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Editorial

Regional foundations of energy transitions

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Due to a spatial turn in the socio-technical transition literature, the geography of energy transitions has recently been taken increasingly seriously, leading to burgeoning research output on regional energy transitions since early 2010. Amidst this wealth of publications, however, it can be difficult to keep track of its diverse and constantly evolving landscape. This editorial therefore aims at developing a framework that allows for bringing multiple approaches to regional energy transitions into conversation with each other and that helps to understand and explain the complexity of these interdependencies in ways that go beyond observing regional variety in energy transitions.

Keywords: regional energy transitions, energy transition, sustainability transition, framework
JEL Classifications: O18, P18, Q42, Q48

Energy transitions, in what sense a regional problem?

Across the world, we are witnessing a plethora of actions, policies and innovations that are expediting energy transitions away from fossil fuels towards zero-carbon energy production. The global energy landscape is diversifying, and yet only recently is this development becoming the subject of regional studies and cognate fields of research. As recently as 2019, Donald and Gray observed, 'the intellectual and policy legacies of our focus on regional competitiveness leaves our discipline out of step with the most pressing regional environmental and economic issues of our time' (Donald and Gray, 2019, 300). Increasingly, the twin crisis

of growing social inequality and accelerating climate change is met by calls for 'just transitions' that allow for inclusive and expedited transformations of energy and related systems based on renewables and other zero-carbon technologies (Jasanoff, 2018; Schot and Kanger, 2018; Skjølsvold and Coenen, 2021; Swilling and Annecke, 2012). This Special Issue of *CJRES* demonstrates that these debates should not be divorced from regional contexts but argues that a place-based perspective is critical to understand the multifaceted nature of contemporary energy transitions (and instrumental to the development of effective policies).

Not surprisingly, voluminous theoretical and empirical research exists across the social sciences more generally that addresses transition pathways towards zero-carbon energy. Much of this research emphasises the role of science, technology and innovation (Hess and Sovacool, 2020). And yet, emerging evidence suggests there is growing consensus that energy transitions are accelerating due to human factors, including (i) expanding coalitions of interests, (ii) discourses and visions that appeal to mass publics and (iii) significant policy changes that alter technology selection environments (Sovacool et al., 2020). A crucial theoretical framing of energy transitions research (Grubler, 2012) acknowledges the importance of socio-technical (sustainability) transitions (Köhler et al., 2019; Markard et al., 2012) and their associated analytical frameworks, including the Multi-Level Perspective (Geels, 2002) and Technological Innovation Systems (Bergek et al., 2008; Hekkert et al., 2007). Common to this literature is the embedding of energy transitions into a wider field of social, institutional and economic change informing theory development that blends historical macro-perspectives with actor-based microeconomic and institutional foundations (Grubler, 2012).

Our definition of (sustainable) energy transitions adds a regional component to the '… long-term, multi-dimensional, and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption' (Markard et al., 2012, 956). Initial theorising and empirical research on transitions largely ignored energy transitions' spatial context (Coenen et al., 2012). However, the geography of transformation is becoming increasingly important (Bridge et al., 2013; Calvert, 2015; Chlebna and Mattes, 2020; Coenen et al., 2010; Hansen and Coenen, 2015; Truffer and Coenen, 2012; Truffer et al., 2015). Witness the burgeoning volume of research output over the last decade that recognises local- and regional-level processes that are contributing to energy system transitions (Coutard and Rutherford, 2010; Mattes et al., 2015; Ruggiero et al., 2021; Yu and Gibbs, 2018) (see also Figure 1).

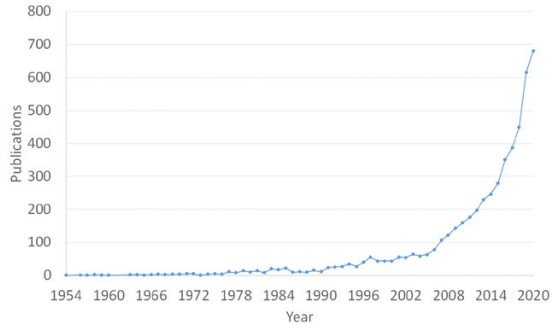

Figure 1. *Number of yearly publications in Scopus on regional energy transitions.*

