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# How to avoid unjust energy transitions: insights from the Ruhr region

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## Abstract

**Background:** The transition of the Ruhr region in Germany from a hard coal belt into a knowledge-based economy with a dynamic service sector and state of the art universities over the past 60–80 years has been widely touted as a successful example of how just and fair low carbon energy transitions can unfold.

**Methods:** This paper leverages documentary analysis of data across a wide array of sources to test these claims and identify lessons by creating a novel just energy transition framework.

**Results:** The study finds economic motivation, mindset and reorientation—not environmental concerns—to be the defining features for at least the first two decades of this shift. The lack of willingness to acknowledge environmental impacts and market realities has delayed the transition and led to wasteful allocation of resources towards supporting the hard coal mining industry. The prominence given to distributional justice cushions the victims of this transition financially, but does not allow a broad based coalition to advance the transition process. It is in the second phase (mid-1980s onwards that we see procedural aspects of justice come forth and support greater ownership and sustainability of the transition to emerge, while the evidence of recognition justice continues to be scant.

**Conclusions:** There are many nuanced successes in the Ruhr's example, along with some failures worth highlighting. It is in the breakdown of this transition into two distinct phases and their nuances (particularly in the domain of justice) that fresh insights emerge and allow for a better understanding of what constitutes a suitable energy transition in a particular socio-economic and political context. As the international community embarks on ambitious greenhouse gas reduction targets, it can maximise the benefits and minimise the damages and costs by considering these realities on the ground.

**Keywords:** Just energy transition, Low carbon economy, Climate justice, Energy justice, Participatory policymaking, Energy inequities

## Background

The list of countries that have vowed to achieve net zero carbon by 2050 or 2060 continues to grow and now includes India, South Africa, Japan, Canada and China [1, 2]. Furthermore, the Global Coal to Clean to Power Transition Statement supported by 77 signatories, of which 46 are countries, at the 26th Conference of the Parties

(COP26) prioritises just and inclusive transitions away from coal [3]. The markets for solar photovoltaics, wind power and batteries are buoyed by cost reductions, making them more appealing to buyers in search for alternatives to carbon-intensive energy [4]. However, will this energy transition usher in economic opportunities and socio-cultural well-being for everyone? History shows that these questions do not generate black and white answers. Energy transitions have been accompanied by abrupt job cuts, physical and mental distress, displacement and opposition [4]. Vulnerable communities in Gujarat, India, for example, have been forcibly displaced

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due to the construction of a large solar project [4]. The coal mining industry in the Ruhr region and elsewhere that supports coal-based electricity production has also suffered heavy losses [5].

Transition, by definition, comes with structural changes, such as rearrangements in policies, economies and societies [6] and redistributes power, resources and risks [7, 8]. The political and economic agendas of ruling elites are contested [9, 10] and there are risks of elite capture that can stymie transformation and perpetuate social inequality [11]. Gillard et al. [12] speak of the need to expose, problematise and resist the continuation of harmful power relations. The rights, responsibilities and worldviews of local people are often ignored, undermining ownership and sustainability [11, 13]. These concerns fundamentally fall in the domain of justice, equality and fairness within the context of sustainability transformations [14]. As a result, the characteristics and nature of the transition need careful scrutiny to ensure that it does not lead to discrimination against individuals, regions or communities and remains aligned with global climate commitments. It leads this paper to ask: Did the transition of the Ruhr region from coal-based to a knowledge-based economy meet components and parameters of justice? What facilitated the transition to a knowledge-based economy in the Ruhr? Finally, where did the transition fall short and what lessons can be learned from?

The term just transition came about in the 1970s in the United States when environmental regulations threatened the jobs of workers in polluting industries. Labour unions insisted on financial assistance for these workers and subsequently partnered with environmental justice coalitions in the 1990's [4, 15]. Since then, scholars have proposed diverse definitions, understandings and viewpoints, and the debate has branched into domains of energy access, sustainability, poverty and climate justice goals. Distributional, recognition and procedural are central tenets of justice in transition literature [16–18].

The transitions literature views energy transitions as a process with material and social implications [19]. This definition broadens the discussion from expert-level questions about the transformation of the energy apparatus to its impact on justice and equity in society [20]. It is leading the academic literature to engage with crucial questions, including on the attributes of the transformation, who benefits from the change and who is central to the process. This level of framing is both wider and more sweeping and demands an “ambitious social and economic restructuring that addresses the root causes of inequality” [21, p. 9], while the former privileges livelihoods support [22]. According to Murphy [23], socio-technical embeddedness, multi-scalarity and power dynamics merit more attention in the process of transitions. Bridge

et al. [24] view transitions as a route towards more sustainable societies.

Just transition is now accepted as an international norm with the International Labour Organisation [25] guidelines for a fair shift to environmentally sustainable society and economy for all. The Paris Agreement also refers to it: “Taking into account the imperatives of a just transition of the workforce and the creation of decent work and quality of job in accordance with nationally defined development priorities” [26, p. 21]. During COP24, the Solidarity and Just Transition Silesia Declaration was officially supported by more than 50 nations [27].

