Spatially just low carbon transitions for a net zero future

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The candidate confirms that the work submitted is their own, except where work which has formed part of jointly authored publications has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated below. The candidate confirms that appropriate credit has been given within their thesis where reference has been made to the work of others.

Thesis structure

The thesis is written in the alternative format, including two peer-reviewed and published academic papers and one article under review. Each forms a central chapter in the thesis. In all cases Alice Garvey as lead author was responsible for the conceptualisation of the research, methodological design, data collection and analysis, visualisations, all stages of writing, and for revisions during the peer-review process. The supervisory team (Professor John Barrett, Professor Milena Büchs, and Dr Jonathan Norman) were co-authors on each article, and provided input in the form of guidance and feedback on the research design, draft manuscripts and during the peer-review process.

The chapters of the thesis have appeared as the following publications:[1]

- Chapter 2:
  Garvey, A., Norman, J.B., Büchs, M. and Barrett, J. 2022. A 'spatially just' transition? A critical review of regional equity in decarbonisation pathways. *Energy Research & Social Science*. **88**, p. 102630. https://doi.org/10.1016/j.erss.2022.102630.

- Chapter 3:
  Garvey, A., Büchs, M., Norman, J.B. and Barrett, J. Climate ambition and respective capabilities: Are England's local emissions targets spatially just? *Climate Policy*. https://doi.org/10.1080/14693062.2023.2208089.

- Chapter 4:
  Garvey, A., Büchs, M., Norman, J.B., and Barrett, J. 'How could it be our responsibility?' The equity of Local Authority climate action in England. [Submitted to *Local Environment* in June 2023, under review as of September 2023].

[1] Chapters present the journal papers as published, except for revisions to ensure a consistent referencing style, or where other minor formatting changes were needed to improve clarity.

Justification for alternative format

The following elaborates on why it was considered appropriate to publish the thesis via the alternative format route.

The peer review process means that the research must a) respond to and engage with the academic community and literature; b) directly address genuine research gaps. In an increasingly diverse and ever expanding research area, this ensures that the work makes a meaningful contribution to knowledge in this space. The format also means that three separate dimensions of the topic can be explored in depth and through diverse methodological approaches, united through an overarching narrative as set out in the introduction, discussion, and conclusion.

The alternative format route allows the research to be responsive to a changing policy environment and engage with relevant emerging issues. The first two years of the research were conducted during the COVID-19 pandemic, meaning many policy agendas beyond public health stalled, and policy developments have only recently regained momentum (for instance regarding Levelling Up).

Publishing the chapters as journal articles also means that research which is time-sensitive, or at least timely, can more readily be available to stakeholders and interested parties in a more accessible format. For instance, the second paper has been shared with interested stakeholders including the Climate Change Committee, and is the feature of a case study for the non-profit organisation Climate Emergency UK.[2]

[2] Nixon, M. 2023. Emissions reduction and regional inequality. 16 June. *mySociety*. [Online]. [Accessed 12 July 2023]. Available from: https://www.mysociety.org/2023/06/16/emissions-reduction-and-regional-inequality/.

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Finally my thanks to the participants of my research, to whom much of this work owes its existence, for bringing alive the reality of delivering net zero in the world outside academia. I hope that the work does justice to the great knowledge and experience of those I interviewed.

Abstract

The UK is the most regionally unequal of all developed countries, and the low carbon transition (LCT) risks introducing new, or exacerbating old, spatial inequalities. This research therefore applies spatial justice theory to explore issues of equity in the LCT, particularly considering the geographic gap in how the benefits and burdens of transition are distributed. This study first presents a theoretically novel 'semi-systematic' review, providing conceptual definition around the term spatial justice as it applies to LCTs. The review responds to an earlier research gap in the narrow focus on employment as the main regionally varied impact of transition, and instead applies a whole systems approach.