A wealth of publications grows in diversity and represents a constantly evolving landscape of geographically based energy transitions. The literature encompasses several facets, including the range, role and responsibility of actors involved in energy production, distribution, innovation and expanding significance of renewable energy deployment. First, renewables' growth often creates decentralised energy geographies, where prosumers (individual residents and community energy organisations) and other social movement actors are playing an increasingly critical role (Radtke,

2016; Seyfang and Haxeltine, 2012). Incumbent actors are re-thinking and reconfiguring their original business models. Small- and medium-sized entrants are reconfiguring value chains and are leading to the emergence of regional energy clusters. Second, energy policy and politics are becoming increasingly complex with a growing role for inter- and extra-national actors. Moreover, we see increased attention for issues such as energy poverty, inequality, justice and 'just transitions' (Newell and Mulvaney, 2013). Simultaneously, countertendencies are evident such as the re-municipalisation of local energy grids (Becker et al., 2015). Also, there is a general need to ensure that social benefits result from infrastructures that deliver foundational services (Engelen et al., 2017; Nygaard and Hansen, 2020).

The complexities of regional energy transitions yield radical and systemic change across multiple dimensions (for example, economic, technological, social, institutional, cultural, political, ecological). New theories are needed to inform leaders, scholars, citizens and activists of regional energy transitions' complexity. On the one hand, a challenge is the multi-dimensionality and embeddedness of energy transition in regional contexts. On the other hand, the diversity of contexts offers a relevant rationale for geographical and spatial perspectives on energy transitions that uncover the spatial particularities of energy transitions through contextual analysis (Asheim, 2020; Cox and Evenhuis, 2020; Gong and Hassink, 2020).

Yet, the research field engaging with energy 'transitions' geography struggles sometimes to move beyond topical concern (Binz et al., 2020). While there is broad consensus that place-specificity matters for energy transitions, the relevant literature is yielding little generalisable knowledge about how place-specificity uniquely matters in achieving successful changes (Hansen and Coenen, 2015). It would be futile and naïve to assert that this Special Issue would fill that gap. It does, however, take stock of the rich but fragmented and increasingly expanding research field around regional energy transitions. This Editorial aims to develop a framework that exposes our readers to the multiple approaches to regional energy transitions and places them into conversation with each other, including (but not limited to) the respective contributions of the special issue. Our intention is not to arrive at some unifying general theoretical framework but instead to move beyond a tendency for idiosyncratic regional descriptions and shift from fragmented to engaged pluralism (Barnes and Sheppard, 2009; Hassink et al., 2014).

At one end, authors have deployed a well-known and fairly conventional geographical terminology to examine energy transitions as spatial processes. For example, Bridge et al. (2013) suggest a conceptual language based on geographic terminology to explain and understand spaces and places of energy transitions. On the other hand, spatially naïve theorisations of energy transitions that drew on the bourgeoning literature of socio-technical transitions, including frameworks such as the above-mentioned multi-level perspective, strategic niche management and technological innovation systems have become increasingly influended by a geographical turn (Truffer et al., 2015). Despite efforts to add spatial context to the use of these frameworks,[1] these strands of theorising are rarely in conversation (Figure 2).

To structure the plurality in the literature, we make a non-mutually exclusive distinction between approaches that focus on energy transitions *in, of* and *by* regions. In doing so, we took inspiration from Hölscher and Frantzeskaki (2021), who distinguish between three perspectives on urban transformations in, of and by cities. All approaches seem to utilise similar questions: what are the foundations of regional energy transitions, how do energy transitions unfold across space, and to what effect(s)?