The Ruhr region, comprising 11 cities and four counties, is one of Germany's largest urban conglomerates [28]. Its name stems from the river Ruhr that flows through the south of the region (ibid). Historically, the Ruhr region gained prominence throughout Europe for its hard coal, iron and steel production [29]. In fact, the abundant resources in the Ruhr region supported German military endeavours in World Wars I and II and were crucial to the economic success of West Germany after World War II. In the 1950s, the production of steel and hard coal reached its highest levels in the Ruhr. About 807,400 people were employed in the steel, iron and coal industries in 1957. This comprised around 7/10 of the Ruhr's entire workforce. The hard coal mining sector absorbed some 473,600 workers [30, p. 2].

Since then, the Ruhr region has gained prominence for evolving from a coal, iron and steel economy to a knowledge economy [31]. This transformation away from hard coal has been widely lauded as a prominent case of the management of economic restructuring, although this transition was conducted primarily on account of economic reasons, such as cheap imports and availability of substitutes, such as crude oil and natural gas [25, 31–33]. Coal mining, however, continues for brown or lignite coal in other parts of Germany. Climate Transparency [34] states that Germany needs to accelerate coal and natural gas phase out in line with renewable deployment to achieve the national target of a 65% reduction of emissions below 1990 levels by 2030. Germany started reducing subsidies on coal from 1990 onwards. The 2007 tripartite agreement then gradually phased out the mining of hard coal in the Ruhr and nearby areas by 2018. Meanwhile, it remains the highest producer of lignite coal from open-pit mines spread across the country, which comes with high environmental costs [35]. Employment in hard coal mining in the area fell from 473,000 in 1957 to 11,448 by the end of 2013 and reached zero by 21 December 2018 [36, p. 30].

A just transition cannot be reduced to a checklist but needs to be seen as a participatory process involving workers, industry and governments. It is implemented

with a core set of tenets, such as the International Labour Organisation's Guidelines for a Just Transition. However, there still is a requirement for additional investigation and understanding about several aspects of low-carbon transitions, such as the broader distributional implications, benefits, costs and the effectiveness of governance processes. The literature analysed in this paper was found to comprehensively cover the distributional and procedural aspects of justice. However, the understanding of recognition aspects is downplayed. The widespread claim of "success" is questionable at many levels. We only find a passing mention of failures and facilitators, leaving scope for analysis.

In this context, our value addition to the literature is threefold. Overall, we contribute to a growing body of literature that unpacks the role and influence of justice to the energy transition processes [37–41]. First, this paper goes beyond the dominant narrative of distributional justice, often understood in the form of financial compensation, to shed light on the importance of procedure and recognition justice in energy transition. Second, it debunks the broad brush of success attached to the energy transition process in Ruhr and breaks it down into phases, where different narratives of justice unfold, where they succeed and fail [35, 41]. Third, we identify the key convenors that facilitate the practice of justice. Ours is one of the few papers that have taken this focused and forward-looking approach to justice in energy transition. This paper goes some way in providing energy communities a structured way to consider justice. This article proceeds with a brief description of the methods and conceptual framework, before moving on to the results and discussion. It ends with the conclusion that highlights the main takeaways.

## Methods

In our explorative study, we used a qualitative data analysis approach to arrive at an in-depth understanding of justice, facilitators and failures of energy transition in the Ruhr region. The main research questions are:

1. Did the transition of the Ruhr region from a coal-based to a knowledge-based economy meet components and parameters of justice?
2. What facilitated the transition to a knowledge-based economy in the Ruhr?
3. Where did the transition fall short and what lessons can be learned from it?

We compiled relevant literature and critically examined more than 100 published documents, including academic papers, government reports, grey literature, media reports and blogs on the energy transition in the Ruhr

region. The data was assigned descriptive codes and an active search for burdens and benefits, everyday experiences, stakeholders, quotations, values, policy decisions and key events was carried out. This entailed multiple rounds of careful reading of the texts to identify themes, concepts and patterns, which informed and shaped the conceptual framework as well as the analysis. In this manner, the study will create an elaborate understanding of the dynamics of the transition in the Ruhr region.

We chose documents on the basis of their alignment to our research questions and offer a multi-sectoral perspective and contextual depth. We searched the Google Scholar and Web of Science databases using the following permutations and combinations of keywords: "Ruhr energy policy", "Ruhr just energy transformation", "Ruhr just energy transition", "gender justice Ruhr", "energy Ruhr Germany", "just transitions Ruhr", "Ruhr workers", "fossil fuel workers Ruhr", "coal workers Ruhr", "oil workers Ruhr", "climate change jobs Ruhr" and "just transition policy Ruhr." A broader search was also carried out via the Google search engine and this process was further complemented by the snowball technique to identify more data. The search was carried out between August and December 2020. Literature in English and German was reviewed, because the majority of the literature was available in these two languages and was aided by the language proficiencies of the authors. The geographical focus was on account of this region's elaborately recorded energy transition. Article selection followed a set of inclusion criteria summarised in Table 1 below.

