decline in firms, organisations, and states (Vol. 25). Harvard university press.
- IOP PAN. (2020). Resolution of the Scientific Council of IOP PAN on the urban greenery of Krakow (In Polish: Uchwała Rady Naukowej IOP PAN na temat zieleni miejskiej Krakowa). <https://naukadlaprzyrody.pl/2020/12/12/uchwala-rady-naukowej-iop-pan-na-temat-zieleni-miejskiej-krakowa/>.
- Isgren, E., Jerneck, A., & O'Byrne, D. (2017). Pluralism in search of sustainability: Ethics, knowledge and methodology in sustainability science. *Challenges in Sustainability*, 5(1), 2–6. <https://doi.org/10.12924/cis2017.05010002>.
- Jones, C. I. (2005). The shape of production functions and the direction of technical change. *The Quarterly Journal of Economics*, 120, 517–549. <https://doi.org/10.1093/qje/120.2.517>.
- Jones, C.I. and Klenow, P.J. (2016). Beyond GDP? Welfare across countries and time. *American Economic Review*, 106(9), 2426–2457. <https://doi.org/10.1257/aer.20110236>.
- Krakow. (2020). 2019 City Report (In Polish: Raport o stanie miasta 2019). https://www.bip.krakow.pl/?dok_id=146665&_ga=2.254817035.2012822757.1661967539-1801661065.1661967539.

- Krakow. (2021a). Krakow citizens (In Polish: Kraków i krakowianie). https://strategia.krakow.pl/dziedziny_zarzadzania/254668,2220,komunikat,krakow_i_krakowianie.html.
- Krakow. (2021b). Krakow is successfully acquiring new taxpayers (In Polish: Kraków skutecznie pozyskuje nowych podatników). https://www.krakow.pl/aktualnosci/253094,26,komunikat,krakow_skutecznie_pozyskuje_nowych_podatnikow.html?_ga=2.38068835.1926669809.1632807520-566546345.1632807520.
- Krakow Metropolitan Association. (2021) Krakow Metropolitan 2030 Strategy (In Polish: Strategia Metropolia Krakowska) <https://metropoliakrakowska.pl/sektory/plan-rozwoju-20-30/strategia-metropolia-krakowska-2030>.
- KRKNews. (2021). There are fewer green areas in Krakow, but there are still a lot of them. (In Polish: W Krakowie ubywa terenów zielonych, ale wciąż jest ich dużo). [https://krknews.pl/w-krakowie-ubywa-terenow-zielonych-ale-wciaz-jest-ich-duzo/#:~:text=To%20du%C5%BCo.,\(20%20pa%C5%BAdziernika%202021\)%20prof.](https://krknews.pl/w-krakowie-ubywa-terenow-zielonych-ale-wciaz-jest-ich-duzo/#:~:text=To%20du%C5%BCo.,(20%20pa%C5%BAdziernika%202021)%20prof.)
- LoveKrakow. (2022). Office buildings in Krakow cost the most. (In Polish: Biurowce w Krakowie kosztują najwięcej). https://biznes.lovekrakow.pl/aktualnosci/biurowce-w-krakowie-kosztujaj-najwiecej_46401.html#:~:text=Całkowite%20zasoby%20nowoczesnej%20powierzchni%20biurowej,Małopolski%20to%2015%2C6%25.
- Lucas Jr, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22(1), 3–42. [https://doi.org/10.1016/0304-3932\(88\)90168-7](https://doi.org/10.1016/0304-3932(88)90168-7).
- Lucas Jr, R. E. (2009). Ideas and growth. *Economica*, 76(301), 1–19. <https://doi.org/10.1111/j.1468-0335.2008.00748.x>.
- Luthar, S. S., Cicchetti, D., & Becker, B. (2000). The construct of resilience: A critical evaluation and guidelines for future work. *Child Development*, 71(3), 543–562. <https://doi.org/10.1111/1467-8624.00164>.
- Mankiw, N. G., Romer, D. & Weil, D. N. (1992). A contribution to the empirics of economic growth. *The Quarterly Journal of Economics*, 107(2), 407–437. <https://doi.org/10.2307/2118477>.
- Ministry of Climate and Environment (2021). Poland's energy policy until 2040. <https://www.gov.pl/web/climate/energy-policy-of-poland-until-2040-epp2040>.
- NIK. (2022). Green areas in cities without protection against buildings (In Polish: Tereny zielone w miastach bez ochrony przed zabudową). <https://www.nik.gov.pl/aktualnosci/tereny-zielone-w-miastach.html?fbclid=IwAR02YETivqANpVwn6EpykQTdAiJxRhv8IdIH7LrtEo1qmX84JSbGDaFkbGI>.
- Olsson, L., & Jerneck, A. (2018). Social fields and natural systems: integrating knowledge about society and nature. *Ecology and Society*, 23(3). <https://doi.org/10.5751/es-10333-230326>.
- PGE. (2020). PGE Energia Ciepła Oddział nr 1 w Krakowie technical data [in polish]. <https://pgeenergiasciepla.pl/spolki-i-oddzialy/elektrocieplownie/PGE-Energia-Ciepła-Oddzial-nr-1-w-Krakowie>.
- Polityka. (2018). Ranking of poviat cities. (In Polish: Ranking miast powiatowych) <https://www.polityka.pl/niezbednik/rankingmiast/1597031,1,ranking-miast-powiatowych.read?cityId=10>.
- Raymond, C. M., Brown, G., & Weber, D. (2010). The measurement of place attachment: Personal, community, and environmental connections. *Journal of Environmental Psychology*, 30(4), 422–434. <https://doi.org/10.1016/j.jenvp.2010.08.002>.

- Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5), S71–S102. <https://doi.org/10.1086/261725>.
- Rotmans, J., Kemp, R., and Van Asselt, M. (2001). More Evolution than Revolution: transition management in public policy. *Foresight* 3(1), 15–31. <https://doi.org/10.1108/14636680110803003>.
- Smoglab. (2021). 20,000 furnaces drowned Krakow in smog. A lawsuit is planned against the municipal authorities of neighbouring communes (In Polish: 20 tysięcy pieców utopiło Kraków w smogu. Planowany jest pozew przeciwko władzom gmin obwarzanka). <https://smoglab.pl/pozew-obwarzanek-krakowski-smog/>.
- Solow, R. M. (1956). A contribution to the theory of economic growth. *The Quarterly Journal of Economics*, 70(1), 65–94. <https://doi.org/10.2307/1884513>.
- Solow, R. M. (1957). Technical change and the aggregate production function. *The Review of Economics and Statistics*, 39(3), 312–320. <https://doi.org/10.2307/1926047>.
- Urbnews. (2015). Quality of life in Polish cities – ranking. (In Polish: Jakość życia w polskich miastach). <http://urbnews.pl/jakosc-zycia-w-polskich-miastach-ranking/>.
- Uzawa, H. (1965). Optimum technical change in an aggregative model of economic growth. *International Economic Review*, 6(1), 18–31. <https://doi.org/10.2307/2525621>.

APPENDIX

Appendix

Regional delineation

Table 8 – Case delineation

CCT	CCT (NUTS 3)		LMA		PAR	
Krakow Subregion	PL213	Krakow Subregion	PL213	Krakow Subregion	PL21	Lesser Poland Province
			PL214	Krakowski Subregion		