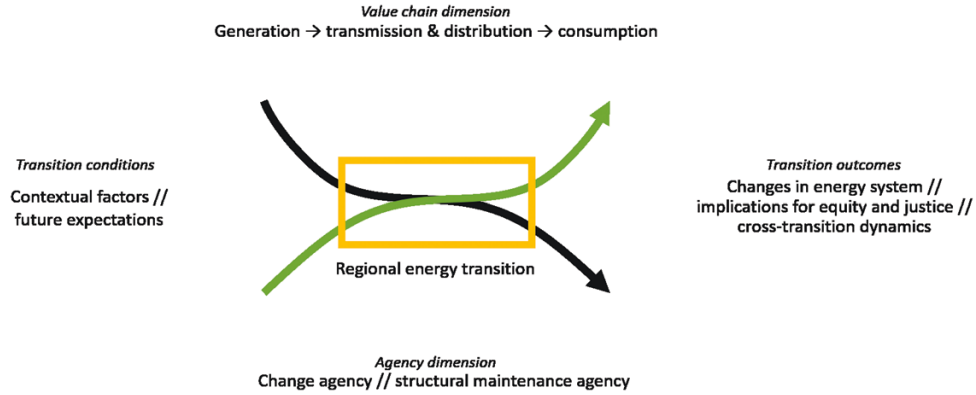

Figure 2. *Conceptualising regional energy transitions.*

1. The research focussed on energy transitions *in* regions is primarily geared to understanding how regions contextualise energy transitions: which place-based factors, processes and mechanisms enable and constrain energy transitions (in regions)? Often it zooms in on place-specific factors that shape energy transitions in terms of regional industrial capabilities, institutions, resource endowments, policy portfolios and market configurations (Hansen and Coenen, 2015). It mainly adds spatial sensitivity to non-spatial frameworks in the energy transitions literature.
2. The research focussed on energy transitions *of* regions assesses the outcomes and impacts of energy transitions on regions. Such consequences reflect the functions of regional systems of provision (for example, energy (sic), transport, housing, food). Still, it can equally consider the impact of energy transitions on sector structure, employment, industrial structure and regional innovation systems.
3. The research focussed on energy transitions *by* regions hones in on agentic features of areas in governing energy transitions. It conceptualises regions as 'agents of change', through their political powers and administrative capabilities. Often, this means such approaches and perspectives need to position the region in a multi-level governance structure to describe the way influence is spread vertically between many levels of government and horizontally across multiple quasi-government and non-governmental organisations and actors.

While all three approaches address critical dimensions of regional energy transitions, they are by default selective and risk providing only a partial account of the mutually constitutive influence of the direction and shape of regional development and energy transitions. We therefore need a conceptual framework to order and structure the arguably messy, recursive relationships between regions and energy transitions, and that helps explain the complexity of these interdependencies in ways that go beyond observing regional variety in energy transitions.

In section two, we develop such a bridging framework that emphasises regional energy 'transitions' recursive features, highlighting the interconnections between energy transitions in, of and by regions. Our approach seeks to illustrate how regions influence energy transitions and energy transitions shape regions. This emphasis on recursive embeddedness aims to bring disparate contributions into conversation with one another without 'bracketing the other'. Section three will then draw on the framework developed in section two to discuss

the respective contributions to this Special Issue. Rather than emphasising that these articles have something important and relevant to say about particular elements of energy transitions in, of and by regions, our endeavour is to demonstrate how the articles straddle multiple couplings between regions and energy transitions. Section four offers our concluding thoughts and suggestions for future research.

Towards a conceptual framework for regional energy transitions

Given the growing but heterogeneous scholarship on regional energy transitions, there is a need to better position the contributions of different kinds of literature to one another. Here we suggest that regional energy transitions:

1. May vary across value chains.
2. Are conditioned by various contextual factors.
3. Are enacted through different forms of agency.
4. Produce multiple types of outcomes.

A value chain perspective underlines that regional energy transitions require changes in the way energy is generated, transmitted, distributed and consumed (as well as arguably wasted). Thus, here 'value chain' refers to the activities across different organisations involved in the production or use of energy. While individual energy generation technologies are in themselves constituted by value chains where organisations exchange materials, components and services for money (Stephan et al., 2017), we take the broader perspective of the entire energy value chain. Consequently, regional energy transitions need increased production of renewable energy, but also transmission and distribution infrastructures to handle new fuels such as hydrogen, and changes on the user side among citizens, industry and transport to achieve greater energy efficiency. While empirical work on regional energy transitions focuses on specific parts of the energy value chain, interactions across scales affect the likelihood of the value chain itself transitioning (Binz and Truffer, 2017; Elola et al., 2013). Key elements affecting transitioning include the governance arrangement of value chains and the interests of lead firms and other central chain actors within them (Coe and Yeung, 2019; Horner, 2017; Neilson et al., 2014). Such contextual factors include the visions and policies of actors and organisations, the presence of informal institutions, existing natural resource endowments, technological and industrial specialisations, market characteristics, and other socio-economic factors. While these factors arise at different spatial scales, attention to them is increasingly important at the local and regional scale (Hansen and Coenen, 2015).