To carry out our analysis, we identified themes around the aspects of transitions that were prominent in the literature as well as any similarities and differences across different publishing outlets. The human interest stories and community experiences came out clearly through newspaper reports and blog pieces. They speak to both the new opportunities and the hardships of the transition at the household level. The academic literature, on the other hand, provided a nuanced phase-based understanding of justice and temporal components of the transition. Some studies, for example, laud the participatory policy framework within which the transition unfolded, while others bring forth the pressure applied by labour unions to move the needle towards distributional justice. Government reports were found to focus on distributional measures and particularly the support offered by the Federal government. We included environmental, climate and energy justice literature to identify theoretical categories of procedural, distributional and recognition justice against which to test the justice components of energy transition in the Ruhr region. The data compiled helped inductively identify a set of facilitators, sources of resistance and failures in just transition. These two

**Table 1** Literature inclusion criteria for this study

Items	Details	Rationale
Context	Just transitions for fossil fuel workers, communities and industry in the Ruhr region	This case study area was chosen due to the recognition of this region as an example of successful just energy transition in wider literature
Language	English and German	We limited the scope of our review to data in the English and German because of the researchers' proficiency in these languages and the availability of documents
Types of publication	Academic papers, books, grey literature, media reports, government documents and blogs	We focused on data from a wide variety of sources to arrive at a more in-depth and diverse understanding of issues central to just energy transition
Period	1960–2020	This is the period during which energy transitions begin to take place and develops offering insights
Database	Google Scholar, Web of Science, Google search engine	Wide usage, credibility and easy access to these repositories
Key words	"Ruhr energy policy", "Ruhr just energy transformation", "Ruhr just energy transition", "gender justice Ruhr", "energy Ruhr Germany", "just transitions Ruhr", "Ruhr workers", "fossil fuel workers Ruhr", "coal workers Ruhr", "oil workers Ruhr", "climate change jobs Ruhr", "just transition policy Ruhr"	The relationality of these keywords to the study region and the research themes

aspects were then stitched together into a framework that provides recommendations for applied interventions for energy transitions (explained below). Put together, this analysis allowed us to thematically organise and identify the key pillars and facilitators of justice. These elements were then linked to form our conceptual framework. The relevant text was mapped against each theme and new themes created wherever required.

### Conceptual framework

The conceptual framework presented in Fig. 1 illustrates the key components of the transition in the Ruhr region from an economy based on fossil fuels to an economy focused on low-carbon energy. Placed in the inner ring, the three main components are distributional justice, procedural justice and recognition justice, which together form the fulcrum of just transition. In practice, these components are not mutually exclusive, i.e., each must be considered in relation to all others. The outer ring presents the convenors, i.e., the elements that facilitate or support the implementation of the components. These convenors are polycentric governance, availability of adequate finance, time scales and ability to overcome resistance.

