CLIMATE CHANGE
33/2021

Structural change in coal regions as a process of economic and social-ecological transition – Lessons learnt from structural change processes in Germany

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publisher:

German Environment Agency

For our Environment

Umwelt Bundesamt

CLIMATE CHANGE 33/2021

Ressortforschungsplan of the Federal Ministry for the Environment,
Nature Conservation, Nuclear Safety and Consumer Protection

Project: Structural change in coal regions as a process of economic and social-ecological transformation – Scope for action for a just transition in light of climate policy objectives

Project No. (FKZ) 3716 41 113 0
Report No. FB000720/ENG

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On behalf of the German Environment Agency

Imprint

Publisher:
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Study completed in:
November 2021

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Publication as pdf:
http://www.umweltbundesamt.de/publikationen
ISSN 1862-4359

Dessau-Roßlau, January 2022

Abstract

Effective policies to mitigate climate change need to be accompanied by a socially just transition. This is especially relevant for coal regions. This paper draws on the experiences of past and ongoing transition policies, exploring their effectiveness and transferability. The challenges of structural change in coal regions are complex and region-specific, spanning from technical aspects over political and economic to social and cultural aspects.

To facilitate the exchange of experiences, a typology is suggested and applied to five coal regions in Germany, Romania, Poland and the Czech Republic. It characterises regions according to the type of coal mined, population density, economic prosperity, existence of national coal phase-out policies, advancement of regional transition strategies and the anticipated speed of transition.

Insights are mainly derived from two different structural change processes in Germany. The hard coal mining phase-out in the Ruhr area that started in the 1950s and has recently been completed is compared with the more recent lignite mining phase-down in Lusatia. A new approach can be observed: As climate change has become a major driver of structural change, time frames for structural policies have become significantly shorter, and such policies are being shaped by more proactive engagement.

Lessons learnt include the need for proactive and forward-looking structural policies and the importance of timing. Regions should set realistic expectations on structural policy and develop strategies that account for their individual situation whilst learning from past experiences in other regions. Uncertainties should be communicated in a transparent manner. Diversification of the economy is needed to avoid lock-in effects. Stakeholder participation, just transition strategies as well as multi-layered and multi-faceted governance approaches are key aspects as well. With the European Green Deal, a strategy is highlighted that can facilitate a just transition in coal regions in the future.

Kurzbeschreibung

Eine wirksame Klimaschutzpolitik muss von einer sogenannten „Just Transition“, einem sozial gerechten Strukturwandel hin zur Klimaneutralität, begleitet werden. Dies ist insbesondere für Kohleregionen relevant. Diese Publikation stützt sich auf die Erfahrungen vergangener und laufender Politiken zur Gestaltung von Strukturwandel und untersucht deren Wirksamkeit und Übertragbarkeit. Die Herausforderungen des Strukturwandels in Kohleregionen sind komplex und regionsspezifisch und reichen von technischen Aspekten über politische und wirtschaftliche bis hin zu sozialen und kulturellen Aspekten.

Für den Erfahrungsaustausch wird eine Typologie vorgeschlagen und auf fünf Kohleregionen in Deutschland, Rumänien, Polen und Tschechien angewendet. Sie charakterisiert die Regionen nach der Art der Kohle, der Bevölkerungsdichte, dem wirtschaftlichen Wohlstand, dem Vorliegen nationaler Politiken für einen Kohleausstieg, den Fortschritten bei der Entwicklung von Strategien für einen regionalen Strukturwandel und der erwarteten Geschwindigkeit des Strukturwandels.

Die Erkenntnisse basieren vor allem auf Strukturwandelprozessen in zwei Kohleregionen in Deutschland. Der in den 1950er Jahren begonnene und kürzlich abgeschlossene Steinkohleausstieg im Ruhrgebiet wird mit dem Braunkohleausstieg in der Lausitz verglichen. Neu ist, dass der Klimawandel zu einem wesentlichen Treiber des Strukturwandels geworden ist, dass die Zeit für Strukturpolitiken deutlich kürzer ist und dass ein proaktiveres Engagement vieler Akteure zu beobachten ist.

Zu den Lernerfahrungen unserer Analyse gehören die Notwendigkeit einer proaktiven und vorausschauenden Strukturpolitik und eine gute zeitliche Planung. Die Regionen sollten realistische Erwartungen an die Strukturpolitik stellen und Strategien entwickeln, die zu ihrer individuellen Situation passen und zudem Lehren aus den Erfahrungen anderer Regionen ziehen. Unsicherheiten

sollten transparent kommuniziert werden. Eine Diversifizierung der Wirtschaft ist notwendig, um Lock-In-Effekte zu vermeiden. Die Beteiligung von Stakeholdern, Strategien für einen sozial gerechten Strukturwandel sowie vielschichtige und facettenreiche Steuerungsansätze sind ebenfalls wichtige Aspekte. Mit dem European Green Deal wird auf eine Strategie hingewiesen, die zukünftig einen sozial gerechten Strukturwandel in Kohleregionen unterstützen kann.

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CCS	Carbon capture and storage
EU	European Union
GDP	Gross domestic product
GDR	German Democratic Republic
IEA	International Energy Agency
IG BCE	Industriegewerkschaft Bergbau, Chemie, Energie (German mining, chemical and energy industry trade union)
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
LMBV	Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft mbH [Lusatian and Central German mining management company]
RAG	Ruhrkohle Aktiengesellschaft [Ruhr coal corporation, a stock corporation for coal from the Ruhr area] today: RAG Aktiengesellschaft [RAG corporation]
SDG	Sustainable Development Goal
UNFCCC	United Nations Framework Convention on Climate Change

Summary

There is growing awareness that an effective policy to mitigate climate change must be accompanied by a socially just transition in all sectors which according to current scientific evidence contribute to global warming. Therefore, just transition was a key priority of Poland's Presidency during the 24th Conference of the Parties (COP24) of the United Nations Framework Convention on Climate Change (UNFCCC) in Katowice in December 2018. Efforts towards a joint understanding of just transition resulted in the Solidarity and Just Transition Silesia Declaration signed by many representatives of government. Already in December 2017, the European Commission launched an Initiative for coal regions in transition, bringing together coal regions and stakeholders from different member states of the European Union (EU) which are affected by reductions of coal mining and power production. For all these initiatives, the exchange of experiences and mutual learning about positive and negative effects of different approaches to shape a just transition are becoming increasingly important.

Anticipating the relevance of the debate on a just transition, the research project "Structural change in coal regions as a process of economic and social-ecological transformation – Scope for action for a just transition in light of climate policy objectives" has analysed historical structural change processes and related policies of two very different coal regions in Germany to compare experiences and to deduce lessons learnt which could inspire future structural policies. Its insights and lessons from policy measures of these structural change processes and their conceptualisation can be of interest not only for upcoming transitions in European coal regions but also for the decarbonisation of other economic sectors internationally. The research project also sought to contribute to the debate on success factors and barriers of transition processes by developing an approach for the analysis of coal regions and by presenting cases of coal regions in transition and respective structural policy measures to shape these processes. Our lessons include the following insights:

Coal mining regions in Europe and globally have previously experienced structural change and will continue to undergo changes in the future. Transitions bring specific benefits and challenges to the regions: The opening of mines often created economic prosperity but also caused environmental damage and associated health risks. Technological advancements made working in coal mines safer but also reduced the number of workers required. Depletion of mines or changes in the economic framework conditions and their implications for the competitiveness of domestic coal mining have often resulted in unemployment and a decreasing population, but in many regions, safe, well-paid jobs were created in the transition process and the quality of life eventually increased.

In recent years, structural change in coal regions was accelerated by a new driver: climate change mitigation policies. While historic structural change processes in the analysed regions, Lusatia and the Ruhr area, were mainly driven by disruptive political and economic change after the German reunification in the former case and by a gradual loss of economic competitiveness in the latter case, current policies to frame a coal phase-out are increasingly driven by necessities of climate change mitigation. Effectively reducing CO2 emissions requires a rapid reduction of coal use in Europe and globally in the next two decades. This will accelerate the speed of structural change in coal regions. Nevertheless, this is not the only driver of current dynamics. Coal regions are also challenged by other megatrends, such as globalisation, urbanisation, digitalisation or demographic change. A policy-induced change like phasing out coal to help mitigate climate change is often perceived as a more "deliberate" choice, implying an even higher responsibility of governments to reduce social hardship for regions and people that are negatively affected.

Timing is crucial for proactive, forward-looking structural policies. In the past, governments have intervened in structural change processes in coal regions with different approaches, ranging from reactive approaches in early transition phases to forward-looking approaches in later phases. Based on past evidence in our case studies, early-phase subsidies and support schemes were used to protect industry and jobs which conserved existing structures and which sustained coal jobs even when

mining was already uncompetitive. This hampered forward-looking policies and innovation and thus prevented new job opportunities for upcoming generations. Meanwhile, paradigms of structural policy have shifted and showcase more awareness for timing and forward-looking policies, including investment in education and research. Today, multi-faceted potential challenges for coal regions are often anticipated. From an economic perspective, the phase-out of coal is inevitable because coal is becoming increasingly uncompetitive compared to other sources of energy. From a climate perspective, the transition must be accelerated to limit global warming. **For coal regions, it is in their self-interest to proactively ensure planning security and a just transition early in the process**. The analysis of past processes revealed that successful structural change processes can last several decades. Starting early and thinking long-term will be key to manage a timely and just transition in future structural changes.

At the same time, it is important to **be realistic on what structural policy can deliver**. "Much achieved, little gained" ("Viel erreicht – wenig gewonnen", Bogumil et al. 2012, own translation), is the main conclusion of 60 years of structural policy for the Ruhr area in Germany. Once the “heart” of Europe's coal and steel industry, the region today is both a modern, innovative, highly industrialised megacity region but also a hotspot of inequalities and unemployment in Germany. This is an example for the limitations of structural policy in coal regions: It has the potential to frame and shape transition processes to reduce negative consequences, but the decline of coal-related industries cannot easily and not fully be compensated. Importantly, structural policy cannot compensate for past policy failures and cannot solve all other challenges of social and economic policy in a region. To illustrate the range of possibilities: Despite the dramatic loss of almost 500,000 jobs in coal mining since the late 1950s, economic development and structural policy for the Ruhr area have managed – in the very particular framework conditions of that time – to keep the total number of jobs in the region almost constant. In contrast to this, in Lusatia, the “heart” of the GDR’s energy supply, industry – not only coal mining – collapsed after the German reunification which increased the challenges to be addressed by structural policy after 1990. 30 years later, the region is still struggling with the impacts of this structural break. Because the framework conditions in the Ruhr area have been so particular, it is more likely that structural policies for other rural regions, including lignite regions in other parts of Europe, will operate in less favourable framework conditions much closer to the conditions in Lusatia.

Each region is different and requires a tailored structural policy. Inspiration from past policies and other regions is essential for learning and policy making. There is a wealth of knowledge on good practices and failures from past structural policies in coal regions which can inspire political decision making. However, achievements in one region are not easily transferable to other contexts as different coal mining regions show very distinct characteristics. The urban, densely populated Ruhr area in Germany has much more in common with Upper Silesia in Poland than with the rural region of Lusatia in Germany. Therefore, even within a country, structural policy measures may not be transferable to other regions. When developing transition policies to shape structural change in coal regions, a detailed analysis of the regional framework conditions is crucial to identify region-specific opportunities and challenges for tailored transition strategies. These framework conditions comprise, inter alia, technical, political, economic, social and cultural conditions (see Chapter 2.1). Despite all differences, learning from past policies and other regions is possible and promising. A prerequisite to understanding the usability of lessons is the awareness of similarities and differences of the framework conditions. Due to the complexity of structural change processes, it is, however, hard to trace back stories of success and failure of structural policies to single policy measures. Instead, successful structural policies have been a mix of tailored measures addressing the specific framework conditions. In Chapter 2.2, we distinguished six key categories to better understand similarities and differences of coal regions: the type of coal produced, population density, economic prosperity, the existence of national coal phase-out policies, advances in regional transition strategies and the anticipated speed of transition.

There is no blueprint for a just transition. Policy makers must openly and honestly address and communicate uncertainties throughout the process. Each transition process requires learning from past experiences, flexibility and openness to experimental approaches to identify promising paths. Past experiences show that all transition processes come with successes and failures. Because each transition process is complex, decision makers and stakeholders are confronted with a considerable and inevitable degree of uncertainty regarding the effectiveness and efficiency of available measures. Furthermore, decision makers and stakeholders must understand that not all sectors and not all affected people will likely "win" in such a transition. Therefore, an appropriate communication about uncertainties and potential consequences, both positive and negative, is important for the legitimacy and credibility of the process and of the involved actors. Such a communication should be (region-)specific, transparent and honest. It must acknowledge the achievements of people and regions, be open for mutual exchange and understanding and encourage engagement. In addition, an appropriate communication between political levels and policy fields in the multi-layered political system is key to increase coherence of structural policies. Investments into education and awareness-raising are essential for the success of these communication approaches.

Building on strengths and assets of regions and diversifying their economy to avoid lock-ins is a key challenge. Structural change processes can only be managed successfully when building on the strengths and assets of a region. The assets of coal regions include, for example, energy infrastructure as well as capacities, knowledge and institutions of the energy sector. However, with the decline of coal mining, regions are challenged to diversify economically, thereby developing new strengths and skills and decreasing mono-industrial dependencies. Lock-in effects in old structures and specific challenges may, however, become barriers to new visions for a region. We have categorised typical challenges in coal regions along five dimensions: technical, political, economic, social and cultural aspects. An effective structural policy must consider and integrate all these dimensions. This can also include preserving and repurposing existing infrastructure as done with the site of "Zeche Zollverein" (customs association colliery) in the Ruhr area.

An effective structural policy must ensure participation of all affected stakeholders. Participation can provide valuable insights to achieve strong policy outcomes, and it can increase public acceptance as well as the legitimacy of a policy process and its results. Historic examples show that a multi-layered approach to structural policy is necessary which goes beyond the mere protection of old and the creation of new employment and considers, for example, investments in infrastructure, education and research as well as cultural aspects and health concerns, thus seeking to increase the overall attractiveness of a region. Because existing established institutions and stakeholders often prefer "more of the same", it is important to include new actors in transition processes to widen the focus. Engaging local stakeholders, start-ups and civil society in truly participatory planning processes can leverage creative ideas and prospects for a region, and by enabling regions to benefit from their endogenous potentials, it can reduce local resistance. This is particularly important when incumbents use powerful means, such as larger networks, access to and knowledge about institutions, financial resources and a higher degree of organisation and coordination, to preserve existing structures. The Commission on Growth, Structural Change and Employment in Germany was one example how a stakeholder participation approach can address transition challenges and increase engagement in such processes.

A well-designed governance of change – across administrative boundaries, political levels and policy fields – is essential in transition processes. Because of their complexity, transitions should be governed following a multi-layered and multi-faceted approach to foster cooperation of local, regional, national and international actors across administrative boundaries and policy fields. Carefully designed, inclusive processes and support schemes that foster innovation are a key element of transition policies, including bottom-up elements and demand-side approaches. The focus beyond administrative boundaries especially applies to structural change processes in coal regions because

many of them cover a geographical area which does not correspond with administrative boundaries. Historic examples have shown that setting up region-specific institutions, which work across these boundaries – with a clear mandate for the development of a coherent transition strategy – and which ensure institutional learning, are one successful approach to support transition processes. Institutional learning about transition experiences is one critical approach for the efficient use of time and money. **Well-designed funding mechanisms can open opportunities for stakeholders at all levels and ensure coherence across policy fields**.

Effective strategies for a just transition contribute to transformative change. Transitions strategies must ensure that affected regions and people are not left behind and remain able to compete in the future. Thoroughly designed and carefully managed transition processes engaging all stakeholders and affected groups can contribute to regional economic diversification and job creation, to the strengthening of public infrastructure and social services as well as to the restoration of degraded environment, for example, by recultivating landscapes which were impacted by lignite mining. In the case of structural policies, it is important that success cannot only be measured in, for example, new jobs created, but must consider a variety of aspects to address the complexity of structural change processes. For example, jobs lost in the mining industry should optimally be replaced with new jobs in other industries and sectors with at least comparable salaries. Anticipative elements like a communication of phase-out plans, diversifying education opportunities and early retraining can ease the disruptions of upcoming changes by helping former coal miners to stay in the labour market and prevent suboptimal education and employment choices.