Source: own delineation

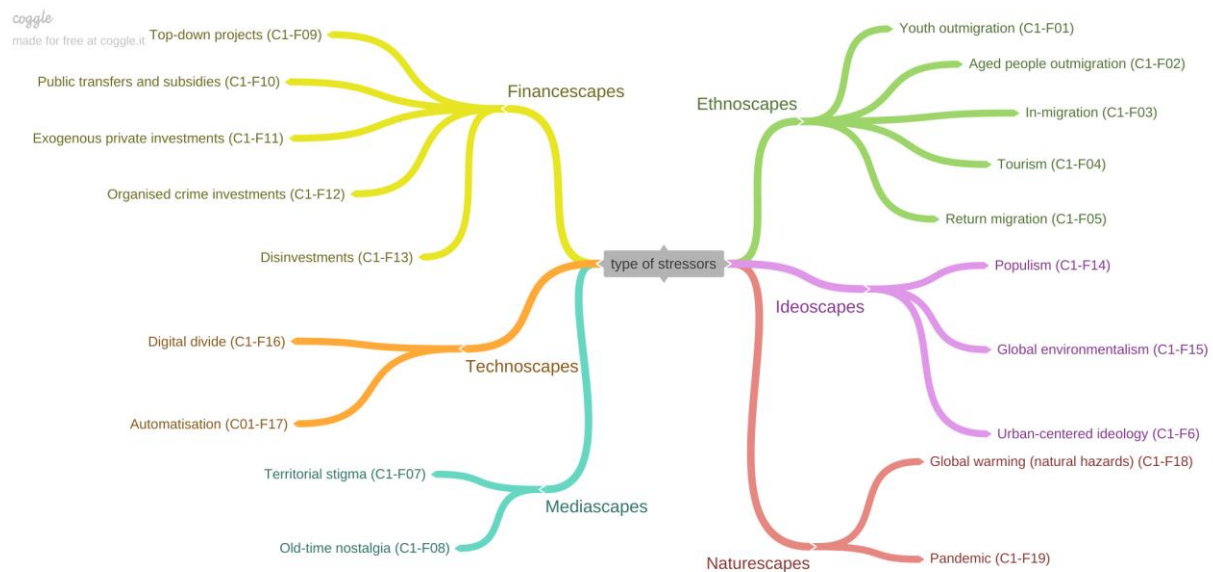
Table 9 – Municipalities in CCT

Community	National Identifier	Area in km ²	Population	Population Density	Average Age
Krakow	1001121216101	327	779,115	2,382.61	42.5

Source: The Polish Central Statistical Office and own calculations

Appendix socio-cultural component

Figure 13 – Overview of socio-cultural factors



Source: Deliverable 1.2 of ENTRANCES project.

Description of the strain situations

Strain situations related to finanscapes

01: Stench in the Płaszów region

- **Type:** Exo Conflict
- **Rationale:** This strain situation is about a conflict on the stench in Krakow – Płaszów District.
- **Description:** The strain situation started in 2017. Due to the sewage management and the large increase in housing development in the Płaszów area. People complain, but unfortunately there are not enough resources for the city to deal with it
- **Geo-position:** Krakow
- **Time-position:** 2017
- **Sources:** Focus Group
- **Gender of the FG source:** Male

02: Intensive development of green areas since

- **Type:** Exo Conflict
- **Rationale:** This strain situation is about the conflict surrounding the intensive development of green areas.
- **Description:** This strain situation started in 2000. Purchase of land and sale of plots for development by private investors. The lack of plans results in a lack of control over the buildings. The plants withdraw and then sell their land to developers.

- **Geo-position:** Krakow
- **Time-position:** 2000
- **Sources:** Focus Group
- **Gender of the FG source:** Male and Female

03: Clean Air Programme

- **Type:** Endo Conflict
- **Rationale:** This strain situation is about a conflict on solid fuel.
- **Description:** The strain situation started in 2015. Internal conflict between different groups of residents and stakeholders on the feasibility and sensibility of a ban on solid fuel.
- **Geo-position:** Krakow
- **Time-position:** 2015
- **Sources:** Focus Group
- **Gender of the FG source:** Female

04: Imposition of heat supply in the form of system heat

- **Type:** Dependence
- **Rationale:** This strain situation is about a conflict on the imposition of heat supply in the form of system heat.
- **Description:** The strain situation started in 1953. Residents were under the impression that system heat was imposed top-down, from the outside. People feared they were losing control over the energy supply issue.
- **Geo-position:** Krakow
- **Time-position:** 1953
- **Sources:** Focus Group
- **Gender of the FG source:** Male

05: Waste incineration plant

- **Type:** Exo Conflict
- **Rationale:** This strain situation is about a conflict on a waste-incineration-plant building.
- **Description:** The strain situation started in 2010. Residents protested about the chosen location for the waste incinerator. Despite the protests, the waste incinerator was built and is operating without causing any nuisance to residents. The only conflict that smoulders is related to the promise of free heat and power for the nearest residents. This promise has not been fulfilled.
- **Geo-position:** Krakow
- **Time-position:** 2009
- **Sources:** Focus Group
- **Gender of the FG source:** Male

06: Anti-Smog Resolution

- **Type:** Impasse
- **Rationale:** This strain situation is about a conflict on the provisions of the Anti-Smog Resolution

