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Coal, green growth and crises: Exploring three European Union policy responses to regional energy transitions

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ABSTRACT

Despite increasing interest in energy transitions in the European Union, little attention has been paid conceptually to regional energy transitions in terms of development nor to the potential regional impacts of cumulative policies. A contextual understanding of regional energy transitions in Europe is therefore lacking. To address this gap, this paper considers regional energy transitions from a political economy perspective, using an institutional lens and critical varieties of capitalism approach to examine European Union policy responses within the scope of innovation driven and growth based regional development. Policy responses for regional energy transitions are first structured using crises as turning points and then explored in three themes: an energy transition with roots in coal regions; an energy transition that harnesses the green growth agenda; and an energy transition intensified by multiple crises. Going beyond the traditional economic aspects of regional policy and acknowledging the contradictions of green growth, critical reflection on these themes calls into question the extent of policy responses to address the potentially diverse regional futures enabled through the energy transition. Considering the aim of territorial cohesion, renewable energy resources and green innovation capacities can be seen as either sources of prosperity or aggravators of existing inequalities. Further attention is therefore needed toward current understandings of regional development in light of policy objectives and the sustainability ambitions of regional transitions. While limiting this analysis to the green growth logic, the arguments acknowledge critical perspectives that can potentially be brought into European policy perspectives for sustainable regional development.

1. Introduction

In recent years, multiple crises spanning economic, social, political and environmental domains have renewed the impetus for coordinated policy responses in Europe to support societal transformations for sustainability. Following the political and economic turmoil of the global financial collapse, migrant crisis and Brexit, strategies for decarbonizing the European economy were debated and enshrined in the European Green Deal (EGD), a 'green growth' strategy guiding regional development in the European Union (EU) [1], mere months before the declaration of the Covid-19 pandemic [2]. Most recently, the crises of skyrocketing energy prices and insecurity of supply due to Russia's invasion of Ukraine have put the energy transition, including transition away from coal to meet Europe's climate goals [3,4], squarely at the top of Europe's priorities [5]. Yet, in light of regional socio-economic and political polarization [6–8] and varying capacities to respond [9,10], the addition of health and geopolitical crises to the longer term economic and environmental ones [11,12] raises concerns for regional energy

transitions.

Crises have the potential to shock the system but, as critical junctures, provide opportunities for transformation (for a recent review, see [13]). Taking the core European policy objective of territorial cohesion, policymakers must pay attention to the potential of crises to help or hinder the energy transition and must also consider the wider impacts of transition processes and structural transformations. For regional energy transitions, which speak to structural transformations in socio-technical systems, the scope of the challenge facing policymakers extends from the energy sector to include notions of economic development as well as socially oriented policy perspectives around a just transition, all within political-institutional contexts. Together, these require coordinated policy responses across multiple policy domains, as has begun to be addressed in Europe by the EGD, but these have not yet been analyzed holistically in terms of regional energy transitions as an interdisciplinary subject of regional development.

Researchers of EU policy orientations have devoted ample attention to relevant policy areas such as Regional Policy and Innovation Policy

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(e.g., regarding territorial cohesion, competitiveness and growth in the aftermath of the global financial crisis [14–18]) as well as to the Strategic Energy Technology (SET) Plan [19], which have common technological and economic theoretical underpinnings. Since the adoption of the EGD signalled a turn in EU policy toward the United Nations' *Agenda 2030* and Sustainable Development Goals [20,21], however, the unexpected health and geopolitical crises mentioned above rekindled discussions around the core principles of regional development in Europe (e.g., cohesion, competitiveness and growth). They also called attention to the potential disruption of strategies for Europe's sustainable future, which under the EGD has been cast in terms of carbon emissions and climate change [1].

In response to the little research so far on regional energy transitions as a subject bridging energy, innovation, regional development and sustainability transitions, this paper takes steps to contextualize regional energy transitions in the EU based on the trajectory of policies and strategies, punctuated by crises, thereby enabling a discussion on regional energy transitions as a means toward a more sustainable regional development. The paper proceeds to present the theoretical approach, taking an institutional lens and critical interpretation of varieties of capitalism (VoC) for sustainability transitions in the context of green growth and regional development in the EU. It continues with a presentation of the methods and materials of the analysis which are used to frame EU policy development in terms of critical junctures and policy responses. The policy case of EU responses to regional energy transitions is then developed and critically discussed based on the three themes of coal, green growth and crises.

2. Varieties of capitalism and sustainability transitions

2.1. Crises, critical junctures and institutional change in varieties of capitalism

In the rapidly developing field of sustainability transitions research, the institutionalist lens has found relevance in the study of low carbon energy transitions [22]. While institutional theory enables the study of institutional (including policy) change over time and supposes that crises open opportunities for change [23–26], the role of crises in shaping political and institutional responses for energy transitions is still less explored. In the current research, crises are taken to structure policy responses that settle as relatively stable policy periods, in the example of EU policies related to regional energy transitions.

Crises can create the conditions for macro-level changes in an aspect of society, invoking the concept of critical junctures in institutional theory [13], which has broad technological (e.g., [27,28]) as well as social, economic and political (e.g., [24,29,30]) applications. As turning points, critical junctures can be characterized by the temporal dimension and magnitude of the change elicited (i.e., from one path trajectory to another). Thus, critical junctures are often examined through a historical institutionalist lens following a transformation. Sustainability transitions researchers have invoked critical junctures in the analysis of transitions pathways where potential branching points and choices may appear [31], indicating a future-oriented, strategic perspective. As such, we do not necessarily seek to argue for the existence of critical junctures but use the concept to identify potential branching points in policy contexts.

The institutionalist lens is further specified by the adoption of a VoC approach, given the regional dimension of energy transition studied. The concepts and theories surrounding crises and institutional change apply to the rules and relations of capitalist society [32], which has strong relevance to regional transitions and development discourses. The VoC approach developed in the field of comparative political economy to account for political sources of comparative economic and institutional advantage, shaped by path dependencies and institutional legacies [33]. In the institutionalist tradition, VoC is an evolutionary and actor-centred approach, rooted in the study of institutional stability and

change. However, use of VoC has been limited in scope to the conditions of contemporary capitalism [34]. It is most commonly used to relate stakeholder configurations and strategic interactions with economic outcomes, such as the emergence and persistence of industries within institutional contexts according to a state, firm and labour sectoral division. This constellation focuses attention on economic policies, competitiveness and skills in the international capitalist order. A VoC better oriented to sustainability transitions research may be widened to a state (political), market (economic) and community (social) sectoral division focused on sustainability rather than economic growth [34], to enable a stronger accounting of non-economic aspects shaping VoCs. Hence, its use here is not limited to understanding regional economies per se but applies to the wider context of regional development which can be expressed in terms of socio-technical systems in sustainability transitions research (see e.g., [35–38]).

The international crises setting the scope of this paper can be understood as potential critical junctures inasmuch as they are exogenous shocks threatening existing structures. These shocks can be harnessed through actors' agency through the exercise of policy choices, denoting a social dynamic perspective in which endogenous factors play a role, reinforcing VoCs in the crisis response. Institutions serve as a resource and create stability but can also be mobilized for change [32]. In the political economy of crisis mitigation, a paradigmatic shift, such as to a form of green growth constrained by climate commitments, would restabilize in response to the extent of the change, actors involved, scientific legitimacy and distributional consequences [39]. Thus, given the importance of the regional dimension and the variety of policy options available in different political economies, VoC is a relevant approach to consider for regional energy transitions in Europe, amidst the potential paradigmatic shift offered by the EGD at its highest level of ambition.

2.2. Varieties of capitalism and green growth in the EU policy context

Even though VoC has been named a promising political economy approach for use in sustainability transitions research [40], a 'greening' of VoC [41–44] has hardly taken hold. As for the field of political economy in general [45,46], there is a need to overcome a "blindness to capitalism" [47] in sustainability transitions research, which means reframing and applying VoC more critically through the reorientation of its prime objective from economic growth to sustainability [34]. This warrants further consideration of social, political and environmental aspects in addition to the economic aspects traditionally put in focus. Of relevance to regional energy transitions, VoC has been recognized for its role in regional diversification processes [48], which in turn relates to green industrial paths [49] and the geography of sustainability transitions [50]. Nonetheless, since relatively little is known about 'greening' or otherwise non-economic aspects of VoCs, the often polarizing green growth paradigm that paradoxically pursues both growth and sustainability provides an opportune area for exploration.