Political developments will continue to frame transition processes. The European Green Deal is a key opportunity to enable just transition processes in EU coal regions which help to mitigate climate change, foster sustainable development and make regions more resilient to future crises. In the past, structural policy has largely focused on securing economic prosperity. The European Green Deal calls for a new paradigm: Europe has set itself the goal to align policies with the SDGs and to become climate neutral by 2050. The European Commission will now have to deliver on these commitments, inter alia, by aligning EU structural funds with these policy goals. The transition towards a net zero-emission economy will be a challenge and opportunity at the same time. It will require the courage to embark on new paths. Decades of structural policy in coal regions shed light on a wealth of experiences of what has worked and could be replicated and on mistakes and failures which should not be repeated. In the end, however, it is people which are decisive for shaping change in regions. Only with their support, policies for sustainable regional development can be successful and create strong, diversified economies, social justice, a stable climate and a healthy environment.

Zusammenfassung

Es gibt ein zunehmendes Bewusstsein dafür, dass Klimaschutzpolitik effektiver sein kann, wenn sie mit Maßnahmen für eine sogenannte "Just Transition", einem sozial gerechten Strukturwandel hin zur Klimaneutralität, in allen Sektoren ergänzt wird, die gemäß derzeitigen wissenschaftlichen Erkenntnissen zum Klimawandel beitragen. Das Thema „Just Transition" war deshalb ein Schwerpunkt auf der 24. Vertragsstaatenkonferenz (Conference of the Parties, COP24) zur Klimarahmenkonvention der Vereinten Nationen (United Nations Framework Convention on Climate Change, UNFCCC) unter der polnischen Präsidentschaft im Dezember 2018 in Katowice. Die Verhandlungen über ein gemeinsames Verständnis von „Just Transition" führten zur „Solidarity and Just Transition Silesia Declaration", die von Vertreterinnen und Vertretern vieler Regierungen unterschrieben wurde. Bereits im Dezember 2017 startete die Europäische Kommission eine Initiative für Kohleregionen im Wandel (Initiative for coal regions in transition), die seitdem Akteure aus Kohleregionen in Mitgliedsstaaten der Europäischen Union (EU) zusammenbringt, die von auslaufendem Kohlebergbau und sinkender Energieproduktion betroffen sind. Für all diese Initiativen werden Erfahrungsaustausch und gemeinsames Lernen über positive und negative Wirkungen unterschiedlicher politischer Ansätze zur Gestaltung einer „Just Transition" immer wichtiger.

Das Forschungsprojekt "Strukturwandel in Kohleregionen als Prozess ökonomischer und sozialökologischer Transformation – Handlungsmöglichkeiten für einen sozialverträglichen Strukturwandel im Lichte der klimapolitischen Ziele" antizipierte die Relevanz der Debatte um eine „Just Transition" und analysierte dafür Strukturwandelprozesse und Strukturpolitiken in zwei sehr unterschiedlichen Kohleregionen in Deutschland. Es verglich Erfahrungen und leitete Erkenntnisse ab, die für zukünftige Strukturpolitiken inspirierend sein könnten. Seine Einblicke und Lernerfahrungen zu strukturpolitischen Maßnahmen und ihrer Konzeptionalisierung können nicht nur interessant für anstehende Strukturwandelprozesse in europäischen Kohleregionen sein, sondern auch für Dekarbonisierungsvorhaben in anderen Wirtschaftssektoren weltweit. Das Forschungsprojekt leistet auch einen Beitrag zur Debatte über Erfolgsfaktoren und Hindernisse für Strukturwandelprozesse, indem es einen Ansatz für die Analyse von Kohleregionen entwickelte sowie Beispiele für Kohleregionen im Wandel und in ihnen umgesetzte Politiken zur Gestaltung dieses Wandels vorstellte. Folgende Erkenntnisse wurden gewonnen:

Kohleregionen in Europa und weltweit haben bereits Strukturwandelprozesse durchlebt und werden sich auch in der Zukunft kontinuierlich strukturell verändern. Strukturwandelprozesse bringen für die Regionen spezifische Chancen und Herausforderungen mit sich: Die Erschließung von Bergbaubetrieben schuf oftmals wirtschaftlichen Wohlstand, aber verursachte auch Umweltschäden und damit verbundene Gesundheitsrisiken. Technologischer Fortschritt erhöhte die Arbeitssicherheit im Kohlebergbau, doch reduzierte er auch die Zahl der Arbeitsplätze dort. Die Erschöpfung der Vorräte oder Änderungen der wirtschaftlichen Rahmenbedingungen minderten oftmals die Wettbewerbsfähigkeit des einheimischen Kohlebergbaus und führten damit zu Arbeitslosigkeit und Bevölkerungsschwund, doch in vielen Regionen wurden im Verlauf des Strukturwandelprozesses sichere, gut bezahlte Arbeitsplätze geschaffen und schließlich auch die Lebensqualität erhöht.

In den letzten Jahren wurden Strukturwandelprozesse in Kohleregionen von einem neuen Treiber beschleunigt: dem Kampf gegen den Klimawandel und entsprechenden Klimaschutzmaßnahmen. Während vergangene Strukturwandelprozesse in den von uns analysieren Regionen, der Lausitz und dem Ruhrgebiet, vornehmlich durch disruptive politische und wirtschaftliche Änderungen nach der Wiedervereinigung im Falle der Lausitz und durch den Verlust der Wettbewerbsfähigkeit der Steinkohle im Falle des Ruhrgebiets ausgelöst wurden, sind derzeitige Kohleausstiegsvorhaben notwendig, um die Auswirkungen des Klimawandels zu mindern. Eine effektive Minderung von CO_2-Emissionen erfordert in den nächsten zwei Jahrzehnten in Europa und weltweit eine rasche Reduzierung der Kohlenutzung. Der Strukturwandel in Kohleregionen wird sich deshalb beschleunigen. Der Klimaschutz ist jedoch nicht der einzige Treiber der derzeitigen Dynamik. Kohleregionen werden zusätzlich durch andere Megatrends wie Globalisierung, Urbanisierung,

Digitalisierung oder demographischer Wandel herausgefordert. Weil der klimapolitikgetriebene Kohleausstieg jedoch vielfach als eine aktive politische Entscheidung wahrgenommen wird, stehen die Regierungen in einer noch größeren Verantwortung, soziale Härten für die betroffenen Regionen und Menschen zu reduzieren.

Das richtige Timing ist essenziell für eine proaktive, zukunftsgerichtete Strukturpolitik. Regierungen griffen in der Vergangenheit mit unterschiedlichen politischen Ansätzen in Strukturwandelprozesse ein, die in Kohleregionen stattfanden. Diese reichten von reaktiven Ansätzen in frühen Phasen bis zu zukunftsorientierten Ansätzen in späteren Phasen. Gemäß den Ergebnissen unserer Fallstudien zielten Subventionen und Unterstützungsmaßnahmen der frühen Phasen insbesondere darauf ab, Industrie und Arbeitsplätze zu schützen, was die existierenden Strukturen konservierte und Arbeitsplätze im Kohlesektor erhielt, obwohl die Kohleindustrie schon längst nicht mehr wettbewerbsfähig war. Dies behinderte zukunftsgerichtete Politikansätze und Innovationen und verhinderte somit neue Beschäftigungsmöglichkeiten für die folgenden Generationen. Inzwischen haben sich die Paradigmen der Strukturpolitik geändert. Sie zeigen ein größeres Bewusstsein für das richtige Timing und für Zukunftsorientierung, etwa durch Investitionen in Bildung und Forschung. Heute werden potenzielle Herausforderungen für Kohleregionen frühzeitig antizipiert und farcettenreich wahrgenommen. Aus wirtschaftlicher Sicht ist der Kohleausstieg unausweichlich, weil Kohle im Vergleich zu anderen Energieträgern immer unwirtschaftlicher wird. Aus Sicht des Klimaschutzes muss dieser Prozess beschleunigt werden, um die Klimaerwärmung aufzuhalten. **Für Kohleregionen ist es in ihrem eigenen Interesse, proaktiv und frühzeitig für Planungssicherheit und einen sozial gerechten Wandel zu sorgen.** Die Analyse vergangener Prozesse zeigt, dass erfolgreiche Strukturwandelprozesse mehrere Jahrzehnte dauern können. Früh zu beginnen und langfristig zu denken wird für die Gestaltung eines rechtzeitigen und sozial gerechten Wandels zukünftiger Strukturwandelprozesse von besonderer Bedeutung sein.

Gleichzeitig ist es wichtig, realistisch einzuschätzen, was Strukturpolitik leisten kann. „Viel erreicht – wenig gewonnen“ (Bogumil et al. 2012), ist eine zentrale Schlussfolgerung von 60 Jahren Strukturpolitik im Ruhrgebiet. Das ehemalige „Herz“ der europäischen Kohle- und Stahlindustrie ist heute sowohl eine moderne, innovative und hochindustrialisierte Metropolregion als auch ein Brennpunkt von Ungleichheit und Arbeitslosigkeit in Deutschland – und damit ein Beispiel für die Grenzen von Strukturpolitik in Kohleregionen. Strukturpolitik kann dem Wandel einen Rahmen geben und ihn gestalten, um negative Auswirkungen zu verringern, sie kann aber nicht alle Auswirkungen des Niedergangs der Kohleindustrie problemlos und vollständig ausgleichen. Insbesondere kann sie nicht vergangenes Politikversagen ausgleichen und alle anderen sozialen und wirtschaftlichen Herausforderungen in einer Region lösen. Um die Bandbreite der Möglichkeiten begreiflich zu machen: Trotz des dramatischen Verlusts von fast 500.000 Arbeitsplätzen im Kohlebergbau seit Ende der 1950er Jahre gelang es der Wirtschafts- und Strukturpolitik im Ruhrgebiet – in den sehr spezifischen Rahmenbedingungen der damaligen Zeit –, die Zahl der Arbeitsplätze in der Region fast konstant zu halten. Im Gegensatz dazu kollabierten in der Lausitz, dem Zentrum der Energieversorgung in der damaligen DDR, nach der Wiedervereinigung nicht nur der Kohlebergbau, sondern viele Industrien – was die Strukturpolitik nach 1990 vor noch größere Herausforderungen stellte. 30 Jahre später leidet die Lausitz noch immer unter den Auswirkungen dieses Strukturbruchs. Da die Rahmenbedingungen im Ruhrgebiet so spezifisch waren, ist es wahrscheinlich, dass Strukturpolitiken für andere ländliche Regionen, einschließlich Braunkohleregionen in anderen Teilen Europas, in ungünstigeren Rahmenbedingungen gestaltet werden müssen, die jenen in der Lausitz ähnlicher sind als jenen im Ruhrgebiet.

Jede Kohleregion ist einzigartig und erfordert eine maßgeschneiderte Strukturpolitik. Anregungen aus vergangenen politischen Maßnahmen und aus anderen Regionen sind wichtig für Lern- und Politikentwicklungsprozesse. Es gibt eine Vielzahl positiver und negativer Beispiele vergangener strukturpolitischer Maßnahmen in Kohleregionen, die für die Politikentwicklung hilfreich sein können. Erfolgreiche Maßnahmen aus einer Region sind jedoch nicht einfach in andere Kontexte übertragbar, da Kohleregionen sehr unterschiedlich sind. Das urbane Ruhrgebiet in Deutschland mit

seiner hohen Bevölkerungsdichte hat deutlich mehr Gemeinsamkeiten mit Oberschlesien in Polen als mit der ländlichen Lausitz in Deutschland. Deshalb sind strukturpolitische Maßnahmen auch innerhalb eines Landes nicht einfach von einer Region auf eine andere Region übertragbar. Bei der Entwicklung von strukturpolitischen Maßnahmen für Kohleregionen müssen daher regionale Rahmenbedingungen genau analysiert werden, um regionsspezifische Chancen und Herausforderungen identifizieren und zur Grundlage einer maßgeschneiderten Strukturpolitik machen zu können. Diese Rahmenbedingungen umfassen unter anderem technische, politische, wirtschaftliche, soziale und kulturelle Bedingungen (siehe Kapitel 2.1). Trotz aller Unterschiede sind Lernerfahrungen aus vergangenen politischen Maßnahmen und aus anderen Regionen möglich und hilfreich. Eine Voraussetzung dafür, den Nutzen von Lernerfahrungen bewerten zu können, ist, sich bewusst zu sein, worin sich die Rahmenbedingungen ähneln und worin sie sich unterscheiden. Die Komplexität von Strukturwandelprozessen macht die Zuordnung von Erfolgen und Misserfolgen einer Strukturpolitik zu konkreten Maßnahmen dennoch schwierig. Erfolgreiche Strukturpolitiken bestanden und bestehen deshalb aus einem Mix maßgeschneiderter Maßnahmen, die die jeweils spezifischen Rahmenbedingungen adressieren. Um Gemeinsamkeiten und Unterschiede zwischen Kohleregionen besser verstehen zu können, unterscheiden wir im Kapitel 2.2 sechs Kategorien: die Art der Kohle, die Bevölkerungsdichte, den wirtschaftlichen Wohlstand, die Existenz nationaler Politiken für einen Kohleausstieg, Fortschritte bei der Entwicklung von Strategien für einen regionalen Strukturwandel und die Geschwindigkeit des Strukturwandels.

Es gibt keine Blaupause für einen sozial gerechten Strukturwandel. Politische Entscheidungsträgerinnen und Entscheidungsträger müssen Unsicherheiten während des Prozesses offen und ehrlich kommunizieren. Jeder Prozess eines Strukturwandels erfordert ein Lernen aus vergangenen Erfahrungen, Flexibilität und eine Offenheit für experimentelle Ansätze, um zukunftsweisende Wege identifizieren zu können. Erfahrungen zeigen, dass es im Laufe eines jeden Strukturwandelprozesses Erfolge und Misserfolge gibt. Weil jeder Strukturwandel komplex ist, sehen sich Entscheidungsträgerinnen und Entscheidungsträger sowie Stakeholder bei der Bewertung der Wirksamkeit und der Effizienz von möglichen politischen Maßnahmen mit einem unvermeidbaren und hohen Grad an Unsicherheit konfrontiert. Darüber hinaus müssen Entscheidungsträgerinnen und Entscheidungsträger sowie Stakeholder verstehen, dass wahrscheinlich nicht alle Branchen und nicht alle betroffenen Menschen von einem Strukturwandel profitieren werden. Eine angemessene Kommunikation der Unsicherheiten sowie möglicher positiver und negativer Wirkungen ist für die Legitimität und Glaubwürdigkeit des Prozesses und seiner Beteiligten deshalb wichtig. Eine solche Kommunikation sollte regionsspezifisch, transparent und ehrlich sein. Sie muss die Errungenschaften der Menschen in den Regionen anerkennen und würdigen, offen sein für den Dialog und für gegenseitiges Verständnis und sie muss zur Beteiligung anregen. Darüber hinaus ist eine angemessene Kommunikation zwischen den verschiedenen Ebenen und Politikfeldern in dem politischen Mehrebenensystem wichtig, um eine kohärente Strukturpolitik entwickeln zu können. Eine Grundvoraussetzung für eine erfolgreiche Kommunikation sind Investitionen in Bildung (im Sinne von Schul-, Aus- und Weiterbildung) sowie Bewusstseinsbildung.