- **Description:** The strain situation started in 2016. Boiler replacement as part of the subsidy (100 and 80%), which accelerated the replacement of boilers in Krakow and the suspension of the replacement by residents of the so-called KMA, who decided to wait for similarly favourable conditions.
- **Geo-position:** KMA
- **Time-position:** 2016
- **Sources:** Focus Group
- **Gender of the FG source:** Female

07: Establishment of a paid parking zone

- **Type:** Impasse
- **Rationale:** This strain situation is about a conflict on the establishment of a paid parking zone.
- **Description:** The strain situation started in 2010. Conflict between the inhabitants of the zones and those outside the zone about the sense and mechanism of regulating parking fees.
- **Geo-position:** KMA
- **Time-position:** 2010
- **Sources:** Focus Group
- **Gender of the FG source:** Male

08: ArcelorMittal steelworks closure

- **Type:** Dependence
- **Rationale:** This strain situation is about a conflict on ArcelorMittal steelworks.
- **Description:** The strain situation started in 2019. Disinvestment and closure of successive sections of the steelworks has caused social unrest about jobs and professional futures. There is great uncertainty as to what will happen next with the Kombinat, and of what idea there is of developing the area after the shrinking of the plant.
- **Geo-position:** Krakow
- **Time-position:** 2019
- **Sources:** Focus Group
- **Gender of the FG source:** Male

09: Moving industrial enterprises outside Krakow

- **Type:** Dependence
- **Rationale:** This strain situation is about a conflict on moving industrial enterprises outside Krakow.
- **Description:** The strain situation started more or less in 2010. Industrial enterprises are moving outside Krakow. As a result, these areas are being taken over by developers. The authorities of the city have no idea what can be done about this.
- **Geo-position:** Krakow
- **Time-position:** 2010
- **Sources:** Focus Group
- **Gender of the FG source:** Male and Female

Strain situations related to technoscapes

10: Housing associations - heat-allocation meters

- **Type:** Dependence
- **Rationale:** This strain situation is about a conflict on heat-allocation meters.

- **Description:** The strain situation started in 2010. Heat allocators have been installed in cooperatives and this has caused disputes among residents. The cooperative has to install heat allocators in individual flats if it is profitable. The heat allocator is a source of conflict – heat allocators do not reflect their real consumption.
- **Geo-position:** Krakow
- **Time-position:** 2010
- **Sources:** Focus Group
- **Gender of the FG source:** Female

11: Air-quality-monitoring technologies

- **Type:** Dependence
- **Rationale:** This strain situation is about a conflict on technologies related to the monitoring of air quality.
- **Description:** The strain situation started in 2016. Imbalance in access to current information on air status despite access to sensors – including a lack of competence and knowledge and sometimes significant delay in disclosing information.
- **Geo-position:** Krakow
- **Time-position:** 2016
- **Sources:** Focus Group
- **Gender of the FG source:** Male

12: Digitalisation of the application process for subsidies and boiler replacement

- **Type:** Dependence
- **Rationale:** This strain situation is about a conflict on digitalisation of the application process for subsidies and boiler replacement.
- **Description:** The strain situation started in 2016. The problem of insecurity and risk of exclusion is associated with the fact that not all groups are able to fill in applications using computers and the internet. Consequently, these groups are limited in their ability to benefit from discounts, subsidies and support.
- **Geo-position:** Krakow
- **Time-position:** 2016
- **Sources:** Focus Group
- **Gender of the FG source:** Female

13: Collection of surplus energy into the grid

- **Type:** Dependence
- **Rationale:** This strain situation is about a conflict on the collection of surplus energy into the grid.
- **Description:** The strain situation started in 2016. The problem concerns the impeding of the development of RES due to the lack of technical capacities of Tauron to collect excess energy, and also the problem of changing the rules of accounting for producer solutions in the energy area.
- **Geo-position:** Krakow
- **Time-position:** 2016
- **Sources:** Focus Group; AS01
- **Gender of the FG source:** Male

14: Gas boilers problem

- **Type:** Endo Conflict
- **Rationale:** This strain situation is about a conflict concerning gas boilers