Analysing the enactment of energy transitions *by* regions through the lens of agency rather than actors avoids reproducing expectations about the influence that specific actors may exercise on regional transitions. It also reduces the risk of falling into the 'region-as-a-closed-system'-trap. What matters for an energy transition *by* a region is not restricted to actors *in* the region but includes those actors (operating at various scales) that perform activities influencing a region's transition. Still, this focus on the agency does not preclude attention to specific actor groups and changes in the types of roles they perform during energy transitions.[2] Finally, explicit attention to transition outcomes is one step towards rectifying the lack of attention to the intended and unintended effects reported in the sustainability transitions literature. Paradoxically, there is a tendency here to study sustainability transitions without empirically analysing or questioning the sustainability effects of the socio-technical transitions in focus. Thus, rather than assuming that, for example, diffusion of specific technologies will necessarily have positive impacts 'on the ground', this requires specific emphasis on the multiple ways that energy transitions

instigate changes *of* regions, not only within the energy system, but also in terms of, for example, socio-economic consequences.

Below we expand on each of these four points.

The *value chain dimension* highlights regional energy transition analyses that focus on specific parts of the energy system. While some studies analyse decarbonisation of the entire energy system in the context of energy islands (for example, Sperling, 2017) that cover the whole value chain, most regional energy transition studies are 'partial' in the sense that their focus is either upstream in the energy generation part or downstream in energy consumption.

Regional transitions in the energy generation part of the value chain have been intensely studied (Dewald and Truffer, 2012; Essletzbichler, 2012; Rohe and Chlebna, 2021; Wirth et al., 2013). Part of this literature considers how regions positioned upstream in the value chain and characterised by exports of renewable energy become resource peripheries where value is extracted and captured by actors located elsewhere (Munro, 2019; Murphy and Smith, 2013). Conversely, work on regional energy transitions in the downstream part of the value chain focuses on reducing energy demand or fuel switching at the household or industry level without considering changes on the energy generation side. In this sense, regional energy transitions in the downstream part of the value chain may closely rely on increases in renewable energy generation capacity elsewhere.

Place-based transition analysis (Hansen and Coenen, 2015) focuses on *transition conditions* at the regional and urban scale, and how they are conditioned by nation-state strategies and institutional structures. This literature examines socio-economic conditions, institutions, capabilities, networks, materiality and policies as critical elements of spatial differentiation (Frantzeskaki et al., 2017; Mattes et al., 2015; Ruggiero et al., 2021; Späth and Rohracher, 2012; Strambach and Pflitsch, 2020). While empirical analyses have perhaps tended to emphasise success cases, it is evident that context-specific conditions are also central to understand barriers to energy transitions (Feola and Nunes, 2014; Jolly and Hansen, 2021). Still, the question remains whether contextualised transition analysis is primarily of topical concern or does it also lend explanatory theoretical engagement to energy transition scholarship (Binz et al., 2020; Köhler et al., 2019)?

In addition to influences by such contextual factors of the past and present, future expectations on the implications of energy transitions for regions also matter for regional energy transitions (Steen, 2016). The performative role that future expectations play for current transition processes (Borup et al., 2006; van Lente, 2012) may influence regional energy transitions. For example, expectations of co-benefits and trade-offs of renewable energy development and diffusion significantly impact regional energy transitions (Couture et al., 2019).

While energy transitions *in* regions are conditioned by contextual factors and future expectations, the *agency dimension* highlights that actors construct and shape these transitions. Even though socio-technical transition theory emphasises local innovation and experimentation, its focus on the systems as a whole '…diminish the role of individual agency, downplay the complexity of politics, power and asymmetries in human-environment dynamics…' (Scoones et al., 2020, 67). Interrogations of energy transitions by urban and regional scholars have indeed asked for a more vigorous examination of the power and agency orchestrated in acts of innovation and experimentation to produce particular outcomes and foreclose others (Bulkeley et al., 2016; Grandin and Haarstad, 2021). The agency dimension of regional energy transitions depends on different types of change agents operating at different scales. These include Schumpeterian entrepreneurship focussed on developing novel solutions with better value for users, institutional

entrepreneurship aimed at creating or transforming institutional arrangements, and place-based leadership concerned with coordination and bridging between different future visions (Grillitsch and Sotarauta, 2020), as well as various support roles for these core types of agency (Sotarauta et al., 2021). However, regional energy transitions are not purely an outcome of different forms of change agency, but also involve structural maintenance agency that focuses on reproducing existing institutions and resisting disruption and radical change (Jolly et al., 2020). While some work emphasises the strategic character of structural maintenance agency by actors seeking to protect assets and future profit streams (for example, Hess, 2013), Geels (2020) warns against the risk of voluntarism.