Eine der größten Herausforderungen ist es, bestehende Stärken und bereits vorhandene Infrastrukturen der Regionen für ihre Weiterentwicklung zu nutzen und gleichzeitig ihre Wirtschaft zu diversifizieren, um Lock-In-Effekte zu verhindern. Strukturwandelprozesse sind nur erfolgreich, wenn sie die Stärken und bereits vorhandene Infrastrukturen einer Region berücksichtigen. Dazu gehören in Kohleregionen etwa die Energieinfrastruktur sowie Kapazitäten, Wissen und Institutionen im Bereich der Energiewirtschaft. Mit dem Niedergang des Kohlebergbaus muss in den Regionen aber auch die Wirtschaft diversifiziert werden und dafür müssen neue Stärken und Fähigkeiten entwickelt und mono-industrielle Abhängigkeiten reduziert werden. Lock-In-Effekte in alten Strukturen und andere spezifische Herausforderungen können die Entwicklung neuer Visionen für eine Region behindern. Typische Herausforderungen in Kohleregionen kategorisierten wir anhand von fünf Dimensionen: technisch, politisch, wirtschaftlich, sozial und kulturell. Eine

effektive Strukturpolitik muss all diese Dimensionen berücksichtigen und integrieren. Das kann auch bedeuten, existierende Infrastruktur neu zu nutzen, wie im Falle der „Zeche Zollverein" im Ruhrgebiet geschehen.

Eine effektive Strukturpolitik muss sicherstellen, dass alle betroffenen Akteure beteiligt werden. Beteiligungsprozesse können wertvolles Wissen für politische Entscheidungen verfügbar machen und sowohl die öffentliche Akzeptanz als auch die Legitimität von Politikprozessen und -ergebnissen erhöhen. Beispiele der Vergangenheit zeigen, dass ein Mehrebenenansatz von Strukturpolitik notwendig ist, der über den reinen Schutz der bestehenden Arbeitsplätze und die Schaffung neuer Arbeitsplätze hinausgeht und zum Beispiel Investitionen in Infrastruktur, Bildung und Forschung sowie kulturelle und gesundheitliche Aspekte berücksichtigt, um die Attraktivität einer Region zu erhöhen. Da etablierte Institutionen und Stakeholder oft bestehende Strukturen bevorzugen, ist es wichtig, an Strukturwandelprozessen auch neue Akteure zu beteiligten, um den Fokus zu erweitern. Die Beteiligung von lokalen Stakeholdern, Start-Ups und der Zivilgesellschaft an Planungsprozessen mit geeigneten Beteiligungsformaten kann kreative Ideen hervorbringen und neue Perspektiven für eine Region schaffen – und dadurch, dass sie den Regionen ermöglichen, von ihren endogenen Potenzialen zu profitieren, können sie lokalen Widerstand reduzieren. Dies ist insbesondere wichtig, wenn etablierte Akteure ihre Macht, wie große Netzwerke, Zugang zu und Wissen über Institutionen, finanzielle Mittel sowie eine bessere Organisation und Koordination nutzen, um bestehende Strukturen zu erhalten. Die Kommission für Wachstum, Strukturwandel und Beschäftigung in Deutschland war ein Beispiel dafür, wie eine Stakeholderbeteiligung Herausforderungen von Strukturwandel adressierte und die Beteiligung an diesem Prozess erhöhte.

Eine gut konzipierte Governance des Wandels – über Verwaltungseinheiten, politische Ebenen und Politikfelder hinweg – ist essenziell für Strukturwandelprozesse. Aufgrund ihrer Komplexität sollten Strukturwandelprozesse mit einem vielschichtigen Mehrebenenansatz gesteuert werden, der die Zusammenarbeit von lokalen, regionalen, nationalen und internationalen Akteuren verschiedener Verwaltungseinheiten und Politikfelder fördert. Klug konzipierte, inklusive Prozesse und Unterstützungsmaßnahmen, die Bottom-up-Elemente und nachfrageorientierte Ansätze enthalten und Innovationen fördern, sind ein Kernelement von Politiken des Wandels. Der Blick über Verwaltungseinheiten hinweg ist insbesondere für Strukturwandelprozesse in Kohleregionen von Bedeutung, da viele von ihnen geographisch eine Fläche einnehmen, die nicht mit administrativen Grenzen übereinstimmt. Beispiele der Vergangenheit zeigen, dass die Einrichtung regionaler Institutionen, die – mit einem klaren Mandat für die Entwicklung einer kohärenten Strategie für den Strukturwandel – über die Grenzen von Verwaltungseinheiten hinweg arbeiten und institutionelles Lernen sicherstellen, ein erfolgreicher Ansatz zur Gestaltung von Strukturwandelprozessen ist. Institutionelles Lernen über Erfahrungen mit Strukturwandel ist ein wichtiger Ansatz zur effizienten Nutzung von Zeit und Geld. **Gut konzipierte Finanzierungsmechanismen können für Stakeholder aller Ebenen Handlungsmöglichkeiten eröffnen und eine politikfeldübergreifende Kohärenz ermöglichen.**

Wirksame Strategien für einen sozial gerechten Strukturwandel leisten einen Beitrag zu einem transformativen Wandel. Strategien für einen Strukturwandel müssen sicherstellen, dass betroffene Regionen und Menschen nicht zurückgelassen werden und auch in der Zukunft wettbewerbsfähig sind. Sorgfältig konzipierte und klug gesteuerte Strukturwandelprozesse, die alle Stakeholder und betroffenen Gruppen beteiligen, können dazu beitragen, die regionale Wirtschaft zu diversifizieren und Beschäftigungsmöglichkeiten zu schaffen, die öffentliche Infrastruktur und die Sozialsysteme zu stärken sowie Umweltschäden zu beseitigen, etwa durch die Renaturierung von Braunkohletagebauen geschädigter Landschaften. Im Falle von Strukturpolitiken ist wichtig, dass ihr Erfolg beispielsweise nicht nur an der Zahl neu geschaffener Arbeitsplätze gemessen wird, sondern dass viele andere Faktoren berücksichtigt werden, die die Komplexität von Strukturwandelprozessen abbilden. Beispielsweise sollten Arbeitsplätze, die in der Kohleindustrie verloren gingen, optimalerweise in anderen Industrien und Branchen entstehen, die ein ähnliches Gehaltsniveau bieten. Vorausschauende

Ansätze wie die Kommunikation von Kohleausstiegsplänen, die Diversifizierung von Bildung sowie frühe Weiterbildungsangebote können Brüche durch anstehende Änderungen abfedern, indem sie Beschäftigten der Kohleindustrie dabei helfen, im Arbeitsmarkt zu bleiben, und suboptimale Ausbildungs- und Berufswahlentscheidungen verhindern.

Politische Entwicklungen werden Strukturwandelprozesse weiterhin beeinflussen. Der European Green Deal bietet eine Gelegenheit, den Kohleregionen der EU einen sozial gerechten Strukturwandel zu ermöglichen, der hilft, den Klimawandel zu verlangsamen, eine nachhaltige Entwicklung zu fördern und Regionen widerstandsfähiger gegen zukünftige Krisen zu machen. In der Vergangenheit zielte Strukturpolitik insbesondere darauf ab, wirtschaftlichen Wohlstand zu sichern. Der European Green Deal basiert auf einem neuen Paradigma: Europa hat sich zum Ziel gesetzt, die eigene Politik mit den Nachhaltigkeitszielen (Sustainable Development Goals, SDGs) in Einklang zu bringen und bis 2050 klimaneutral zu werden. Die Europäische Kommission muss diese Ziele nun verfolgen, unter anderem indem sie die europäische Strukturförderung an diesen Zielen ausrichtet. Der Wandel hin zu einer klimaneutralen Wirtschaft ist eine Chance und eine Herausforderung zugleich. Er erfordert den Mut, neue Wege zu begehen. Jahrzehnte von Strukturpolitik in Kohleregionen bieten eine Vielzahl an Lernerfahrungen darüber, welche Ansätze erfolgreich waren und beispielhaft sein könnten, und darüber, welche Ansätze ihre Ziele verfehlten und nicht wiederholt werden sollten. Im Endeffekt sind es jedoch die Menschen, die den Strukturwandel in ihren Regionen gestalten. Nur mit ihrer Mitwirkung können Strategien für eine nachhaltige regionale Entwicklung erfolgreich sein und eine starke, diversifizierte Wirtschaft, soziale Gerechtigkeit, ein stabiles Klima und eine gesunde Umwelt ermöglichen.

1 Introduction and approach

There is growing awareness that an effective policy to mitigate climate change must be accompanied by a socially just transition[1] in all sectors which according to current scientific evidence contribute to global warming. Therefore, just transition was a key priority of Poland's Presidency during the 24th Conference of the Parties (COP24) of the United Nations Framework Convention on Climate Change (UNFCCC) in Katowice in December 2018. Efforts towards a joint understanding of just transition resulted in the Solidarity and Just Transition Silesia Declaration[2] signed by many representatives of government. Already in December 2017, the European Commission launched an Initiative for coal regions in transition[3], bringing together coal regions and stakeholders from different member states of the European Union (EU) which are affected by reductions of coal mining and power production. For all these initiatives, the exchange of experiences and mutual learning about positive and negative effects of different approaches to shape a just transition are becoming increasingly important.

Anticipating the relevance of a debate on a just transition, the research project "Structural change in coal regions as a process of economic and social-ecological transformation – Scope for action for a just transition in light of climate policy objectives" has analysed historical structural change processes and related policies of two very different coal regions in Germany to compare experiences and to deduce lessons learnt which could inspire future structural policies. Its insights and lessons from policy measures of these structural change processes and their conceptualisation can be of interest not only for upcoming transitions in European coal regions but also for the decarbonisation of other economic sectors internationally. The research project also sought to contribute to the debate on success factors and barriers of transition processes by developing an approach for the analysis of coal regions and by presenting cases of coal regions in transition and respective structural policy measures to shape these processes.

In previous work packages of this research project, the consortium has analysed the very different structural change processes in the Lusatian lignite mining region and in the Ruhr hard coal mining area in Germany. The results of these analyses are documented in detail in two case study papers available in German and English (Ragnitz et al. 2021a and 2021b; Dahlbeck et al. 2021a and 2021b). The case study papers present detailed quantitative and qualitative research on the two structural change processes, particularly analysing the socio-economic contexts, introducing the different structural policy measures and analysing the framing of the debates throughout the structural change processes to help understand political decisions. In addition, over the last few years, global knowledge about transition processes in coal regions has grown significantly. Hence, we also base this paper on extensive transition literature, including in-depth analyses of transitions in coal regions beyond Germany, on international experiences of research partners in the context of just transition processes as well as on information from participants in the EU Initiative for coal regions in transitions. Furthermore, an expert review provided additional information and reflection on the findings of the research project. Based on this information, this paper presents the identified lessons learnt from previous and ongoing transition processes which are considered to be inspirational for similar transitions in other coal regions in Europe and for transitions in other sectors, thereby exploring effectiveness and transferability of specific approaches.

In order to draw transferable lessons, Chapter 2 of this paper provides a systematic approach to analyse structural challenges in coal regions along five dimensions. It suggests a typology for a better understanding of similarities and differences of coal regions using six categories, and it applies this typology to five different coal regions in Germany (Lusatia and Ruhr area) and in Central and Eastern

[1] The just transition concept originates from the trade union movement (see, for example, ITUC (2007) or ILO (2015)) and focuses on securing jobs and alleviating local social problems in the context of climate change mitigation.

[2] https://cop24.gov.pl/fileadmin/user_upload/Solidarity_and_Just_Transition_Silesia_Declaration_2_.pdf

[3] https://ec.europa.eu/energy/topics/oil-gas-and-coal/EU-coal-regions/initiative-for-coal-regions-in-transition_en

Europe (Gorj County in Romania, Upper Silesia in Poland and Ústí region in the Czech Republic). Chapter 3 compares historic structural change processes and related policies in Lusatia and in the Ruhr area, identifies a key paradigm shift in the transition debate in the last years, summarises recent progress in this debate with a focus on the Commission on Growth, Structural Change and Employment (also referred to as "coal commission") and indicates EU and global policy contexts which are likely to further facilitate the identified paradigm shift. Chapter 4 introduces a selection of structural policy measures and lessons which have been learnt during the research project. The paper concludes with a summary of lessons learnt for structural change processes and a just transition.

2 Structural change in coal regions

"The excitement and fanfare that surrounds the opening of a new mine is never present when it finally closes." (Laurence 2006)

Coal mining regions undergo a constant process of change. The opening of new mines brings economic growth to the region and attracts workers which often migrate from distant places. Change is persistent even in times of regular mining operations. New technologies often result in higher productivity but also in a decrease of coal mining jobs and in new requirements for skills of workers. At some point, every mine must close – either due to depletion or because of changing economic framework conditions, for example, because of an increasing competition on the global market. Structural change processes and related challenges are thus not a new phenomenon in coal regions. Jobs in coal mining and use decreased in all European countries over the last decades. Globally, around 4 million coal-related jobs were lost in half a century (World Bank 2018). Transition processes in coal regions differ significantly, which can be explained by many factors, including technical, political, economic, social and cultural aspects as well as the historical development of specific regions and past structural policy interventions. Detailed regional analysis is therefore crucial to identify region-specific opportunities and challenges and to develop effective transition policies. Nevertheless, a comparison of structural change and transition processes in coal regions helps to identify possible patterns across regions to draw conclusions beyond specific cases, to foster mutual learning and to improve future transition policies.

Thoroughly designed and carefully managed transition processes, engaging all stakeholders and affected groups, provide opportunities for coal regions. They can contribute to regional economic diversification and job creation, the strengthening of public infrastructure and social services and the recultivation of landscapes, particularly in lignite mining regions. In addition, well-managed transitions are essential to shape the implementation of climate legislation. The transition of coal regions is necessary to make an important contribution to the global effort of limiting global warming. Effective and just transition policies are therefore an opportunity to shape this transformative change, ensuring that affected regions and groups are not left behind and remain able to compete in a low-carbon economy. Importantly, a well-managed transition is also necessary to address direct negative effects of structural change in coal regions and reduce uncertainties for affected groups.

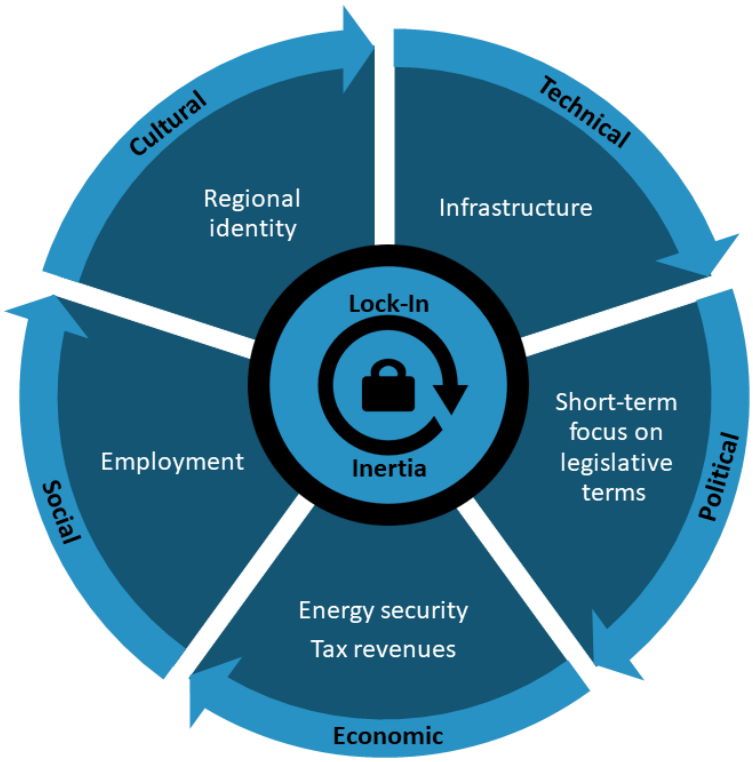
2.1 Challenges of structural change

Experiences from several countries, including Germany[4], show that supporting renewable energies but not managing the phase-out of conventional energy carriers is not enough for a successful energy transition. Incumbent actors feeling threatened by resulting distributional effects use their influence to slow down or even halt the transition (Kungl 2015; Frei et al. 2018). Studying elements of exnovation theories and political economy can therefore help to understand the underlying challenges and to find approaches which ease and overcome the lock-in they can lead to (Geels, Berkhout and Vuuren 2016; Johnstone and Kivimaa 2018; Markard 2018; Geels et al. 2017).

