

Just transitions for industrial decarbonisation: A framework for innovation, participation, and justice

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ARTICLE INFO

Keywords:

Industrial clusters
Just transitions
Evaluative framework
Systematic review

ABSTRACT

Here we propose a framework for considering the justice issues of industrial cluster decarbonisation, a pressing challenge confronting many industrialised economies. Industrial clusters are large, multi-point source emitters, users of energy and employers of regional and national significance. In the UK, establishing low carbon industrial clusters is one of several grand challenges of industrial strategy. Theorising the just transition of industrial clusters requires concepts from multiple literatures. We abstract relevant themes from the intersections of the literatures of just transitions, innovation studies and sociotechnical transitions, and public participation in spatial planning, and illustrate their empirical relevance. The broad themes of our framework are (i) politics, space and institutions, with sub-themes of justice, democracy, financialization; (ii) new processes and procedures, with sub-themes of legal recognition of public concerns, community-based planning, community capacity enhancement and life cycle impact assessment; and (iii) correlates of acceptance and resistance, with sub-themes of environmental values, perceived loss of amenity, pre-existing politics, perceptions of just process and trust in the developer. The framework is intended to both guide the design of just transition processes ex-ante and evaluate these post-hoc.

1. Introduction

While it is increasingly understood that contemporary industrial societies require rapid decarbonisation, how to achieve this and what forms this decarbonisation should take are inevitably debatable. While efficiency gains tend to bring win-wins, they may be subject to substantial rebound effects through freeing up financial, moral and temporal resources [1]. More substantive changes to system architectures or individual behaviour, rather than change that involves involving drop-in, substitutional technologies, is more likely to be contested [2]. Thus even for instrumental reasons alone, i.e. managing potential dissent, a case can be made for involving stakeholders and communities in various forms of planning processes that will affect them [3].

There are a wide variety of theoretical perspectives, based in a

variety of disciplines, that bring together normative and instrumental reasons in the case for such engagement, some of them using the umbrella term “Just Transition” [4]. Without attempting to be exhaustive, notable among work focusing on the justice and equity issues of socio-technical change is a long history of science and technology studies that dates from the 1970s onwards [5]. Viewing scientific and technological production as profoundly social, the co-evolutionary premise of this perspective is also explored in contemporary sociotechnical transitions studies oriented towards sustainability norms [6]. offer a forward-looking review of connections between the two literatures, particularly implications for climate and energy research and including discussion of expertise and public engagement.

In this paper, we firstly provide an overview of the just transitions literature and secondly examine how this literature addresses the issue

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¹ The authors gratefully acknowledge support from the Industrial Decarbonisation Research and Innovation Centre (IDRIC) in the United Kingdom, funded via the ESRC and EPSRC via Grant EP/V027050/1.

² The author acknowledges support of the Transformative Innovation Policy Consortium (TIPC) for her contribution to this paper.

of public and other stakeholder participation in relation to place. The latter involves a systematic review at the intersections of three distinct literatures relevant to just transition in an industrial context—energy justice, equity and transitions, and participation and energy democracy. Thirdly, we synthesize a conceptual framework that we then apply to the three empirical cases of industrial clusters in Grangemouth (Scotland), Merseyside (England), and South Wales (Wales). Our aim is to justify and articulate elements of an approach to public engagement in the low carbon transformation of industrial clusters, grounded in relevant literature. Our research questions are thus: how is the concept of just transitions being defined and approached; what does the literature at the intersection of just transitions, place and participation say about how their integration; and, building on the latter, what themes can we abstract for a framework intended to guide engagement of affected parties in the design of industrial decarbonisation strategy?

Our focus on clusters matches recent advancements in both energy and industrial policy in the United Kingdom. The United Kingdom is actively pursuing low-carbon industry by 2035 and net-zero industry as soon as 2040, supported both by law (the Climate Change Act of 2008) and the newly launched Industrial Decarbonisation Research and Innovation Centre and the Industrial Strategy Challenge Fund. The Fund in particular has 23 challenges and is backed by £2.6 billion of public money, with £3 billion in matched funding from the private sector [7]. The approach taken to net zero industry in the United Kingdom is based on clusters, which cut across engineering, spatial, and socio-political dimensions. For example, in the UK, six specific clusters account for 53% of direct carbon emissions from industry [8]. These clusters are spread across Scotland (Grangemouth), Wales (South Wales), and England (the Humber, Merseyside, Southampton and Teeside). They have aggressive implementation plans in place for the deployment of net-zero infrastructure, carbon capture utilization and storage as well as industrial hydrogen systems being deployed across the clusters to support a 95% reduction in emissions by mid-century [9]. The clusters are therefore leading net-zero ambitious, with actual, enforceable timetables to achieve decarbonisation—making them ideal test beds to explore Just Transition themes and dynamics.

In scoping the narrative boundaries for the review sections of the paper, we assume that commercial and public sector stakeholders can be defined as distinct to publics in the sense of affected communities; and that an emphasis on engagement of the latter – publics as affected communities – is justifiable, given that incumbent actors generally have greater resources and hence power in transitions processes [10]. In addition, the active engagement of publics, or indeed individual actors in general, are rarely analysed within sociotechnical transitions frames [11]. That said, we are here referring to a matter of emphasis in the literature review, not advocating the exclusion of organised stakeholders.³

In terms of the structure of the paper, we first set out the method and purposes of our reviews, following which we derive a framework for approaching the decarbonisation of industrial clusters in ways that engage publics, both analytically and in terms of practice. We then apply this to three case study clusters.

2. Research design: A comprehensive narrative review and comparative case analysis

The first part of the research problem involves identification and selective review of literatures that underpin a framework for guiding and evaluating the engagement of publics in defined spatial contexts, where sociotechnical transitions and innovation is required and in which the norms of “just transitions” are appealed to, with latter potentially involving the concept of partnership. Studies focusing on this

specific combination of features – sociotechnical innovation, place, public engagement, partnerships and justice – are uncommon. A Scopus search in Title-Abstract-Keywords fields with the terms (innovation AND place AND engagement AND partnership AND justice) gives only three papers,⁴ only one of which is directly relevant: [12], and which presents a framework for “engaged creative-placemaking”, setting out conditions by which public and private enterprises, university and communities may collaborate to “a just society through creative-placemaking”. Innovation in the latter paper, however, primarily refers to the creation of places, not sociotechnical phenomena. Note that we did not search for terms such as “energy poverty” or “housing retrofits” or other interventions at household and community scales given the industrial focus of our research question, and thus our review protocol, which focuses on the context for Just Transition in an industrial context.

While we include the latter paper in our review, return of only three papers implies undue restriction in search terms. Given the end objective of producing an integrated framework, plus the very substantial, combined size of the literatures on innovation and transitions literature, public participation in land use planning, and just transitions, we have opted to abstract key characteristics from relevant papers returned with meaning-sensitive search terms, and to integrate these in a framework as described above. Accordingly, we draw on Scopus Title-Abstract-Keywords returns from a search with the terms “energy justice” (2104 items); narrowed by “place” (reduces to 544 items), narrowed by “participation OR engagement” (reduces to 286 items), narrowed by “innovation OR transitions” (reduces to 215 items), narrowed by “planning” (reduces to 169 items). This type of literature review can be described as a qualitative systematic review, in that it seeks to integrate the findings from (primarily but only) qualitative studies, looking for “themes” or “constructs” that lie in or across individual (often qualitative) studies [13]. The abstracts of the 169 items were then manually screened for accessibility⁵ and relevance to the research objective, namely the development of a literature-based, integrative framework reflecting the principles and practices of (i) public participation in land use planning, (ii) sociotechnical transitions and (iii) just transitions (with an emphasis on energy). This left 37 papers for close attention < Appended Table 1>. The data period is the Scopus default, i.e. the earliest date in the database to the present at the time of the review (June 2021). It should be noted that we have not sought to review papers that use the term “transformation”, which has connotations of “deeper” forms of societal change that move beyond the implicit eco-modernisation leaning of the transitions literature [14]. Nonetheless papers with a similar argument still form a prominent theme in the search returns.

Supplementing the above, systematic review, we also provide a narrative overview of thinking on just transitions per se (section 3). This is based on expert judgement and involves 23 “reference” papers < appended Table 2> selected primarily on the basis of the authors’ judgement and knowledge of relatively recent papers on the topic. It constitutes a short “state of the art” review [13], in that it tends towards recent material and endeavours to include a range of authors. It is prefaced by an overview of different perspectives on public engagement in sociotechnical innovation and sustainability problem-solving, to provide a wider context.

Our resulting framework is thematically integrated, rather than seeking theoretical integration [15]. A framework for analysing public engagement in geographically situated sociotechnical change involving carbon emissions reduction and norms of justice inevitably requires drawing upon theoretical approaches, concepts and empirical concerns that are significantly different. Thematic grouping avoids the need for high-impossible theoretical integration because it is based on

³ Indeed publics as individuals are often members of organised stakeholders such as unions, employers and NGOs.

⁴ Substituting “tech” for “innovation” generates no search returns.