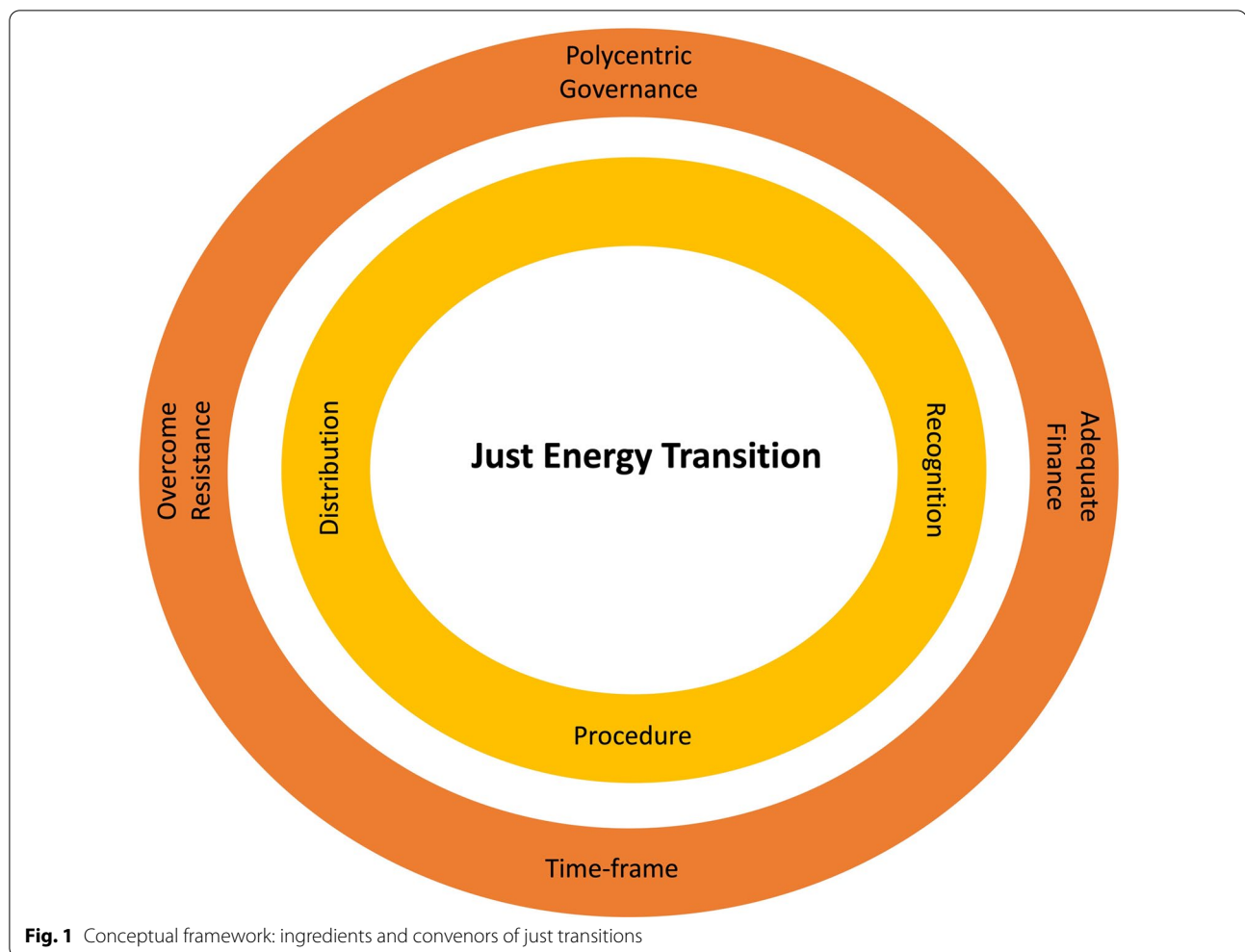
#### Inner ring of justice

Our inner ring of justice includes three components—distribution, procedure and recognition. Distributional justice is primarily related to the equitable distribution of the advantages and disadvantages of transition [37, 38]. The shift in energy systems is often accompanied by financial strains and stresses at individual, community and regional levels. The livelihoods that were lost in

mining must be compensated with equivalent employment in other industries. Furthermore, there are industries that mushroom around mining sites which also suffer from the shutdown. According to Pinker [21, p. 13], distributional justice raises questions, such as: "Which coal mines and oil reserves should be closed down first? Who should be compensated for the financial losses? How can support across companies, workers, households and communities be channelled?" The answers are naturally context specific, and the distributive lens aims to address the questions with rigour.

The procedural justice lens is primarily concerned with the process, methods and mechanisms of transition [37, 39]. The shift in the energy system has a differential and disproportionate impact on stakeholder groups. It is critical to understand their perspective, integrate their concerns and meaningfully involve them in the decision-making process [6, 40, 41]. This brings forth issues of power, participation, agenda-formation, etc. Procedural justice raises questions, such as: Who frames the agenda? Is the process participatory and inclusive? How far does it go towards a more inclusive, equitable and locally owned transition?

Recognition justice lays stress on the treatment of marginalised and deprived communities, differentiation in values, needs and experiences [6]. This form of justice plays a pivotal part in relation to the other pillars of justice and strives to make sense of pluralistic needs [7]. Without recognition, for instance, both procedural justice and distributions are likely to be undermined [42]. In practice, it may entail facilitation techniques that allow constructive and meaningful participation of marginalised communities on their own terms. Recognition



justice raises questions, such as: What worldviews do different stakeholders bring to deliberations? How does a certain group experience energy transition? How will transition impact them and what means can help identify and integrate their understanding into the transition process? The recognition lens allows us to centre our discussion on people and their particularities.

#### Outer ring of justice

The outer ring of the framework consists of the four convenors of just energy transition. These convenors paved the way for the Ruhr to embed justice in its energy transition, which we elaborate on below. Polycentric governance contains a network of interconnected centres of authority for governing matters [41, 43, 44]. This form of governance allows collective action problems to have diverse centres of decision making across scales and levels that operate with some level of autonomy [45–47].

A just transition is difficult to achieve, if not impossible, without adequate finance mechanisms that provide

short- and long-term aid to relevant stakeholder groups [39, 44]. Financial resources are necessary to mitigate price hikes, offer early retirement options and pensions, compensate for damages to infrastructure from underground mines and offer education, research, on-the-job training and tax exemptions, among other things.

Resistance can arise given that there are winners and losers in the energy transition process [4]. For example, the mining workers and unions, mining companies and politicians stand the risk of losing money, power and influence as a result of the transition [49]. They can take coercive steps to prolong or undermine the transition process to protect their interests [29, 51]. Energy transition may face some form of opposition and need to confront hostility.

Finally, our components of just transitions identified above require long time frames that stretch into years, if not decades [36, 48]. A transition process implemented in a rushed manner without considering

temporal dimensions of change can be unbalanced and inequitable and by extension unjust.

## Results

Between 1960 and 2001, the number of workers employed in the mining industry sank by 90% to less than three% of the region's workforce, while employment in the iron and steel sector sank by 80% [4, 21, 25]. In a significant reduction between 1960 and 2001, the mining output declined from 115.4 million tonnes to 20 million tonnes (ibid). In the iron and steel industry, the output in 2001 was 80% less than in 1960 [25]. It is worth noting that this decline came primarily as a result of changes in economic realities, although environmental cleanup was a part of the discourse. There were cheaper substitutes available in the form of crude oil, natural gas and imports from low-wage countries that made the industry less competitive [49]. The sharp decline in demand for cars and ships led to the closure of many steel firms in 1974 (ibid). Academic and policy research literature, in particular, divides the transition into two distinct phases, the first spanning from 1960 to the mid-1980s and the second from the mid-1980s to the present.