Figure 1 illustrates the complexity of challenges of structural change in coal regions with examples along five dimensions which can contribute to a "carbon lock-in". These challenges result from historic developments, including past (structural) policy measures, and are therefore region-specific. This difference in structural change processes in coal regions increases the complexity for policy making and therefore the uncertainty structural policies have to deal with.

Figure 1 also illustrates that the success of a transition cannot only be measured in, for example, the number of new jobs created but must consider the variety and complexity of the aspects depicted in the dimensions of Figure 1. The following subchapters present more detailed information on the challenges to be considered in structural change processes.

Figure 1: The "carbon lock-in" of coal regions and actors originates from various challenges



Source: DIW, own depiction

[4] The information of this chapter and its subchapters is based on our research which combined an extensive literature review, analyses of the structural change processes in Lusatia and in the Ruhr area in Germany (Ragnitz et al. 2021a and 2021b; Dahlbeck et al. 2021a and 2021b) and related in-depth analysis and experience from projects on transitions in coal regions beyond Germany.

2.1.1 Technical challenges

Significant progress has been made in recent years regarding the technical feasibility of sustainable energy systems. The costs of renewable energy technologies have decreased significantly in the last decade and is now just a fraction of the price compared to the time when Germany started deploying photovoltaic and onshore wind on a significant scale. Many studies have modelled energy systems which are entirely based on 100 % renewable energies – not only for Germany but also for the global energy system (Henning and Palzer 2012; Jacobson et al. 2017; Löffler et al. 2017). Among the technical challenges that remain are:

Local heat supply: Local and district heating systems exhibit a strong technical path dependence (DIW Berlin, Wuppertal Institut and Ecologic Institut 2019). If cogeneration units are no longer to be fuelled with coal or are decommissioned entirely, high regional investment may be needed in order to provide alternative renewable and energy-efficient heat supply.

Transportation infrastructure: Rural and peripheral coal regions, such as Lusatia in Germany, often suffer from infrastructural deficits that are a disadvantage for location decisions of companies. Improved rail and highway connections to major cities and reliable public transport are helpful to increase such regions' attractiveness as a company location as well as a place to live. Careful management is necessary to prevent a growing inequality between cities and rural areas, including in terms of connectedness.

Digital infrastructure: High-speed data connections are a prerequisite for the creation of an attractive business environment, yet, they are still widely lacking, especially in rural areas (RWI 2018).

2.1.2 Political challenges

Megatrends, such as globalisation, urbanisation, digitalisation and demographic change, can induce or accelerate structural change processes and have therefore an effect on the framework conditions for political decision-making. Regarding structural change processes in coal regions, common political challenges are, inter alia, uncertainty, the timely development of an adequate institutional framework for transition processes, coordination, communication and the short-term focus on legislative terms.

Political contexts – history and legacies: The region of Lusatia in East Germany still suffers from the effects of the change of the political and economic system following the German reunification in 1990 which led to the breakdown not only of the mining sector but of the whole economic system in East Germany (Stognief et al. 2019). Substantial political changes and economic breakdown have taken place also in many Central and Eastern European countries after the collapse of the Warsaw Pact system and after the Yugoslav Wars. The prospect of EU membership gave many of them orientation as well as political and financial support; nevertheless, the transition necessary to fulfil the accession criteria has been challenging.

Region-specific institutional framework for designing the process of structural change: As the case studies of Lusatia and the Ruhr area show, former mining regions have specific needs that cannot be addressed with a "one-size-fits-all" approach. Structural policy decisions should therefore be driven by regional needs and at the same time include all relevant political levels, depending on the local context.

Coordination between municipalities, political levels and policy fields: If mining cities follow individual and competing strategies, this may result in redundant industries and projects. In order to be able to fully exploit the regions' economic potential, a region should develop a coherent strategy (Oei, Brauers and Herpich 2019). An institution that conceptualises and coordinates development strategies across the region, as it exists in the Ruhr area, might help guide the structural change and improve stakeholder participation (ibid.).

Participation: Effective political decision making is not possible without participation of all relevant groups affected by a policy. Stakeholder participation is needed to gain valuable information on how to achieve appropriate policy outcomes, and it can increase public acceptance and therefore the legitimacy of a policy process and its results.

Communication: Political decision makers from all levels should regularly engage in exchange with affected communities. An appropriate and effective communication needs to be (region-)specific, transparent and honest. When the achievements of people and regions are not acknowledged, mutual exchange and understanding are more difficult. Despite the possibility of challenging reactions, honest communication needs to address potential consequences, both positive and negative, to achieve legitimacy and credibility. A lack of communication between political levels and policy fields in a multi-layered system can result in policy incoherence.

Short-term focus on legislative terms: Politicians often plan along election cycles. Hence, there are limited incentives for long-term action beyond the scope of election terms. Politicians are therefore – even if the positive effects would prevail in the long term – often reluctant to take structural policy measures that may be unpopular in the short term for fear of losing votes.

Corruption and nepotism: Additional aspects hindering a transition can be existing structures of corruption or nepotism leading to a non-transparent and inefficient allocation of funds and administrative capacity. Suboptimal policies based on formal and informal influencing channels can hamper all stages of political decision making, including in the early agenda setting stage.

2.1.3 Economic challenges

From an economic perspective, the phase-out of coal mining is inevitable because coal deposits deplete and because coal is becoming increasingly uncompetitive compared to other sources of energy. Dependency on the coal sector is a major risk for successfully managing structural change. Regions often rely on the industry for tax revenues and jobs. Hence, it is crucial to provide viable alternatives.

International business environment: In some cases, decisions about the future of industries are made by transnational companies and stakeholders – a fact which should be considered in the design of transition policies and in the governance of their implementation.

Mono-industrial dependence: In former coal regions, the levels of industrialisation, research intensity and innovation capacity are often relatively low (RWI 2018). This may result in a lack of alternative employment opportunities beyond coal which can cause structural unemployment and decline with devastating impacts on regional development and prosperity. A lack of alternative employment opportunities can also boost emigration.

Innovation capacity: Skillsets of coal workers, for example, in mines and power plants, vary widely, affecting their individual opportunities to find new employment in other sectors. Furthermore, large-scale industrial structures in coal regions fuel the perception of employees being workers instead of potential entrepreneurs. Therefore, local actors often prefer to preserve industrial structures instead of creating new enterprises and engaging in innovative projects.

Diversified educational opportunities and research-business clusters: Universities and research facilities are often not integrated into networks of companies and other institutions. This limits opportunities to create competitive and resilient structures which keep companies in the region and attract new businesses. In Lusatia, only two universities exist, concentrating skills in the respective cities. However, due to a lack of high-skilled job opportunities, emigration after completing a degree remains a problem (Oei, Brauers and Herpich 2019). As a further challenging element, responsibility for education policy falls under various political levels in some federal systems.

Planning security: Affected regions in transition often lack planning security due to a complex set of external factors driving structural changes. It is impossible to fully eliminate uncertainty in complex transition processes. A lack of a certain level of planning security and management processes can reduce investment and resilience.

Costs of recultivation and liabilities, for example, eternity costs: Coal mining impacts nature, biodiversity and landscapes and thus causes substantial costs for decades after mining has stopped. The polluter-pays principle is rarely ensured, and companies are not sufficiently held accountable to secure funds in a timely manner before the regular mining business ends. If legal obligations for companies have not been in place before the end of mining, it often falls back on public funds or foundations to pay for the liabilities (Oei, Brauers and Herpich 2019; Oei et al. 2017).

Post-industrial sites and lack of land for new companies: Old mining sites and abandoned industrial sites often require high investment before they can be transferred to other uses. This can lead to a scarcity of land for new companies which could bring new jobs to a region. Investors are less likely to purchase land in a region if inherited burdens pose an investment risk.

Loss of tax revenues: The end of coal operations can lead to a massive decline of tax revenues for local and regional authorities, especially if regions are highly dependent on coal industries. This may constitute a challenge for municipalities which use tax revenues from coal companies to finance important public services and municipal infrastructure, such as schools, public transport, cultural and sport facilities.

2.1.4 Social challenges

Phasing out coal causes a major transition for society, especially in regions that are directly affected. In addition, there are further challenges, such as demographic change and a lack of alternative employment, which make it even more important to manage the structural change in a socially responsible way in order to reduce social hardship for negatively affected regions and communities.

Demographic change: Rural regions in particular face the challenges of demographic change, for example, an ageing population and emigration. Such developments aggravate the shortage of skilled workers (RWI 2018).

Direct and indirect job losses: The closure of coal mines and power plants causes a direct loss of – often well-paid – jobs. Affected by indirect job losses are, inter alia, upstream businesses in the supply chain and businesses directly dependent on the coal sector, for example, energy-intensive industries, the service sector around coal infrastructure and, for example, the chemical industry in Lusatia. Regional effects differ between

a) people who are currently employed in these sectors and are to become unemployed in the future (this number depends, inter alia, on the speed of closure and on the age structure of employees) and
b) the loss of future employment opportunities for people who do not yet work in these sectors (for example, vocational trainees).

Level of education and awareness: A lack of education about complex processes, like climate change, and their regional implications, a lack of capacity to cope with uncertainty and a lack of understanding for the dynamics of climate and energy policies can decrease the capability to engage in a transition process.

Redistribution of income and wealth; poverty: Poorly managed transitions can accelerate an unintended redistribution of income and wealth and therefore increase poverty if effective social support schemes are not in place.

Soft location factors: Soft location factors like opportunities for leisure time, including culture and sport, as well as the quality of environment (air pollution levels, clean rivers, etc.) play an important role in the public perception of a region. They influence the perceived quality of life in the region and can convince people to stay or to move to another region. Migration is not only caused by better job options but also by a higher cultural potential of other regions (Oei, Brauers and Herpich 2019).

2.1.5 Cultural aspects of regional identity

Identity aspects play a major role in former coal regions – not only for the workers but for all of society. Therefore, the energy transition is a very personal subject for many people that touches upon their deeply held convictions.

Regional identity: The affected regions are often significantly shaped by coal mining. Over decades, mining has become a central part of the regional identity, characterising landscapes and everyday life. In the past, coal regions have often enjoyed high recognition and were positively associated with economic growth and independence. This, along with the influence of powerful trade unions and strong ties between businesses and governments at state and federal levels, helped to prevent a faster transition away from coal. The close regional attachment to coal mining often prevails even when mining declines and jobs are cut. In the case of Lusatia in East Germany, the lignite industry is still considered highly important for the region by a large part of the population (Müller 2017).

Personal identification of workers with coal mining: In the past, a strong identification and pride existed among workers with the tough and often dangerous mining job, thought to be essential for regional prosperity. However, the perception of coal mining as an attractive and necessary job is fading which might facilitate the transition away from coal in other countries, especially when other well-paid jobs are available (Oei, Brauers and Herpich 2019). At the same time, insecurity about the future of jobs and the perception of a fading attractiveness of one's occupation can lead to psychological stress (Müller 2017) and can constitute a fertile ground for identity crisis.

Social cohesion: Poorly managed processes of structural change may cause people to feel left behind or ignored by local, regional and (inter-)national politics.

Division of society: In the transition debate in Germany, there is a division between actors supporting change and actors supporting the status quo (Leipprand and Flachsland 2018). The future of coal touches very personal subjects, such as possible job losses or relocation. This can lead to heated debates and social tensions (Müller 2017).

Weariness of change: The term "structural change" is often negatively connoted among actors in former coal regions. People tend to associate it with a loss of the "old and proven", while novelty is perceived as uncertain and therefore negative. The public debate in former mining regions often tends to be fear- and shortage-driven (Leipprand and Flachsland 2018). People fear a loss of income, a lower standard of living and even displacement if they must leave the region for economic reasons (Müller 2017).

2.2 Typology of coal regions

Coal mining regions differ with respect to many characteristics, and each region is unique with specific capacities and specific challenges calling for tailor-made structural policies. This means that there is no blueprint for a just transition. When looking at experiences from other regions for inspiration, it is important to understand key differences between coal regions. To support this reflection, we have identified six categories[5] which we consider to be of fundamental relevance. This selection is not aiming to be a comprehensive list of indicators to compare coal regions. An extensive list would include many other aspects, such as the potential for economic diversification or the discretion of local and state levels to make far-reaching decisions. Instead, the six categories presented in this chapter were chosen to illustrate similarities and differences that impact effective transition policies.

2.2.1 Coal type

The type of coal which is mined in a region strongly impacts the industrial potential of a region and the consequences of decline in coal mining. Therefore, lignite (brown coal) and hard coal mining regions should be distinguished when designing policies.

- Lignite is of lower quality (lower energy intensity, high water content). In consequence, it is uneconomic to transport lignite over long distances. Therefore, lignite is mainly used for electricity generation in power plants within a 50 km distance of mines. In consequence, a closure of mines implies a closure of power plants and vice versa. Even a reduction of coal use, for example, by reducing the electricity production of individual power plants, can make large scale mines uneconomic and could lead to a complete shut-down of coal mining in a region.
- Hard coal is of higher quality and can be transported over long distances. A global hard coal market exists, and hard coal mining regions face global competition. Hard coal mining in the Ruhr area, for example, was phased out due to competition from imported cheaper coal. With the imported coal, it was possible to continue the electricity and the steel industries based on coal in the Ruhr area, even after the last mine closed in 2018. As a complement, some hard coal mining regions strongly rely on export options. An extreme case is Colombia which exports 95 % of the coal mined in the country (IEA 2017a).

Regions with high-quality hard coal have a higher potential to attract other industrial activities, for example, in the steel industry. In the past, lignite mining regions were only able to attract other industries, for example, chemical industry companies, under specific framework conditions, such as the demand for autarky in key sectors in the centrally planned economy of the German Democratic Republic (GDR). Whether a region can attract a variety of industrial and other economic activities strongly influences options to support a transition away from coal. In general, the risk of job losses is higher for lignite mining regions because mining and coal use are closely interlinked and because it is virtually impossible to sustain one without the other.

[5] These categories were identified based on a literature review of structural change processes in coal regions, on our own empirical analysis of Lusatia and of the Ruhr area as well as on expert judgments by participants in the EU Initiative for coal regions in transition.

2.2.2 Population density

When searching for measures to support coal regions in their transition away from coal, one important factor is whether the region is highly urbanised, for example, the Ruhr area in Germany or Upper Silesia in Poland, or mainly rural, for example, Lusatia in Germany or Western Macedonia in Greece. This difference strongly influences options to attract new businesses and skilled workers to the region, needs and efficiency of infrastructure, education and research facilities as well as the quality of life, including cultural institutions and much more.

We chose “population density” as an indicator to characterise urban or rural areas. However, the subject is more complex. A key difference with respect to potential pathways for structural change is whether the population in a region is growing or declining. Depopulation is a massive challenge for regions as it requires, for example, the downscaling of existing infrastructure under the constraint of shrinking (tax) revenues. Thus, the rate of population growth could be a separate indicator. It can be observed that rural areas are generally more inclined to decreases in population than urban centres.

Furthermore, it needs to be noted that a detailed look at the specific location is necessary when reflecting the possible transferability of structural policy approaches. For example, the two biggest lignite mining regions in Germany, Lusatia and the Rhenish lignite mining region west of Cologne, are both regions with a relatively low population density but the distance to urban centres makes a difference in their prospects because the options for former mine workers and their children to stay in the region and to commute to work instead of moving further away are fundamentally different.

2.2.3 Economic prosperity

The overall economic prosperity of a region based on economic diversification strongly impacts its capacity to handle the challenges of structural change. In economically thriving and sufficiently diversified regions, workers in the coal sector can often find jobs in other well-paid sectors. In contrast, in regions with high unemployment rates and a lack of economic diversity, mine closures constitute a major threat both to individuals and municipalities – even if the total number of jobs is relatively low. Furthermore, prosperous regions have a higher potential to create attractive framework conditions for new businesses and skilled workers, for example, by public support for education and research, transport infrastructure, social services and cultural attractions. To showcase one clear indicator for economic prosperity, we have chosen GDP per capita which indicates a region’s potential to invest in forward-looking structural policies.