- **Description:** The strain situation started in 2000. Residents' concerns about gas boilers - the need to have them serviced (the responsibility lay with the consumer) and fears of carbon dioxide and NOx poisoning. As a result, a programme was set up in 2004 to connect more properties to the district heating network. Decisions about connecting to the grid caused tensions among the residents themselves. Those with renovated flats did not want to upgrade. In addition, the financial side is also important, as connection to the Municipal Heat Engineering Company and district heating is more expensive than gas, which discourages change - even today.
- **Geo-position:** Krakow
- **Time-position:** 2000
- **Sources:** Focus Group
- **Gender of the FG source:** Female

Strain situations related to ethnoscapes

≈15: Increased number of tourists as well as economic and educational immigrants

- **Type:** Impasse
- **Rationale:** This strain situation is about the increased number of economic and educational tourists and immigrants.
- **Description:** There is a lot of noise. Cities are jammed.
- Consequently, there are problems with parking cars. Over the last 5-10 years, the availability of cars has increased significantly among both students and others. This has significantly increased the number of cars entering and leaving the city every day. At the same time, there is an insufficient development of transport infrastructure in the situation of the urban sprawl of people fleeing from the city centres to the suburbs while keeping employment in the centre.
- **Geo-position:** Krakow
- **Time-position:** 2004
- **Sources:** Focus Group
- **Gender of the FG source:** Female

≈16: Erosion of social relations in neighbourhood communities

- **Type:** Endo Conflict
- **Rationale:** This strain situation is about the erosion of social relations in neighbourhood communities
- **Description:** In the past, people moved into flats to form natural neighbourhood communities. Today, increased migration and renting is eroding social relationships, creating a sense of unease and instability - especially among older people. This is linked to the growth of short-term rental services and cheap international flights.
- **Geo-position:** Krakow
- **Time-position:** 2004
- **Sources:** Focus Group
- **Gender of the FG source:** Male

≈17: Unpreparedness to accommodate increasing numbers of residents

- **Type:** Dependence
- **Rationale:** This strain situation is about unpreparedness to accommodate increasing numbers of residents.

- **Description:** Infrastructure has not kept pace with population growth while the cost of living has risen.
- **Geo-position:** Krakow
- **Time-position:** 2004
- **Sources:** Focus Group
- **Gender of the FG source:** Male

≈18: Reversed trend of people moving to Krakow (due to clean air) after years of moving out of Krakow due to smog

- **Type:** Dependence
- **Rationale:** This strain situation is about a reversed trend of people fleeing to Krakow after years of fleeing from smog in Krakow
- **Description:** After changes associated with clean air efforts, a reverse migration trend has emerged. Previously, people were fleeing the city to escape the smog, now Krakow appears as a green island amidst the smog enveloping the region.
- **Geo-position:** Krakow
- **Time-position:** 2017
- **Sources:** Focus Group
- **Gender of the FG source:** Female

≈19: Introduce of clean transport zones and paid parking zones

- **Type:** Exo Conflict
- **Rationale:** This strain situation is about the introduction of clean transport zones and paid parking zones
- **Description:** The aim is to restrict traffic and inhibit entry into the centre by non-residents, although tensions arise mainly among residents themselves, who do not always have new cars or feel it is restricting.
- **Geo-position:** Krakow
- **Time-position:** 2022
- **Sources:** Focus Group
- **Gender of the FG source:** Female

Strain situations related to ideoscapes

≈20: Tensions between young and old

- **Type:** Endo Conflict
- **Rationale:** This strain situation is about tensions between young and old.
- **Description:** Young people want to change the world and the older generation wants to live in a stable environment and prosperity. Youth climate protests are emerging. In practice, it turns out that young people consume far more resources.
- **Geo-position:** KMA
- **Time-position:** 2016
- **Sources:** Focus Group

- **Gender of the FG source:** Male

≈21: Populism of science centres

- **Type:** Dependence
- **Rationale:** This strain situation is about the populism of science centres in the Nowa Huta district of Krakow.
- **Description:** A researcher working for a coal marketing corporation spread the word that a ban on the burning of solid fuel does not improve air quality. He used unreliable data. This then had to be rectified by other groups.
- **Geo-position:** Krakow
- **Time-position:** 2018
- **Sources:** Focus Group
- **Gender of the FG source:** Male