### Phase I: economic motivation, mindset and protectionism

The first phase was a period of "reindustrialization and lock-in", where efforts were made to preserve structures and coalitions built around coal and steel [49–51]. The industry was deemed too big to fail and was accompanied by a general sense of denialism that the Ruhr's heavy industries were undergoing permanent decline. There were significant efforts to bolster the scale of the mining industry and pushback against reforms and innovation by traditional industry [49]. Government made significant efforts to enhance the competitiveness of the Ruhr's fledgling hard coal industry [31, p. 224–25, 52]. North Rhine-Westphalia (NRW) made efforts to diversify the economic base of the region and set aside 17 billion Deutsche Mark (equals €32 billion real) as part of a structural programme, "Development Program Ruhr" [50]. A case in point is the invitation to General Motors to build a car factory in Bochum.

Drawing on the conceptual framework, we find distributional justice to occupy prominence during this phase evidenced by monetary relief. The transition was cognizant and responsive to the disproportionate burdens this change placed on the mining community. The so-called "losers" of the shift from fossil fuel-based energy were provided generous social security and welfare benefits long term [44, 53–55]. A case in point is the "redundancy payments" granted to miners who were let go of. The redundancy payments ranged between 2000 Deutsche Mark (USD 1213) and 5000 Deutsche Mark (USD 3033),

determined by age and seniority between 1966 and 1982. The federal government funded this payment, which was to the tune of EUR 223 million (USD 266 million). Meanwhile, the annual disposable income of private households per inhabitant in the Ruhr was approximately 5800 Euros (USD 6475) in 1975 [56].

Financial support amounting to EUR 126.6 billion (USD 141.35) in subsidies was given by the German government to the coal industry between 1960 and 2015 [48]. The government made provisions for appropriate premises to small firms and employment initiatives through access to unused or derelict industrial buildings. There was no legal requirement for the steel industry to clear away the extant pollution as the German government decided to shoulder this responsibility. The Climate Protection Start Programme issued several hundred million euros of loans and grants for low carbon investments in NRW's industry. The Coal Commission called for EUR 40 billion of investment in transition measures and an annual recompense of up to EUR 2 billion for consumers to meet rising energy prices [57].

By the 1980s, there was greater support for economic diversification as well as addressing fundamental challenges, including branching out into renewable energy [58]. Policy-making adopted a bottom-up approach with design and implementation undertaken at the local level with local actors involved [59, p. 9]. This launched a process of "neo-industrialization", through which Small- and Medium-sized Enterprises (SMEs) received a boost [60].

### Phase II: structural change and culture of co-determinism

The procedural and recognition components of justice, reflected in the conceptual framework, take centre stage as the transition reorients itself during Phase II. The Ruhr region (post mid-1980s) also saw a more inclusive approach, wherein support was granted to 'lead markets' with enhanced coordination at different governmental levels [41]. Abraham points to the contribution of sustained militancy by workers and labour unions (IG BCE) to wrest a just transition. He states: "The democratic nature of Germany's corporatist labour relations and industrial planning system, which workers won over a period of decades through continuous labour militancy, forces politicians and energy executives to coordinate and compromise with angry miners" [39, p. 230]. Notwithstanding differing agendas, a number of studies hint towards a less aggressive stance characterised by social partnerships, cooperation and consensus-seeking among stakeholders to arrive at a socially acceptable structural change [55, 61]. This success, in part, can be attributed to the nature of capitalism in Germany and Rhineland, which is recognized for its collaborative ethos which respects employees' co-determination. This sense

of co-determinism coined as *Montanmitbestimmung* [31] provides rights for employee participation and co-determination. For instance, the Works Constitution Act (2001) allows equal representation at the supervisory board: with one-third of the board strength reserved for employee representatives, including proportional gender representation. This structuring paved the way for coordinated negotiation between employers and employees [25].

In 1987, a *Kohlerunde* or ‘coal roundtable’ facilitated in arriving at a deal to scale down the sector by 1995. A customised individual re-employment strategy was crafted for each affected worker [36]. The Coal Commission examined representations from trade unions, environmental groups, industry and academia to develop a schedule for the nation’s changeover [62]. This Roundtable established a mechanism through which “a company had to retain employees for alternative employment or relocate them to other sectors” [61, p. 24]. The agreement allowed miners who had been employed for a minimum of 25 years to retire by the age of 49. They were entitled to a stipend every month for as long as it took them to qualify for a pension. The miners who were younger and with lesser experience were guaranteed alternative employment. The German Coal Association and IG Bergbau, Chemie, Energie (IG BCE) also offered the rest of the hard-coal mine workers a regular sum and decent working conditions if they remained flexible.

According to Oei et al. [41], the financial burden of the transition was carried by the government. Nonn [63] posits that when the coal crisis began, Germany’s strong economy enabled most of the ex-miners of the regions to shift from hard coal to the metals industry. Employment rates were controlled through early retirement and retraining schemes. The investments in transport infrastructure helped those transitioning to commute to their new locations of work [29]. Heinz Spahn, whose family had been working in coal mines for generations, alludes to the success of the job retraining programme: “One son is now a professional security guard and the other is a landscaper” [35].