⁵ Items were all English language. Books and book chapters were mostly inaccessible but were very few as a proportion of the narrowed total.

Table 1
Summary of three literatures on socially just or equitable sociotechnical transitions.

Literature	Disciplinary groundings	Predominant focus	Common unit of analysis	Key concepts	Illustrative studies
Energy and environmental justice	Philosophy, law, ethics, moral studies, environmental studies	What is morally just or right	Tenets of justice or principles	Procedure, recognition, distribution, cosmopolitanism	[19,21, 35–39]
Equity and sustainability transitions	Transition studies, innovation studies, business and management, evolutionary economics, science and technology studies	Who wins and who loses from transitions processes or outcomes	Sociotechnical system	Niches, regimes, and landscapes, transitions pathways	[40–42]
Participation and energy democracy	Energy studies, climate studies, sociology, political science	Ownership of and engagement in energy supply	Ownership share, production share, decision-making rights	Governance and participation processes	[43–51]

Source: Authors

Table 2
Fits and misfits in three perspectives on just transitions.

Community	In focus	Out of focus	Fits (strong explanatory power)	Misfits (weak explanatory power)
Energy and environmental justice	Disruption of ethical values, culture, or health	Early patterns of innovation and design	Impacts on communities or the environment, mobilizations in support of energy justice goals	Less visible impacts that “embodied” or “hidden” in practices, design, or waste flows
Equity and sustainability transitions	Distributional consequences of sociotechnical change	Processes of sociotechnical embedding	Social acceptance and objection of technology	Long term technological trajectories
Participation and energy democracy	Engagement and ownership processes	Large scale sociotechnical processes	Social acceptance and objection of energy infrastructure	Wider dynamics of sociotechnical change

Source: Authors, based on their collective insights drawn from the review process Each of the “fits” and “misfits” are drawn from the theoretical strengths and weaknesses elaborated on in Sections 3 and 4.

descriptive, topical similarity rather than explanatory premises and concepts. Nonetheless the rationale given by the latter and by Ref. [16], regarding the value of integration in the social sciences, particularly for the understanding of institutions as social rules [16], remains relevant here: applied problems necessitate multi- or interdisciplinary perspectives.

The final part of the paper, the three-case comparison, briefly illustrates how the framework may be applied to the cases of industrial cluster decarbonisation in the UK, providing examples of the themes identified.

3. An analytical framework for just transitions

At the most general level, the term “just transition” “connects the concept of social justice – more specifically, the equitable distribution of the benefits and costs of the transition away from high carbon and unsustainable development trajectories – with the environmental, climate, resource and energy reasons for that transition” [17] p. 7. The more specific and elaborated definitions of a just transition refer to at least three forms of such justice [18] p.2: distributional justice as the “distribution of benefits and burdens across populations”; procedural justice as seeking “to ensure that to ensure that ... procedures are fair, equitable and inclusive of all who choose to participate”; recognition justice as understanding and acknowledging “historic and ongoing inequalities” [18]. Some authors add restorative justice in the sense of remedying the foregoing injustices (e.g. Heffron and McCauley 2018) [19–21]). Some further add cosmopolitan justice as relating to “to global and universal impacts” [22]p.4; [23].

Although a fairly recent scholarly phenomenon, there is a long-standing discussion within various literatures of science and technology studies and more recently sociotechnical transitions that highlights justice and/or societal participation in research and innovation. One recent, normative strand is *transitions management*, which aims to encourage social learning, the co-production of knowledge and action towards sustainability through inclusive, multi-sector engagement processes [24]. With transitions management as a frame [25], use a case study of mobility system innovation options to discuss how publics may

be engaged in sociotechnical innovation both “upstream” and “downstream” – at different points in sociotechnical system change process [26]. also makes an extended case for extending STS analysis to pay more attention to the actual and potential roles of local and wider publics in analysing and supporting energy system transitions.

The literature of *responsible innovation* also includes a principle of inclusiveness but is less overtly transformative in ambition. For example [27], offer a framework for understanding and supporting this comprised of four integrated dimensions: anticipation, reflexivity, inclusion and responsiveness. Of these, the principle of inclusion supports at a minimum some degree of public dialogue about scientific and technological developments. Concepts of *quadruple* and *quintuple helix innovation* are pitched in a similar vein: in a knowledge economy, legitimisation by civil society is a condition of a system involving interactions in a university-industry-government-public-natural environment system [28,29].

Outside of innovation studies frames are firstly post-normal science, which can be described as both a philosophy and a methodology that advocates stakeholder engagement in scientific processes, where: “facts are uncertain, values in dispute, stakes high and decisions urgent” [30] p.742. Post-normal science has been used to justify and analyse public engagement in sustainability management where normative positions are central to policy choices, for example in studies of ecosystem services [31]. Some discussion of post-normal science takes a logically further step to *citizen science* [32]. Whereas post-normal science argues that the above features characterise scientific contexts in many contemporary societies and proposes close co-production of knowledge with stakeholders including publics, citizen science advocates and supports the use of scientific methods by citizens.

Second is transdisciplinary sustainability science. This has similarities with transitions management in its socially inclusive ambitions [33], but is less technology-focused and pays more attention to the integration of different types of knowledge – a feature that it has in common with post-normal science. Transdisciplinary sustainability science aims to generate scientific insights within and through the participation of stakeholders, again in common with post-normal science, despite the many challenges to doing so [34].

In common with much of STS, critical geography perspectives tend to go beyond participation and challenge deeper assumptions of economic growth and the capitalist structures that shape development. Hence [17] asks whether the objective of economic growth that underlies development requiring planning is “now ecologically unsustainable, socially divisive and has in many countries passed the point when it is adding to human wellbeing” (p.1). He asks whether both growth and planning are dependent upon a fossil fuel energy system that is similarly destructive. While there is a difference between a post-carbon and a post-growth economy [17], argues against both and further argues that if we want to plan for both, we need to understand the “pro-growth” biases and “carbon energy dependence within dominant understandings of planning. These include, inter alia, planning’s role in promoting policies and discourses of international competitiveness, the privatisation of public space, support for pro-market urban regeneration, and a view of planning as facilitating market-based economic growth” (p.1). With this in mind [17], refers to the metaphors of *social justice floors* and *ecological ceilings* when thinking about just transitions and whether “we want a low carbon version of an unjust system” (p. 8). In short [17], challenges the context of planning itself.

In short, there are multiple antecedent literatures that address similar themes to those of the just transitions literature and indeed which also comprise that literature. They inform different approaches to just transitions that are not distinct in the sense of being mutually exclusive. Their overlap is emphasised by Ref. [23], who argue for bringing together the concepts of *energy justice* (the application of human rights across the energy life-cycle); *environmental justice* (treating all citizens equally and involving them in the “development, implementation and enforcement of environmental laws, regulations and policies”); and *climate justice* (sharing the benefits and burdens of climate change from a human rights perspective) within the umbrella concept of just transitions [23] p.74. The justification for an umbrella term, for [23], is that climate, energy, and environment policy and practice are empirically global in their effects and that a united scholarly effort is needed in the face of progress towards low carbon economies that is currently far too slow relative to the rate of progress required. One might also point to structural reasons for this pace, and also the merit in conceptual differentiation, while also agreeing that communication with stakeholders is likely to be assisted through a simplified set of terms.

These nuances and distinctions notwithstanding, in the next sections we identify and illustrate three core directions in which the just transitions literature has developed, with a particular focus on energy, drawing primarily on the systematic review. These are summarised in Table 1 and visualized in Fig. 1. Fig. 1 also shows some of the diverse disciplinary groundings behind the three approaches and also inter-linkages across different themes and dimensions of equity. To clarify, while Table 1 presents seminal works in the general areas of each of the three perspectives, the proceeding analysis in Sections 3.1 to 3.3 are more limited and contextualized to the topic of Just Transitions for industrial decarbonisation.

3.1. Energy and environmental justice

Our first collection of studies deals with energy and environmental justice in the context of industrial decline. For instance Ref. [20], argue that the core concepts of justice in environmental justice - distributive justice, procedural justice and justice as recognition - adequately characterise most of the relevant justice issues involved in just transitions. They derive classes of key questions regarding just transitions that become even more apt in an industrial context: the risks of not incorporating justice concerns when thinking about and enacting transitions processes; and mitigation strategies to overcome those risks [20]. Most authors, however, argue for additional nuance. For example [52], argues for an interdisciplinary and integrative perspective of environmental justice (a line of work contributory to the just transitions literature) that

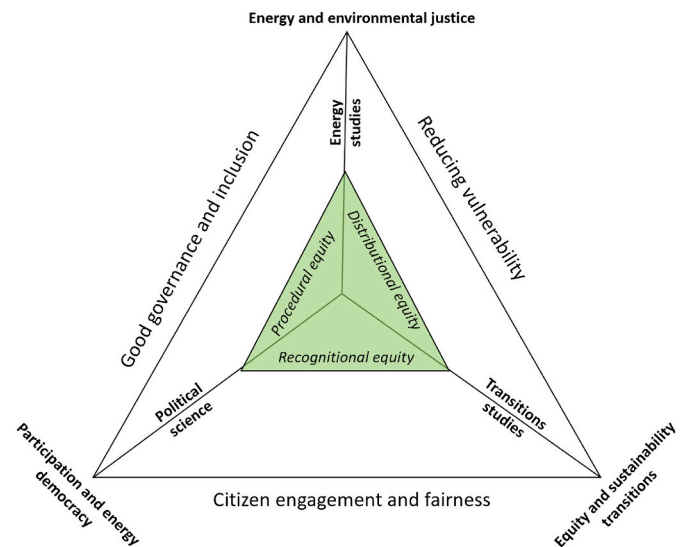


Fig. 1. Visualizing the contributions and connections between Energy and environmental justice, equity and transitions, and energy democracy. Source: Authors.

combines theories and studies in geography, environmental policy and planning with a justice psychology approach. This is intended to reflect both social and individual perspectives of environmental justice, based on the premise that there is not “one” environmental justice. Similarly [52] draws on [53] to argue that simply deploying participatory methods does not in and of itself mean that justice is done or perceived to be done [54].