2.2.4 Existence of national coal phase-out policies

An essential framework condition for coal regions is the respective energy policy framework and the national energy strategy (or regional energy strategies in those countries with energy-related mandates at the regional government level). It is decisive for structural policy measures whether a coal phase-out plan and a final termination date exist or not. Currently in Europe, almost all Northern and Western European countries have either retired their coal fleet or have clear plans to do so. In contrast, in most Central and Eastern European countries, no explicit coal phase-out policies exist[6].

A coal phase-out plan or final termination date gives a clear framework, which the development of a transition strategy can build on, and therefore increases planning security. It facilitates discussions of stakeholders in the region because the question "Why should we act and when?" loses importance and stakeholders can immediately reflect the question "How should we support the transition?". It is important to note that even in the absence of specific coal phase-out plans, framework conditions may exist which lead to a reduction of coal mining. Examples for this range from the EU Emission Trading

[6] See https://beyond-coal.eu/data/ for an overview of the status.

Scheme to national environmental protection laws such as in the Czech Republic. However, stakeholders may have a different understanding about the impacts of these political conditions on coal mining and use in a country. Therefore, their participation in structural policy processes is very important.

2.2.5 Advancement of regional transition strategies

The decline of coal mining is not a new phenomenon. For many decades, coal mining regions around the world had to adapt to changing market conditions and to the decline of (easy-to-mine) coal reserves. In consequence, many coal regions have already developed transition policies or are currently developing them to prepare their region for a future with less or no coal mining and use. It is important to note that in the past, most structural policies were triggered by economic factors, and examples of regions with elaborated policies exist (see examples of the Czech Republic and the Ruhr area below). The future challenge will be to develop strategies which are more anticipatory and proactive and which take into consideration environmental drivers such as climate change mitigation. In any case, the framework conditions for regional decision makers are more favourable if a consistent and agreed transition strategy for a region exists.

2.2.6 Anticipated speed of transition

Structural change processes in coal regions happen at different speeds. One extreme example is the hard coal mining phase-out in the Ruhr area in Germany where the decline of coal started in 1957 and the last mine closed more than 60 years later in 2018. In contrast, in Lusatia in Germany, 90 % of mine workers lost their jobs within a few years after the German reunification in 1990.

The effectiveness of policies supporting regions in their transition strongly depends on the speed of the transition. In consequence, it makes a big difference for decision makers in a region whether they expect the decline of coal mining to happen within a few years or during several decades. However, while one could easily classify past processes on a range between gradual structural change and structural break, this classification is more difficult for ongoing processes. To anticipate the speed of the current and future transitions, we assessed factors like the existence of a coal phase-out plan and an exit date for the use of coal, the existence and the time horizons of a structural change programme, transition strategies of coal companies and the participation in frontrunner initiatives like the EU Initiative for coal regions in transition.

2.3 Profiles of selected coal regions in Central and Eastern Europe

Based on the six categories to differentiate coal regions (see Chapter 2.2), this chapter briefly sketches the situation of three exemplary coal regions in Central and Eastern Europe, namely Gorj County in Romania, Upper Silesia in Poland and the Ústí Region in the Czech Republic (Figure 2). These regions were selected because they represent key coal regions and countries in Central and Eastern Europe and exhibit a considerable variation along the six categories. Therefore, they serve as examples to illustrate the diversity of coal regions in Europe which is important to consider when trying to derive recommendations for future coal transitions based on past experiences as will be done in subsequent chapters. Figure 3 provides an overview of these three regions in 2019. The categorisation is relative to national averages. For a comparison, findings from previous research on Lusatia and on the Ruhr area in Germany at the beginning of their analysed transition periods (Lusatia: 1990, Ruhr area: 1960) are presented, too. More details on both regions in Germany are presented in Chapter 3.

Figure 2: Location of selected coal regions in Central and Eastern Europe

Source: E3G, own depiction

Gorj county is located in the southwest of Romania and is the country's main lignite region. It produced 24 Mt of lignite and had 4.5 GW of coal capacity as reported in 2018 (Alves Dias et al. 2018). 13,140 coal-related direct jobs, with 10,600 jobs in mining and 2,540 jobs in power plants, existed in the region (Alves Dias et al. 2018). Gorj County had 320,000 inhabitants in 2018. With 57 inhabitants per km^2, the population density was slightly below the national population density in 2018 (Eurostat 2019a).

Because GDP per capita of the region was below the national average, its economic prosperity can be considered low in 2016 (Eurostat 2018). The most important sectors of the economy are energy production, industry, agriculture and tourism. The unemployment rate was 7.7 % in 2017, which was above the national average of 4.9 % (European Commission 2019).

In Romania, there was no coal phase-out or transition under discussion at the regional or national levels at the time of this paper's analysis. In fact, Romania's energy strategy confirmed an important role for fossil fuels and foresaw only a slight decrease in coal use (Ministry of Energy of Romania n.d.).

Coal accounts for a quarter of the energy produced in Romania and is considered crucial for ensuring the stability of the energy system.

Similarly, no tangible steps had been taken to develop a transition strategy for Gorj County. Once initiated, it can be expected that a transition of Gorj County could be slow for the following reasons: First, Romania's government has supported coal and has tried to extend coal power plants' lifespans. Moreover, it has a direct financial stake in the coal industry as it owns 77 % of the country's main lignite coal producer, Oltenia Energy Complex (Complexul Energetic Oltenia, CEO), which is situated in Gorj County (Ciuta and Gallop 2018). Second, until recently there existed no coal phase-out date. In addition, no just transition strategy was under consideration by the government.

Upper Silesia is the southeastern part of Silesia and Poland's main hard coal mining region as well as today's largest hard coal mining area in the EU. The Upper Silesian basin consists of 30 hard coal mines and produced 64 million tons of coal as reported in 2018 (Alves Dias et al. 2018). The coal sector provided 87,700 jobs in the region, with 84,200 employed in mines and 3,500 working in power plants (Alves Dias et al. 2018). In 2018, 4.5 million people lived in the Silesian Voivodeship, which covers a part of Upper Silesia. With 370 inhabitants per km², population density in the Silesian Voivodeship was considerably higher than the national population density (Eurostat 2019).

Upper Silesia's economy is dominated by mining, energy and heavy industry. Because GDP per capita was slightly above the national average in 2015, it can be considered an economically prosperous region. However, there are big differences between urban and rural subregions in Upper Silesia. Similarly, the unemployment rate of 5 % in 2017 was below the national average but varied between cities, for example, Bytom had an unemployment rate of 10 %. Upper Silesia is also characterised by low levels of professional activity and employment because many males aged above 50 receive special mining sector pension benefits (Bukowski, Sniegocki and Wetmanska 2018).

Poland is extremely dependent on domestic coal for its energy supply. Coal made up 79 % of energy production and 51 % of total primary energy supply in 2015. However, coal production is declining due to a lack of profitability and has more than halved from its peak in 1987 (IEA 2017b). Poland's government remains committed to coal and no national coal phase-out is under discussion. In fact, Poland's National Energy and Climate Plan (NECP) indicates that Poland will still produce 60 % of its energy from coal in 2030 (Ministry of Energy of Poland 2019).

Despite shrinking amounts of minable hard coal and declining competitiveness of the coal sector, neither the national government nor the public authorities of Upper Silesia have made meaningful advances in developing a strategy to guide the transition of the region. The speed of such a transition can be expected to be slow for the following reasons: First, structural changes have already been ongoing since the 1990s. Second, strong ties between the coal industry and the national government hamper change as major coal companies are partially or fully state-owned. Lastly, there is no coal phase-out date to guide a transition. On the other hand, Upper Silesia's role as a pilot region of the EU's Initiative for coal regions in transition might enhance the speed of the transition. Various local stakeholders are increasingly engaged in transition debates.

The Ústí Region is the Czech Republic's main lignite mining area. It is located in the northwest of Bohemia sharing a border with Germany. Its six opencast mines produced 52 million tons of lignite in 2015. The mines and adjacent coal power plants provided 7,000 relatively well-paid direct jobs which made up 3.8 % of jobs in the region as reported in 2018 (Schulz and Schwartzkopff 2018).

The Ústí Region had 820,000 inhabitants as reported in 2018 (Schulz and Schwartzkopff 2018). With 157 inhabitants per km², the population density was higher than the national average in 2018 (Eurostat 2019). Economic prosperity in the region is low as the regional GDP per capita was below the national GDP per capita in 2018 making it one of the poorest regions in the Czech Republic. The Ústí Region has a strong industry sector which, aside from lignite mining and electricity generation, focuses on the production of lower-value parts for the car industry, on the mineral and metal industry

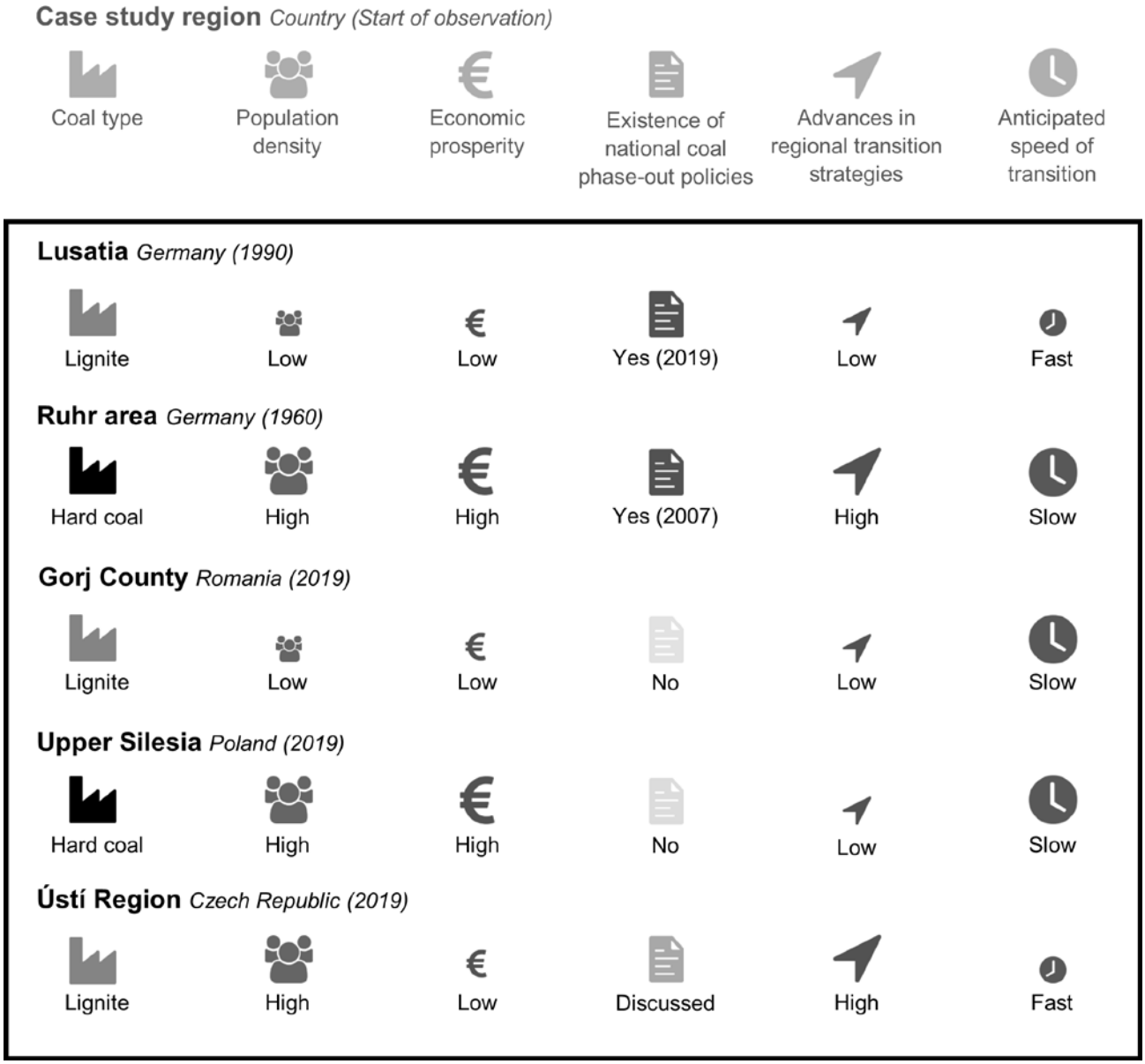
as well as on machinery and chemicals. With 8 %, the Ústí Region was the Czech region with the highest unemployment rate in 2017 (Schulz and Schwartzkopff 2018).

The Czech Republic does not have an official phase-out date for coal but the need for a transition away from coal is increasingly discussed. The national energy strategy from 2014 foresees a decreased role for fossil fuels and a reduction of jobs in the lignite sector over the coming decades. It assumes a halving of employment in mining from 20,000 jobs to 10,000 jobs between 2015 and 2035, and the number of workers employed in coal power plants is projected to decrease from 5,000 to 2,000 in the same period (Czech Ministry of Industry and Trade 2014). Moreover, there exist phase-out plans for several coal plants.

The Ústí Region has already made advances in the strategy development for a regional transition as it takes part in a national strategic framework for the economic restructuring of the country's three mining regions. The strategy named RE:START is a top-down programme with the goal to diversify the regional economy, to improve training of the workforce and to attract investments for the regions. It was adopted in January 2017 by the former social democratic government after the country's main coal regions had requested support in developing their economies.

Given its strategic advances and the economic situation of coal in the country, it can be expected that the transition will be relatively fast for the following reasons: First, RE:START has the potential to enable well-managed structural change in the Ústí Region as the strategy can provide a frame for coordination between decision makers and local actors, and it will help to attract targeted investments and partners for projects. Second, the region's engagement as a pilot region in the EU's Initiative for coal regions in transition can be expected to catalyse change. Finally, the strongest actor in the energy sector, Czech Energy Works (České energetické závody, ČEZ), is already reorienting its business model away from coal and is planning to phase-out or sell capacities (Schwartzkopff, Schulz and Goritz 2017).

Figure 3: Categorisation of coal regions in Europe



Source: E3G, own depiction

3 Structural change in coal regions in Germany

3.1 Structural policies in two coal regions in Germany

Germany has a long tradition in coal mining, and the coal and steel sectors were extremely important for Germany's economy in the past. However, Germany has also seen a strong decline of its coal mining activities over the last decades. Consequently, coal regions in Germany have developed a wide range of approaches to support and to govern the transition processes they were facing. Detailed analyses of the structural change processes in two major coal mining regions – the lignite mining region Lusatia in East Germany and the hard coal mining Ruhr area in West Germany – are given in two case studies (Ragnitz et al. 2021a and 2021b; Dahlbeck et al. 2021a and 2021b). This chapter gives a summary of these processes and related policies.

3.1.1 The lignite mining region of Lusatia[7]

The Lusatian region extends across two states of Germany: The larger, northern part of Lusatia is located in the State of Brandenburg; the smaller, southern part is located in the State of Saxony. Lusatia is a rural area with 1.1 million inhabitants. The largest city is Cottbus with 100,000 inhabitants. The closest urban agglomerations are Berlin, Dresden and Leipzig.

Lusatia is Germany's second largest lignite mining region. In 2016, 62 million tons were mined corresponding to 35 % of Germany's lignite production. In Lusatia, 94 % of the lignite produced is used for the generation of electricity and heat in combined heat and power plants. Mining is done exclusively in opencast mining at four sites, covering a mining area of 87,000 hectares (Statistik der Kohlenwirtschaft 2019).

Mining activities in Lusatia date back to 1815. From the 1950s onwards, mining was strongly increased because lignite was the only major domestic energy source for the GDR. In 1988, 80,000 miners were employed in the region, producing 200 million tons of lignite (Statistik der Kohlenwirtschaft 2019). However, due to the geological conditions of Lusatia, high transport costs and insufficient replacement investments, this type of energy supply was highly cost-intensive (Kahlert 1988).