Green growth has been described as the "pursuit of green solutions as a business case" [51], which may in turn contribute to green economic transformation. In the EU context, green growth is interpreted as economic growth that is decoupled from resource use, or carbon neutral [1]. It can be seen in itself as a shift within the systemic logic of existing capitalisms, representing deep "ideational and institutional change" without totally reimagining the system [39]. The associated systemic change suits notions of a critical juncture since it falls short of a total system revolution [13]. Discussions of green growth show its proponents to believe that it can exist within the capitalist system, while its critics contend that decoupling resource use and economic growth is not likely possible and that global green growth initiatives are misguided and even politically motivated [39,52]. Critics may further subscribe to alternate capitalist perspectives such as degrowth and post-growth [39,47,53,54], but, for the purposes of this paper, the focus rests on green growth as the paradigm promoted in EU policy.

Following Buch-Hansen and Carstensen's [39] description, green

growth entails a range of activities to achieve sustainability transitions, from policy changes to regulation and market creation, using the institutional mechanisms of capitalist political economies, i.e., in the interplay between governments and markets. This is paralleled in current perspectives on mission-oriented innovation policy that aim to use the power of markets and resource mobilization in the public sector to solve societal challenges [55,56]. Alongside green growth, mission orientation has become highly influential in EU policies for research and innovation and their governance and implementation [57–59]. The EU's green growth policy context thereby sets up paradoxes of innovation, state intervention and speed of transitions for deeper investigation in Europe's political economies.

The conventional use of VoC has drawn associations between certain varieties (e.g., liberal and coordinated market economies) and types of innovation thought most likely to occur in the respective institutional environment (e.g., radical innovation supporting rapid transformations versus incremental innovation supporting slow transformations) [33]. However, in light of resurfacing questions about state intervention and innovation, the traditional associations between VoCs, innovation and speed of transitions for sustainability purposes can be cast into doubt [34], and further consideration of VoC-relevant national and regional factors producing comparative institutional advantages for sustainability-focused innovation is needed.

Examples from Europe can be drawn for energy transitions. Continental European economies have by and large been considered more 'state-coordinated' than others (e.g., United Kingdom), but they have also long been frontrunners in environmental innovation and sustainability. In the case of the energy sector, governments have been instrumental in bringing innovations to market [60]. For example, Germany has been a leader in the energy transition thanks in part to investment in renewables and market incentives supporting 'prosumerism' [61]. Denmark was also an early leader in the deployment of offshore wind power, but the United Kingdom, a relatively liberal market once thought to be a comparative laggard [62,63], is now expected to outperform other European countries in net capacity additions of offshore wind power [64]. To support innovations and transitions in energy systems, the political economies of Europe have begun a policy process to ensure a just transition [65], which may be considered in terms of state intervention. These topics surrounding the energy transition, including coal specifically [66], highlight the need for further attention to VoC-informed aspects of regional energy transitions – political-institutional, social and environmental factors – complementary to the economic ones traditionally considered in the neoliberal capitalist view.

2.3. Regional development and regional energy transitions

The context and goal of regional development in the EU is changing in line with sustainability movements that call for a transition to net zero carbon energy systems (e.g., [21]). Broadly speaking, the zero carbon transition means a shift to renewables in energy supply and a decrease in energy demand through efficiencies and behavioural change [67,68]. In line with the critique of endless economic growth [69], the energy transition literature highlights the biophysical limits to growth [70–72], for example, taking environmental carrying capacity as a limitation of the natural environment [73]. These limits are being investigated in Europe using a range of tools and techniques, including the ecological footprint and biological footprint [72], with the aim of minimizing environmental impacts through the shift from carbon-intensive to renewable and sustainable energy and, ultimately, the transformation of socio-technical systems. The EU's energy strategy has targeted such transformation for nearly 15 years through coordinated technological innovation and market creation [19,74]. The emphasis on cooperation across sectors cannot be overstated [68], and since the overall transition is believed to be more important to the global energy shift than any individual country reaching net zero [67], the political aspect of VoCs is

ever more important.

While energy transitions are expected to mainly occur within existing socio-technical systems, their implementation stands to be shaped within political economies, which can be understood using VoC and related insights on innovation and transition. In terms of regional energy systems, the transition raises political questions of resource use and exploitation in the shift from carbon-intensive sources to clean and renewable generation. Of political importance, the EU's energy strategy responds to a dependence on external energy imports [5,74], the extent of which varies across countries. Internally, as renewable energy potentials also vary, member states that have traditionally exploited their own carbon-intensive resources may negatively perceive a shift from partial self-sufficiency to dependence on green energy imports, revealing political motivations behind the integration of energy systems [75]. On the other hand, member states tied to relatively cheap energy imports have been reluctant to transition to more expensive alternatives, as highlighted by the dependence of Central European states on Russian gas amidst Russia's war on Ukraine [5]. The history of coal as both an inexpensive energy source and a basis of 'less innovative' regional economies – often contrasted with potentials for sustainable and renewable energy – also helps to set the context of regional energy transition and development in Europe.

Despite this context, regional energy systems have not figured strongly in notions of development underlying European policy (e.g., EU Regional Policy). Here, regional development takes on multiple meanings, from development that strengthens economic, social and territorial cohesion on the EU level, in its broadest sense, to a metric of economic productivity (e.g., regional GDP per capita) according to the more traditional assessment of living standards. Thus, it is necessary to characterize the very regional (often national) energy systems that are basic to regional economies and understandings of development. Electricity systems, for instance, vary from already more than 90 % carbon-free in the Nordics to carbon-heavy in Central and Eastern Europe, with the largest shares of renewables in gross energy consumption to be found in Sweden, Finland, Denmark, Latvia, Lithuania and Austria and the largest shares of solid fossil fuels (e.g., coal) in Poland, Czechia, Bulgaria, Germany and Greece [68]. While variations can generally be seen in the (macro-) regional energy systems, policy preferences to do not clearly align with regional blocs (see [76]). This is shown, for example, by varying support for climate and energy policies in Central and Eastern Europe [77]. Rather, research suggests that policy preferences tend to be sector-specific [78], which, in the context of innovation-based regional development and green innovation, depends on endogenous natural resources, skills and capacities. The issue of justice as a key theme in sustainability transitions thus relates to the concept of territorial cohesion that has underpinned Europe's regional development strategies, albeit mainly in the scope of economic competitiveness since the 2000s [79,80] (see also Cohesion Reports, e.g., [81,82]).

Taking the socio-technical approach to system transformation that sees energy systems as embedded in society [83], socio-political factors (alongside market and community factors) including institutional capacity, political commitment and legal and regulatory frameworks are believed to facilitate the acceptance of renewable energy [84]. Such factors are amenable to the VoC approach discussed above and have been increasingly present in policy discourses around territorial cohesion [81,82]. Also finding relevance to the socio-technical view, research on regional innovation has seen a shift from economic to political-institutional factors for tailored policy responses in regional contexts [57,85–87]. Thus, knowledge of political-institutional contexts is seen to be increasingly important for the complementarity and momentum essential to regional energy transitions in Europe.

In light of the attention to regional economic convergence and global competitiveness in EU policy over recent decades [1,79,80], the energy transition can be seen as an opportunity or a threat for regional competitiveness, depending on energy resources, industrial structure and innovation capacities, that could also lead to a two-track 'green'

Europe on top of pre-existing regional disparities [81,82,88,89]. While neither innovation nor competitiveness are the same as development, they are highly correlated [88,90]. Thus, the geography of transitions is also put in the spotlight due to the potential impacts of energy transition on uneven development and regional peripheralization [91,92]. As recognized in the scientific advice to policymakers, strategies to further the energy transition and drive green development should take regional differences into account and mitigate regressive distributional effects to ensure a just transition [68]. Yet, in supporting a relational understanding of regional challenges and opportunities, policymakers must also reckon with contending potential geographical futures to emerge in the energy transition [93]. To do so, analyses of regional energy transitions should account for existing polarization processes which have long been at the core of regional policy (i.e., cohesion, the place-based approach and smart specialization [80,94,95]). In terms of EU policy responses, those related to EU Regional Policy and its concern with territorial cohesion and development are an appropriate starting point to account for the main themes and evolution of policy for regional energy transitions.

3. Method

Investigation of the regional energy transition in the EU's green growth policy context is hereby undertaken and informed by a critical VoC approach which calls particular attention to non-economic aspects affecting transitions in the policy discourse. As described in the preceding sections, an expanded VoC for sustainability transitions addresses state (political), market (economic) and community (social) aspects with an orientation toward environmental sustainability. Therefore, policy responses can be analyzed and critiqued holistically according to which of these aspects they address and, often of interest for sustainability transitions, which ones they do not. Table 1 summarizes the different theoretical concepts and levels structuring the analysis in the traditional economic approach versus the institutional approach, using VoC, toward regional energy transitions in the EU policy context.