[55] review the energy justice literature generally to identify injustice across energy supply and use life cycles, with a focus on energy poverty. They name four mechanisms of energy injustice: “landscapes of material deprivation”, relating to multiple factors beyond simply climate; “geographic underpinnings of energy affordability”, relating to factors such as socio-economic opportunity; “vicious cycles of vulnerability”, in which ill-health, energy access and poverty are interconnected; and “spaces of misrecognition”, a spatial version of recognition justice, in which the causes of energy poverty in locations are mis-diagnosed. The authors’ main concern is to give a spatial dimension to energy justice arguments in terms of spatial mapping and in terms of their production through the “geographical inequities and flows that are engrained in the economic, infrastructural and cultural make-up of society” [55] (p.640).

[56] also seek to expand the conceptual and analytical basis of energy justice beyond the three-tenet framework, to address three institutionalized tendencies of dominant modern energy systems: a preference for large-scale technical systems and distancing of system designs from local decision-making processes; centralization of energy production and distancing of supply from users; and what they see as widespread risk-taking tendencies presented as a necessary “price to pay” for technological innovation and social progress (the latter referring to nuclear power, its siting and the consequences of nuclear accidents).

[23] take a different tack, arguing for encompassing energy, environmental and climate justice within the concept of just transitions, viewing associated conceptual differentiation as “distortion” that complicates communication in a context where time is short. They use the Legal Geography “JUST” framework, comprised of distributive, procedural, restorative, recognition and cosmopolitan justice, with additional considerations of space (location) and time (when). The authors argue that the just transitions literature too often elides the question of how and whether justice - as the literature elaborates it - could be achieved in practice. Thus their JUST framework adds spatial and

temporal specificity to justice principles: where and when these forms of justice would should or will be implemented.

In an editorial introduction to a special issue that brings the concept of energy justice to engineers [19], observe that energy justice can be viewed not only as involving distributional, recognition and procedural dimensions, but also as having a restorative dimension. They also provide an overview of non-Western understandings of justice, including those from non-Western religions and philosophies that refer to e.g. notions of community (Ubuntu), harmony with the universe (Taoism), context-specific notions of moral duty (Dharma in Hinduism and Buddhism).

[57] add to this a focus on *just urban transitions*, reviewing the environmental justice, energy justice, climate justice and urban justice literatures to develop a research agenda. They treat environmental justice as having close connections with distributive, procedural and recognition justice: that which “seeks to overcome any phenomena that expose marginalized groups or communities to unequal and unfair environmental burdens” (p. 2). Regarding climate justice, they observe that “Local and urban articulations of climate justice more closely resemble environmental justice, with a focus on inequitable vulnerabilities and the importance of local participation and engagement” (p. 4). Indeed, the global applications of the concept are similar, applying “many of the principles of environmental justice to the climate change domain” (p. 4). *Energy justice* again applies “many of the principles of environmental justice to the climate change domain”, embodying these principles in further principles and frameworks (p.5). Urban justice and the concept of the “just city” relate to a broader set of literatures, including planning and structural critiques of capitalism and its production of urban (and other) space [57]; argue that the idea of just transitions has the potential to draw on the foregoing prospectively, to consider how to shape urban futures. They pose research questions accordingly, emphasising “questions of governance, decision-making, and community building that are multilevel” (p. 8). Finally – at least in terms of this introductory overview – [18] in an extensive review further emphasise that energy justice needs to be considered with a wide spatial and temporal brief if it is to avoid missing non-local impacts (see also [58]).

3.2. Equity and sustainability transitions

Our second collection is based on several authors who have in recent years sought to connect energy justice ideas specifically with the *socio-technical* transitions literature, including those that focus on industry (e.g. Refs. [59–61]). As an example [62], integrate energy justice concepts with those of the multi-level perspective (MLP) [63], by considering distributional, procedural and recognition justice at niche, regime and landscape levels, where the niche is the site of sociotechnical innovation, the regime is the dominant inter-relationship of economic, social and material practices and underlying values, and the landscape is the site of slow-changing exogenous factors that condition both [63]. The authors use the three levels of the MLP to structure a discussion of the types of injustices, and causes of injustice, that may arise at each of what are intended to represent different levels or degrees of structuration. They argue that this can help to “expose niche developments that are

exclusionary”, help actors evaluate regimes, and draw attention to the need to reappraise energy choices and the ethical principles that these – often tacitly – imply.

Also working with a sociotechnical transitions paradigm [64], propose a bridging of the sociotechnical dynamics and justice aspects of energy transitions,⁶ focusing for this purpose on the co-evolution of institutions, social relationships and material elements with justice implications. They specifically bring together the literatures of socio-technical transitions, energy justice, STS and energy geographies, using selective review and the case of multi-scale solar energy in Portugal [64]. argue that the perspectives are complementary in that while the niche-regime-landscape framework involves an increasing scale in terms of social structuration, the energy justice view is characterised by a more horizontal type of spatiality, in terms of the socio-spatial distribution of energy-related benefits, costs and risks. The authors view the different approaches to institutions, materiality and relationality in the two perspectives as complementary. They do not extend their contribution to theorising each element, but rather highlight that it is in these areas – (i) how institutions change and modulate change; (ii) how material, particularly socio-technical change takes place; and (iii) how social relationships around production and consumption evolve – that recognition of the justice implications needs to be focused (see also [65]).

3.3. Participation and energy democracy

There is third strand of relevant literature on participation in transitions or industrial sectors specifically. Making the point that publics are engaged in transitions as part of their daily lives regardless of bespoke engagement exercises [66], propose a “constructivist relational ecology” view of engagement as a co-producing relationship of publics, energy objects/issues and participation modes. Their perspective contrasts instances of discrete (“residual realist”) engagement with relational perspectives that emphasise everyday socio-material engagement. The authors illustratively map “ecologies” of participation in the UK accordingly.

[67] propose and apply a “Just Transition Management” framework that combines ideas of transitions management with the principles of distributional, recognition and procedural justice. Transitions management is an idea and ideal of participatory, reflexive and responsive governance in which transitions “experiments” are developed and trialled in collaborative, multi-stakeholder processes [68]. The approach has been used repeatedly in the Netherlands and elsewhere [24]. [67] also refer to the phases of transitions that transitions management and sociotechnical thought more generally assumes: those of pre-development, take-off, acceleration and stabilisation [69]. With reference to an Australian case study, the authors argue that bringing the concept of just transitions into transitions processes has the potential to counter prevailing environment vs employment narratives. It does this by helping to identify political barriers to transitions and energy justice and by supporting the development “powerful niche actor-networks” through the participatory and co-productive nature of transitions management (p. 110). In the present context, the contribution of [67] is notable for its explicit connection of both sociotechnical and just

⁶ Here we are referring to work that specifically uses and connects the concepts of sociotechnical sustainability transitions and justice. The body of work that connects “transitions” and justice more generally is much larger (e.g. Ref. [146]). There are calls for work that bridges different approaches to transitions, leaving this to scholars in future [147]). Here we are referring to work that specifically uses and connects the concepts of sociotechnical sustainability transitions and justice. The body of work that connects “transitions” and justice more generally is much larger (e.g. Ref. [146]). There are calls for work that bridges different approaches to transitions, leaving this to scholars in future [147]).

transitions concepts. Outside of a sociotechnical transitions framework [70], takes a longer perspective, providing an historical overview of just transitions initiatives and concepts, emphasising the importance of labour unions and social dialogue mechanisms in just transitions, and drawing on political economy and environmental labour studies perspectives.

A similar series of approaches use the term “energy democracy” to examine transition dynamics. Van Veelen and Van Der Horst argue that energy democracy reflects “struggles around the social, economic and political relations embedded in energy.” [45]. It is thus not only about what democratic theory can bring to energy studies, but how questions of energy transitions may challenge our conceptions and norms about democratic theory and practice, i.e., what kinds of energy transitions generate a stronger democracy or a more engaged, democratic public [47]. Delina notes that for energy democracy to work, publics need access to processes and exercises in which they can reflect on what they need, weigh the various options, and experiment with multiple alternatives [71].