≈22: Uneven and inconsistent distribution of costs associated with clean air measures

- **Type:** Endo Conflict
- **Rationale:** This strain situation is about the uneven and inconsistent distribution of costs associated with clean air measures.
- **Description:** KAS strikes and protests have been supported by residents since 2016. This was the inflammatory factor that helped push through all the key resolutions to fight for clean air. Against this background, there were huge tensions between KAS and fireplace manufacturers and coal sellers.
- Some elderly people also resented the fact that on the one hand, there is a fight for clean air by imposing restrictions on people, while on the other hand, one can see the lack of restrictions on a chaotic development on a daily basis, the abuse of power in the use of cars, the renting of car parks for officials, etc. This gives rise to a sense of injustice and unequal distribution of costs.
- **Geo-position:** Krakow
- **Time-position:** 2016
- **Sources:** Focus Group
- **Gender of the FG source:** Female and Male

≈23: Anti-Smog Resolution with timetable for removal of individual types of heat sources

- **Type:** Exo Conflict
- **Rationale:** This strain situation is about the introduction of an Anti-Smog Resolution with a timetable for the removal of individual types of heat sources.
- **Description:** From 2023, according to the schedule, all heating devices without at least three classes are to be eliminated. Municipalities are obliged to enforce and punish residents who do not comply with the provisions. Local government officials are pressing for the withdrawal of these provisions due to the rather large failure to modernise individual heat sources and the change in the geopolitical situation (the war in Ukraine). As a result, Krakow would be heavily disadvantaged, as due to the lay of the land, pollution from outside (neighbouring communes) flows into Krakow.
- **Geo-position:** Krakow
- **Time-position:** 2017

- **Sources:** Focus Group
- **Gender of the FG source:** Male

≈24: Breaking supply chains during the pandemic

- **Type:** Dependence
- **Rationale:** This strain situation is about disrupted supply chains from Asia.
- **Description:** The pandemic has disrupted supply chains from Asia, where most of the components for individual RES installations come from, significantly slowing down the replacement of boilers.
- **Geo-position:** KMA
- **Time-position:** 2020
- **Sources:** Focus Group
- **Gender of the FG source:** Female

≈25: Inconsistency of climate action in the context of urban development

- **Type:** Exo conflict
- **Rationale:** This strain situation is about concreting green spaces and intensive residential development
- **Description:** Intensive construction is occurring, causing increasing problems in coping with climate change, a lack of rainwater drainage and the concreting of green spaces. The onset and course of the pandemic has been critical in this respect, due to the increased need to escape into greenery.
- **Geo-position:** Krakow
- **Time-position:** 2007
- **Sources:** Focus Group
- **Gender of the FG source:** Male

≈26: Decisions at the EU level on changing energy sources vs. the geopolitical situation

- **Type:** Dependence
- **Rationale:** This strain situation is about the indirect effects of global warming and geopolitics on solutions regarding the fight for clean air.
- **Description:** Misguided policies at the EU level that have resulted in a narrowed approach to energy replacement, almost exclusively to gas, which is contrary to the recommendations and voices of various stakeholders. Consequently, the looming energy crisis will have serious consequences for slowing down the transition, replacing boilers, etc. In addition, legislation at the national level does not make things any easier – there is huge uncertainty. Consumers themselves are completely at a loss as to which energy source to choose at this point. They are also afraid of prosumers, who translate political uncertainty into their decisions on RES use.
- **Geo-position:** KMA
- **Time-position:** 2015
- **Sources:** Focus Group
- **Gender of the FG source:** Male and Female