Despite the need for a clearer understanding around the potentials of regional energy transitions in Europe, a comprehensive analysis to inform complex processes is made difficult due to a lack of regional data addressing non-economic aspects, although data availability is evolving according to the needs presented by the Sustainable Development Goals and EGD. With the exceptions of data introduced to inform quality of governance, institutions, innovation and competitiveness in recent Cohesion Reports [81,82], comprehensive regional data (e.g., from Eurostat) generally lacks relevance to the political, social and environmental aspects of energy transition as well as regional potentials for the low-carbon economy. The imbalance may be a result of earlier drives for regional economic data for the purpose of measuring competitiveness, which was a strong impetus for generating regional datasets Europe-wide. Nevertheless, energy data still tends to be reported nationally [96], while relevant regional topics are wide-ranging (e.g., agriculture, business structures, labour, water use, cooling and heating days, etc.)

Table 1

Conceptual levels of analysis and additions of the current approach to the sustainability perspective.

	Traditional approach	Current approach	Additions to sustainability perspective
Disciplinary lens	Economic	Institutional	<ul style="list-style-type: none"> • Inclusion of (and shift in attention to) non-economic actors and institutions as research subjects
Disciplinary approach	(Evolutionary) economic geography	Varieties of capitalism (VoC) for sustainability transitions	<ul style="list-style-type: none"> • Shift to alternate aspects of analysis including political, social and environmental
Objective	Growth-based regional development	Green growth and regional development	<ul style="list-style-type: none"> • Shift of objective from economic growth to sustainability • Shift of objective from economic growth to sustainability
Policy area	Regional, innovation and energy policies	EU policy responses to regional energy transitions	<ul style="list-style-type: none"> • Constraint of development to sustainable activities and identification of areas for transition (e.g., regional energy systems) • From siloed policy areas to cross-cutting policy areas • Trans- and interdisciplinarity

[97] but only vaguely applicable to energy transitions. Of note, comprehensive projects of the EU territory such as ESPON Climate (Climate Change and Territorial Effects on Regions and Local Economies) [98] and GRECO (Territorial Potentials for a Greener Economy) [51] laid foundations for the study of regional energy transitions by addressing topics such as environmental carrying capacities and green innovation through e.g., future scenarios of adaptive capacities to climate change, potential impacts of climate change on the energy sector and green economy performance and potentials. Nevertheless, these studies pre-dated the current climate policy context, and ongoing comparable data is not available. Recent efforts of the EU's Joint Research Centre to elaborate regional green potentials [99] are beginning to fill thematic gaps. Instead of analysing regional potentials and responses quantitatively, therefore, the current analysis orients on regional energy transitions through EU policy responses, as a starting point for addressing this research topic.

The paper proceeds to set the context for Europe's regional energy transitions and development as a policy case based on EU strategies and related frameworks that have evolved through multiple periods of crisis. These are taken to represent policy responses to regional energy transition under the banner of green growth, which reflects the choice of VoC in critique of this aim. The material making up the policy case is summarized in Table 2, which presents chronological and conceptual linkages between crisis periods and EU policies of relevance for regional energy transitions, citing their general policy aims and key areas of intervention. The following crisis periods affecting EU policy are identified and approximated: first, a perceived crisis of competitiveness in the mid-2000s (see [79]) which was acutely aggravated by the global financial crisis of 2008; second, the climate crisis, the recognition of which can be dated to the signing of the Paris Agreement in 2015 [21]; third, the Covid-19 pandemic, which can be dated to the declaration of the World Health Organization in 2020 [2]; and fourth, Russia's war in Ukraine, triggered by the military invasion of February 24, 2022 (see [5]). Listed in the example policies and strategies is the inventory of documents considered to be representative of the EU policy discourses related to regional energy transition, including energy, regional development and crisis recovery. From these, their policy aims and areas of intervention are generalized to highlight aspects relevant for VoC at the highest level, as an aid to the case development and discussion in Sections 4 and 5, respectively.

4. Policy case: the EU regional energy transition

The policy case surrounding the EU regional energy transition is developed through the exploration of policy responses. The EU's development policies that have come to shape its approach to energy transition have been rooted in a coal phase-out strategy, on the one hand, and growing focus on regional economic competitiveness through innovation, on the other, which have together become a product of crisis responses and policy re-orientation for widespread regional economic transformation. In the following section, the policy responses are summarized according to three themes: an energy transition with roots in

Table 2
Crises and policy responses for European regional energy transitions.

Crisis period	Example policy or strategy	Policy aim/scope	Area of intervention
Crisis of competitiveness, mid-2000s;	<ul style="list-style-type: none"> • Lisbon Strategy [79] 	<ul style="list-style-type: none"> • Competitiveness • Territorial cohesion 	<ul style="list-style-type: none"> • Economy • Society
Financial crisis, ca. 2008	<ul style="list-style-type: none"> • SET Plan [19] • An Energy Policy for Europe [74] • Barca Report [94] • Europe 2020 Strategy [80] 	<ul style="list-style-type: none"> • Greenhouse gas emission reductions; decarbonization • Renewable and sustainable energy; technology • Competitiveness • Territorial cohesion 	<ul style="list-style-type: none"> • Energy • Security • Economy • Economy • Society • Environment
Climate crisis, ca. 2015	<ul style="list-style-type: none"> • A Clean Planet for All [4] • Clean Energy for All Europeans [3] • European Green Deal [1], with: <ul style="list-style-type: none"> • Just Transition Mechanism [65] • Framework for Sustainable Investment [100] • European Climate Law [101] • Fit for 55 [102] 	<ul style="list-style-type: none"> • Climate change, decarbonization • Competitiveness, green growth • Just transition 	<ul style="list-style-type: none"> • Energy • Environment • Economy • Society • Environment
Covid-19 pandemic, ca. 2020	<ul style="list-style-type: none"> • Next Generation EU [103] 	<ul style="list-style-type: none"> • Pandemic recovery 	<ul style="list-style-type: none"> • Economy • Society
Russia's War in Ukraine, ca. 2022	<ul style="list-style-type: none"> • REPowerEU [5] 	<ul style="list-style-type: none"> • Energy security 	<ul style="list-style-type: none"> • Energy • Political

coal regions; an energy transition that harnesses the green growth agenda; and an energy transition intensified by multiple crises.

4.1. An energy transition with roots in coal regions

Due to the origins of the EU in the European Coal and Steel Community, coal regions as objects of policy are appropriate points of departure for Europe's regional energy transition when taking an institutionalist approach. Recently, coal regions have become a case for the just transitions discourse to flourish, thanks to their association with old industrial regions and technological path dependency [104] which illustrate socio-technical systems, critical junctures and structural change as discussed in Section 2.1. Research on Europe's coal regions has highlighted the socio-economic impacts of decline and state strategies affecting the rate and severity of restructuring since the 1980s [66,104–108]. Notions of social and economic cohesion from past restructuring thereby underpin the current discourses of regional energy transition. Prior to the latest energy crisis, the EU's Joint Research Centre calculated that most of the direct job losses due to coal phase-out would be concentrated geographically in Central and Eastern Europe, but the social impacts of transition could be felt widely [109], making it relevant for regional transitions in general.

Given the history of coal in the just transitions discourse, frameworks developed can also be applied to the energy transition in general, placing due attention to VoC-inspired aspects for sustainability transitions. Harrahill and Douglas [110], for example, address the political by identifying the roles of local government and the welfare state amongst dimensions for evaluating policy responses. Linking to the policy discourses on regional development, their framework was interpreted for the EU context to support economic revitalization in coal regions [111,112], reflecting the turn toward innovation-based economic competitiveness, i.e., green growth. Whereas Harrahill and Douglas highlight social dialogue as a mode of action in the pre-transition phase, Iotzov and Gauk [112] add entrepreneurial development as a mode of action for the transition phase, connecting just transition, economic diversification and structural change debates. Work in this area (e.g., by ESPON) has potential for translating the complexities of structural change for policymakers including regional and local authorities.

This modified framework takes the EU's Just Transition Mechanism (JTM) proposal [65], in connection with the EGD, as the main policy response dealing with the regional energy transition. Although the JTM deals with more than coal, it is built upon the platform developed for coal to deal with the highest carbon-intensive regions, extended to heavy industry and other energy sources like oil shale and peat. The JTM acts on the lowest regional level (NUTS-3) to support a localized

response. Although the regions proposed to receive additional support for transition are highly dependent [113], the JTM does not necessarily align with needs of future green economies based on other (non-economic) aspects of analysis. Given the variation amongst the proposed regions, a just transition framework more widely relevant to the green growth strategy for development ought to consider factors beyond those relevant to coal regions alone, for example, to include regions with untapped green energy potentials that stand to benefit from green development and fulfill a new role in the energy system. However, as limited regional data suggests, contradictions are raised in the regions selected for a just transition amongst indicators concerning climate potentials, green innovation and governance [51,98,111], while other regions suggested to have development potentials in need of policy support are not addressed.