[45] also consider what energy democracy might mean, observing that this concept emerged largely from social movements, with little connection to established academic debates and theories. Reviewing the energy democracy sub-literature, they identify and address four themes: rationale; those included and excluded in decision-making; material foci; and geographical focus. The authors argue that energy democracy implies, *inter alia*, widening of the right to input to the electricity grid for new and small renewable electricity producers; a broadening of the ownership base of aspects of this system; and greater citizen involvement and ownership. In the context of decarbonising industrial clusters, though, perhaps the most distinctive contribution of the literature is its identification of three, different forms of democratisation. These are (i) associative democracy, whereby non-State, civil society groups that are voluntary, democratic and self-governing own the means of electric power generation; (ii) deliberative democracy and its limits, whereby those affected are involved in decision-making; and (iii) material democracy, whereby there is wide participation in the actual material production of power. Clearly all of these reflect norms that are not embedded in the ownership and management of a typical contemporary industrial cluster, but they do nonetheless align with just transitions norms, most directly with procedural norms. Indeed, some of the literature returned by the Scopus search poses ideals that are simply in stark contrast to prevailing and relevant socio-economic and governance structures.

Since energy democracy encompasses a diverse array of goals, which are not always compatible, its pursuit may lead to conflict. In a US case [44], observe that conflicting goals can include resisting dominant energy agendas, and seeking to “reclaim” and restructure it. Others concur: energy transition coalitions may have diverse goals and involve different sets of interests, institutions and coalitions [49]. In the next section, we look for intersections of the literatures referred to above, identifying argumentative themes present at different levels of categorisation.

4. Synthesizing and problematizing just transition perspectives

Here we critically and systematically review the papers returned by the Scopus search described above, beginning with those focusing on the context to public engagement in transitions processes. The papers are organised by theme (we identify five inductively) and the review is summarily descriptive, the intention being to inform the integrated perspective presented in section 4. Fig. 2 shows how these five inductive themes often cut across more than one of the just transition perspectives iterated in Section 3. As Fig. 2 indicates, not all themes arise across all approaches, although three of them (spatial justice, new tools, and place and resistance) are evident in all three literatures. Institutional behaviour is concentrated more in the equity and transitions and participation and democracy fields, whereas rethinking capitalism is evident in the energy justice and equity and transitions literatures.

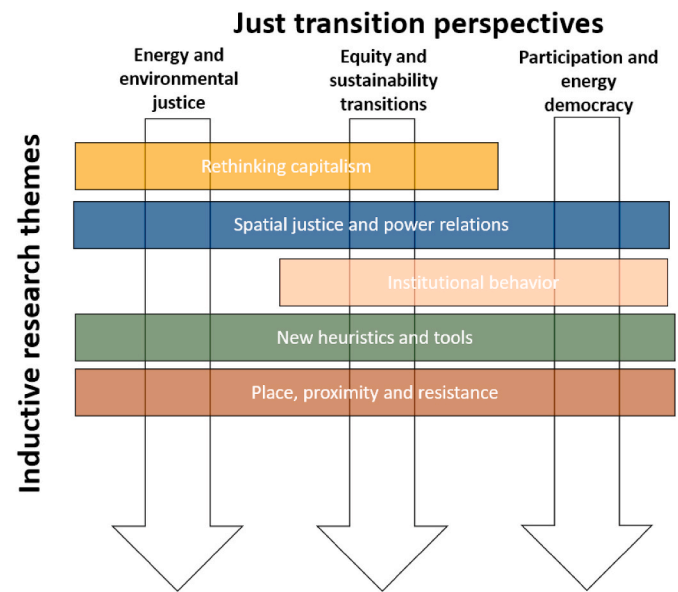


Fig. 2. Positioning core research themes among three Just Transition perspectives.

Source: Authors

4.1. Rethinking the material politics of capitalism

The theme of rethinking the politics of capitalism arises across both literatures of justice and transitions. We have already referred to Ref. [17] above, in relation to arguments against the sufficiency of ecological modernism to stave off ecological collapse. The author's concerns relate to the economic instabilities of ongoing financialization trends and more longstanding Keynesian concerns about capitalism requiring constant stimulus (and hence material consumption), to avoid stagnation once basic productive capacity is in place [72]. [52] echoes this theme, citing [73], who sees no possibility of fundamentally changing or reducing inequalities under capitalist market conditions. Instead, in his view, there is more of a danger that even well-intentioned approaches can turn into the opposite, such as infrastructural improvements of urban districts leading to gentrification processes and thus to the (re)production of social inequality and displacement (as [72, 74] above).

4.2. Spatial justice and power relations

Spatial justice and power relations are a theme spanning all three of our perspectives, given that many researchers take critical geography perspectives [75]. analyses the urban material politics of decarbonisation in Stockholm, London and San Francisco, finding that short-term decision-making timelines are encouraging actions that reduce GHG incrementally, but that leave larger problems of fossil-fuel supply unaddressed. She also highlights issues of justice and uneven development, whereby wealthier demographics benefit from lower carbon gentrification [74].

A key issue highlighted in this strand of work is the reinforcement of pre-existing inequities, which may, notably and through financialization, take the form of the beneficiaries of new infrastructure being located far from affected areas [76]. consider how new energy landscapes reveal the inequalities of the German *Energiewende*, using work by Ref. [77] on the production of space (i.e. why and how particularly urban forms are as they are). The authors argue that achieving climate targets requires an understanding of “sustainable energy landscapes” as the “production of a discourse about sustainability, equity, and justice”. By this the authors mean that achieving climate targets requires more low carbon energy infrastructure; that this requires local acceptance;

and that the latter is not so much a function of technological properties, but of local discourses, contexts, and power relations. In other words, the places in which renewable energy infrastructure is sited should not be regarded as neutral, empty spaces but as “pre-formatted carriers of social structures and processes”. The power to shape spaces is thus viewed as discursive as well as financial.

[78] examine embodied energy injustices: the externalities of fossil fuel extraction and use that justify enhanced sustainable energy governance and corporate accountability for transboundary damage, placing local struggles within wider national, regional and global energy politics. Other work on political themes examines the role of pre-existing political ideology in affected communities [79]. used surveys and focus groups in Nova Scotia and Ontario to examine the effects of a politicisation of energy infrastructure proposals, particularly in relation to a rural/urban divide. Their context was a Democrat-Republican divide regarding policy for, and attitudes to, environmental protection and climate change mitigation, a distinction replicated in many countries to some degree. The authors cite a meta-analysis by Ref. [80] of the correlates of climate change opinion across 171 studies in 56 countries, which shows ideologies, worldviews and political orientations as having relatively strong relationships. In their particular study [79], found that support and opposition to wind energy in Ontario was related to wider political views, albeit not always strongly, whereas in Nova Scotia, where divisive political rhetoric was less prevalent, there was no such relationship.

4.3. Institutional behaviour and strategic action fields

Another strand of research in the intersectional literature examines participation in relation to institutions, including regulatory bodies, governments, coalitions, programs and cities, residing primarily in the perspectives grounded in transitions and participation. In the US [81], observe that publics are largely marginalized from collective decisions about if, when and where unconventional oil and gas (UOG) production should occur. This marginalization occurs via a lack of recognition and authentic participation as well as limited community capacity to make decisions about zoning and regulating UOG. The authors argue that “*metapower* - the power to structure the conditions of social contexts—frames negotiations between corporate actors and members of the public, shaping the outcomes of these interactions toward development and away from authentic participation by community members.” (p. 1811).

[82] apply strategic action field theory [83] to understand the behaviour of consumer-owned utilities in the United States. An organizational field is an arena in which organisations interact, affect one another through institutional processes and share a common meaning system. The approach applies the elements of institutional theory [84] - i.e. regulative, normative and cultural-cognitive rules - with variation these in terms of duration, scope and scale of acceptance assumed to indicate the strength of a sociotechnical regime. The authors show how the organisations involved interpret and respond in accordance with their own perspectives and circumstances, renegotiating the semi-coherent structures of the regime and assigning novel meanings, as new energy technologies and practices are encountered. In this regard the study is of more relevance to understanding business behaviour in the cluster than public engagement per se.

In the UK [85], map and assess how UK governments have engaged publics with energy infrastructure planning, and how this has changed over time. They document consultation processes and support measures (e.g. community benefits) and use a pragmatist sociology framework to help explain their observations. They find a trend towards a reduced scope for public engagement, in tandem with greater encouragement of community benefits, with differences between energy sectors. That is, the authors argue that the UK government has made judgements as to what it considers politically expedient in terms of public engagement processes.