The research then operationalises the term 'spatial justice' in an evaluation of the equity of regional decarbonisation pathways in England. A methodologically novel scenario analysis of Local Authority (LA) net zero emissions targets in England (n=311) indicates significant regional variation in burden-sharing for mitigation. An accompanying composite indicator framework analysis provides a subnational application of the international equity principles of Common But Differentiated Responsibility and Respective Capabilities (CBDR-RC). This highlights the relationship between responsibility-taking and capability, how this varies between regions, and the associated implications for the justice of the LCT in the UK.

This regional variation in local government net zero targets informs the final piece of research. Empirically novel interview research with stakeholders (n=28) from across the English regions, sectors and levels of government, evaluates the equity of LA climate action, applying the framework of CBDR-RC to the local scale. The analysis explores the drivers of differential capabilities across LAs, the equity of a local statutory responsibility, as well as governance mechanisms that could reduce inequalities in capabilities between LAs.

The research concludes with a series of recommendations for embedding the principles of spatial justice into policymaking to achieve net zero.

Graphical abstract

Research questions	1. What could be considered a 'spatially just' low carbon transition (LCT)?	2. What are regional responsibilities and capabilities for decarbonisation in England?	3. What governance mechanisms can embed spatial justice into UK net zero policymaking?
Novelty	Conceptual	Methodological	Empirical
Journal article	A 'spatially just' transition? A critical review of regional equity in decarbonisation pathways	Climate ambition and respective capabilities: Are England's local emissions targets spatially just?	'How could it be our responsibility?' The equity of Local Authority climate action in England
Methods	Semi-systematic review Thematic analysis	Carbon budget analysis Composite indicator framework (responsibility vs. capability)	Stakeholder interviews Thematic analysis
Sample	**75** academic articles	**301** Local Authorities, **10** Combined Authorities	**28** stakeholders (across English regions, sectors, and levels of government)

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iii. Abbreviations

BEIS	Department for Business, Energy and Industrial Strategy
BNZP	Balanced Net Zero Pathway
CA	Combined Authority
CAQDAS	Computer Aided Qualitative Data Analysis Software
CBA	Community Benefit Agreement
CBDR-RC	Common But Differentiated Responsibility and Respective Capabilities
CCC	Climate Change Committee
CCUS	Carbon Capture, Utilisation and Storage
CED	Climate Emergency Declaration
CEE	Climate, Energy, Environmental
CEUK	Climate Emergency UK
Co-I	Composite Indicator
DA	Devolved Administration
DESNZ	Department for Energy Security and Net Zero
DLUHC	Department for Levelling Up, Housing and Communities
ETS	Emissions Trading System
EV	Electric Vehicle
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IMD	Index of Multiple Deprivation
LA	Local Authority

LCT	Low Carbon Transition
LEP	Local Enterprise Partnership
LGA	Local Government Association
LULUCF	Land Use, Land Use Change and Forestry
MCAs	Mayoral Combined Authority
MLG	Multi-Level Governance
MLP	Multi-Level Perspective
MRV	Monitoring, Reporting and Verification
NI	National Indicators
NUTS	Nomenclature of Territorial Units for Statistics
OECD	Organisation for Economic Co-operation and Development
PCAN	Place-based Climate Action Network
QDAS	Qualitative Data Analysis Software
SBTi	Science-Based Targets initiative
SR	Statutory Responsibility
SSN	Sustainable Scotland Network

1. Introduction

Space is not an empty void. It is always filled with politics, ideology, and other forces shaping our lives and challenging us to engage in struggles over geography

Soja, 2010, 'Seeking Spatial Justice'