4.2. An energy transition that harnesses the green growth agenda

Green growth has come to represent the European approach to regional development following the 2007–2008 financial crisis, when the competitiveness paradigm of the Lisbon Strategy was brought under the banner of 'smart, sustainable and inclusive growth' in the Europe 2020 Strategy [79,80]. As Europe 2020 was transposed to 'place-based' regional policy [94], themes such as socio-economic convergence and sustainable urban development emerged in regional responses [114]. Nevertheless, economic growth continued to supersede social and environmental policy objectives [16]. During the Europe 2020 period, sustainability has seen strengthening representation in policy, with EU and Member State commitments under international initiatives to limit global warming and promote sustainable development [20,21]. Continuing on this trajectory, the EU has reinforced its green growth strategy in the EGD programme for 2021 to 2027, which aims to set a "new path of sustainable and inclusive growth" that "will accelerate and underpin the transition needed in all sectors" [1]. The aims of the EGD have been strengthened through legal and implementation measures including the Climate Law and Fit for 55 package, respectively [101,102], which come under the umbrella of the master EGD strategy. The EGD and related policies exhibit similar language as the Clean Planet for All climate strategy: "to ensure that this transition is socially fair" and "[enhance] the competitiveness of EU economy and industry on global markets, securing high quality jobs and sustainable growth in Europe, while providing synergies with other environmental challenges, such as air quality or biodiversity loss" [4], which suggests stronger environmental legitimacy than the prior Europe 2020 Strategy.

The EGD is expected to mobilize at least one trillion euros for green transition [115]. It stipulates that transition must be just and inclusive,

acknowledging the uneven, negative social and economic impacts of decarbonization [1]. To mitigate negative social impacts, the JTM, including a fund of 17.5 billion euros, has been proposed to complement the EGD and link to Cohesion Policy in the 2021–2027 period [65]. To address its earlier climate commitments (see [4,20,21]), the EGD re-orientates the EU development strategy to tackle “climate and environmental-related challenges” with a “growth strategy that aims to transform the EU into a fair and prosperous society ... where economic growth is decoupled from resource use” [1], thereby transposing environmental and social aspects of sustainability transitions to the core of prior development strategies within the existing bounds of capitalism.

To further the transformation of markets and institutions, complementary measures have been added to cement the ambitions of the EGD, including the so-called EU Taxonomy on sustainable finance and investment, which addresses the impacts of economic activities on climate change mitigation and adaptation [100], and the Fit for 55 package of interconnecting proposals to achieve the climate goals [102]. The former supports a green growth agenda while setting limits on sustainable economic activities in an attempt to address potential greenwashing. It takes steps to promote sustainable activities and direct investment, such as in the area of renewable energy, but it also raises questions about the territorial impacts of new market creation – that is, which regions are poised to attract investments for sustainable development and which regions may become relative ‘no-go’ zones? When framed from an approach of market creation overtly shaped by political interventions, territorial dynamics of capital attraction and accumulation stand to become highly relevant especially against peripheralized regions that potentially lack qualities to attract sustainable investments for green regional futures.

The latter Fit for 55 package strengthens existing legislation and drives green transition by focusing on pricing, targets, standards and support measures [102], thereby also acting on markets to support the EDG goal of green growth. Like the others, it is focused on competitiveness and industrial transformation, but also emphasizes a socially fair transition, taking the step to establish a Social Climate Fund (separate from the JTM) to support citizens at risk of energy or mobility poverty due to the introduction of carbon pricing and emissions trading schemes. The package also joins climate and biodiversity goals through, e.g., forest policy, carbon sinks and restoration, which suggests a possibility for recognizing new green regional potentials within the scope of regional development, based on natural rather than economic capital.

4.3. An energy transition intensified by multiple crises

Amidst mounting international political momentum since the 1990s, EU policy responses surrounding the energy transition have been oriented toward achieving globally relevant climate goals: most recently, to make Europe carbon neutral by 2050 and limit the global temperature increase to 1.5 degrees Celsius [3,4,116]. Recent crises affecting the EU, including the financial crisis, Covid-19 pandemic, unprecedented rises in energy prices and Russia's war in Ukraine, have provided opportunities for coordination, entrenchment and intensification of the policy responses for an accelerated energy transition.

The Europe 2020 Strategy signified not only the adaptation of the competitiveness aims of the Lisbon Strategy toward more sustainable development, but also addressed the disruption of the financial crisis on economic and social cohesion [80]. While the EGD continued the trajectory of aligning Europe's development strategy with the growing climate crisis [1], the pandemic provoked the additional Next Generation EU strategy to cope with social and economic impacts of the pandemic under the headline of “repair and prepare for the next generation” [103]. Next Generation EU foresees an additional 672.5 billion euros for the EU's common budget for 2021–2027, with 560 billion euros for the Recovery and Resilience Facility as well as support to existing instruments (e.g., Cohesion Policy, InvestEU). Amongst its objectives, the facility addresses green transition and smart, sustainable and

inclusive growth and jobs, all related to just transition and reinforcing social and territorial cohesion. As such, Next Generation EU takes the disruption caused by the pandemic as a moment for action to reinforce the EGD, taking advantage of political momentum from the earlier budgetary negotiations. Even so, Dupont et al. [117] suggest it may be too early to determine whether the pandemic constitutes a critical juncture in EU policy, although energy scholars broadly support the categorization in terms of energy transition [118]. Since the Covid-19 crisis, support measures to the EGD including the Climate Law [101] and Fit for 55 package [102] also strengthened coordination across policy areas.

Additionally, and on top of the framework for sustainable investment and the JTM, Russia's attack on Ukraine provoked a relatively rapid policy response in REPowerEU, which seeks to “ramp up the production of green energy, diversify supplies and reduce demand, focusing primarily on [Russian] gas” but also oil and coal [5]. While the action is a direct political response to the international conflict threatening energy security, it is also framed in terms of mitigating the impact on economic growth and earlier rising energy prices, which together create an energy crisis. REPowerEU calls for the accelerated deployment of renewable energy technologies and decarbonisation of industry, as well as streamlined permitting processes, to be decided with member states and supported by existing initiatives (Recovery and Resilience Plans, Cohesion Policy, etc.). As with other initiatives like the sustainable investment framework, attention must be paid to the territorialization of the pandemic and energy crisis responses to ensure that the regional energy transition unfolds evenly across Europe and creates new opportunities, not only supporting the regions with fossil fuel dependencies.

5. Energy transitions as solutions for all regions?

The three themes of Europe's regional energy transition above open strands for critical reflection on EU policy responses and future potentials of regional development, as they pertain to a political basis of transition policies in coal regions, an orientation to a green growth agenda pursuing both growth and sustainability and a capitalization on crises as opportunities for policy re-orientation and entrenchment. Yet, while the policy responses have noble content, they can be challenged for neglecting apparent contradictions, especially regarding the territorialization of their potential impacts in light of persistent regional inequalities and peripheralizing processes across Europe. It is therefore useful to consider these responses in the longer term view of regional development in the EU, particularly recognizing the tradition of academic scrutiny of (and contributions to) EU Regional Policy over several decades. Building on the rhetoric of competitiveness and innovation over multiple policy periods, the green growth agenda is not yet matched with policy supports for less developed regions that may have green economy potentials but lack political-institutional or innovation capacities, which can be seen as a major challenge for the low carbon economy in peripheries. The JTM, as the policy intervention meant to help, is selectively oriented to coal and carbon-intensive regions and therefore has a limited scope in relation to the diversity of potential regional futures of the low-carbon economy [93].

Other policy responses such as the framework for sustainable investment, pandemic recovery and energy crisis responses also need to be considered in terms of their potential regional impacts, since they fail to distinguish where investments should occur. Lessons from VoC so far suggest that capital tends to flow to the most economically competitive regions, innovation and transitions occur where there is higher risk-taking and lower market and institutional barriers, and state intervention may play a role in sustainability focused investments and innovations. Moreover, the institutional lens of VoC also suggests a certain path dependency, that regions with established institutional capacities supporting innovations and foundations of the low-carbon economy will continue to develop a comparative advantage, while those without and failing to receive additional supports will fall behind. These all suggest

that green growth developments stand to become concentrated in already advanced economies with high innovation capacities and a high quality of governance that also fulfils a state coordinating role. In the EU, these could be identified in the economic cores of Western and Northern Europe. The territorialization of policies slated to influence regional energy transitions is therefore of utmost importance to ensure that investments are not concentrated in the already innovative economic cores, exacerbating regional inequalities. Similarly, a perverse scenario in which capital avoids less developed regions altogether must be avoided.

Relevant datasets prepared by prior projects have pointed to potential regional differences in adaptive capacities and potentials for green growth [51,98], but more research is needed to bring the evidence up to date and comprehensively monitor regional developments in the scope of energy transitions. In order to better evaluate potential regional futures and open green development opportunities to all regions, more comprehensive data is needed Europe-wide on topics such as the low-carbon economy, renewable resources, innovation capacities and political-institutional and social factors, which have been partially addressed by a limited number of projects. Even as the most recent pandemic and energy crises have shown an unprecedented coordination of policy responses, and the most recent implementation measures to the EGD (e.g., Fit for 55 [102]) cross multiple policy areas, close attention must be paid to the regional impacts of implementation to ensure that the directionality stays on course, to achieve sustainability aims and further cohesion.