Also in the UK [86], examined public perceptions of who should fund programmes designed to ease the transition to a more sustainable and equitable energy system, finding that publics tend to allocate most responsibility to energy companies, with beliefs about procedural justice prominent in this. Willingness to pay personally towards low carbon energy supply was dependent on several factors, including individuals’ perceptions of the importance of distributive justice and the extent to which the energy system is considered to be fair procedurally [87]. add a place-based element to this issue, observing that while some households and localities will benefit from decarbonisation, others will be disproportionately affected by rising energy costs and job losses arising from decarbonisation. The authors examine different dimensions of advantage and disadvantage in low carbon restructuring and how these might be reinforced or mediated by intervention by governments, NGOs and citizens. Finally, with reference to citizens [88], considering the UK’s first ecological, affordable cohousing community, identifies six lessons for a “roadmap” towards post-carbon cities: the need for holistic approaches that deal with complex challenges, prioritizing self-determination rather than just participation, engaging with productive political tensions, adopting a process rather than an outcomes-based approach, developing strategy for replicability, and finally, embracing a non-parochial approach to localities.

4.4. Calls for new heuristics, processes and democratic procedures

Calls for new heuristics and tools also cut across all three perspectives [89]. look at the transformation of the social imaginary of places affected by energy installations and the consequences of such imaginaries for place attachment and place identity. The authors see a need to identify factors relevant to the anticipation of associated issues, in order to support policy evaluation tools for those involved in the planning phase of energy installations [90]. examine formal and informal assessment or evaluation processes in energy projects: formal processes embedded in the legal system; and informal processes mainly embedded in public discourse. They view the latter as a response to an absence of recognition for public concerns or values and describe this as “overflowing”. The authors observe that informal assessment may subsequently lead to project modifications, which they describe as “backflowing”. They argue that for legitimate and effective energy policy, overflowing and backflowing should be understood and addressed as interrelated rather than as separate processes.

[91] proposes an ethical framework for policy evaluation based upon the principle of *prima facie* political equality [92], regarding the connections between the distributive and procedural elements of environmental justice. This principle implies that all citizens be given equal consideration and concern with respect to decisions over distributive outcomes and that the onus for justifying environmental risks rests with those proposing potentially environmentally damaging developments, not those opposing them [91]. explores the application of this principle in the context of public objection to fracking in the UK and specifically the way in which planning law reforms modified the role of local decision-makers in the case of nationally significant infrastructure.

[57] are also concerned with questions of procedural specifics, in the context of just urban transitions. They view as key research questions:

- “How should we pursue, recognize, and measure just urban transitions:
- What are the political and programmatic strategies for just urban transitions, who are the actors, and what tools are available?
- How much variation is there between cities in the visioning and implementation of just urban transition?
- Who is accountable for just urban transition and by what measures should they be evaluated?”

The authors do not answer these questions, but pose them as implicit on the fusion of thinking on climate action and justice concerns at the

urban scale.

In the context of Canadian wind energy development [93], compare community-based and technocratic siting processes in terms of perceived procedural justice, using community surveys and focus groups. For most of the procedural justice principles examined, Nova Scotia was perceived by stakeholders as performing better than Ontario, for its use of a community-based program, compared to perceptions of Ontario's more technocratic siting procedures, which were seen as not permitting sufficient opportunities for participation. By "community-based program" is meant models of local profit sharing and involvement in decision-making. The principles considered included provision of information, opportunity to engage, perceptions of the developer and ability to affect the outcome. All of these are widely relevant in planning contexts.

In the UK context, specifically Cornwall [94], offer a specific procedural suggestion reflecting a concern to pre-empt undue influence of planning officers on planning committees at the local level composed of political representatives. Although such committees are not obliged to accept officers' recommendations, they must specify reasons for rejection and officers' reports form an important part of the evidence base for appeals. The authors suggest that planners should be required 'o produce neutral discussion documents of issues raised, rather than primarily recommendations. The documents would describe the impact and justice criteria used; feedback from stakeholders and publics would be elicited through participatory planning, and the document would then provide a basis for decision-making. This would, the authors suggest, change the decision-making basis to one of constructive dialogue and would avoid the problem of issues raised by residents being treated as non-material. There are some echoes here of earlier work in SW England by Ref. [95], which also advocated that affected communities be engaged in dialogue, with projects considered in the context of regional plans that indicate the upper limits of renewable energy infrastructure deployment, given community fears that allowing some development would set a precedent for much more.

Instead of information provision as a means of behaviour change in relation to energy [96], propose a community knowledge networks approach to energy and justice, which defines community as social networks; and which recognises "the contexts and relationships in which people live and use energy and their role in shaping what people know about energy". This perspective emphasises situated knowledge and practices, to understand more about individual and community understandings of energy, and also to give greater recognitional justice to different social groups.

[97] evaluates the citizen engagement processes of the energy utility Western Australia, as it struggled to gain community consensus to site a small community-owned wind farm [98]. used Q-method to study the discourses of electricity transmission line siting in the UK, arguing that while greater information provision and more upstream citizen participation in contexts of transmission line planning is recommended to enhance public trust, such an approach is also limited by an absence of clarity at the national level regarding the configuration of future energy systems.

[99] use the concept of institutional "lock-out" towards local self-governance in the context of Dutch social housing neighbourhoods, where Dutch housing associations encouraged tenants to take a more active role in sustainability transitions. They observe that, particularly in deprived neighbourhoods, there was no bottom-up activity, nor was this likely without external support. The authors examine how historic institutional pressures resulted in a diluting of the engagement programme into a top-down technology-push approach. The authors advocate capacity building with environmental justice in mind, to examine the conditions for local self-governance and how to address these.

4.5. Place, proximity and other correlates of acceptance and resistance

Place, proximity, and resistance also feature in all three perspectives. While tools intended to assist public engagement in the place-related impacts of energy infrastructure have long been available [100], a large literature documents the challenge to overcoming the concerns of citizens who place a high value on landscapes (and seascapes [101]) without the visual "intrusion" of new energy infrastructure. Similarly, compensation for impacts in this context can also be very difficult to manage [102]. In relation to social imaginary of energy infrastructure [103], discuss the psychology of mobilising place attachment for climate change mitigation by modifying threat perceptions, but the authors are under no illusion as to the challenges involved.

Turning to India [104], describes how Kerala, India, in which there was a surplus of renewable power, shifted to fossil fuel combustion as a result of environmentalist opposition to hydro-electric projects. Opposition in specific local contexts led to increased emissions in the region as a whole and the authors argue that this challenges the tenets of energy justice, revealing conflicts between environment law and climate Law, and between the principles of energy justice and law [105]. describe how Australia has experienced a high degree of societal objection to windfarms. Analysis of seven case studies found four common themes relating to objection, despite strong community support for wind farms: trust in the developer, perceptions of distributive and procedural justice, and place attachment. These are similar to recurrent themes in other cases of objection to renewable energy developments internationally and all need to be addressed.

In a paper empirically close to the present concern [106], ask what drives public acceptance of chemical industrial park (CIP) policy and project in China? The authors use surveys in three cities, examining the nature and level of public acceptance towards chemical industrial park policies and projects. They find that publics were more positive towards national policy on chemical industrial parks than policy on these at the city and project level. Public acceptance of CIP policy and project was significantly influenced by factors including income (respondents with higher income were less likely to accept a CIP near their home); the extent to which respondents hold environmental values; perceptions of risks, procedural justice, distributive justice and benefits of CIP; and the distance of a proposed CIP from a respondents' home.

[107] analyse the effect of community acceptance on planning applications for onshore wind and solar farms in Great Britain between 1990 and 2017. For both technologies, the visibility of a project, its installed capacity, the social deprivation of the area, and the year of the application are significant. Aesthetics and visual impacts are strongly associated with planning outcomes for both onshore wind and solar farms, which is in line with much of the existing literature on public acceptance of these technologies. Significant variables common across the technology types (visibility of modern artefacts and structures, installed capacity, Townsend Index score, and the year of the planning application) suggest that the project's visual impact, installed capacity, the social deprivation of the local area, and the time of application are all important in terms of planning outcome for both onshore wind and solar farms.

In the context of Portugal and solar power [108], advocate opening up to learning from living laboratories at the community level [109]. responds to a perceived deficit in studies of the spatial implications of procedural justice, examining how local geography may influence the procedural justice of a planning process, and arguing for effective mobilisation of local knowledge for more localised practices. The author attributes lack of engagement being due to fear of repercussions but argues that this can be counter-productive in terms of siting acceptance. In the context of Wales [110], shows that community energy is often involved in meeting a wide range of local objectives and argues that attention needs to be given as to how best to support these initiatives and deliver more widespread equity gains.

With reference to the first operational US offshore windfarm (Block

Island) [111], document the way in which process leaders first established public trust in themselves, then in the development process, and then in the outcome. A key part of this was understanding and addressing public expectations, alongside early stage and on-going informal interactions as a supplement to the formal process. Specific aspects of the project were modified in response to public and stakeholder concerns and input.

In the aptly named study “(Not) talking about justice” [94], use the concept of self-recognition to argue for greater attention to public discussion of the justice dimensions of renewable energy and processes that might integrate distributive and procedural justice principles into renewable energy decision-making. The authors argue that this requires treating community concerns as constituting a source of legitimacy, rather than only being a hurdle to overcome; and hence support for local negotiation with impacted communities, such as via a statutory duty for local authorities to develop negotiated low-carbon plans. They also suggest that planning officers might be required to produce neutral discussion documents of issues raised by publics and stakeholders, rather than recommendations.