Other countries have poor bits. Britain has a poor half

Economist, 2020

This thesis began in a pandemic and ended in an energy and cost of living crisis, both of which drew even firmer lines around the United Kingdom's (UK) regional inequalities. The UK remains the most regionally[3] unequal of all large developed countries (McCann, 2020). This inequality demands critical consideration in the context of meeting the UK's climate commitments. The UK's legislated target of achieving net zero greenhouse gas (GHG) emissions by 2050 (Climate Change Committee [CCC], 2020) poses both significant opportunities and opportunity costs to regional economies, threatening to introduce new or exacerbate old regional inequalities (While and Eadson, 2021). Variable policy powers combined with geophysical factors, natural resources, and differing socioeconomic contexts mean that there is no single 'panacea' suitable for national decarbonisation. This renders the low carbon transition (LCT) a fundamentally 'geographical process' (Bridge et al., 2013). The ability of decarbonisation to contribute to regional development has been suggested in recent discourse around a 'green recovery' from pandemic-induced economic instability, as well as the political agenda of 'Levelling Up' (IPPR North, 2020). However, there are questions of how spatially fair current policy frameworks are given their implicit allocation of responsibility for climate change mitigation to sites of industrial activity, which are regionally concentrated throughout the UK (Eder and Narodoslawsky, 1999; Martin and Rowthorn, 1986). In essence, the net zero agenda has the potential to reshape the landscape of UK regional inequalities for better or worse.

Many analyses of the LCT in the UK are polarised, considering either local case studies or undertaking national assessments. This is to be expected given the longstanding lack of a 'regional tier' or the 'missing middle' in the UK's subnational governance (Shaw and Greenhalgh, 2010). This also aligns with the highly centralised political system in the UK (Lockwood, 2021). There is considerable regional variation in the powers devolved to

[3] The term 'regional' is used throughout this thesis in varying contexts. The term is 'relative', that is, its definition may vary depending on the context it is used in. Following the approach of Armstrong and Taylor (2000, p. 1) I 'adopt a definition that is most appropriate at the time', though it is generally used to imply any jurisdiction at the subnational scale.

the Combined Authority (CA) level in England, and only partial devolution (Armstrong and Taylor, 2000) and 'constitutional asymmetry' between the Devolved Administrations (DAs) of Scotland, Wales, and Northern Ireland (Royles and McEwen, 2015). The majority of powers relating to net zero are held centrally, and much of the abatement potential required to reach a net zero consistent carbon budget lies within the remit of UK government (CCC, 2020). This creates scope for tensions between the approach of central and devolved governments to delivering net zero.

Though there is limited devolution of powers over net zero, there is still an implicit geography of responsibility and capability over mitigation at play in the UK. That is, different regions will have more or less capability to decarbonise, and different scales of emissions to address. As Sauter et al. (2016) note, *intra*national differences in the scale of carbon dioxide (CO_2) emissions can be greater than *inter*national differences. Furthermore, some regional economies are bigger than national economies (Armstrong and Taylor, 2000). There is therefore a key gap in applying the typically international concept of Common But Differentiated Responsibilities and Respective Capabilities (CBDR-RC; Pauw et al., 2019) to the subnational level to explore the equity implications of the LCT in the UK from a critical spatial perspective. I utilise the theoretical frameworks of 'spatial justice' and subnational CBDR-RC to identify how the geographical gap between those who win and lose from the LCT can be minimised.

1.1. Rationale for the research

1.1.1. Responding to research gaps

The research aims to respond to several critical research gaps in both the academic literature and the policy space surrounding the UK's LCT.

1.1.1.1. Gap 1: Aspatiality and scalar 'traps'

Firstly, there has been broad criticism of the 'aspatiality' of previous studies of the LCT (Balta-Ozkan et al., 2015; Bouzarovski and Simcock, 2017), and calls for further research take an explicitly 'spatial' perspective (Sovacool et al., 2017). The current research aims to address this by applying a spatial lens to the LCT. Though the 'place-based' agenda in sustainability studies goes some way to correct this 'aspatiality', there is still a prevailing focus on certain scales of assessment, namely the national (Gibbs and O'Neill, 2017) and local scales. Indeed, the 'local trap' – the assumption that the local scale is

more ‘virtuous’ has been widely critiqued (Barnett, 2020). In the present work, a cross-scalar approach is taken, to highlight the merits and demerits of how the transition plays out at different scales. Chapter 2 takes a broadly ‘subnational’ perspective, Chapter 3 explores local-regional dynamics, and Chapter 4 evaluates the equity of local involvement in the delivery of net zero. The research particularly builds on the work of Bouzarovski and Simcock (2017) in their review of the spatial aspects of energy justice and use of the term ‘spatial justice’ in this context. It similarly draws on the work of Kythreotis et al. (2023) in the ‘cross-sectional’ use of scale; that is, the interactions between different scales of governance of net zero are explored. For instance, the interview research explores stakeholder insights on local government climate action from both within and without councils, to include divergent perspectives on the local role in net zero. The research is also informed by the work of Hsu et al. (2017) in their conceptual framework of vertical and horizontal coordination, which highlights that the interactions between scales are as important as the discrete work of a particular scale.