The JTM addresses the regional impacts of regional energy transitions most directly. Taking the proposed criteria and characteristics for regional eligibility [65,113], however, the territorial view of regional potentials for energy transition could be further developed to include all regions and account for political-institutional differences affecting transition outcomes, thereby enriching perspectives on just transition. This could effectively shift the scope of analysis from the limitations of path dependence (e.g., in coal regions) to the feasibility of multiple transition pathways (i.e., in all regions) [31] as a strategy supporting wider regional transitions. The JTM proposes to target regions which surely deserve attention. Yet, its limited geographical scope may downplay the need for extra policy supports for transition elsewhere, such as in less developed regions in general, where green energy and the green economy can be a source of green growth, according to the EU's own strategy. Basing the justification for JTM regional supports on characteristics derived from coal regions, there seem to be important aspects of just transition left unsupported for regions that would otherwise need them for green development in the future. The political processes behind the JTM and other strategies for decarbonization are far from completed, nevertheless may provide a model for other types of interventions.

Pushing VoC to the limits, it is necessary to recognize alternatives to growth which could potentially exist alongside each other in a zero carbon European economy, but research targeting extended VoC aspects, and indeed alternative and non-capitalist views in sustainability transitions, is still at an early stage. First, wider perspectives on development enabled by VoC, with attention to alternate (non-economic) aspects of analysis, should be applied more often in regional research to uncover instances worthy of deeper study. At the same time, green growth should also be critiqued as a strategy applicable to and desirable in all regions. On the ground, alternative post-growth paradigms more closely related to sustainability transitions, including steady state or degrowth, could come to sit amongst the existing VoCs, bringing Europe to a net zero carbon economy. While degrowth has recently entered the highest level climate discourse [119], the notion has not yet entered EU policy. Whether growth can or should be part of long-lagging regions' sustainability strategies should be questioned in light of just transitions and the necessity for growth to achieve 'good life' objectives [120]. Still, energy transition is needed in all regions, and while it is likely to be a source of green growth for some, it may not be for others, which does not

reduce its importance. Thus, by shifting perspectives, the appropriateness of growth as an ultimate societal objective can be questioned, and the concept of justice in transition can be extended from regions that stand to 'lose' to regions that otherwise do not stand to grow or, alternately, stand to grow to the detriment of other regions.

6. Conclusions

Despite being a global leader in the energy transition, EU policies affecting regional energy transitions have not been strongly considered in relation to regional development, while the topic of regional energy transitions itself has neither been exploited academically to bridge multiple research areas which are the current focus of policy interventions. This paper begins to shed light on the topic of regional energy transitions in Europe through the analysis and critical discussion of EU policy responses for regional energy transitions, opening the discourse on regional energy transitions from a political economy perspective and the broader sustainability transitions literature. To these ends, a critical VoC approach has been employed to shift focus from economic factors favoured by other dominant approaches in regional development, setting the spotlight on less studied political, social and environmental aspects influencing innovation and socio-technical systemic transformation. In doing so, it has departed from the traditional economic geography view, even while staying within a green growth paradigm, to question assumptions and contradictions in the European approach to regional development while humbly pushing the bounds of neoliberal capitalist logic. Taking the extension of VoC, it is argued that paying increased attention to political-institutional, social and environmental settings for regional transitions and supporting these settings to develop foundational aspects of the future low-carbon economy such as renewable energy potentials, could raise the prospects for transition and ultimately support quality of life and cohesion in all regions, without specifically aiming for growth in all regions.

Policy for Europe's regional energy transition is characterized by its roots in the coal transition, now harnessing the green growth agenda and capitalizing on crises to further entrench climate policy in regional development. The economic underpinnings of policy responses are evident in the goals and support measures for green transformation, aiming toward a sustainable EU, even in the interpretation of related social and environmental goals. A weakness in the context of regional development, however, pertains to the lack of attention to regional impacts and potentials, since the most direct response, the JTM, is the most limited both in terms of geography and solutions applicable only to eligible regions in a green growth context. Noting the aspects of VoC that have hardly been taken into account in Europe's regional energy transitions, there is a need to shift generally from the economic approach underpinning European regional policy to put more weight on alternate aspects, like the political, to support environmental and social aspects of transition, as well as to envision alternate regional futures. Thus, it is proposed to place VoC more centrally in regional energy transition research, to enable more critical and contextualized analysis of political-institutional and cultural aspects underpinning capitalist relations in transitions. To put it into practice, how policy responses and specific regions are studied during transition needs to be more sensitive to diverse political-institutional environments, to address the paradox in VoC regarding state intervention and sustainability innovations, and, more radically, to be open to alternative goals to growth.

The VoC perspective is but one of numerous approaches within sustainability transitions research with potential to enlighten discourses on regional energy transitions. While several common approaches in the transitions literature such as the multi-level approach, strategic niche management and transition management could potentially also be employed, VoC has been highlighted as less explored and deserving of attention [40], especially from the perspective of critical political economy. Nevertheless, other approaches from sustainability transitions research could also be employed to enrich the discourse on regional

energy transitions. These are seen to be compatible rather than competing with VoC [34]. This paper has not sought to compare or assess the potential contributions of other approaches, which would be a welcome topic for future research.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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References