Whereas energy transitions in regions are conditioned by contextual factors, *transition outcomes* consider changes to energy systems and broader regional impacts. Indeed, regional energy transitions may 'backfire' (Cavicchi, 2016) and result in high social costs. Research on just transitions and energy justice emphasises not only how during energy transitions value is redistributed, but also the importance of procedural justice and justice as recognition. The importance of procedures and recognition highlights the fairness and transparency of decision-making processes, and the extent to which different world views are taken into consideration (Jenkins et al., 2016; Newell and Mulvaney, 2013; Sovacool and Dworkin, 2015).

The outcomes of regional energy transitions extend beyond regional borders (Capasso et al., 2019). Lessons from successful innovations travel across space (Sengers and Raven, 2015) through various scaling mechanisms (Naber et al., 2017). Carbon leakage happens at multiple scales as polluting activities relocate to other regions or continents with lower costs and more lax regulations (Elliott and Clement, 2015). While the fuel-versus-food debate (Rosegrant and Msangi, 2014) illustrates energy transition implications for the food system, the broader nexus literature considers interactions with the water system (Hoff, 2011; Schwanen, 2018). The diffusion of renewable energy technologies in developed countries is causing human suffering in developing countries due to the extraction of raw materials needed for renewable technology elements (Sovacool, 2021). There is a need to consider the dark side of innovation and production networks, and how this connects to renewable energy technologies (Coad et al., 2021; Hansen et al., 2021).

Contributions to this Special Issue

Westgard-Cruice and Aoyama (2021) focus on the offshore wind industry in the Northeastern USA. Drawing upon the 'varieties of capitalism' literature, they interrogate the government's failure to follow through on policy promises. They illustrate the complexity of multi-scalar politics in a region's energy transition. They emphasise how the priorities of the national political landscape have highly varying implications at the regional level due to differences in natural resource endowments, institutions and capabilities, which provide regions with different opportunities in the energy transition. Continuing federal support for fossil fuel extraction in politically influential regions in Northern Appalachia has translated into inaction and obstructed development of offshore wind in the coastal regions. In doing so, the article brings together aspects of agency and context in regional energy transitions. It illustrates how structural maintenance agency is explained by relations between contextual factors across regions and scales, which in turn lead to regional variety in energy transition.

Patchell and Hayter (2021) analyse large companies' roles in energy transitions, focussing on their role as large-scale electricity buyers. In a collaborative and coordinated effort, large cloud-based companies run data centres

powered by renewable energy. They have been remarkably successful in reconfiguring the grid system towards more sustainable paths, driving the diffusion of renewables across the energy value chain, pushing investments not only in renewable energy generation but also in regional energy grids, thus calling attention to the aspect of energy distribution. They argue that this process entails institutional entrepreneurship at multiple scales by large incumbent firms, for example in the form of contractual innovations, which have subsequently diffused throughout the cloud computing industry. The article demonstrates how powerful organisations on the energy demand-side can orchestrate energy transitions in specific regions and hints at the importance of pressure by non-governmental organisations in incentivising incumbent firms to take this role in the first place. This study relates how different forms of agency, leveraged by large and resource-rich incumbent firms, can create systemic impact across multiple parts of energy value chains.

Joshi and Agrawal (2021) provide a nuanced study of urban energy transition in Edmonton, Canada, a city located in Alberta's oil-rich province. They describe how an energy transition process can be disrupted by pre-existing energy sources that shape the region's ability to evolve toward new energy sources. The article highlights the challenges of creating visions of a desirable low- or zero-carbon future in a region characterised by petroculture, where everyday life is intimately connected to extraction and use of fossil fuels. Consequently, energy transition strategy and policy promote decarbonisation technologies that allow for continued use of fossil fuels (carbon capture) and are mindful of not presenting renewables and fossil fuels as, respectively, advantageous versus disadvantageous energy sources. The article illustrates how regional culture, natural resources endowments and consumption patterns jointly constitute context conditions that result in unfavourable expectations, which in turn enables and constrains the opportunity space for policymakers to steer the transition process.

Juwet and Deruytter (2021) provide an example of the complexities of the spatial logic and politics of regional energy distribution systems. Analysing the energy system in Flanders, Belgium, they emphasise the problems of territorial and institutional lock-in that hinder transformation. Their analysis shows how a local distribution company plays a strategic and agentic role to address these problems, but is under dispersed control and constrained by unclear incentives to further the energy transition. Technocratic governance 'impedes the development of an integrated framework for a spatially sustainable and socially just energy distribution' and reproduces unsustainable spatial planning traditions. This depoliticised form of governing represents a powerful form of structural maintenance agency that closes down alternative future pathways.