1.1.1.2. Gap 2: Spatial biases

As well as the cross-sectional use of scale, the current research corrects a gap in the cross-sectional consideration of space. Much empirical research on the UK has taken place in one case study location (for instance a single city such as London, see Howarth et al., 2021) rather than comparing perspectives from different regions of the UK. This research, particularly in the case of the interview analysis, therefore takes a comparative approach, and the sample of stakeholders represents a reasonable cross-section of different regions within England.

In addition, in the literature on subnational climate action there is typically a bias towards urban areas (Bulkeley and Betsill, 2005; Castán Broto et al., 2019; Grafakos et al., 2020; Reckien et al., 2018; Russell and Christie, 2021; Salvia et al., 2021). This is manifest in several studies of local net zero targets which focus on the climate commitments of cities (Grafakos et al., 2020; Howarth et al., 2022 [preprint]; Reckien et al., 2018). Though a preprint analysis of the cumulative impact of local net zero targets was recently published (Howarth et al., 2022 [preprint]), the methodological disparities mean that this does not preclude the value of the target analysis in the current research. For instance, the preprint analysis only considers the commitments of urban areas, and does not comprehensively interrogate regional variation in ambition as a result. Many hard-to-decarbonise areas lie outside city regions, in rural areas with poor public transport connections, and in peripheral towns. Purely urban policy can be ineffective if the aim is

to address the most disadvantaged areas, many of which are rural or former coal mining towns (Armstrong and Taylor, 2000). The opportunities of 'elite world cities' (Pearce and Cooper, 2013) are markedly different to those of post-industrial towns. To reach the UK's net zero commitments, action is required in all regions, regardless of the urban-rural dichotomy (Evans, 2020). In this research, local areas are not disaggregated by land use type, to ensure a more comprehensive, representative, and therefore *just* approach.

1.1.1.3. Gap 3: Sectoral biases

A further research gap exists in the focus on one particular aspect of just transitions in the existing academic literature, rather than taking a whole systems perspective (Martiskainen et al., 2021). Many studies focus on a certain sector (for instance the oil and gas industry), or on a particular socioeconomic issue (for example energy poverty). A whole systems approach has the potential to account for overlapping vulnerabilities to transition processes, for example in Robinson and Mattioli's (2020) work on 'double energy vulnerability' from combined transport and energy poverty. Considering particular issue areas in siloes means that the interactions between different impacts are overlooked, and some socioeconomic groups, communities or regions are likely to face multiple burdens resulting from the LCT. This research therefore adopts a whole systems perspective, where the subnational focus means that the spatial perspective is prioritised over detailed consideration of any one sector or impact resulting from the LCT.

1.1.1.4. Gap 4: Raising more questions than answers

A final critique of the existing literature is that it is often more problem than solution-oriented. That is, it identifies injustices more often than it proposes ways to make policy more just. The current work attempts to correct this by presenting recommendations for policy and governance at the end of each piece of research. Chapter 2 presents general (and internationally transferable) mechanisms for ensuring that the benefits and burdens of the LCT are equitably distributed across space. Chapter 3 identifies how local action on net zero in England could be supported and regional differences in capability levelled out. Chapter 4 evaluates perspectives from stakeholders on a selection of mechanisms which would embed equity in the governance of net zero. Finally, Chapter 5 presents an overarching set of policy recommendations, drawing on and integrating the preceding pieces of research.