- [1] European Commission, The European Green Deal. (COM (2019) 640 final), European Commission, Brussels, 2019. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2019:640:FIN>.
- [2] WHO, WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020, 2020. <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19-11-march-2020>. (Accessed 14 June 2021).
- [3] European Commission, Clean Energy for All Europeans, Publications Office of the European Union, Luxembourg, 2019. <https://doi.org/10.2833/9937>.
- [4] European Commission, A Clean Planet for All: A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy (COM (2018) 773 final), European Commission, Brussels, 2018. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0773>.
- [5] European Commission, REPowerEU: Joint European Action for more affordable, secure and sustainable energy, European Commission, Brussels, 2022. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2022%3A108%3AFIN>.
- [6] L. Dijkstra, A. Poelman, A. Rodríguez-Pose, The geography of EU discontent, *Reg. Stud.* 54 (2020) 737–753. <https://doi.org/10.1080/00343404.2019.1654603>.
- [7] A. Rodríguez-Pose, The revenge of the places that don't matter (and what to do about it), *Cambridge J. Reg. Econ. Soc.* 11 (2018) 189–209. <https://doi.org/10.1093/cjres/rsx024>.
- [8] T. Lang, F. Görmann, Regional and Local Development in Times of Polarisation: Re-thinking Spatial Policies in Europe, Palgrave Macmillan, Singapore, 2019. <https://doi.org/10.1007/978-981-13-1190-1>.
- [9] C. Hadjimichalis, Uneven geographical development and socio-spatial justice and solidarity: European regions after the 2009 financial crisis, *Eur. Urban Reg. Stud.* 18 (2011) 254–274. <https://doi.org/10.1177/0969776411404873>.
- [10] C. Hadjimichalis, R. Hudson, Contemporary crisis across Europe and the crisis of regional development theories, *Reg. Stud.* 48 (2014) 208–218. <https://doi.org/10.1080/00343404.2013.834044>.
- [11] B. Donald, M. Gray, The double crisis: in what sense a regional problem? *Reg. Stud.* 53 (2019) 297–308. <https://doi.org/10.1080/00343404.2018.1490014>.
- [12] C. Hadjimichalis, An uncertain future for the post-brexit, post-COVID-19 European Union, *Eur. Urban Reg. Stud.* 28 (2021) 8–13. <https://doi.org/10.1177/0969776420968961>.
- [13] G.L. Munck, *Critical Junctures and Historical Legacies: Insights and Methods for Comparative Social Science*, in: D. Collier, G.L. Munck (Eds.), Rowman & Littlefield, Lanham, MD, 2022, pp. 109–138.
- [14] B. Loewen, Towards territorial cohesion? Path dependence and path innovation of regional policy in Central and Eastern Europe, Tartu University Press, Tartu, 2018.
- [15] R.C. Lois González, The "Europe 2020 Strategy" as a vision to emerge from the crisis: an overall interpretation, in: R.C. Lois González, V. Paül Carril (Eds.), *European Regions in the Strategy to Emerge from the Crisis: The Territorial Dimension of the "Europe 2020"*, Servizo de Publicacións da Universidade de Santiago de Compostela, Santiago de Compostela, 2013, pp. 17–27. <http://hdl.handle.net/10347/10387>.
- [16] V. Avdikos, A. Chardas, European Union Cohesion Policy Post 2014: More (Place-Based and Conditional) Growth – Less Redistribution and Cohesion, *Territ. Politics Gov.* 4 (2016) 97–117. <https://doi.org/10.1080/21622671.2014.992460>.
- [17] C. Mendez, The Lisbonization of EU cohesion policy: a successful case of experimentalist Governance? *Eur. Plan. Stud.* 19 (2011) 519–537. <https://doi.org/10.1080/09654313.2011.548368>.
- [18] V. Monastiriotis, Regional growth and national development: transition in central and eastern Europe and the regional kuznets curve in the east and the west, *Spat. Econ. Anal.* 9 (2014) 142–161. <https://doi.org/10.1080/17421772.2014.891156>.
- [19] European Commission, A European strategic energy technology plan (SET-PLAN) (COM (2007) 723 final), European Commission, Brussels, 2007. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52007DC0723>.
- [20] United Nations, Transforming our world: the 2030 Agenda for Sustainable Development, United Nations, New York, 2015. <https://sustainabledevelopment.un.org/post2015/transformingourworld>.
- [21] United Nations, Adoption of the Paris Agreement, 21st Conference of the Parties, United Nations, Paris, 2015. <http://unfccc.int/resource/docs/2015/cop21/eng/10a01.pdf>.
- [22] P. Andrews-Speed, Applying institutional theory to the low-carbon energy transition, *energy res. Soc. Sci.* 13 (2016) 216–225. <https://doi.org/10.1016/j.erss.2015.12.011>.
- [23] P.A. Hall, R.C.R. Taylor, Political science and the three new institutionalisms, *Political Stud.* 44 (1996) 936–957. <https://doi.org/10.1111/j.1467-9248.1996.tb00343.x>.
- [24] P. Pierson, *Politics in Time: History, Institutions, and Social Analysis*, Princeton University Press, Princeton, 2004. <http://press.princeton.edu/titles/7872.html>.
- [25] W. Streeck, K. Thelen, Introduction: Institutional change in advanced political economies, in: W. Streeck, K. Thelen (Eds.), *Beyond Continuity: Institutional Change in Advanced Political Economies*, Oxford University Press, Oxford, 2005, pp. 1–39.
- [26] K. Thelen, Institutional change in advanced political economies, *Br. J. Ind. Relat.* 47 (2009) 471–498. <https://doi.org/10.1111/j.1467-8543.2009.00746.x>.
- [27] W.B. Arthur, Competing technologies, increasing returns, and lock-in by historical events, *Econ. J.* 99 (1989) 116–131. <https://doi.org/10.2307/2234208>.
- [28] P.A. David, Clio and the economics of QWERTY, *Am. Econ. Rev.* 75 (1985) 332–337. <http://www.jstor.org/stable/1805621>.
- [29] J. Mahoney, Path dependence in historical sociology, *Theory Soc.* 29 (2000) 507–548. <https://www.jstor.org/stable/3108585>.
- [30] D.C. North, Institutions, *J. Econ. Perspect.* 5 (1991) 97–112. <https://doi.org/10.1257/jep.5.1.97>.
- [31] B. Turnheim, B. Nykvist, Opening up the feasibility of sustainability transitions pathways (STPs): representations, potentials, and conditions, *Res. Policy* 48 (2019) 775–788. <https://doi.org/10.1016/j.respol.2018.12.002>.
- [32] P.A. Hall, K. Thelen, Institutional change in varieties of capitalism, *Socio-Econ. Rev.* 7 (2009) 7–34. <https://doi.org/10.1093/ser/mwn020>.
- [33] P.A. Hall, D. Soskice, *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage*, Oxford University Press, Oxford, 2001.
- [34] B. Loewen, Revitalizing varieties of capitalism for sustainability transitions research: review, critique and way forward, *Renew. Sust. Energy Rev.* 162 (2022), 112432. <https://doi.org/10.1016/j.rser.2022.112432>.
- [35] P. Cooke, Socio-technical transitions and varieties of capitalism: green regional innovation and distinctive market niches, *J. Knowl. Econ.* 1 (2010) 239–267. <https://doi.org/10.1007/s13132-010-0019-2>.
- [36] L. Fuenschilling, B. Truffer, The structuration of socio-technical regimes—conceptual foundations from institutional theory, *Res. Policy* 43 (2014) 772–791. <https://doi.org/10.1016/j.respol.2013.10.010>.
- [37] A. Cherp, V. Vinichenko, J. Jewell, E. Brutschin, B. Sovacool, Integrating techno-economic, socio-technical and political perspectives on national energy transitions: a meta-theoretical framework, *energy res. Soc. Sci.* 37 (2018) 175–190. <https://doi.org/10.1016/j.erss.2017.09.015>.
- [38] F.W. Geels, Socio-Technical Transitions to Sustainability, in: *Oxford Research Encyclopedia of Environmental Science*, Oxford University Press, Oxford, 2018. <https://doi.org/10.1093/acrefore/9780199389414.013.587>.
- [39] H. Buch-Hansen, M.B. Carstensen, Paradigms and the political economy of ecopolitical projects: green growth and degrowth compared, *Change* 25 (2021) 308–327. <https://doi.org/10.1177/1024529420987528>.
- [40] J. Köhler, F.W. Geels, F. Kern, J. Markard, E. Onsongo, A. Wiecek, F. Alkemade, F. Avelino, A. Bergek, F. Boons, L. Fuenschilling, D. Hess, G. Holtz, S. Hyysalo, K. Jenkins, P. Kivimaa, M. Martiskainen, A. McMeekin, M. S. Mühlmeier, B. Nykvist, B. Pel, R. Raven, H. Rohracher, B. Sandén, J. Schot, B. Sovacool, B. Turnheim, D. Welch, P. Wells, An agenda for sustainability transitions research: state of the art and future directions, *environ. Innov. Soc. Transit.* 31 (2019) 1–32. <https://doi.org/10.1016/j.eist.2019.01.004>.
- [41] S. Četković, A. Buzogány, Varieties of capitalism and clean energy transitions in the European Union: when renewable energy hits different economic logics, *Clim. Policy* 16 (2016) 642–657. <https://doi.org/10.1080/14693062.2015.1135778>.
- [42] H. Doering, C. Evans, D. Stroud, Sustainable varieties of Capitalism? The greening of steel work in Brazil and Germany, *Relat. Ind.-Ind. Relat.* 70 (2015) 621–644. <https://doi.org/10.7202/1034897ar>.
- [43] E. Magnin, Varieties of capitalism and sustainable development: institutional complementarity dynamics or radical change in the hierarchy of Institutions? *J. Econ. Issues* 52 (2018) 1143–1158. <https://doi.org/10.1080/00213624.2018.1536017>.