Busch (2021) focuses on frugal innovations in energy transitions in a case study of solar energy in Sao Paolo, Brazil. Typically, frugal innovations are made inexpensive by focussing on core functions and coping strategies for developing country economies. His analysis demonstrates how specific resource-constrained contextual conditions (lack of knowledge, financial resources and infrastructural constraints) have stimulated the development of low-complexity renewable energy innovations. Complexity reduction allows for the development of scalable solutions, which are potentially less context-dependent than more complex solutions. Resource-constrained regions may function as generative incubation spaces for innovations (niches) that may exercise considerable influence on transition processes elsewhere. This study pluralises views on how local constraints and what could seemingly be perceived as barriers may in fact become conducive conditions for energy transitions.

In their comparative study on urban energy transitions in two Chinese cities, Huang and Yu

(2021) focus on electric vehicles in Shenzhen and solar water heaters in Dezhou. They use the Dimensions of Urban Energy Transitions (DUET) framework to explore different development stages of the two cities and the necessary alignment between industry actors and local governments for the energy transition. The authors show how regional alignment across agentic processes, that is, between entrepreneurial activities and regional leadership, has been central to the development and diffusion of the renewable energy technologies in both regions. At the same time, the Dezhou case exemplifies how misbehaviour among regional leadership in the form of corruption and overinvestments led to decline of the regional solar water heater industry and hints at the risks of such agentic alignment when core proponents engage in wrongdoing.

Munro (2021) sheds light on the electricity grid's expansion on the South Pacific island nation of Espiritu Santo, north of the Vanuatu Archipelago. He emphasises the political dimensions of this expansion towards energy transition. He concludes that the island nation's energy transition is constrained by pre-existing neoliberal and neo-colonial aid policies and is shackled by business interests that are both fragmented and parochial. In this final contribution to the Special Issue, the author shows how local development impacts are influenced by power relations that are shaped by global political economy dynamics, in particular donor interventions by international development agencies. In turn, these interventions have resulted in lengthy legal battles, which have effectively stopped investments in energy infrastructures. In summary, the article highlights how conflicts between various powerful national and international interests influence the materialisation of future expectations of regional energy transitions, bridging how contextual conditions and agency shape development outcomes of regional energy transitions.

Conclusion

As Table 1 illustrates, there is scope to bring the burgeoning literature on regional energy transitions in closer conversation on a range of dimensions that become increasingly pertinent as energy transitions unfold. While many, if not most, studies of regional energy transitions have honed in on contextual place-based factors conditioning energy transitions, this Special Issue demonstrates that such a singular focus would cut research on regional energy transitions short of its wider relevance and theoretical purchase. Our conceptual framework geared to energy transitions in, of and by regions illustrates the place-based interplay between value chain structuring and actor agency—at local and global levels—as well as the recursive interdependencies between 'regions shaping energy transitions' and 'energy transitions shaping regions'.

Illustrated by the variety of topics, themes and of course geographies cutting across the articles that constitute this Special Issue, regional energy transitions make a heterodox endeavour. Our conceptual framework was not set up with the intention to 'lump' regional studies of energy transitions into a coherent theoretical whole. Obviously, the topic is far too multifaceted for that. On the other hand, we are concerned that the burgeoning field of energy transition research is at risk of splintering and splitting into piecemeal frameworks, concepts and insights when regional particularity and idiosyncrasy becomes the norm. Following Peck (2015) in his keynote delivery 'navigating economic geographies', we call instead for a theory-culture and research practice that would allow for cohabitation of splitters and lumpers in regional energy transition research, simultaneously aware of the 'big picture' developments and transformational dynamics in energy transitions while at the same time capturing the local opportunities and challenges for diversity, contestation, experimentation and