The legal mechanism was based on the transition payments system adjustment allowance or *Anpassungsgeld* (APG), which the state legislation introduced in 1972. These payments morphed into financial bridging support, offered monthly to employees whose jobs were dissolved early, for up to 5 years [21]. All workers who will have lost their jobs before 31 December 2022 have been granted such benefits on meeting the specified age threshold and service time. The European Community, the German federal labour office, the federal state and the German federal government supported these initiatives [56].

The Ruhr Action Programme in 1980 (*Aktionsprogramm Ruhr—APR*) worked towards building coordination between the largest interest groups and state institutions and the development of small to medium enterprises [36, p. 235]. The APR had a total budget of DM6.9bn, of which DM5.1bn was provided by the state of NRW and DM1.5bn by the German federal government [44]. Funds were provided by the European Union, state and private funding with hard coal received €337bn in subsidies between 1970 and 2016 [64].

The attention of the structural policy programs—in the 1980s and 1990s—moved to ecological and cultural aspects and particularly to fostering entrepreneurship [29, 51]. The education infrastructure was strengthened with a focus on underserved regions. For instance, the northern Emscher region built a technical college (*Fachhochschule Gelsenkirchen* in 1992). The Ruhr witnessed physical regeneration as former industrial sites were converted to demonstrate ‘industrial culture’ to tourists and the mining sites qualified to be included in the UNESCO World Heritage list [29, 33, 41]. An example of the reorientation and cultural rebranding and revival is the 180-foot-high winding tower of the *Zollverein* mining compound. The complex was celebrated as Europe’s biggest and most modern coal mine. After its closure in 1986, the state of North Rhine-Westphalia acquired the complex and turned it into a memorial. Tourists visit and enjoy cultural activities on the story of coal and steel. Rem Koolhaas has turned the site around and ornamented it with a bright orange escalator. The *Zollverein* tower is popularised as “the Eiffel Tower of the Ruhr” [35, 65]. According to a tour guide in the area, “Now the number of hotels has increased. There are new museums. We have five philharmonic orchestras in the Ruhr area, and so many theaters” [35, p. 3, 65].

Cities were empowered to create their own development strategies and plans [41]. Dortmund, for example, transformed into a technology hub with expertise in microsystem technologies (*ibid*). Entrepreneurship and innovation flourished with steady expansion of transport, educational and research infrastructure [66, 67]. Kriegesmann, Böttcher and Lippmann [68] argue that this allowed the Ruhr to transform into a knowledge-based society with a growing focus on ‘liveable’, ‘green’ and ‘knowledge’ to signal ecological modernization [40]. Capacity-building programmes were organised for workers, architects, unemployed citizens and project developers [70].

There was a marked increase in tourism activity in the Ruhr between 1990 and 2011, with foreigner visits rising from 3,588,394 overnight stays in 1990 to 7,026,396 in 2012, an increase of 95% [28]. “It was no longer seen as a stagnant, polluted area of sunset industries, but as

a place for innovation” [21, p. 44]. In 2014, there were 22 universities in the Ruhr catering to 2,50,000 students [68]. According to Bottrop’s Mayor, Bernd Tischler, winning the industry-driven competition—“Innovation City Ruhr”—“was crucial to give people something to hold on to—a new vision from the 150-year tradition of coal mining. Now people are encouraging each other to look forward. However, make sure to integrate the past into the new vision” [69]. The rebranding of Gelsenkirchen as a “solar city” or “city of thousand suns” from its former nickname of “city of thousand fires” illustrates this developmental arc [49], and ushering in of green jobs around solar energy technology R&D [70–72] state that technology policy in North Rhine-Westphalia changed to a “neo-industrialisation” orientation, which supports the setting up of new industries.

The government’s management exemplified “a bottom-up approach, and the critical role of codetermination with equal voices for workers and employers at the table” [73, p.8]. Codetermination became a unique approach to industrial relations to the coal, iron and steel industry, entailing meaningful participation [55]. A number of studies point to the emergence of polycentric governance based on both formal and informal mechanisms of participation [41, 74, 75]. The local community approved of the philosophy of giving the region voice in its revitalisation (“renewal from within”). In 10 years, 123 cooperative projects saw the light of day [49].

The Ruhr Coal Vocational Training Society (RKB) operated in sync with multiple institutions to develop the aims of the skills development programs [33]. The former mayor of Bottrop, Bernd Tischler, alludes to the need for active and meaningful participation: “You can’t do it against your people; you have to convince your people. You have to work together with institutions and stakeholders that don’t normally work together, [so that] we are sitting in the same boat and we are rowing in the same direction” [76].

#### Failures, delays and resistance across both phases

The mine owners and magnates enjoyed disproportionate power and influence in the Ruhr [55]. The coal culture was dominated by jobs in the mining industry held mostly by men within a patriarchally inclined industry setup [76]. A society heavily influenced by coal, iron and steel workers and their way of life, saw a diversified middle class come forth as part of the de-industrialization process. Carter [75] draws attention to re-skilling and social integration. However, the evidence of recognition justice in the transition process is conspicuous by its absence. For instance, there emerges no evidence of worker unions advocating for broad based social justice

that goes beyond their own constituents. It qualifies as a shortcoming, if not failure, of this process.