Appendix socio-psychological component

Table 10 – ENTRANCES survey questionnaire

Factor	No.	Item
Place Attachment	1	..Name of Study area... means a lot to me.
	2	I am very attached to ..Name of Study area....
	3	I identify strongly with ..Name of Study area....
	4	I feel ..Name of Study area... is a part of me.
	5	No other place can compare to ..Name of Study area....
	6	I would not substitute any other area for the activities I do in ..Name of Study area....
	7	Doing my activities in ..Name of Study area... is more important to me than doing them in any other place.
	8	..Name of Study area... is the best place for the activities I like to do.
	9	Moving from place to place is exciting and fun.
	10	I could not be happy living in ..Name of Study area... for the rest of my life.
	11	There is not much of a future for me in ..Name of Study area....
	12	Living close to(certain natural features such as the ocean or mountains).....is very important to me.
	13	I am extremely satisfied with my present home in ..Name of Study area....
	14	My family is very close-knit and I would be unhappy if I could not see them on a regular basis.
	15	I love to reminisce about the places I played when I was a child.
	16	I have several close, life-long friends that I never want to lose.
	17	Belonging to volunteer groups in ..Name of Study area... is very important to me.
	18	The friendships developed by doing various community activities strongly connect me to ..Name of Study area....
Moderators	19	I can deal with whatever comes.
	20	I try to see humorous side of problems.
	21	I tend to bounce back after illness or hardship.
	22	I can achieve goals despite obstacles.
	23	I am not easily discouraged by failure.
	24	I think of myself as strong person.
	25	I can handle unpleasant feelings.
	26	I believe that I will achieve the main goals of my life.
	27	When I think about the future I am positive.
	28	I see every challenge as an opportunity for success.
	29	No matter how bad things turn out, I find positive aspects.
	30	I see the positive aspects of things.
	31	I am confident in overcoming problems.
	32	I am confident in the future.
Decarbonisation impacts	33	In the last month, how often have you been upset because of something that happened unexpectedly?

Factor	No.	Item
	34	In the last month, how often have you felt that you were unable to control the important things in your life?
	35	In the last month, how often have you felt nervous and “stressed”?
	36	In the last month, how often have you felt confident about your ability to handle your personal problems?
	37	In the last month, how often have you felt that things were going your way?
	38	In the last month, how often have you found that you could not cope with all the things that you had to do?
	39	In the last month, how often have you been able to control irritations in your life?
	40	In the last month, how often have you felt that you were on top of things?
	41	In the last month, how often have you been angered because of things that were outside of your control?
	42	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?
	43	The environmental benefits of decarbonisation are greater than the damage it produces to the people living in our region.
	44	Our region faces greater losses than gains as a result of decarbonisation
	45	Judging its benefits and costs, decarbonisation is a fair process for the people living in this region.
	46	The people in our region pay the price of decarbonisation while others enjoy its benefits.
	47	How uncertain do you feel?
	48	How much do you feel at risk?
	49	How much do you feel threatened?
	50	How much do you worry about it?
	51	How much do you think about it?
	52	People in my region will be better off financially a year from now on.
	53	In my region there will be less unemployment than now during the coming 12 months.
	54	I feel optimistic about the economic future of my region over the next 5 years.
	55	The degree of poverty will decrease in my region over the next 5 years.
	56	How nostalgic do you feel?
	57	To what extent do you feel sentimental for the past?
	58	How much do you feel a wistful affection for the past?
	59	To what extent do you feel a longing to return to a former time in your life?
Coping Strategies	60	I would accept a job offer which requires a change of residence in another region.
	61	It is likely that I will move from my region during the next 2 years.
	62	I actively search for information about new places to live and work in.
	63	I am always searching for new places to live and work in.
	64	I am now learning new skills in order to adapt the current decarbonisation process in the region I live and work.
	65	I have been learning new skills in order to change my profession.
	66	I am taking school/course classes in order to learn a new profession.
	67	I fully support the decarbonisation process in the region I live and work.
	68	I agree with the decarbonisation process in the region I live and work.

Factor	No.	Item
	69	I don't believe that my region should have undergone a decarbonisation process.
	70	I support those protesting against the decarbonisation process for the region I work and live in.
	71	I don't like the decarbonisation plan for the region where I live and work.
	72	I am actively involved in a union/organisation that fights against decarbonisation process in the region I live and work.
	73	I would participate in a meeting/protest against the decarbonisation process in the region I live and work.
	74	I feel that the organisations behind the decarbonisation process in my region are very strong.
	75	I believe that I cannot do anything to stop this process of decarbonisation in the region I live and work.
Life Satisfaction	86	In most ways my life is close to ideal.
	87	The conditions of my life are excellent.
	88	I am satisfied with my life.
	89	So far I have gotten the important things I want in life.
	90	If I could live my life over again, I would change almost nothing.