- [44] F. Reusswig, Sociological tasks in view of the transition to post-carbon societies. Also a comment to Michael Redclift, *Int. Rev. Soc. Res.* 1 (2011) 189–195, <https://doi.org/10.1515/irsr-2011-0028>.
- [45] H. Buch-Hansen, Reorienting Comparative Political Economy: From Economic Growth to Sustainable Alternatives, in: E. Chertkovskaya, A. Paulsson, S. Barca (Eds.), *Towards a Political Economy of Degrowth*, Rowman & Littlefield, London, 2019, pp. 39–54.
- [46] M. Koch, H. Buch-Hansen, In search of a political economy of the postgrowth era, *Globalizations* 18 (2021) 1219–1229, <https://doi.org/10.1080/14747731.2020.1807837>.
- [47] G. Feola, Capitalism in sustainability transitions research: time for a critical turn?, *environ. Innov. Soc. Transit.* 35 (2020) 241–250, <https://doi.org/10.1016/j.eist.2019.02.005>.
- [48] R. Boschma, L. Coenen, K. Frenken, B. Truffer, Towards a theory of regional diversification: combining insights from evolutionary economic geography and transition studies, *Reg. Stud.* 51 (2017) 31–45, <https://doi.org/10.1080/00343404.2016.1258460>.
- [49] M. Trippel, S. Baumgartinger-Seiringer, A. Frangenheim, A. Isaksen, J.O. Rypestøl, Unravelling green regional industrial path development: regional preconditions, asset modification and agency, *Geoforum* 111 (2020) 189–197, <https://doi.org/10.1016/j.geoforum.2020.02.016>.
- [50] T. Hansen, L. Coenen, The geography of sustainability transitions: review, synthesis and reflections on an emergent research field, *environ. Innov. Soc. Transit.* 17 (2015) 92–109, <https://doi.org/10.1016/j.eist.2014.11.001>.
- [51] ESPON, GRECO Territorial Potentials for a Greener Economy. Applied Research 2013/1/20 Final Report, ESPON 2013 Programme, Luxembourg, 2014. https://www.espon.eu/sites/default/files/attachments/GRECO_FR_-_Vol_1.2_Main_Report.pdf.
- [52] J. Hickel, G. Kallis, Is green growth Possible? *New. Polit. Econ.* 25 (2020) 469–486, <https://doi.org/10.1080/13563467.2019.1598964>.
- [53] I. Blühdorn, Post-capitalism, post-growth, post-consumerism? Eco-political hopes beyond sustainability, *Glob. Discourse* 7 (2017) 42–61, <https://doi.org/10.1080/23269995.2017.1300415>.
- [54] O. Koretskaya, G. Feola, A framework for recognizing diversity beyond capitalism in Agri-food systems, *J. Rural. Stud.* 80 (2020) 302–313, <https://doi.org/10.1016/j.jrurstud.2020.10.002>.
- [55] R. Kattel, M. Mazzucato, Mission-oriented innovation policy and dynamic capabilities in the public sector, *Ind. Corp. Change* 27 (2018) 787–801, <https://doi.org/10.1093/icc/dty032>.
- [56] M. Mazzucato, Mission-oriented innovation policies: challenges and opportunities, *Ind. Corp. Change* 27 (2018) 803–815, <https://doi.org/10.1093/icc/dty034>.
- [57] E. Karo, R. Kattel, Innovation (policy) and transformative change in the European Union, in: P. Vihalemm, A. Masso, S. Opermann (Eds.), *The Routledge International Handbook of European Social Transformations*, Routledge, London, 2017, pp. 239–249, <https://doi.org/10.4324/9781315612942-16>.
- [58] M. Mazzucato, Governing Missions: Governing Missions in the European Union, in: *Independent Expert Report, Directorate-General for Research and Innovation*, Publications Office of the European Union, Luxembourg, 2019, <https://doi.org/10.2777/618697>.
- [59] M. Mazzucato, Missions: Mission-Oriented Research & Innovation in the European Union A problem-solving approach to fuel innovation-led growth, Directorate-General for Research and Innovation, Publications Office of the European Union, Luxembourg, 2018, <https://doi.org/10.2777/360325>.
- [60] IEA, Energy Technology Perspectives 2020: Special Report on Clean Energy Innovation, International Energy Agency (IEA), Paris. <https://www.iea.org/reports/clean-energy-innovation>, 2020.
- [61] O. Renn, J.P. Marshall, Coal, nuclear and renewable energy policies in Germany: From the 1950s to the “Energiewende”, *Energy Policy* 99 (2016) 224–232, <https://doi.org/10.1016/j.enpol.2016.05.004>.
- [62] P. Söderholm, G. Klaassen, Wind power in Europe: a simultaneous innovation-diffusion model, *Environ. Resour. Econ.* 36 (2007) 163–190, <https://doi.org/10.1007/s10640-006-9025-z>.
- [63] D. Toke, Wind power in UK and Denmark: can rational choice help explain different Outcomes? *Env. Polit.* 11 (2002) 83–100, <https://doi.org/10.1080/71400647>.
- [64] IEA, Renewables 2020, International Energy Agency (IEA), Paris. <https://www.iea.org/reports/renewables-2020>, 2020.
- [65] European Commission, Proposal for a regulation of the European Parliament and of the Council establishing the Just Transition Fund (COM/2020/22 final), European Commission, Brussels, 2020. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020PC0022>.
- [66] G. Rentier, H. Lelieveldt, G.J. Kramer, Varieties of coal-fired power phase-out across Europe, *Energy Policy* 132 (2019) 620–632, <https://doi.org/10.1016/j.enpol.2019.05.042>.
- [67] IEA, Net zero by 2050: A Roadmap for the Global Energy Sector, International Energy Agency (IEA), Paris, 2021. <https://www.iea.org/reports/net-zero-by-2050>.
- [68] SAPEA, A systemic approach to the energy transition in Europe. Evidence Review Report No. 9, Science Advice for Policy by European Academies (SAPEA), Berlin, 2021, <https://doi.org/10.26356/energytransition>.
- [69] E. von Weizsäcker, A. Wijkman, Come On! Capitalism, Short-termism, Population and the Destruction of the Planet: A Report to the Club of Rome, Springer Nature, New York, n.d. <https://link.springer.com/book/10.1007/978-1-4939-7419-1>.
- [70] D.H. Meadows, D.L. Meadows, J. Randers, W.W. Behrens III, *The Limits to Growth: A Report for the Club of Rome’s Project on the Predicament of Mankind*, Universe Books, New York, 1972.
- [71] W. Steffen, K. Richardson, J. Rockström, S.E. Cornell, I. Fetzer, E.M. Bennett, R. Biggs, S.R. Carpenter, W. de Vries, C.A. de Wit, C. Folke, D. Gerten, J. Heinke, G.M. Mace, L.M. Persson, V. Ramanathan, B. Reyers, S. Sörlin, Planetary boundaries: guiding human development on a changing planet, *Science* 347 (2015) 1259855, <https://doi.org/10.1126/science.1259855>.
- [72] M. Świąder, D. Lin, S. Szebrański, J.K. Kazak, K. Iha, J. van Hoof, I. Belčáková, S. Altiok, The application of ecological footprint and biocapacity for environmental carrying capacity assessment: a new approach for European cities, *Environ. Sci. Policy* 105 (2020) 56–74, <https://doi.org/10.1016/j.envsci.2019.12.010>.
- [73] National Institute of Urban Affairs, New Delhi, Carrying Capacity Based Regional Planning, Institute for Housing and Urban Development Studies, Rotterdam, 1997.
- [74] European Commission, An energy policy for Europe (COM (2007) 1 final), European Commission, Brussels, 2007. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52007DC0001>.
- [75] L. Puka, K. Szulecki, The politics and economics of cross-border electricity infrastructure: a framework for analysis, *energy res. Soc. Sci.* 4 (2014) 124–134, <https://doi.org/10.1016/j.erss.2014.10.003>.
- [76] K. Szulecki, S. Fischer, A.T. Gullberg, O. Sartor, Shaping the ‘Energy Union’: between national positions and governance innovation in EU energy and climate policy, *Clim. Policy* 16 (2016) 548–567, <https://doi.org/10.1080/14693062.2015.1135100>.
- [77] A. Nosko, M. Mišík, No United Front: The Political Economy of Energy in Central and Eastern Europe, in: S.S. Andersen, A. Goldthau, N. Sitter (Eds.), *Energy Union: Europe’s New Liberal Mercantilism?*, Palgrave Macmillan UK, London, 2017, pp. 201–222, https://doi.org/10.1057/978-1-137-59104-3_12.
- [78] S. Četković, A. Buzogány, The political economy of EU climate and energy policies in central and Eastern Europe revisited: shifting coalitions and prospects for clean energy transitions, *Politics Gov.* 7 (2019) 124–138, <https://doi.org/10.17645/pag.v7i1.1786>.
- [79] European Commission, Facing the challenge: The Lisbon strategy for growth and employment. Report from the High Level Group chaired by Wim Kok, Office for Official Publications of the European Communities, Luxembourg, 2004.
- [80] European Commission, Europe 2020: A strategy for smart, sustainable and inclusive growth (COM (2010) 2020 final), European Commission, Brussels. <http://ec.europa.eu/eu2020/pdf/COMPLETE%20EN%20BARROSO%20%20%2007%20-%20Europe%202020%20-%2020EN%20version.pdf>, 2010.
- [81] European Commission, Cohesion in Europe towards 2050: Eighth report on economic, social and territorial cohesion, Publications Office of the European Union, Luxembourg. https://ec.europa.eu/regional_policy/sources/docoffic/official/reports/cohesion8/8cr.pdf, 2022.
- [82] European Commission, My Region, My Europe, Our Future. Seventh Report on Economic, Social and Territorial Cohesion, Publications Office of the European Union, Luxembourg, 2017. http://ec.europa.eu/regional_policy/sources/docoffic/official/reports/cohesion7/7cr.pdf.
- [83] B.K. Sovacool, D.J. Hess, S. Amir, F.W. Geels, R. Hirsh, L. Rodriguez Medina, C. Miller, C. Alvia Palavicino, R. Phadke, M. Ryghaug, J. Schot, A. Silvast, J. Stephens, A. Stirling, B. Turnheim, E. van der Vleuten, H. van Lente, S. Yearley, Sociotechnical agendas: Reviewing future directions for energy and climate research, *Energy Res. Soc. Sci.* 70 (2020) 101617, <https://doi.org/10.1016/j.erss.2020.101617>.
- [84] R. Wüstenhagen, M. Wolsink, M.J. Bürer, Social acceptance of renewable energy innovation: an introduction to the concept, *Energy Policy* 35 (2007) 2683–2691, <https://doi.org/10.1016/j.enpol.2006.12.001>.
- [85] A. Isaksen, R. Martin, M. Trippel, New Avenues for Regional Innovation Systems and Policy, in: A. Isaksen, R. Martin, M. Trippel (Eds.), *New Avenues for Regional Innovation Systems - Theoretical Advances, Empirical Cases and Policy Lessons*, Springer International Publishing, Cham, 2018, pp. 1–19, https://doi.org/10.1007/978-3-319-71661-9_1.
- [86] D. MacKinnon, S. Dawley, A. Pike, A. Cumbers, Rethinking path creation: a geographical political economy approach, *Econ. Geogr.* 95 (2019) 113–135, <https://doi.org/10.1080/00130095.2018.1498294>.
- [87] D. MacKinnon, A. Cumbers, A. Pike, K. Birch, R. McMaster, Evolution in economic geography: institutions, political economy, and adaptation, *Econ. Geogr.* 85 (2009) 129–150, <https://doi.org/10.1111/j.1944-8287.2009.01017.x>.
- [88] European Commission, Regional Innovation Scoreboard 2021, Publications Office of the European Union, Luxembourg, 2021, <https://doi.org/10.2873/674111>.
- [89] B. Loewen, S. Schulz, Regional and Local Development in Times of Polarisation: Re-Thinking Spatial Policies in Europe, in: T. Lang, F. Görmär (Eds.), *Palgrave Macmillan*, Singapore, 2019, pp. 121–148, https://doi.org/10.1007/978-981-13-1190-1_6.
- [90] P. Annoni, L. Dijkstra, EU Regional Competitiveness Index: RCI 2013, Publications Office of the European Union, Luxembourg, 2013. http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/6th_report/rci_2013_report_final.pdf.
- [91] O. Golubchikov, K. O’Sullivan, Energy periphery: uneven development and the precarious geographies of low-carbon transition, *Energy Build.* 211 (2020), 109818, <https://doi.org/10.1016/j.enbuild.2020.109818>.
- [92] K. O’Sullivan, O. Golubchikov, A. Mehmood, Uneven energy transitions: understanding continued energy peripheralization in rural communities, *Energy Policy* 138 (2020), 111288, <https://doi.org/10.1016/j.enpol.2020.111288>.