After the German reunification and the establishment of a market economy in East Germany, the uncompetitive costs of lignite energy were a major factor of massive structural disruptions in the Lusatian region. Lignite was used less and less for heating purposes and large parts of the chemical industry in the region were shut down. The remaining industry used oil as a basis. Power plants were modernised, thus using less lignite for the same amount of electricity generated. Consequently, the production of lignite plummeted, and many mines were shut down: The annual output regressed to around 55 million tons of lignite in 2000 and has remained constant since then (Statistik der Kohlenwirtschaft 2019). Between 1990 and 1999, direct jobs in lignite mining decreased from 80,000 to 8,000 (ibid.). As a result, the unemployment rate in the mining region increased to 20 % in the 1990s, and many people migrated from the region leading to a net population loss of 18 % between 1995 and 2015 (Markwardt and Zundel 2017). In some of the counties (Landkreise) with formerly high mining activities, population even decreased by 30 % (ibid.). An area of more than 55,000 hectares was recultivated, meaning converted into farmland, forests and lakes.

Since the structural disruptions in Lusatia did not differ significantly from those in other parts of East Germany, the structural policy of the federal government and of the States of Brandenburg and Saxony was not specifically directed to Lusatia but to East Germany as a whole. In the early 1990s, structural policy at federal and state levels aimed at mitigating the negative impacts on the labour market, yet,

[7] This chapter is based on Wehnert et al. 2017.

with only modest success in many cases. Since the end of the 1990s, structural policy has become more innovation-oriented. However, especially the economic and structural policy in the State of Brandenburg mainly aimed at strengthening already existing sectors instead of diversifying economic structures. For Lusatia, this meant that the region was defined and still defines itself as an "energy region" which tried to enhance the remaining lignite industry, for example, by developing carbon capture and storage (CCS) technologies, as well as to build up renewable energies. When it became apparent that public acceptance of CCS was too low to be pursued further, the shift towards renewable energies provided opportunities for the region in production, installation, operation and maintenance of wind, photovoltaics and biomass energy generating facilities. Yet, it is perceived as challenging to fully substitute past and also future losses in jobs or GDP due to the foreseeable reduction of coal mining and use (IÖW 2017). Older and less well-trained lignite employees in particular have found it difficult to find jobs in other sectors in the past (Franke et al. 2017). In addition, assessments of the innovation system of Lusatia conclude that the region is not sufficiently developing innovations. This is, inter alia, since employees in large-scale coal mining and energy industries perceive themselves as workers and not as entrepreneurs. The non-mining companies in the region are generally quite small with only few options and ambition for extensive growth. In addition, most potential new job opportunities – in the renewable energy sector or in new business opportunities – are paying lower salaries, resulting in an average salary drop of 26 % when leaving the lignite industry (Franke et al. 2017).

Since Germany started to debate an accelerated coal phase-out in 2014 and agreed on it in 2019 (see Chapter 3.2), the economic situation in the mining regions is increasingly discussed as part of an energy policy debate. Various proposals have been made on how miners or mining regions, especially Lusatia, could be supported in the coming transition process (Agora Energiewende 2017; enervis 2016; especially Kommission Wachstum, Strukturwandel und Beschäftigung 2019). With a new phase of structural change in the Lusatian region becoming more likely, several institutions have been set up locally to strengthen the region's capacity and to diversify it economically (Markwardt et al. 2016).

Today, Lusatia is still characterised by many indicators as a structurally weak region in Germany. Because especially young people left the region in the search for new jobs, the average age is above the national average. Population projections predict a further decline (25 % between 2015 and 2040) which would represent a steeper decline compared to neighbouring regions (Agora Energiewende 2017; Markwardt et al. 2016). Nevertheless, the region shows signs of economic recovery: The unemployment rate of Lusatia in the State of Brandenburg halved from ca. 20 % in 2004 to about 10 % in 2014 which is still higher than the national average but comparable to other structurally weak regions of East Germany or of the Ruhr area (Agora Energiewende 2017; Albrech, Fink and Tiemann 2016). Although the mining, energy and water sectors still strongly contribute to jobs and economic wealth creation, the region is on a pathway towards diversification (Kluge et al. 2014).

3.1.2 Hard coal mining in the Ruhr area

The Ruhr area encompasses Germany's most densely populated conglomerate of cities with about 5.1 million inhabitants. It is located in the State of North Rhine-Westphalia.

For most of the 20th century, the Ruhr area was perceived as Germany's industrial heart (Petzina 1984) because 80 % of the country's hard coal was mined there (Oei, Brauers and Herpich 2019). After decades of decline and massive government subsidies, hard coal production was finally phased out in 2018. No other region in Germany and Western Europe was as strongly influenced by coal mining and by the coal and steel industry as the Ruhr area. The reasons for this were the unprecedented size of the coal deposits and the large companies in the downstream coal utilisation sectors, i.e., the iron, steel and electricity industry which settled there.

Mining activities in the Ruhr area date back to the Middles Ages when farmers mined coal for their own consumption. After the Second World War, the mining industry became highly important for West Germany's reconstruction and a driver for the so-called "economic miracle" ("Wirtschaftswunder") that spread across the Federal Republic of Germany. Hard coal also ensured the security of energy supply and energy independence, especially in times of oil crises (Berghahn 1985). At its peak in 1957, the hard coal mining industry in the Ruhr area employed more than 500,000 people and produced more than 120 million tons of coal per year (Statistik der Kohlenwirtschaft 2017). However, from the end of the 1950s, Germany's hard coal became less competitive due to the liberalisation of the formerly regulated coal price and – later – due to the abolition of import duties on oil. Domestic coal then had to compete with comparably cheap coal from overseas, and oil increasingly substituted hard coal in the heating sector (Heinze et al. 1996, 14). As a result, after 1958, hard coal production and employment declined quickly – employment more than halved within ten years (Statistik der Kohlenwirtschaft 2017). Yet, the unemployment rate was relatively low at first. The development of the steel industry during the period of the so-called "economic miracle" allowed most employees to move into the steel sector, and particular structural policy measures in a wider sense, i.e., including social policy measures, allowed many workers to retire early. Since the oil and steel crisis in the 1970s, the employment rate in the Ruhr area strongly increased and reached a peak in 1987/88 with more than 15 %. It was then well above the averages of the State of North Rhine-Westphalia (10.8 %) and of West Germany (8.4 %) (Statistik Regionalverband Ruhr, 2017).

During the coal- and steel-industry dominating years, a comprehensive coalition of political and economic actors and trade unions had emerged in the Ruhr area. For a long time, this coalition regarded the decline of the coal and steel industry as a temporary crisis. Due to this perception and to the material and psychological significance of the Ruhr area's industry, structural policy measures mainly aimed at preserving the coal industry through technological modernisation and by supporting workers who were facing continuous income losses. Furthermore, political thinking aimed at one policy solution for the entire region, meaning support for one economic branch, for example, the health sector, which would be able to replace the coal and steel industry. The preservation of the old industries and the search for only one alternative branch slowed down structural change and impeded the diversification of the regional economy as well as a small-scale functional differentiation. This changed only at the end of the 1980s with a refocussing of the structural policy towards a more regionalised approach and, more consequently beginning at the turn of the millennium, with a sector expertise-oriented structural policy which promoted the model of a "Metropolis Ruhr" in which individual regions have differentiated areas of expertise (Bogumil et al. 2012).

As in many other parts of Germany, the regional economy developed from an industry-based economy towards a mainly service-based economy: In 2014, the service sector accounted for 72 % and the industrial sector for 28 % of the economic output of the Ruhr area (VGR der Länder, Revision 2014, o. J., calculation IAT).

One vision of the structural policy for the Ruhr area was the development towards a so-called "knowledge region". The first university in the Ruhr area started its lectures in 1965.[8] In 2017, more than 270,000 students studied at universities, colleges and research institutions in the Ruhr area (Statistik Regionalverband Ruhr 2018).

The results of structural change and structural policy of the last six decades in the Ruhr area are ambiguous: "Much achieved, little gained" ("Viel erreicht – wenig gewonnen", Bogumil et al. 2012, own translation), is the main conclusion of 60 years of structural policy for the Ruhr area.

On the one hand, the high employment losses in the coal and steel sector have not yet been fully compensated. Although the unemployment rate has fallen to 11.5 % in 2015, it was still above the

[8] https://uni.ruhr-uni-bochum.de/de/geschichte

average of the State of North Rhine-Westphalia (8.6 %) and of Germany as a whole (8.4 %) (Statistik Regionalverband Ruhr, 2017). Due to the lower productivity and the lower value-added and income effects of the alternative jobs, the regional economic development in the Ruhr area remains well behind the trend in Germany. Furthermore, the Ruhr area does not have a uniform economic and social structure but a differentiated one: In the southern Ruhr area where structural change started earlier, the development is much more advanced than in the northern Ruhr area which is still characterised by high (long-term) unemployment and a weaker economy (Bogumil et al. 2012).

On the other hand, the societal cohesion in the Ruhr area has been maintained by buffering the social implications of the reduction of employment. Despite significant job losses, compulsory redundancies and structural breaks, as were experienced in East Germany after the reunification, have been prevented in the Ruhr area. The recultivation as well as a strong improvement of the infrastructure in the education, traffic and leisure, including culture, sectors have improved the quality of life in the region. The development of old industrial sites, like the former hard coal mining site "Zeche Zollverein" (customs association colliery), towards a venue for research institutes, start-ups, museums and other tourist attractions acknowledged and preserved the regional achievements of the past. The Ruhr area is now one of the densest "knowledge regions" in Germany and Europe and a tourist destination of growing importance (Prognos AG and InWIS-Institut 2015).

3.2 Climate politics: A paradigm shift in Germany's transition debates

In recent years, debates on structural change processes in Germany's coal regions have received increasing attention (again), and since 2018, they have been a priority on the political agenda of the federal government as well as of affected state and local governments. Recent developments indicate different drivers for transitions compared to the historic structural change processes in Lusatia and in the Ruhr area which were summarised in Chapter 3.1.

Namely, climate change due to global warming is one of the most threatening challenges to human well-being[9], and several international policies aim at mitigating its effects, for example, the United Nations Framework Convention on Climate Change (UNFCCC) and related agreements like the Paris Agreement. Because of the necessary commitments to limit global warming, the paradigm of transition debates has changed in Germany: Concerns about climate change play an increasingly important role in discussions about the future of Germany's coal industry because the burning of coal causes a large share of CO_2 emissions from power production in Germany. In 2018, seven of the top ten emitters of CO_2 in Europe were lignite power plants in Germany (Sandbag 2018). The German federal government started to reduce lignite capacity in 2016 by deciding to transfer 2.7 GW of lignite capacity to a lignite reserve. In the same year, the federal government presented a Climate Action Plan identifying emission reduction targets for 2020 and 2030 in all economic sectors. In its 2018 coalition agreement, the German federal government committed to establish a Commission on Growth, Structural Change and Employment (also referred to as "coal commission") mandated to help implementing climate change mitigation policies by recommending a path for a coal phase-out as well as for policies, including funding mechanisms, for the transition and structural development in affected coal regions (see box below). This indicated a paradigm shift which deviates from past structural policies in Lusatia and in the Ruhr area in four ways:

Climate change is a major driver of structural change: Climate change mitigation requires policies which help to reduce greenhouse gas emissions. Policy outputs like the Paris Agreement and long-term climate strategies help defining emission reduction targets which are further specified in national documents like the German Climate Action Plan. The establishment of the Commission on Growth,

[9] IPCC (2014): Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland; https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf.

Structural Change and Employment in Germany with the particular mandate to recommend a coal phase-out pathway for Germany was meant to contribute to closing the gap to the national 2020 and 2030 emission reduction targets. The work of the commission integrated requirements and consequences of climate policy and politics into transition debates in Germany's coal regions to a far greater extent than was the case before. The historic structural change processes in Lusatia and in the Ruhr area – in contrast – were mainly driven by the economic decline of parts of the coal industry which was abrupt in the case of Lusatia and steady in the Ruhr area (Ragnitz et al. 2021a and 2021b; Dahlbeck et al. 2021a and 2021b). In both regions, governments had sought to revive the coal industry or – later – to manage the economic decline. Concerns about climate change and environmental impacts had played only a minor role in regional transition debates and structural policies before.

There is awareness of a significantly shorter time frame for the transition: Recent research by the Intergovernmental Panel on Climate Change and others (IPCC 2018) proved scientifically the urgency of emission reduction which triggered new discussions about an accelerated coal phase-out in Germany and globally as fast as possible (Climate Analytics 2018). In contrast, the phase-out of hard coal mining in the Ruhr area took place over a time frame of six decades: Starting in the late 1950s, the last hard coal mine was closed in 2018 only. The transition period was characterised by a mix of newly developed and regularly adapted policies to address social and economic challenges in the region in a "trial-and-error-mode", comprising a range of policies which aimed, first, to preserve existing industries and, later, increasingly promoted diversification and at the same time providing support to ease social challenges of the structural change. Similarly, after the sharp decline of employment in Lusatia's lignite industry, the situation stabilised in the 2000s. In the absence of stricter environmental and climate legislation, the burning of lignite in Lusatia continued to be a competitive element of Germany's energy mix which is why the motivation to diversify in Lusatia was relatively lower. Many stakeholders consider time to be a key factor for a just transition. Sufficient time is crucial to allow for a smooth structural change process which gives policies intended to support economic development and ease social challenges enough time to have an effect. But the current and anticipated impacts of climate change already now create immense time pressure. To govern a just transition which is fast enough for communities affected by climate change is a new challenge for structural policy and therefore a new aspect in the transition debate.

The transition is now shaped proactively: The composition of the Commission on Growth, Structural Change and Employment provided the opportunity for an early and more proactive planning of structural policies. In the past, structural change processes have largely been addressed reactively, driven mainly by the economic decline in the regions. The abrupt structural break in industrial regions in East Germany, including Lusatia, was a consequence of wider political, social and economic developments after the German reunification. A large part of the industrial and energy sector in East Germany, including its coal industry, was not competitive in a market economy after the period of the centrally planned economy in the GDR. This triggered a rapid decrease in industrial economic activity and employment. Structural policy for East Germany has been a reaction to these developments. In the Ruhr area, policy makers reacted to the decreasing economic competitiveness of Germany's hard coal on the global market and the linked risks to industry and employment. Most of these reactive policies aimed at protecting industry and jobs or buffering negative social and economic consequences.

Region-specific policy measures developed with a wider participation of stakeholders receive increasing attention: Against this background, the political debate about the future of affected regions beyond coal took centre stage in the Commission on Growth, Structural Change and Employment. The members of the commission were chosen to represent most affected stakeholder groups. This created a larger diversity and opened a process where most stakeholders had the chance to participate in the process to plan for the transition. It is however noticeable that some groups, including youth organisations, were not yet represented.

The commission is evidence for all four major paradigm shifts mentioned above: The German federal government decided to accelerate and shape the coal phase-out based on concerns about reaching emissions reduction targets, inter alia, with region-specific measures developed with a wider participation of stakeholders. Its outcomes and governance are outlined in the box below. Although the commission was targeting the nation-wide coal phase-out, many region-specific measures were agreed. Region-specific policies developed with a broad participation of stakeholders was a largely new approach in Lusatia. Before, structural change processes in Lusatia had been targeted by policies either for all East German states together or for the respective States of Brandenburg and Saxony. The Ruhr area had a regionalised structural policy, which however developed over time into a structural policy specific for the State of North Rhine-Westphalia.

The Commission on Growth, Structural Change and Employment ("coal commission")

The Commission on Growth, Structural Change and Employment started with a first meeting in June 2018 (BMU 2019) and was mandated:

- to close the gap to reaching the domestic 2020 emissions reduction target (-40 % emissions compared to 1990) to the extent possible,
- to reach the domestic 2030 emission reduction targets for the energy sector, including a robust impact assessment,
- to gradually reduce and end power production from coal, including the identification of a phase-out date and recommendations for accompanying legal, structural, economic and social measures,
- to ensure financial support for the transition in the affected regions and make funds available for the necessary structural change.