A social result of the energy transition was that it paved the way for women to enter the workforce. According to Goch [55, p. 96], “women were “discovered” as a reservoir of labour, particularly in the service sector.” The workers in hard coal, iron and steel industry were replaced by more skilled workers (ibid). While these stakeholders received the benefits of transition, others who were marginalised were left out. Unemployment was severe for unskilled workers from the producing industries, for foreigners or migrants and for young people [55].

Overall, recognition aspects of justice find least mention across the transition literature and only in passing. Poverty was rampant among the losers of the transition. Question marks remain on the prevailing inequitable interactions of age, class, race, gender and the manner in which the transition addressed this issue. Public consultation was opened to civil society; however, organised groups were better placed to be heard [37]. Academic studies make the criticism that southern Ruhr received more support in comparison to the north ranging from financial support to education infrastructure [41]. In the southern Ruhr region, single neighbourhoods enjoyed superior services and cultural centres [76]. Scholars posit that the transitions did not pay adequate attention to the regional disparities either [77].

The transition was not without its own set of failures, delays and resistance. There were endemic delays caused by a multitude of factors. We find evidence of resistance as mining companies, for example, refused to sell land and obstructed attempts by miners to join the workforce in other sectors [78]. The resistance consisted of economic hurdles (excessive dependence on the steel and mining industries), institutional hurdles (a network of nexus of unions, politicians and corporations) and cognitive hurdles (cyclical understanding of crises) [29, 49, 79]. A case in point is the ‘Jahrhundertvertrag’ (centennial contract), wherein power stations decided to purchase 87% domestic coal until 1995 [80]. This domestic reliance was a product of the federal government’s push to protect local industry by reaching an understanding and compensation with electricity companies to utilise 40 Mt domestic hard coal annually (“Jahrhundertvertrag”) instead of cheaper imported coal [81].

Unemployment was high and protracted in the entire region and continues to remain so. The current unemployment rate is still double the German average, at 10% [53]. Cities were leveraged and low financial income was accompanied by wealth based social segregation. The response of the well-known German industrialist Gustav Krupp to the setting up of educational infrastructure in the Ruhr was revealing: “What we need in the Ruhr are



muscles, not brains" [49, p. 151]. A constant source of criticism is that the steel industry escaped being legally obligated for cleaning up the pollution that remained. The government granted the mining consortium 220 million Euros a year for water treatment. The coal sector was paid subsidies totalling EUR 289 billion (USD 335 billion in 2018) between 1950 and 2008 [82]. These decisions call into question the apportioning of cost and accountability of the private sector.

## Discussion

The study shows that the changes introduced in the 1960s leaned towards and motivated by diversification of economic activity, as well as enhancing competitiveness and protecting the local coal industry [45]. The evidence of transition towards low carbon sources of energy is scant. This phase can be defined as gradual phasing out of domestic hard coal, rather than energy transition, where a distributional sense of justice prevailed [21, 38]. It is in the 1980s onwards that we see meaningful steps towards supporting new technologies, such as photovoltaics, fuel cells, bio-energy and geothermal energy and much greater stakeholder participation and coordination.

Energy transition in the Ruhr region raised distributional challenges with a clear set of winners and losers. The iron and steel mine workers and industry felt the impacts acutely as the number of jobs and output were slashed. From a distributional perspective, the strong focus on social security benefits, early retirement schemes, personalised assistance in job seeking efforts, moving expenses, labour market transitions and compensation were useful instruments. It helped absorb the economic shock on individuals, communities and industry and maintain social order and continuity. As more nations undergo energy transitions, they will benefit from becoming cognizant of stakeholders most acutely affected and by taking a range of concrete measures of support and assistance [45].

The Ruhr's energy transition brought about structural changes that rekindled people's imagination, drive, self-esteem, self-efficacy and sense of purpose, and re-oriented the economy from coal to knowledge and innovation. Transition processes elsewhere will require public investment (monetary and in kind) in public infrastructure, education facilities, inspirational public leadership as well as what is considered soft measures, such as culture and ecology. These will allow new social alliances, power sharing mechanisms, interests and a renewed sense of hope to emerge.

The conceptual framework identifies finance as an important facilitator in this regard. There is no doubt that the strong economic position of the German government helped in bringing about the structural change. Still,

the transition process was further supplemented by EU grants. As more countries chart the low-carbon path and make ambitious clean energy commitments, they will need to focus substantially on the distributional aspects, particularly the financing. The establishment of a just transition fund in the short and medium term can result in a fairer distribution of resources in economies, where poor, coal-dependent regions are switching to cleaner industries [37]. The national sources can benefit from additional supplementation of international funding mechanisms and private sector participation to match the scale and volume of distributional needs.

The Ruhr's energy transition was underpinned by the culture of co-determinism that supported broad-based participation and ownership among stakeholders. This placed the transition on a strong procedural footing and steered the process towards a more equitable, just and locally owned direction. Polycentric governance was at the forefront of this transition [43]. It brought stakeholders with different concerns, needs and solutions together to forge a path ahead through formal and informal structures. This illustrates the benefits of transition, where communities and governments across multiple levels collaborate on devising a policy mix that has a phase-out pathway based on a multilevel, polycentric framework [46, 47]. This was not without contention or protracted debates; however, it secured buy in and ownership to the process.