- [93] G. Bridge, S. Bouzarovski, M. Bradshaw, N. Eyre, Geographies of energy transition: space, place and the low-carbon economy, *Energy Policy* 53 (2013) 331–340, <https://doi.org/10.1016/j.enpol.2012.10.066>.
- [94] F. Barca, An Agenda for a Reformed Cohesion Policy: A Place-Based Approach to Meeting European Union Challenges and Expectations, European Commission, Brussels, 2009. http://www.europarl.europa.eu/meetdocs/2009_2014/documents/regi/dv/barca_report_barca_report_en.pdf.
- [95] D. Foray, P.A. David, B. Hall, Smart Specialisation - The Concept, in: *Knowledge Economists Policy Brief*, 2009, pp. 1–5. http://ec.europa.eu/invest-in-research/pdf/download_en/kfg_policy_brief_no9.pdf.
- [96] Eurostat, Energy (nrg). <https://ec.europa.eu/eurostat/web/energy/data/data-base>, 2022.
- [97] Eurostat, Regional statistics by NUTS classification (reg), 2022. <https://ec.europa.eu/eurostat/web/regions/data/database>. (Accessed 15 August 2022).
- [98] ESPON, ESPON Climate: Climate Change and Territorial Effects on Regions and Local Economies. Applied Research 2013/1/4 Final Report, ESPON 2013 Programme, Luxembourg, 2011. <https://www.espon.eu/sites/default/files/attachments/Final%20Report%20Main%20Report.pdf>.
- [99] A. Sbardella, N. Barbieri, D. Consoli, L. Napolitano, F. Perruchas, E. Pugliese, The regional green potential of the European innovation system, European Commission, Brussels, 2022. <https://publications.jrc.ec.europa.eu/repository/handle/JRC124696>.
- [100] European Commission, Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088 (Text with EEA relevance), European Commission, Brussels, 2020. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32020R0852>.
- [101] European Commission, Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 ('European Climate Law'), European Commission, Brussels, 2021. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R1119>.
- [102] European Commission, "Fit for 55": delivering the EU's 2030 Climate Target on the way to climate neutrality (COM (2021) 550 final), European Commission, Brussels, 2021. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021DC0550>.
- [103] European Commission, Key Instruments Supporting the Recovery Plan for Europe. KV-01-20-262-EN-N., European Union, Brussels, 2020 <https://doi.org/10.2761/02988>.
- [104] L. Coenen, S. Campbell, J. Wiseman, Regional Innovation Systems and Transformative Dynamics: Transitions in Coal Regions in Australia and Germany, in: A. Isaksen, R. Martin, M. Trippl (Eds.), *New Avenues for Regional Innovation Systems - Theoretical Advances, Empirical Cases and Policy Lessons*, Springer International Publishing, Cham, 2018, pp. 199–217, https://doi.org/10.1007/978-3-319-71661-9_10.
- [105] K. Bennett, H. Beynon, R. Hudson, *Coalfields regeneration: Dealing with the consequences of industrial decline*, The Policy Press, Bristol, 2000.
- [106] R. Hassink, *Regional innovation policy: Case-studies from the Ruhr Area, Baden-Württemberg and the North East of England*, Faculteit Ruimtelijke Wetenschappen Rijksuniversiteit Utrecht, Utrecht, 1992.
- [107] R. Hudson, Restructuring region and state: the case of north East England, *Tijdschr. Econ. Soc. Geogr.* 89 (1998) 15–30, <https://doi.org/10.1111/1467-9663.00003>.
- [108] D. Stroud, P. Fairbrother, C. Evans, J. Blake, Skill development in the transition to a 'green economy': a 'varieties of capitalism' analysis, *Econ. Labour Relat. Rev.* 25 (2014) 10–27, <https://doi.org/10.1177/1035304613517457>.
- [109] P. Alves Dias, K. Kanellopoulos, H. Medarac, Z. Kapetaki, E. Miranda-Barbosa, R. Shortall, V. Czako, T. Telsnig, C. Vázquez Hernández, R. Lacal Arántegui, W. Nijs, I. Gonzalez Aparicio, M. Trombetti, G. Mandras, E. Peteves, E. Tzimas, *EU coal regions: opportunities and challenges ahead*, Publications Office of the European Union, Luxembourg, 2018.
- [110] K. Harrahill, O. Douglas, Framework development for 'just transition' in coal producing jurisdictions, *Energy Policy* 134 (2019), 110990, <https://doi.org/10.1016/j.enpol.2019.110990>.
- [111] ESPON, The energy transition and climate change resilience: ESPON evidence, ESPON 2020 Programme, Luxembourg. <https://www.espon.eu/sites/default/files/attachments/Topic%20paper%20%235%20-%20The%20energy%20transition%20and%20climate%20change%20resilience%20-%20ESPON%20evidence.pdf>, 2021.
- [112] V. Iotzov, M. Gauk, Structural change in coal phase-out regions, ESPON 2020 Programme, Luxembourg. <https://www.espon.eu/sites/default/files/attachments/Policy%20Brief%20structural%20change%20in%20coal%20phase-out%20regions.pdf>, 2020.
- [113] European Commission, European Semester 2020: Overview of Investment Guidance on the Just Transition Fund 2021–2027 per Member State (Annex D), 2020, Country Reports: Annexes D, European Commission, Brussels, 2020, https://ec.europa.eu/info/sites/default/files/annex_d_crs_2020_en.pdf.
- [114] S. Nosek, Territorial cohesion storylines in 2014–2020 cohesion policy, *Eur. Plan. Stud.* 25 (2017) 2157–2174, <https://doi.org/10.1080/09654313.2017.1349079>.
- [115] European Commission, The European Green Deal Investment Plan and Just Transition Mechanism explained, 2020. https://ec.europa.eu/commission/press-corner/detail/en/qanda_20_24. (Accessed 18 August 2022).
- [116] IPCC, in: V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B. R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (Eds.), *Global Warming of 1.5°C: An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*, Cambridge University Press, Cambridge and New York, 2018, <https://doi.org/10.1017/9781009157940>.
- [117] C. Dupont, S. Oberthür, I. von Homeyer, The Covid-19 crisis: a critical juncture for EU climate policy development? *J. Eur. Integr.* 42 (2020) 1095–1110, <https://doi.org/10.1080/07036337.2020.1853117>.
- [118] C. Kuzemko, M. Bradshaw, G. Bridge, A. Goldthau, J. Jewell, I. Overland, D. Scholten, T. Van de Graaf, K. Westphal, Covid-19 and the politics of sustainable energy transitions, *Energy Res. Soc. Sci.* 68 (2020), 101685, <https://doi.org/10.1016/j.erss.2020.101685>.
- [119] IPCC, H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, Summary for Policymakers, in: H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (Eds.), *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge and New York, 2022, pp. 3–33. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf.
- [120] J.E. Stiglitz, J.-P. Fitoussi, D. Martine, *Beyond GDP: Measuring What Counts for Economic and Social Performance*, OECD Publishing, Paris, 2018, <https://doi.org/10.1787/9789264307292-en>.