The commission with 28 voting members included representatives from federal, state and local governments, industry, trade unions, academia and civil society. It was asked to develop one joint proposal supported by at least a two-thirds majority. Four ministries formed a Steering Group of the Commission. Four heads – three representatives from states most affected by the coal phase-out and one climate economist – moderated the discussions in the commission which ended with a hard-fought compromise in January 2019. The recommendations were planned to be translated into legislation on coal phase-out and structural change until the end of 2019. This process was, however, delayed and only implemented with some deviations in 2020. Key recommendations of the commission's report included:

- a coal phase-out by 2038 at the latest, including a review in 2032 to decide whether the phase-out date can be preponed to 2035,
- an additional closure of 7 GW of coal capacity until 2022 and a continued reduction of coal capacity to 17 GW in 2030 (equivalent to a ca. 50 % reduction compared to 2019),
- redirection of investments of € 2 billion per year into transition funding for affected regions for the next 20 years,
- early retirement schemes for coal workers above 58 years and additional retraining and job guarantees for younger employees,
- compensations for utilities for early closures and potential compensations for households and industry in the case of rising energy prices due to the coal phase-out,
- regular review mechanisms to monitor progress to adapt ambition.

Internationally, the activities of the commission were observed closely in the light of Germany's leading role in the energy transition and its significance as a major coal burning country, but also regarding good and bad practices for how to manage transitions driven by climate challenges in a highly industrialised country. For this reason, outcomes and governance of the commission, including ambition level, trajectory, compensation mechanisms, bottom-up elements, phases of the negotiation and modes of moderation, could all be essential learnings for phase-out debates and transition policies in other sectors and countries.

3.3 EU and global policies facilitate the paradigm shift

Renewable energies are one growing industry sector for many regions affected by coal transitions. In Germany, around 350,000 jobs in the renewable energy sector have been created by 2018. This number is also rising globally: In 2017, more than 500,000 new jobs emerged globally resulting in overall employment figures of more than 10 million (IRENA, 2018). The existing geographical mismatch of renewable and fossil fuel potential, however, will result in distributional effects because renewable energies-related employment is in most cases more evenly spread throughout a country and less concentrated in specific regions. Furthermore, job conditions of the renewable energy sector differ from job conditions in the coal sector: Salary levels are often lower, and unionisation is weaker in the renewable energy sector, while health, safety and environmental risks are much lower. According to recent studies, the net impact on GDP of ambitious climate policy is positive, especially benefiting growth sectors, such as renewable energies, energy efficiency, e-mobility or circular economy. Negative employment effects are however likely in some strongly affected sectors, including coal. Employment effects per sector should therefore be managed closely to pursue opportunities and buffer negative consequences.

In December 2019, the European Commission presented the "European Green Deal"[10], a strategy for a climate-neutral EU by 2050 which also addresses challenges of resource efficiency, social justice and other sustainable development goals (SDGs)[11]. This strategy and the related policies constitute a key opportunity to facilitate transition processes in European coal regions. With the European Green Deal, the EU has put low-carbon activities at the heart of the EU economy and at the same time commits to ensure a good future for affected regions. The European Commission considers an ambitious climate policy, not the least to ensure competitiveness, growth and social cohesion, to be an integral part of sustainable development. It will now have to deliver on these commitments by aligning EU structural funds, the Just Transition Fund and the Structural Reform Support Programme with these policy goals, including to reduce the risk of stranded carbon-intensive assets.

Already since 2015, the SDGs have provided a vision for sustainable development and since then have given orientation for policy development. Several assessments reflect to which extent the implementation of particular policies contribute to the achievement of one or more SDGs. With a similar focus, the consortium has assessed the potential contribution of coal phase-out policies and renewable energies' phase-in policies to the implementation of SDGs as well as the potential synergies and trade-offs of these policies. We found that combining the phase-out of coal with the phase-in of and replacement by renewable energy sources can even out many trade-offs (see Figure 4). Considering the substance of the different SDGs, which are relevant for the transition of the energy system when developing respective transition policies, can therefore contribute to regional sustainable development.

[10] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

[11] https://www.un.org/sustainabledevelopment/development-agenda/

Figure 4: Selection of synergies and trade-offs of phasing-out coal and phasing-in renewable energies in relation to the SDGs

SDG	Phase-out of coal		+	Phase-in of renewables		=	Coal → Renewables switch	
	Trade-off	Synergies		Trade-off	Synergies		Trade-off	Synergies
1 NO POVERTY	i.a. employment	i.a. climate change			i.a. employment		i.a. employment	i.a. climate change, employment
2 ZERO HUNGER	i.a. employment	i.a. climate change		i.a. land utilisation	i.a. employment		i.a. employment	i.a. climate change, employment
3 GOOD HEALTH AND WELL-BEING		i.a. pollution & climate change						i.a. pollution & climate change
5 GENDER EQUALITY		i.a. climate change						i.a. climate change
6 CLEAN WATER AND SANITATION		i.a. pollution & climate change						i.a. pollution & climate change
7 AFFORDABLE AND CLEAN ENERGY	i.a. electricity prices	i.a. reduction of average CO_2/kWh			i.a. electricity prices, reduced CO_2/kWh		i.a. electricity prices	i.a. electricity prices, reduced CO_2/kWh
8 DECENT WORK AND ECONOMIC GROWTH	i.a. employment, electricity prices				i.a. employment		i.a. employment, electricity prices	i.a. employment
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	i.a. employment, electricity prices				i.a. employment, electricity prices		i.a. employment, electricity prices	i.a. employment, electricity prices
13 CLIMATE ACTION		i.a. climate change			i.a. climate change			i.a. climate change
14 LIFE BELOW WATER		i.a. pollution & climate change						i.a. pollution & climate change
15 LIFE ON LAND		i.a. pollution & climate change		i.a. land utilisation				i.a. pollution & climate change

Source: DIW, own depiction

4 Specific lessons from structural change processes in Germany

This chapter presents specific lessons from structural change processes and related policy measures for lignite and hard coal mining regions in Germany which provide – in addition to the "coal commission" process outlined in Chapter 3.2 – inspiration and learning experiences for future structural or transition policies in other sectors or in other countries.

4.1 Examples of structural policy measures[12]

Education and research – a key success factor for forward-looking regional transitions

At the peak of their mining activities, all mining regions in Germany had either an education and research system that was predominantly geared towards energy- and mining-related expertise or very few academic facilities (for example, the first university in the Ruhr area started giving lectures only in 1965) which had built very little capacity for a more diversified economy. Diversifying the knowledge base in these regions has been one key success factor to prepare the transition away from coal industry. The strategic approaches taken have been different from region to region which corresponds to the different framework conditions in Germany's coal mining regions, for example, when comparing the urban Ruhr area with rural Lusatia. In the Ruhr area, a wide variety of scientific institutions have been established successfully over the last decades.

However, developing a future-oriented and effective education, research and innovation system is not an easy task. Many different approaches have been tried and some have proven to be less successful. For example, the technology transfer initiative in the State of North Rhine-Westphalia in the 1980s and 1990s aimed at bringing science, industry and trade unions together in a huge networking effort – but it turned out to be too academic and lacked practical relevance (Heinze et al. 1996). One successful example is the Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT: It started in the 1980s based on engineering knowledge related to coal but from the beginning explored options to use this knowledge in more future-oriented fields. Environmental engineering, for example, water and soil treatment, became one approach which bridged the existing capacities with future business models. Today, the institute is active in many industry sectors, including material science, chemistry and energy. More generally, investments in education and research with a focus on innovation can be crucial pillars of transition processes and therefore appropriate forward-looking structural policy measures.

Joining forces in a regional economic development agency – the example of the Zukunftsagentur Rheinisches Revier in Germany's largest lignite mining area

The Rhenish lignite mining region in the west of Germany is a rural area but close to many urban centres. Compared to its 2.2 million inhabitants, the 10,000 jobs in coal mining and power plants may sound negligible. But the availability of cheap lignite attracted many energy-intensive industries which today provide more than 90,000 jobs, i.e., more than 10 % of all employees in the region work in this sector. Against the background of a foreseeable end of coal mining, the question "Which future for the region?" emerged well before Germany's recent coal phase-out plans.

Municipalities, business associations of the region and the German mining, chemical and energy industry trade union (Industriegewerkschaft Bergbau, Chemie, Energie, IG BCE) joined forces and became shareholders in a newly founded regional development agency: the Zukunftsagentur Rheinisches Revier[13]. In the beginning, it struggled with a weak mandate and inadequate funding. However today, it is an important promoter of regional development. Since 2014, the agency has been active in developing a shared vision and a development strategy for the region. It has organised idea

[12] This chapter is based on Wehnert and Oei 2019.

[13] http://rheinisches-revier.de/

contests, networking events and conducted studies on the prospects of specific industry branches. Such activities should be standard routine for a development agency. Important specifics of this agency are:

- The towns of the region reduced competition against each other and joint forces to establish the agency, and
- the agency promotes a future-oriented thinking of a proactive structural policy. For example, a process has been started to develop ideas for site conversion of major power plants in the region. Despite significantly later shutdown dates, various stakeholders in the region started developing ideas of how the existing infrastructure could be used for other purposes.

Reliable support through EU structural funds, strong participatory elements and the vision-oriented mandate have been additional key success factors for this agency.

Effective remediation and conversion of decommissioned lignite mining facilities improve location factors – the example of LMBV

The Lusatian and Central German mining management company (Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft, LMBV) has remediated and converted decommissioned lignite mining facilities of the former GDR which had been operated in the mining regions of Lusatia and in the so-called "Central German" coal region (today on the territory of the States of Saxony, Saxony-Anhalt and Thuringia) for more than 20 years. This happened on behalf of and was financed by the German federal and the states' governments. The achieved remediation and conversion of former lignite mining sites have been a success story: LMBV's activities have created safe landscapes that offer new prospects – not only for the people in the regions but also for future activities and businesses in the regions. It also performs backfilling and securing of decommissioned potash spar and ore mines (LMBV, 2017). A key lesson from this example is that remediation does not only require a reliable legal framework (respective regulations exist in most European countries) but also a strong institution which is backed by political will and sufficient funding. Expertise which has been developed by LMBV is not only crucial for the future of landscapes in Lusatia and Central Germany but could also support similar processes in coal regions of other countries.

Environmental revitalisation and participation improve the local quality of life – the example of the International Building Exhibition Emscher Park

In the 1980s, the Emscher river was one of the most polluted rivers in Europe. At this time, the core of the industrial activity in the Ruhr area had already moved north – following the availability of coal – leaving the Emscher region with many very unattractive post-industrial sites. To respond to this legacy, a new programme was launched, the so-called "International Building Exhibition Emscher Park" (IBA Emscher Park). In some ways, this programme marked a new approach in the structural policy of the Ruhr area. It focussed on improving the quality of life in the region. Between 1989 and 1999, more than 120 projects were implemented and supported by investments with a volume of DM 5 billion (€ 4.4 billion real) – two thirds came from public budgets of all political levels (EU, federal level, state level, municipalities) and one third were private investments (Goch 2009). Projects included measures to implement an underground sewage system, to improve water quality and to develop new living spaces for citizens and nature. The touristic attractiveness of the region was increased by transforming former industrial sites into cultural landmarks, thereby preserving the region's coal-related history. Furthermore, 17 technology centres were created, and mining damages were remediated to the extent possible (Goch 2009; Scheck et al. 2013).

The approach of IBA Emscher Park successfully improved the quality of life in the region and thus supported "soft" location factors. With a short-term view on employment, the programme itself managed to create only few new jobs. But it is generally acknowledged that it did increase the attractiveness of the region – also for companies and for qualified workers. Some of the cultural

landmarks have become major tourist attractions, drawing national and international visitors to the region. Combined with the participatory approach, including bottom-up elements with relevant local stakeholders, IBA Emscher Park helped to strengthen regional identity by appreciating coal-related heritage and at the same time opening the region for forward-looking opportunities.

Enabling conditions which were important for the success of IBA Emscher Park have been

- the availability of public funds,
- an appropriate time frame for programme execution (10 years) and
- a development agency which was created specifically to execute the programme and therefore was liquidated at the end of the programme.

The formation of a run-off business can help to govern the phase-out of coal – the example of the RAG

In the case of hard coal mining in the Ruhr area, the RAG corporation was a key institution which helped to govern first the phase-down and then the phase-out of hard coal mining in the Ruhr area: All separate coal mining companies merged into one (private) corporation. In doing so, it was possible to manage the structural change more efficiently by closing down those mines first which were economically least competitive and by transferring laid-off workers to another mine within the RAG corporation more easily. While such an approach might not be transferable to many regions due to the economic situation of coal-related assets and to specific socio-economic factors in the Ruhr area of that time, the RAG corporation still provides relevant lessons for governing a transition process.

In 2007, when the German federal government, the governments of the coal mining states North Rhine-Westphalia and Saarland, the RAG corporation and the IG BCE agreed to discontinue government subsidies for hard coal mining in Germany by 2018, the assets of the RAG corporation were brought into a foundation (RAG Stiftung) with an initial capital of € 2 million (revenue in 2018: € 454 million). The new RAG foundation aims at three key objectives (RAG, 2019):

- **Ensuring that coal mining is discontinued in a socially acceptable manner:** The foundation provides training to the employees promptly so that they can re-enter the job market, and it is also informing them about new employment opportunities.
- **Financing eternity mine management:** Even after the closure of mines, many duties remain to be undertaken and financed, such as securing the shafts and tunnels, eliminating mining-related damage, executing the eternity management of pit water and groundwater, etc.
- **Supporting education, science and culture:** The RAG Foundation supports education, science and culture in the region. It specifically supports institutions that used to be regularly funded by the RAG corporation and whose survival would be at stake with the cessation of coal mining, inter alia, the German Mining Museum as well as the miners' choirs and orchestras.

4.2 Effectively communicating coal transitions

Structural transitions are complex processes. In terms of structural change processes in coal regions, Figure 1 illustrates the different dimensions of challenges to be addressed by region-specific structural policies. Such complexity implies a certain level of uncertainty which requires flexible policy making. Past experiences show that all transition processes come with successes and failures. Complexity, uncertainty and the likelihood of failure need to be communicated to increase understanding for and acceptance of the structural change process in the short, medium and long term.

In addition, decision makers and stakeholders must understand, accept and communicate clearly that not all sectors and people will benefit from a transition. Diversification and innovation can lead to new prospects for a region and to new jobs – but uncertainty about the likelihood of success for potential investment options prevails.

Communicating potential benefits and losses is already a challenge per se. It is even more challenging when the audience struggles to understand the necessity and complexity of change in order to cope with uncertainty. Therefore, investments into education and awareness-raising are crucial for the success of structural change processes. These investments start with education at schools where the perception of and the response to complexity and uncertainty should be taught, and it continues with programmes for vocational training. Investments into research and development, finally, provide the basis for innovation which is one of the many factors that facilitates the success of transition processes.