[112] advocate evaluating energy justice across the life cycle, addressing energy justice concerns by different stakeholder groups at all life cycle stages associated with low-carbon energy systems. With reference to unconventional oil and gas extraction in the US [113], highlight the need for local capacity building to be able to respond to extractive energy firms. They argue that a lack of access to mineral rights leasing data was important in power and knowledge asymmetries. Finally, in a review of the energy justice literature [21], advocate Participatory Value Evaluation (PVE) as a way of integrating the three main tenets of energy justice into economic assessment methodology. They contrast PVE with conventional CBA: in PVE, individuals are viewed as co-owners of the government instead of consumers of public goods. In a PVE, citizens are confronted with the choices of a policy-maker, receiving information about the personal and collective impacts of options and their constraints. They are asked to provide recommendations and a justification of these.

5. An integrative framework for actor engagement in just transitions

Given the complexity of the topic of just transitions, each of the three perspectives presented in Section 3 are often used in isolation, without much consideration of the other. Indeed, each of our three core perspectives can be treated as broad heuristics (either for justice, transitions, or participation) that do not seem to wholly account for the holistic and evolutionary dynamics of transitions. As Table 2 indicates, each approach has a focus but also something out of focus, such as the justice literature focusing on community harms or the erosion of values but neglecting issues of innovation and design. The equity literature often focuses on the distributional impacts of sociotechnical change but neglects a broader investigation of embedding. The energy democracy literature often illuminates patterns of engagement and ownership but discuss less the structural processes that can impede change. Thus, each approach also has strong “fits” with *some* transition dynamics (strong explanatory power) but also “misfits” with *other* transition dynamics (weak explanatory power). There is a missing middle: how they may collectively give a broader view of transitions when integrated.

Themes and sub-themes found in the systematic review, relevant to the decarbonisation of industrial clusters, are synthesized into Fig. 3. The sub-themes are again organised by the larger themes identified above, with themes 1–3 condensed for brevity, given their neo-institutional commonalities.

Section 6 applies these elements of our framework across three empirical cases in the United Kingdom, for the specific purpose of identifying how the framework helps to highlight aspects of the different cases. We also discuss some of the wider issues raised.

6. Industrial decarbonisation through the lens of our integrative framework

In January 2021, six industrial cluster projects across the UK were awarded £8 million in government funding to bring together industry and local authorities to develop plans to reduce carbon emissions [114]. These were selected based on their total level of greenhouse gas emissions (see Fig. 4) and are: South Wales Industry – A Plan for Clean Growth; Repowering the Black Country Phase 2 Cluster Plan; Net Zero Tees Valley: Cluster Plan Stage 2; Scotland’s Net Zero Roadmap (SNZR); The Net Zero NW Cluster Plan; Humber Industrial Cluster Plan. Several deployment projects were also funded: in March 2021, UK Research and Innovation (UKRI) awarded £171 million funding across nine projects (stage 1) to support the delivery of significant emissions reduction in at least one UK industrial cluster by 2030.

For exemplar cases, we selected three of these clusters for the application of our framework: Grangemouth, the NW Cluster (Merseyside) and South Wales, ensuring our case selection also included one for each of Scotland, England and Wales respectively. That said, we must emphasise that the UK as a whole has largely phased out of coal use over the past fifty years [115]. This likely makes UK industrial decarbonisation unique, and perhaps less contested than in other regions more dependent on coal, such as Australia, China, Germany, Indonesia and even the United States and Canada [116–118].

6.1. Industrial cluster context

The Grangemouth industrial cluster (Scotland) hosts the Ineos refinery complex, which annually produces around two million tonnes of chemical products and is Scotland’s sole crude oil refinery. The cluster includes the proposed site of a carbon capture project that aims to reduce costs through shared infrastructure and that would store carbon dioxide in a saline aquifer beneath the North Sea.⁷

The NW Cluster (Merseyside, England) is a part of the multisector Net Zero North West partnership, which consists of multiple projects that include, amongst others, Hynet, a low carbon hydrogen and Carbon Capture and Utilization (CCUS) project. This aims to capture 40 kt of CO₂ for food grade sodium bicarbonate manufacture. The project also aims to capture flue gases from the combined heat and power plant at Tata Chemicals Europe’s Northwich industrial site [119]. The Mersey Tidal Power project would develop whole energy system integration of electricity, storage and hydrogen, with the intention of providing energy supply resilience in the wider region network. Another project is Vanguard, a private-public partnership to build a green hydrogen refuelling station in Middlewich, Cheshire (consisting of PV electrolysis for waste management utility vehicles). HySecure would be a mined hydrogen storage salt cavern capable of storing 50 GWh of energy. Centurion would be a 100 MW power to gas demonstration project to convert and store surplus green electricity to hydrogen, with export to the gas grid as required.

The South Wales Industrial Cluster (SWIC, in Wales) is a group of major industrial companies in the region stretching from the Pembrokeshire Coast to the Severn Bridge along the M4 corridor. SWIC covers various industries such as energy, oil refining, paper, nickel, chemicals, LNG import, steel and cement. Project topics include the production, transport and applications of hydrogen, and the capture and use of CO₂.

6.2. Illustrative description of the framework

In Table 3 we show the relevance of the themes from our framework, as well as exemplar issues for consideration among our three cases, having in mind that the framework is intended to both guide the design

⁷ Further detail here: <https://www.geos.ed.ac.uk/scs/project-info/98>.

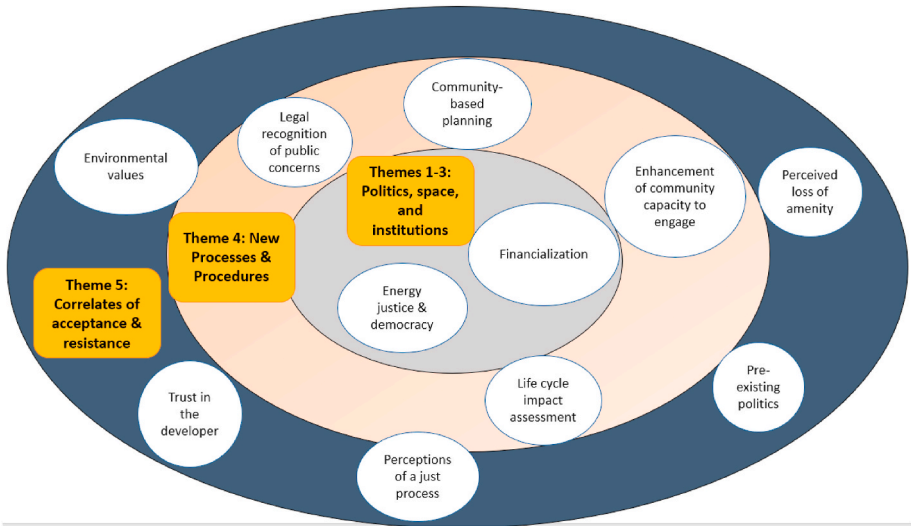


Fig. 3. Selected themes relevant to public engagement and industrial just transitions.



Fig. 4. The largest industrial clusters in the United Kingdom by emissions [114].

of just transition processes ex-ante and evaluate initiatives post-hoc. All the exemplar issues for consideration are present in the review above and are selected for relevance to the planning of industrial cluster decarbonisation.

6.3. Application of the framework

In this section, we highlight some of the evaluative themes and associated issues for consideration for just transitions as applied through our three cases. This is done illustratively, rather than comprehensively and it is both prospective and tentative, given the early stage of cluster transformation. Nonetheless the application both reveals the utility of our framework, and the empirical issues that arise when it is applied to a real-world context.

Table 3
Evaluative themes and exemplar issues relevant to just transition of industrial clusters.