Transitions in different parts of the globe can similarly benefit from outreach to different stakeholders from early on in the design process and engage proactively with civil society to build new alliances. The democratic and economic norms prevalent or absent in a particular context become important. Where these norms are inadequate, the transition process will need to show more opportunistic usage of the state's policy tools, capacity and convening ability to consolidate political and social support.

Questions remain on the focus and seriousness of the Ruhr's energy transition process in giving voice to the historically marginalised and addressing the unfair relations of class, age, gender and race. Furthermore, the overwhelming focus on the monetary compensation can be considered as narrow and insufficient. It did not fully take into account the wide range of losses and came at the cost of marginalising mental and physical functioning, personal attachment, cultural identity, social networks, self-esteem, etc. The transition would have become more just had it also given more weight to different worldviews and particularities of the people affected by it [14]. Moving forward, transitions need to go beyond monetary compensations to encompass a wider sense of socio-cultural well-being. They need to take additional steps to ensure marginalised and unorganised sections of

the population have a seat at the decision-making table. A starting point can be designing more participatory processes, mental health support programmes, financial counselling and support for community gatherings.

In addition, the various shortcomings of the Ruhr's successful energy evolution are useful to consider. It is particularly important to address the lock-ins of different natures that may obstruct, undermine or delay energy transitions [36]. Furthermore, given the urgency to meet Paris Agreement goals, time is running short. We do not have 50–60 years left; instead, the climate crisis and international commitments will require the transition to be accomplished in 10–12 years. The push towards energy transitions can also give rise to unemployment and regional disparities which can exacerbate poverty and inequalities. The transition needs to be alert to avoid such negative and cascading impacts.

## Conclusions

This research sought to examine the transition of the Ruhr region in Germany from a hard coal belt into a knowledge-based economy, with a particular focus on its justice components. Its larger objective was to contribute to the growing academic understanding and policy questions surrounding net zero carbon emissions. It used qualitative data analysis, where we compiled relevant literature from diverse sources and developed themes from the use of inductive and deductive approaches to determine components of justice and facilitators of transition. This method allowed the study to narrow down on the theory of just energy transition and test it based on data from multi-institutions and stakeholder perspectives. We were also able to deduce facilitators and gaps using this approach. This combination was well suited for scientific enquiry of energy transition that carries multiple objectives, interpretations and stakeholders. Furthermore, without being too prescriptive, it allows us to draw out lessons that can inform similar processes globally.

What is deemed as an energy transition spanning 50–60 years can be more accurately categorised as an economically driven reorientation followed by an energy transition. The application of the distributional lens demonstrates that the transition was able to offer significant financial support and other social safety nets to those disproportionately affected by the transition. The government furnished large sums of money to protect individuals, communities and industry from the abrupt economic shock. It was responsive to the burdens placed on the mining community and offered redundancy payments. The application of procedural lens demonstrates that the transition was characterised by co-determinism and multi-stakeholder participation, polycentric governance. The manner in which the

government went about phasing out the mining of hard coal showcases meaningful participation from workers and employers. There were both formal and informal channels of participation which paved the way for social partnerships and cooperation among stakeholders.

The application of recognition lens raises questions on the asymmetrical relations that prevail with regard to race, class, age, and gender and how the transition tackled it. While there were attempts at multi-stakeholder participation, there is scant evidence of the participation of marginalised groups fully or equally. Unemployment was particularly harsh for unskilled workers from the producing industries, foreigners or those individuals who have migrated, and young people under the age of 25. The evidence of recognition justice in the transition process is conspicuous by its absence.

The availability of time, finance, and a setup that fostered participation which proved critical to usher just transition. Overall, this study demonstrates the importance of factoring just elements into energy transitions. As energy transitions race against emissions reduction targets and timetables, they would need to be conscious of these pitfalls and opportunities. The availability of finance mechanisms will be crucial to their implementation. They would be well served with building dedicated transition funds and supplementing national resources with additional financing. They would also require to form new alliances and engage different stakeholders to break the institutional lock-ins that can stymie progress. Just transitions are time and finance intensive affairs that require commitment, innovation and broad-based participation to bear fruit. These are no doubt difficult and burdensome; however, they also bear rich dividends. Not only did they allow transition towards a more climate friendly and sustainable society, but offered opportunities to build back better with equity and sustainability at its core. Promising areas of future research include ownership and sustainability of policies adopted as part of energy transition, outlook of local community and industry and emergence of new socio-political arrangements linked to energy transition.

We realise and acknowledge that these ideas, completely or partially, may not be fully applicable to settings different from Germany, particularly in the global south. The nature of the climate debate and required action has also taken different proportions and much greater urgency. Despite these limitations, this paper aims to provide interested stakeholders and policymakers with some advice based on the lessons from other locations that can offer a general direction, if not exact coordinates.

**Abbreviations**

COP: Conference of parties; RKB: Ruhr Coal Vocational Training Society; EU: European Union.

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Arora carried out most of the research and drafted the first version of the manuscript. Schroeder guided the process and helped extensively with the revisions. Both authors read and approved the final manuscript.

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