Table 1. *Contributions of the Special Issue articles.*

Dimensions of regional energy transitions	Article contributions	Insights and lessons learned
Value chain dimension	**Patchell and Hayter** show how the decarbonisation options for (large) energy consumers in cloud computing industries are conditioned by regional regulations of energy distribution	Interaction effects across the whole of the value chain are growing in importance and lead to an increasingly complex spatial organisation of energy transitions beyond energy generation
	Juwet and Deruytter demonstrate the strategic (and agentic) role of energy distribution companies in regional energy transitions	Attention for transmission and distribution parts of the value chain, as well as the non-transport related parts of energy consumption is critical in governance of regional energy transitions
	Patchell and Hayter provide a detailed analysis of energy transitions in cloud computing, which represents a radically increasing demand for energy	
Conditions for energy transitions	**Busch** illustrates how resource-constrained contextual conditions stimulate the development of scalable, low-complexity renewable energy innovations	The potential generative effect of regional constraints on energy transitions
	Joshi and Agrawal show how negative expectations to the regional energy transitions are tied to regional culture, natural resources endowments, and consumption patterns, and narrow the opportunity space for policy-makers to promote the transition	Besides positive and seemingly progressive future visions, negative future expectations of regional energy transitions matter
Agency dimension	**Huang and Yu** highlight the potential for facilitating regional energy transitions by aligning entrepreneurial activities and regional leadership—but also how this alignment may turn into a liability if core proponents engage in wrongdoing	Pluralising the roles and mechanisms of embedded agency in regional energy transitions beyond change agency
	Juwet and Deruytter describe how dispersed and technocratic governance jointly prevent enactment of change agency and rather reproduce existing structures	
	Westgard-Cruice and Aoyama show how the federal government may perform structural maintenance agency to protect the interests of regions with fossil fuel extraction, hence underlining the importance of relation across regions and scales	
	Patchell and Hayter illustrate how the market power and geographical spread of activities by large incumbents allow them not only to create new institutional arrangements, but also to drive their geographical diffusion	
	Munro demonstrates how energy transition processes may be influenced by power relations heavily shaped by global political economy dynamics, in particular donor interventions by international development agencies	
Transition outcomes	**Munro** shows how regional transitions may be associated with various positive and negative outcomes, in this case cheaper prices but limited grid expansion and increases in outages, which have varying importance across the population	Consideration for a broader spectrum of impacts of regional energy transitions, in particular for citizens

failure when acknowledging the difference that regions make in energy transitions.

In doing so, studies of regional energy transitions may offer a wider outlook on (future) studies of regions and regional development in the age of the Anthropocene. This brings us back to the reflections by Donald and Gray, specifically in relation to the topic of innovation in regional development, which is after all a sine qua non for regional energy transitions: 'Although regional scholars are justly intrigued by the success stories around regional innovation, they must also understand issues of equity and justice and pay attention to the environmental damage of both production and regional consumption' (Donald and Gray (2019, 305). No matter in which variety of capitalism it is embedded, energy transition is widely seen as a growth path for local and regional economies.

Energy transition research has however challenged extant innovation theories for overstating technological progress, confusing means for ends, and risking solutionism, the arguably flawed idea that every social or environmental problem has a technological fix (Coenen and Morgan, 2020). Instead it has focussed the analytical gaze on uncertainty, tensions, heterogeneity and sources of inertia in zero-carbon transitions (Turnheim and Sovacool, 2020). This problematisation of energy transition and innovation offers significant scope for future research to provide richer accounts of neglected themes related to failure, dissent and contestation yet without abandoning hope and trust in human action and our ability to open and pursue new opportunities for transformation to a more sustainable future, both technological and non-technological.

Besides such problematisations, honing in on the regional foundations of energy transitions carries also an explicitly emancipatory agenda. Understanding the regional drivers, consequences and impacts of energy transitions—as done by the respective contributions in this Special Issue—could effectively fill a gap left by the pronounced focus on historical analyses of energy transitions based on longitudinal data and observations across much of the literature. Complementary to evolutionary perspectives on energy transitions, comparative analysis of energy transitions across regions will allow for invaluable insights for governing energy transitions that address pertinent questions why energy transitions in some places effectuate while stalling or even derailing completely in others. Systematic comparative analyses between regional energy transitions went beyond the scope of this issue but provide a promising pathway for regional scholarship to make an effective and meaningful contribution to the bourgeoning literature on energy transitions.

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Endnotes

[1] Where initial theory-building often fell victim to methodological nationalism, assuming national systems and framework to be in place, recent analyses acknowledge the importance of space, place and scale (Binz et al., 2020).

[2] Previous empirical studies include analyses of changes in the agency performed by cluster organisations (Sjøtun and Njøs, 2019) and regional development agencies (Holmen and Fosse, 2017).

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