Evaluative themes	Exemplar issues for consideration
<i>Politics, space and institutions</i>	
Justice	Rights of public participation and redress; degree of social equity (income, information)
Democracy	Worker representation on company boards; labour unions and their role; statutory powers of spatial planning bodies
Financialization	Macro-economic policy; patterns of share ownership; employee shares; influence of various types of investor and financial instruments
<i>New processes and procedures</i>	
Legal recognition of public concerns	Definition of what is material in planning law; processes for taking public concerns into account
Community-based planning	Processes for community engagement at different stages of policy and project life cycles
Community capacity enhancement	Provision of resources to communities to support meaningful engagement
Life cycle impact assessment	Evaluation and response to indirect, spatially and temporally distant impacts
<i>Acceptance and resistance</i>	
Environmental values	Degree of prevalence of different types of environmental value in affected communities
Perceived loss of amenity	Degree of perception of any amenity loss or gain
Pre-existing politics and trust	Public opinion of companies and developments, past, present and future
Perceptions of a just process	Public opinion of planning engagement processes, past, present and future

Source: Authors

6.3.1. Politics, space and institutions

For the shared infrastructure in the Grangemouth cluster, a key justice concern is being able to “retain high-value jobs within Europe’s high carbon manufacturing industries.”⁸ The “clean power and carbon capture plant” is to be provided by a Public Private Partnership (PPP) and a Regulated Asset Based model, at a price intended to be attractive to Government, public, lenders and private investors. While “thousands of jobs” are expected to be created, the role of unionisation and worker representation in boards is yet to be determined. Justice themes arise concerning legal, regulatory and policy work through the many

⁸ Consultation response by Scottish CCS in 2017: https://sccs.org.uk/image/s/expertise/reports/working-papers/WP_SCCS_2017_08_Consultation_Response_UK_Clean_Growth_Strategy.pdf.

processes involved.⁹

In the Net-zero NW cluster plan, a more precise 33,000 jobs are promised across areas of opportunity such as: “engineering support; construction; parts provision; logistics and distribution; third party maintenance; contracts and many other supporting work streams”.¹⁰ Again, issues of the nature of public participation and their roles in company decisions remain unclear. According to HyNet’s Vision, the company itself will protect existing jobs and will create 6000 additional jobs in the region and 75,000 jobs across the country by 2035, to kick-start and support the hydrogen economy.¹¹ The investment involved in the cluster is stated to be some £4bn as well as opportunities for new funding streams. The roadmap for HyNet is intended to identify the projects, technologies and strategic infrastructure required across the region to attract further private and public sector investment in the future.¹²

For the South Wales industrial cluster (SWIC), economic justice is again represented through the creation and retention of jobs that ensure growth of the local economy. The initial source of finance is an award of £1.5 million from the UKRI’s Industrial decarbonisation programme, with an expectation to drive inward investment in the future. At the time of writing there is little publicly available information by which to judge the justice aspects of the cluster’s direction of travel, other than a spotlight on the work of one of the youngest female Chartered Energy Manager in SWIC marketing.

6.3.2. New processes and procedures

In Grangemouth, it is expected that the Caledonia Clean Energy Project will directly generate 1200–1800 jobs during construction (short term) and 300–600 jobs in the long term in Scotland and rest of UK. Summit Power claims to have a “long history of working in collaboration with environmental advocates and local communities to bring forward projects with their support that also meet the rigorous demands of the marketplace.”¹³ The organisation thus sets an expectation of a just and responsive process of project development through recognition of public concerns and community engagement.

The NW cluster plan for industrial decarbonisation emphasises community capacity enhancement, following recommendations from the Green skills taskforce. This involves net-zero skills delivery, identifying emerging skills gaps, internalising knowledge exchange and research on decarbonisation strategies, and developing future-oriented skills and competencies, supported by co-operation with regional universities on roadmap development. The proposed engagement of local planning authorities together with the Secretary of State for Department of BEIS in managing planning permissions for HyNet NorthWest¹⁴ goes some way towards community-based planning, but only to a limited extent.

The SWIC plan – as with other cluster plans – says nothing about legal recognition of those public concerns that may arise in the course of shifting the portfolio of industries that constitute the cluster. There is also scant information on the prospect of community-based planning, however the ambitions to create “local energy hubs” does imply willingness to work with local businesses, universities and organisations. The aspect of “community capacity enhancement” is highlighted through promises of creating “highly skilled jobs”, though what kind of skills, where and how these skills will be developed remains to be

articulated. In the project life cycle, a key positive anticipated impact is enhancing “the UK’s ability to locally manufacture cement and steel products with low carbon emissions, helping to drive the low carbon future of UK construction and other sectors such as defence, car manufacturing and coin production”, while ensuring improved air quality and enhanced well-being in the region.¹⁵

6.3.3. Social acceptance, resistance and values

Grangemouth is expected to play a vital role for “just transition towards net zero” according to the Scottish Minister for Just Transition, Employment and Fair Work, with the latter appointment implying at least some acceptance and trust between the coalition of companies in the cluster and the national political level.¹⁶ The newly unveiled roadmap for achieving net zero emission from Scottish industries, produced by NECCUS, articulates the targets and gains from Industrial Decarbonisation strategy, and aligns with the ambitions of Just Transition commission of the Scottish Government. However, reference to the diversity of environmental values involved, social acceptance of the strategies and level of community engagement in the planning is largely absent in the roadmap itself, which focuses on commissioning, investment and establishment of low emission industries between 2020 and 2050.¹⁷ Nevertheless, resistance from publics to the construction of the CCS plant, arising from the possibility of negative environmental and economic value associated with CCS, are documented as a project risk in the feasibility study.¹⁸

The commitment of the NW Cluster to deliver net-zero targets and to become a frontrunner for a green industrial revolution in the UK largely showcases their own type of environmental values, particularly so in the context of the region having declared climate emergencies. To some extent, pre-existing politics and trust is reflected in the visions of the politicians and mayors of the regions who expressed pride in representing “UK’s first low carbon cluster” and creating a “blueprint for the world.”¹⁹ Business leaders at least use the discourse of just transitions: the Chair of the Cheshire and Warrington Local Enterprise Partnership says that: “Securing an inclusive and sustainable economic recovery is at the heart of the long term vision” for her region, and that “the region has a strong and proud track record of collaborative working and we intend to build on these powerful partnerships to ensure we are the catalyst for sustainable growth.” Our framework provides a theoretically informed basis for both guiding and assessing the extent to which such partnerships can deliver justice in practice.

For SWIC, the predominant environmental value is “clean growth” which encompasses not only net zero carbon targets, but also “reversing the decline of heavy industry and creating economic prosperity for Wales”.²⁰ Beyond this, little can be said at present regarding the extent to which the cluster’s activities meet or will meet the criteria of the framework, on the basis of publicly available information alone.

7. Discussion: justice, equity, and democracy in tension?

As our narrative analysis of the three cases shows, industrial cluster transformation tends to be publicly represented primarily in terms of retaining existing jobs and creating new employment, in alignment with decarbonisation roadmaps. Aspects such as public participation (in politics and space), involvement of local communities (in processes and procedures) and consideration of public perceptions of loss and injustice

⁹ <https://summitpower.com/overview-2/regulatory-matters/>.

¹⁰ <https://netzeronw.co.uk/net-zero-nw-cluster-plan/>.

¹¹ https://hynet.co.uk/wp-content/uploads/2020/10/HyNet_NW-Vision-Documents-2020_FINAL.pdf.

¹² <https://www.nwhydrogenalliance.co.uk/news-stories/north-west-secures-funding-to-roadmap-journey-to-net-zero/>.

¹³ <https://summitpower.com/whoware-our-values/>.

¹⁴ https://hynet.co.uk/wp-content/uploads/2020/10/HyNet_NW-Vision-Documents-2020_FINAL.pdf.

¹⁵ <https://www.swic.cymru/news>.

¹⁶ See <https://www.endsreport.com/article/1721833/industrial-giants-power-ccs-plans>.

¹⁷ <https://www.neccus.co.uk/the-roadmap/>.

¹⁸ <https://summitpower.com/wp-content/uploads/2018/06/CCEP-Feasibility-Final-Report-MAY-2018-SUMMARY-VERSION.pdf>.

¹⁹ <https://netzeronw.co.uk/why-the-north-west/>.

²⁰ <https://www.swic.cymru/news>.

(acceptability and resistance) are hardly referred to. In contrast, much of the literature reviewed argues for counterfactuals. It implicitly or explicitly applies norms that find that the world as it is falls short in terms of different forms of justice or claims to justice.

Moreover, industrial clusters are very different to some of the empirical objects studied in the corpus of papers covered by our systematic review: they are physically large and extensive, occupying large footprints, sometimes along transport routes; they are comprised of multiple processes and companies, often transnational and large employers; they refine and process potentially hazardous materials with mandated buffer zones to residential populations. Materially, they are a world away from community-owned energy infrastructure.

While modes and processes of engagement may by necessity differ across contexts, we would argue that the principles of just transitions hold across those contexts: most importantly, that those affected have a right to influence the processes involved. We know that this poses challenges for various aspects of the status quo, and we know that, even with the latter point accepted, this leaves many substantive issues to be resolved, going forward.

Our findings furthermore have implications in terms of revealing different challenges across the three dimensions of academic work on energy and environmental justice, equity, and transitions; and participation and energy democracy. For the energy and environmental justice communities, our findings speak to the difficulty of generalizing broader findings from other sectors to industry, which appears to have greater degrees of path dependence and lock-in than e.g. consumer-facing sectors. This in turn, can lead to communities becoming dependent on, and attached to, industrial production in ways that make decarbonisation a perceived prospective injustice, rather than the other way around. This may further result into tensions between the speed of transitions, and how just or inclusive they can be [120].