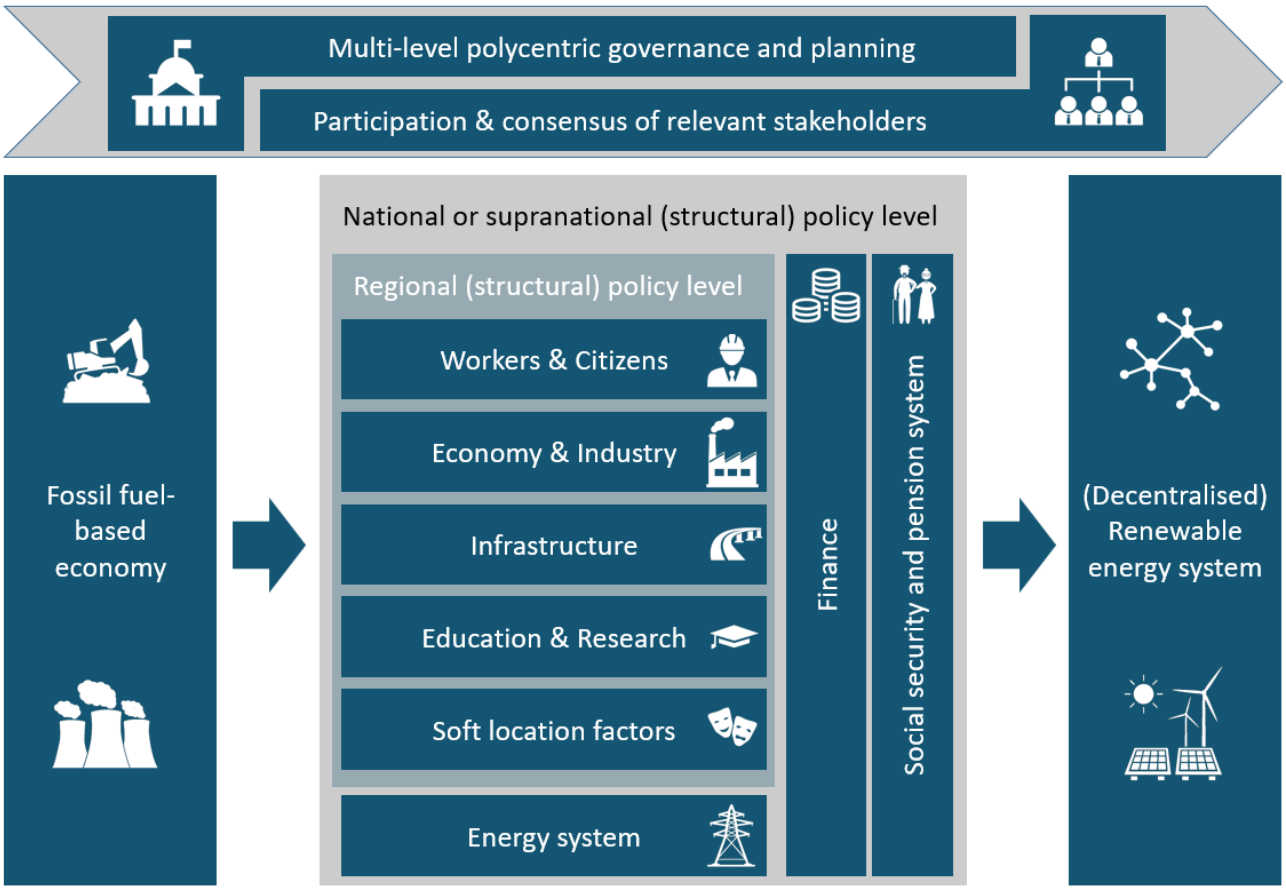
Whenever possible, decisions that shape framework conditions should be communicated early to improve planning security. For the case of structural change processes in coal regions, coal phase-out announcements can provide planning security for all affected stakeholders and trigger innovation for regions. While many older coal workers will retire throughout the phase-out process, younger employees and upcoming generations can require additional training or reskilling based on often valuable existing skills and experience.

Therefore, a tailored communication approach is necessary to facilitate transitions. It should be (region-)specific, transparent and honest. It should acknowledge the achievements of people and regions, be open for mutual exchange and understanding as well as proactively encourage participation. Such an honest and constructive communication fosters legitimacy and credibility and can even improve policy coherence across political levels and policy fields in a multi-layered system.

4.3 Governing and financing a transition

Because of their complexity, transitions should be governed following a multi-layered and multi-faceted approach providing for the cooperation of local, regional, national and international actors, including stakeholder participation and bottom-up elements, across administrative boundaries and policy fields. Figure 5 illustrates such an approach using the example of a transition from a fossil fuel-based energy system towards an energy system based on renewable energy sources.

Figure 5: Governing a just and timely transition from fossil fuels to renewable energy sources



Source: DIW, own depiction

The focus beyond administrative boundaries especially applies to coal regions because many of them cover a geographical area which does not correspond with administrative boundaries. Coal regions can consist of several municipalities which sometimes compete for funding or for attracting new businesses. Lusatia in Germany even spans across two states, and the coal fields extend into neighbouring Poland. Considering also other policy fields in the governance of transitions can facilitate the debate on the diversification of the economy in a region – which can increase its prospects to benefit from a transition.

Integrating new, sometimes weakly organised actors, such as climate activists and youth groups, as well as those affected by structural change in the regions, such as coal workers or villagers living next to coal mines, is critical for developing appropriate policy measures with high legitimacy and acceptance – and it is crucial to ensure social cohesion in regions. In the case of energy transitions, participation of groups most affected by climate change and by climate policy – which can be very different groups – will help to address relevant questions in the debate on appropriate policy measures.

Furthermore, the institutional framework, including a clear definition of roles and responsibilities, influences the performance of policy development and implementation. Past examples in coal regions have shown that setting-up region-specific institutions, which work across boundaries, have a specific mandate for the development of a coherent transition strategy and ensure institutional learning, is one successful approach to facilitate a transition process.

Eventually, communities and people are decisive for shaping change in their regions. Only with the support of communities, policies can deliver a strong, diversified economy, social justice and a healthy environment.

In this context, finance is a key opportunity and challenge. Transition policies constitute investment opportunities in many policy fields and economic sectors – but they also constitute major financial risks. For this reason, access to funding and smart, coherent financing mechanisms are key for aligning financial flows with transition policy goals. Therefore, it is important to ensure coherence of funding across policy fields and political levels. A good mix of local, regional, national, EU or international public and private funding significantly impacts the success of the transition process. In this complex financing environment, policy makers must ensure access to funding for different stakeholders, including local actors and initiatives, and allow for forward-looking projects. Given the inevitable uncertainty in transition processes, it is essential to provide planning security to the extent possible. Furthermore, it can be an option to designate funds for regional or bottom-up experimental approaches. Experience from the Ruhr area proves that experimental approaches with different formats is helpful. Funding mechanisms should reflect this insight, and proactive communication should encourage stakeholder participation in order to include their local and technical knowledge in this process of experimentation. Often, public funds will not be enough to address transition challenges. Hence, attracting diverse private investments and cooperation with local business initiatives should be given sufficient attention, too.

5 Conclusions and lessons learnt

Coal mining regions in Europe and globally have previously experienced structural change and will continue to undergo changes in the future. Transitions bring specific benefits and challenges to the regions: The opening of mines often created economic prosperity but also caused environmental damage and associated health risks. Technological advancements made working in coal mines safer but also reduced the number of workers required. Depletion of mines or changes in the economic framework conditions and their implications for the competitiveness of domestic coal mining have often resulted in unemployment and a decreasing population, but in many regions, safe, well-paid jobs were created in the transition process and the quality of life eventually increased.

In recent years, structural change in coal regions was accelerated by a new driver: climate change mitigation policies. While historic structural change processes in the analysed regions, Lusatia and the Ruhr area, were mainly driven by disruptive political and economic change after the German reunification in the former case and by a gradual loss of economic competitiveness in the latter case, current policies to frame a coal phase-out are increasingly driven by necessities of climate change mitigation. Effectively reducing CO_2 emissions requires a rapid reduction of coal use in Europe and globally in the next two decades. This will accelerate the speed of structural change in coal regions. Nevertheless, this is not the only driver of current dynamics. Coal regions are also challenged by other megatrends, such as globalisation, urbanisation, digitalisation or demographic change. A policy-induced change like phasing out coal to help mitigate climate change is often perceived as a more "deliberate" choice, implying an even higher responsibility of governments to reduce social hardship for regions and people that are negatively affected.

Timing is crucial for proactive, forward-looking structural policies. In the past, governments have intervened in structural change processes in coal regions with different approaches, ranging from reactive approaches in early transition phases to forward-looking approaches in later phases. Based on past evidence in our case studies, early-phase subsidies and support schemes were used to protect industry and jobs which conserved existing structures and which sustained coal jobs even when mining was already uncompetitive. This hampered forward-looking policies and innovation and thus prevented new job opportunities for upcoming generations. Meanwhile, paradigms of structural policy have shifted and showcase more awareness for timing and forward-looking policies, including investment in education and research. Today, multi-faceted potential challenges for coal regions are often anticipated. From an economic perspective, the phase-out of coal is inevitable because coal is becoming increasingly uncompetitive compared to other sources of energy. From a climate perspective, the transition must be accelerated to limit global warming. **For coal regions, it is in their self-interest to proactively ensure planning security and a just transition early in the process.** The analysis of past processes revealed that successful structural change processes can last several decades. Starting early and thinking long-term will be key to manage a timely and just transition in future structural changes.

At the same time, it is important to **be realistic on what structural policy can deliver.** "Much achieved, little gained" ("Viel erreicht – wenig gewonnen", Bogumil et al. 2012, own translation), is the main conclusion of 60 years of structural policy for the Ruhr area in Germany. Once the "heart" of Europe's coal and steel industry, the region today is both a modern, innovative, highly industrialised megacity region but also a hotspot of inequalities and unemployment in Germany. This is an example for the limitations of structural policy in coal regions: It has the potential to frame and shape transition processes to reduce negative consequences, but the decline of coal-related industries cannot easily and not fully be compensated. Importantly, structural policy cannot compensate for past policy failures and cannot solve all other challenges of social and economic policy in a region. To illustrate the range of possibilities: Despite the dramatic loss of almost 500,000 jobs in coal mining since the late 1950s, economic development and structural policy for the Ruhr area have managed – in the very particular

framework conditions of that time – to keep the total number of jobs in the region almost constant. In contrast to this, in Lusatia, the "heart" of the GDR's energy supply, industry – not only coal mining – collapsed after the German reunification which increased the challenges to be addressed by structural policy after 1990. 30 years later, the region is still struggling with the impacts of this structural break. Because the framework conditions in the Ruhr area have been so particular, it is more likely that structural policies for other rural regions, including lignite regions in other parts of Europe, will operate in less favourable framework conditions much closer to the conditions in Lusatia.

Each region is different and requires a tailored structural policy. Inspiration from past policies and other regions is essential for learning and policy making. There is a wealth of knowledge on good practices and failures from past structural policies in coal regions which can inspire political decision making. However, achievements in one region are not easily transferable to other contexts as different coal mining regions show very distinct characteristics. The urban, densely populated Ruhr area in Germany has much more in common with Upper Silesia in Poland than with the rural region of Lusatia in Germany. Therefore, even within a country, structural policy measures may not be transferable to other regions. When developing transition policies to shape structural change in coal regions, a detailed analysis of the regional framework conditions is crucial to identify region-specific opportunities and challenges for tailored transition strategies. These framework conditions comprise, inter alia, technical, political, economic, social and cultural conditions (see Chapter 2.1). Despite all differences, learning from past policies and other regions is possible and promising. A prerequisite to understanding the usability of lessons is the awareness of similarities and differences of the framework conditions. Due to the complexity of structural change processes, it is, however, hard to trace back stories of success and failure of structural policies to single policy measures. Instead, successful structural policies have been a mix of tailored measures addressing the specific framework conditions. In Chapter 2.2, we distinguished six key categories to better understand similarities and differences of coal regions: the type of coal produced, population density, economic prosperity, the existence of national coal phase-out policies, advances in regional transition strategies and the anticipated speed of transition.

There is no blueprint for a just transition. Policy makers must openly and honestly address and communicate uncertainties throughout the process. Each transition process requires learning from past experiences, flexibility and openness to experimental approaches to identify promising paths. Past experiences show that all transition processes come with successes and failures. Because each transition process is complex, decision makers and stakeholders are confronted with a considerable and inevitable degree of uncertainty regarding the effectiveness and efficiency of available measures. Furthermore, decision makers and stakeholders must understand that not all sectors and not all affected people will likely "win" in such a transition. Therefore, an appropriate communication about uncertainties and potential consequences, both positive and negative, is important for the legitimacy and credibility of the process and of the involved actors. Such a communication should be (region-)specific, transparent and honest. It must acknowledge the achievements of people and regions, be open for mutual exchange and understanding and encourage engagement. In addition, an appropriate communication between political levels and policy fields in the multi-layered political system is key to increase coherence of structural policies. Investments into education and awareness-raising are essential for the success of these communication approaches.

Building on strengths and assets of regions and diversifying their economy to avoid lock-ins is a key challenge. Structural change processes can only be managed successfully when building on the strengths and assets of a region. The assets of coal regions include, for example, energy infrastructure as well as capacities, knowledge and institutions of the energy sector. However, with the decline of coal mining, regions are challenged to diversify economically, thereby developing new strengths and skills and decreasing mono-industrial dependencies. Lock-in effects in old structures and specific challenges may, however, become barriers to new visions for a region. We have categorised typical

challenges in coal regions along five dimensions: technical, political, economic, social and cultural aspects. An effective structural policy must consider and integrate all these dimensions. This can also include preserving and repurposing existing infrastructure as done with the site of “Zeche Zollverein” (customs association colliery) in the Ruhr area.

An effective structural policy must ensure participation of all affected stakeholders. Participation can provide valuable insights to achieve strong policy outcomes, and it can increase public acceptance as well as the legitimacy of a policy process and its results. Historic examples show that a multi-layered approach to structural policy is necessary which goes beyond the mere protection of old and the creation of new employment and considers, for example, investments in infrastructure, education and research as well as cultural aspects and health concerns, thus seeking to increase the overall attractiveness of a region. Because existing established institutions and stakeholders often prefer "more of the same", it is important to include new actors in transition processes to widen the focus. Engaging local stakeholders, start-ups and civil society in truly participatory planning processes can leverage creative ideas and prospects for a region, and by enabling regions to benefit from their endogenous potentials, it can reduce local resistance. This is particularly important when incumbents use powerful means, such as larger networks, access to and knowledge about institutions, financial resources and a higher degree of organisation and coordination, to preserve existing structures. The Commission on Growth, Structural Change and Employment in Germany was one example how a stakeholder participation approach can address transition challenges and increase engagement in such processes.

A well-designed governance of change – across administrative boundaries, political levels and policy fields – is essential in transition processes. Because of their complexity, transitions should be governed following a multi-layered and multi-faceted approach to foster cooperation of local, regional, national and international actors across administrative boundaries and policy fields. Carefully designed, inclusive processes and support schemes that foster innovation are a key element of transition policies, including bottom-up elements and demand-side approaches. The focus beyond administrative boundaries especially applies to structural change processes in coal regions because many of them cover a geographical area which does not correspond with administrative boundaries. Historic examples have shown that setting up region-specific institutions, which work across these boundaries – with a clear mandate for the development of a coherent transition strategy – and which ensure institutional learning, are one successful approach to support transition processes. Institutional learning about transition experiences is one critical approach for the efficient use of time and money**. Well-designed funding mechanisms can open opportunities for stakeholders at all levels and ensure coherence across policy fields.**

Effective strategies for a just transition contribute to transformative change. Transitions strategies must ensure that affected regions and people are not left behind and remain able to compete in the future. Thoroughly designed and carefully managed transition processes engaging all stakeholders and affected groups can contribute to regional economic diversification and job creation, to the strengthening of public infrastructure and social services as well as to the restoration of degraded environment, for example, by recultivating landscapes which were impacted by lignite mining. In the case of structural policies, it is important that success cannot only be measured in, for example, new jobs created, but must consider a variety of aspects to address the complexity of structural change processes. For example, jobs lost in the mining industry should optimally be replaced with new jobs in other industries and sectors with at least comparable salaries. Anticipative elements like a communication of phase-out plans, diversifying education opportunities and early retraining can ease the disruptions of upcoming changes by helping former coal miners to stay in the labour market and prevent suboptimal education and employment choices.

Political developments will continue to frame transition processes. The European Green Deal is a key opportunity to enable just transition processes in EU coal regions which help to mitigate climate change, foster sustainable development and make regions more resilient to future crises. In the past, structural policy has largely focused on securing economic prosperity. The European Green Deal calls for a new paradigm: Europe has set itself the goal to align policies with the SDGs and to become climate neutral by 2050. The European Commission will now have to deliver on these commitments, inter alia, by aligning EU structural funds with these policy goals. The transition towards a net zero-emission economy will be a challenge and opportunity at the same time. It will require the courage to embark on new paths. Decades of structural policy in coal regions shed light on a wealth of experiences of what has worked and could be replicated and on mistakes and failures which should not be repeated. In the end, however, it is people which are decisive for shaping change in regions. Only with their support, strategies for sustainable regional development can be successful and create strong, diversified economies, social justice, a stable climate and a healthy environment.

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