Appendix socio-economic component

Table 11 – NACE Rev. 2 Classification

NACE Rev. 2	Description
A	Agriculture, forestry and fishing
B	Mining and quarrying
C	Manufacturing
D	Electricity, gas, steam and air-conditioning supply
E	Water supply, sewerage, waste management and remediation
F	Construction
G	Wholesale and retail trade
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M	Professional, scientific and technical activities
N	Administrative and support service activities
O	Public administration and defence; compulsory social security
P	Education
Q	Human health and social work activities
R	Arts, entertainment and recreation
S	Other service activities
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
U	Activities of extraterritorial organisations and bodies

Appendix socio-ecological and technical component

Table 12 – List of quantitative indicators and corresponding questions for Transformative Capacity Assessment

T.C. Factor	Description	Corresponding Question	Question Text <i>To what extent do you agree or disagree that:</i>
C1.1	actor diversity	Q2	“Beyond public authorities, diverse stakeholders – citizens, civil society, businesses, NGOs and academia – are actively participating in steering the clean energy transition.”
C1.2	diverse governance	Q5	“Governance/steering approaches used for the clean energy transition are varied and hybrid – including formal AND informal processes, centralised AND decentralised, top-down AND bottom-up arrangements, as well as governing through hierarchy, market, and networks.”
C1.3	intermediaries	Q6	“Intermediaries are playing an influential role in governing the clean energy transition at present.”
C2	transformative leadership	Q7	“Leadership for the energy transition (i) comes from all sectors (public, private, civil society), (ii) offers motivating visions and (iii) drives collaboration between stakeholders.”
C3.1	social needs focus	Q8	“The clean energy transition addresses social needs.”
C3.2	community empowerment	Q9	“Support is given to citizens, innovators and communities of change (e.g., energy cooperatives, local sustainability networks, start-ups) to act autonomously to advance the energy transition.”
C4.1	system(s) analysis	Q10	“There is a widely shared awareness among stakeholders of the importance of (systemic) interdependencies between the cultural, institutional, socio-economic, ecological, and technical aspects of the transition.”
C4.2	path dependency	Q11	“Stakeholders recognise (systemic) interdependencies between the cultural, institutional, socio-economic, ecological, and technical aspects of the transition as critical obstacles to change.”
C5.1	knowledge production	Q12	“There is a broad diversity of knowledge produced from different stakeholders that informs the transition (e.g., technical science, social science, civil society, government, industry).”
C5.2	sustainability vision	Q13	“The transition vision for [region] is explicit, radical, collectively produced, motivates action and provides clear orientation for stakeholder actions.”
C5.2.1	–explicit	Q13.a	...explicit?
C5.2.2	–radical	Q13.b	...radical / far-reaching?
C5.2.3	–collective	Q13.c	...collectively produced?
C5.2.4	–motivating	Q13.d	...motivates action?
C5.2.5	–orienting	Q13.e	...provides clear orientation?

C5.3	alternative scenarios	Q14	“Present implementation of / planning for the transition makes use of future scenarios, including alternative development options based on stakeholder choices, and addressing uncertainties and (systemic) interdependencies (between the cultural, institutional, socio-economic, ecological, and technical aspects).”
C6	disruptive experimentation	Q15	“There is a diversity of experiments undertaken to develop fundamental alternatives to current ways of thinking, organizing and doing.”
C7.1	resource availability	Q16	“Stakeholders are given access to resources that enhance their organisation and cooperation, their inclusion and participation, or enable vision- and scenario-development and experimentation.”
C7.2	organisational adjustment	– n/a –	– n/a –
C7.3	reflexive regulation	Q17	“Regulatory changes have been implemented to support the transition and overcome obstacles.”
C8	social learning	Q18	“There is monitoring of and active learning of all stakeholders about the transition process that feeds back into its implementation.”
C9	across agency levels	Q3	“Measures to move the clean energy transition forward actively involve all different types of social actors; including individuals and households, as well as groups, organisations, networks, and associations.”
C10	coordination across scales/tiers	Q4	“Measures in support of the clean energy transition, as it is presently unfolding, involve strong dialogue and coordination across spatial scales; from local to regional, national, inter- or transnational, and EU.”



ENTRANCES

Energy TRANSitions from Coal and carbon: Effects on Societies