For the sustainability transitions communities, our findings reveal the interesting sociotechnical dynamics inherent in industrial net-zero, ways that may result in different dynamics than one sees in other sectors such as electricity supply, transport, or energy use. Namely: industrial decarbonisation may require different types, scale, and scope for experimentation and learning [121], and it may also necessitate more meaningful coupling between different systems and forms of project management [122]. Industrial decarbonisation also demands decarbonisation across different technologies (wind, solar, e.g. Ref. [123] as well as clusters and within very energy intensive (and hard to abate) sectors such as industrial process emissions and fluorinated gases [124], chemicals [125], cement and concrete [126], iron and steel [127], ceramics and glass [128], lime [129], ammonia [130], and oil refining [131]. Crosscutting solutions such as renewable energy, material efficiency, energy efficiency, nuclear power, hydrogen, and carbon capture could hold significant cross-sectoral appeal across these different sectors and clusters [132–134]). Such solutions can even have other social or economic co-benefits such as reducing household energy poverty [135].

For the energy democracy and participation communities, we reveal how not engaging in discussions of industrial systems transformation and reorientation is itself a decision or stance about participation (not acting is an active decision). At the same time, how including all stakeholders in discussions can lead to greater contention rather than consensus [75,136]. Policies in favour of industrial decarbonisation may also enhance democracy and inclusion (and shift power relations) in some dimensions (i.e., local or national) but only at the expense of other dimensions and scales (i.e., global or regional) [137]. Similar tensions

could arise with the disruption of jobs and employment that occur within just transition pathways, with fossil-fuel communities suffering losses but other sectors of the economy benefitting [4,138].

At a broader level, our findings imply that some elements of justice can intersect with and even conflict with notions of equity and accelerated transitions (what is just may be too slow), and notions of inclusion and participation can conflict with both justice (it can include hegemonic actors that dominate others) and equity (consensus decision making can still entrench majority views). Managing industrial Just Transitions becomes about accepting and navigating trade-offs between different dimensions of justice, equity, and participation rather than a predetermined “win” across all of those dimensions. Industrial decarbonisation can in practice see multiple dimensions of sustainable energy development (environmental, social and economic) in conflict with one another [139].

8. Conclusion

We have developed and justified a framework for the identification of just transitions themes relevant to the low carbon transformation of industrial clusters, with reference to UK case studies. The framework is inferred from themes present in work at the intersections of the three literatures of just transitions, innovation studies/sociotechnical transitions, and public participation in spatial planning, with intersections identified through systematic literature review. We have grouped the themes identified as those relating to (i) politics, space and institutions, with sub-themes of justice, democracy, financialization; (ii) new processes and procedures, with sub-themes of legal recognition of public concerns, community-based planning, community capacity enhancement and life cycle impact assessment; and (iii) correlates of acceptance and resistance, with sub-themes of environmental values, perceived loss of amenity, pre-existing politics, perceptions of just process and trust in the developer. The higher-level thematic categorisation broadly distinguishes between theory, engagement practice and consequences, reflecting a notional chronology of action.

While the framework is intended to both guide the design of just transition processes ex-ante and to help evaluate these post-hoc, there is no legal or statutory mandate for either in the UK or, to our knowledge, elsewhere. In terms of spatial planning, publics in many countries have rights to information and participative representation of their views under the Aarhus Convention [140], but in terms of prescriptions for engagement, this is minimal. In terms of spatial planning, publics in many countries have rights to information and participative representation of their views under the Aarhus Convention [140], but in terms of prescriptions for engagement, this is minimal. Our framework highlights issues far beyond this, and its norms implicitly assign a range of rights to publics and affected parties that are generally not reflected in law or policy. Nonetheless it is a key axiom of the just transitions literature that all stakeholder voices deserve to be heard and respected in law and action. The decarbonisation of industrial clusters is no exception and broader concerns on the horizon beyond the provision of employment and industrial restructuring per se may determine whether just transitions research truly informs industrial practice.

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.

Appendix

Table 1
Selected reference papers

Citation	Focus	Theoretical perspective(s) if any	Empirical application(s)	Location of case(s) if any
Energy justice				
[55]	Literature review informing identification of spatial and temporal variation of cross-sectoral and entire-energy-chain injustices that lead to elevated energy poverty risks. Four mechanisms of energy injustice: landscapes of material deprivation; geographic underpinnings of energy affordability; vicious cycles of vulnerability; and spaces of misrecognition.	Spatial justice as geographical dimensions of inequality and inequity, missing from notions of distributional, procedural and recognitional justice; and related to the socio-economic construction of spaces	Multiple; review paper	Europe
[141, 141]	Empirical case of an unjust transition achieved through strategic framing and closed stakeholder involvement, leading to legally misallocated funds intended for structural adjustment (coal phase-out)	Argues that when strategic place frames conflict with accepted territorial boundaries, they invite opposition and resistance. Thus, the potentials of strategic issue and scale framing are limited by the political durability of territorial place frames	Coal	Australia
[23]	Argues for encompassing energy, environmental and climate justice within the concept of just transitions	The Legal Geography “Just” framework (distributional, procedural, restorative, recognition and cosmopolitan justice; plus considerations of space (location) and time (when))	Sustainability applications	Conceptual paper
[20]	Energy justice and just transitions	Views various literatures relevant to transitions research through the lens of distributive, procedural, and recognitional justice	Critical review paper	International, inc. indigenous Canadian
[19]	Introduction to energy justice thinking	Energy justice as distributional, recognitional, procedural, restorative; plus an overview of non-Western understandings of justice	Editorial introduction to multiple studies	International
[57]	Just urban transitions research agenda	Multiple: reviews environmental, energy, climate and urban justice literatures	Urban planning; review paper	Conceptual paper
[18]	Energy justice through the life cycle	Energy justice as distributional, recognition and procedural, cosmopolitan.	Review paper	International
Justice and sociotechnical transitions perspectives				
[62]	Integration of energy justice with the multi-level perspective [63]	Distributional, procedural and recognitional justice considered at the niche, regime and landscape levels	Energy supply and consumption	Conceptual paper
[64]	Proposes a bridging of sociotechnical dynamics and justice aspects of energy transitions via the co-evolution of institutions, social relationships and material elements. Notes differing emphases re scale: as magnitude or in relation to distribution of impacts	Socio-technical transitions, energy justice, STS and energy geographies	Selective review paper; multi-scale solar	Portugal
Participation/engagement				
[142, 142]	Advocates a high level of community dialogue	Urban design	Two city/region case studies (Iskandar and Greater Kuala Lumpur)	Malaysia
[66]	Develops a constructivist relational ecology view of engagement as a co-producing relationship of publics, energy objects/issues and participation modes	Contrasts discrete (“residual realist”) engagement with relational perspectives that emphasise everyday socio-material engagement	Selective review paper; multiple	UK
[67]	Proposes and applies a “Just Transition Management” framework	Combines theory of sociotechnical transitions processes & management with concepts of distributional, recognition and procedural justice	Energy supply options; community & trade union engagement	Australia
[143, 143]	Differing understandings of impact, community and benefit	Critical review paper	Selective review paper; offshore renewables and community benefit mechanisms	International
[144, 144]	Configurations of participation in local development planning practice	None: narrative literature review	Review paper; options for the organization of participation, selection of stakeholders, methods of communication etc.	International
[144, 144]	Exploratory review of participation options for local, spatial socio-economic development, from which is developed a participation plan model differentiated according to the specifics of the local environment	Constructs a participation and communication matrix of principles and methods, ranging from 1-way information provision to co-creation	Multiple; scoped review paper; acknowledges the challenges to participation	International
[70]	Reviews and connects just transition concepts from political economy and environmental labour studies perspectives	Historical overview of initiatives and concepts, emphasising the importance of labour unions and social dialogue mechanisms in just transitions	Selective review paper; automobiles and coal	Europe
Mixed				
[89]	Advocates four research priority strands in just transitions: (a) intergenerational justice and energy justice; (b) justice and energy vulnerability; (c) transformation of the social imaginary and energy infrastructure; (d) damage, compensation, and energy infrastructure	Energy justice, social representations theory, social acceptance, place attachment.	Conceptual, research agenda paper	International
			Multiple	International

(continued on next page)

Table 1 (continued)

Citation	Focus	Theoretical perspective(s) if any	Empirical application(s)	Location of case(s) if any
[145, 145]	Advocates that: 1. Energy transition strategies should be long-term and align both with agreed climate goals and commitments to improving social equality; 2. Participatory, applying both distributive and procedural justice, and taking into account those who will be affected by transition processes across the socio-economic system; 3. Taken as an opportunity to redress systemic injustices that exist under the current fossil fuel dependent social, political and economic paradigm.	Offers a typology of just transition approaches: 1. Status quo: approaches that seek to craft transition processes without modifying the current socio-economic system; 2. Managerial: approaches that alter rules and arrangements within the existing system; 3. Structural: approaches that use procedural and distributive justice mechanisms to modify aspects of the system; 4. Transformative: approaches that seek to radically overhaul the current system.		
[21]	Review of characteristics of the energy justice literature	Primarily distributional, recognition and procedural justice in some combination; also cosmopolitanism and others	Multiple, review paper	Multiple
[26]	Advocates applying the STS to public engagement in transformative system change	STS and environmental justice in general	Multiple	Multiple
[22]	Asks what the innovation, social practice and justice literatures have to say about energy transitions	Identifies the emphases ("fits and misfits") of each perspective with energy transition processes	Review paper: nuclear, wind, off-grid solar, shale	International

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