1.1.2. A case study of the UK

There are three main reasons for the selection of the UK as a case study in this research.[4] The first is that spatial justice as a theoretical framework has rarely been applied to a UK context, let alone in terms of its bearing on the LCT. The term spatial justice has been most notably applied to Soja's (2010) case study of Los Angeles' public transit system; though this case had implications for environmental quality, the main framing was one of social justice. The second is that the UK presents a singular case in terms of subnational governance, representing a highly centralised state with a distinct 'regional problem' (Massey, 1986). Historically, this has never been satisfactorily resolved (Shaw and Greenhalgh, 2010). This presents an interesting case study in terms of how the UK will address the governance of net zero, given the ongoing lack of a clear 'cascade' of responsibilities for net zero to the subnational level (Marsden et al., 2014). Similarly, the UK presents a unique challenge in the degree of its regional inequalities; there would be less imperative to consider questions of spatial justice if regions were more equal.

The singularity of UK subnational governance could be considered a limitation on the transferability of insights from the research. However, whilst the empirical insights from the research are perhaps most relevant to the UK, the theoretical insights into the subnational governance of net zero and the concept of a spatially just transition offer more potential for international application. Similarly, the methodological approaches employed in the research could readily be applied to other country contexts, or, more valuably, in comparative analyses. The third reason for choosing a UK case study is a pragmatic one, in my pre-existing knowledge of the country and familiarity with its policymaking environment, which provides insight into the challenges and realities of implementing net zero 'on the ground'.

1.1.3. The contributions of the research

Sovacool et al. (2018) suggest that research should attempt to be novel in at least one of the following three ways: theoretically, methodologically, or empirically. This thesis aims to make contributions along each dimension of novelty:

[4] Though methodologically speaking the focus and samples of the work in Chapters 3 and 4 are on England, the climate policy framework for England is generally the same as that for the UK.

- The first paper presents *theoretical* novelty by applying 'spatial justice' theory to the case of the LCT. The term has not previously been systematically explored, resulting in its lack of use (see Section 1.3.1.1). This research also presented methodological novelty in using a 'semi-systematic' review technique (outlined further in Section 1.4.1).
- The second paper presents *methodological* novelty in developing a quantitative composite indicator to track normative, ethical concepts such as responsibility and capability (see Section 1.4.2). The novelty here consists of using more diverse metrics, beyond those based on income, to track relative inequalities (Agbim et al., 2020).
- The final output introduces *empirical* novelty, by collating a large number of stakeholder perspectives representing the majority of the English regions and levels of government. This piece of research brings to life the realities of delivering net zero from the perspectives of practitioners. The choice of a comparative approach, considering stakeholders from across different regions and scales, means that the work synthesises insights beyond a single case study site. This generates a novel empirical evidence base to inform current policy debates.

The following sections of the introduction discuss the research design, including the aims, objectives and research questions of the project, and the structure of the research and interlinkages between chapters. This is followed by reflections on interdisciplinarity, research philosophy and positionality in the study. An overview of the literature is then presented, before the discussion and justification of the research methods employed. The structure of the thesis to follow is then signposted.

1.2. Research design

1.2.1. Aims, objectives and research questions

The overarching aim of this research is to explore the value of 'spatially just transitions' as a conceptual framework to improve the fairness of the UK's low carbon transition. The research is structured by the following three research questions:

1. What could be considered a 'spatially just' low carbon transition (LCT)?
2. What are regional responsibilities and capabilities for decarbonisation in England?

3. What governance mechanisms can embed spatial justice into UK net zero policymaking?

Table 1. Summary of research design.

Research Question	**Objective**	**Methods**	**Outputs**
1. What could be considered a 'spatially just' low carbon transition (LCT)?	a. To construct a conceptual framework of 'spatial justice' in the context of the LCT, by synthesising interdisciplinary literature in this area.	Semi-systematic literature review, thematic coding of academic articles (n=75)	A 'spatially just' transition? A critical review of regional equity in decarbonisation pathways (Garvey et al., 2022)
2. What are regional responsibilities and capabilities for decarbonisation in England?	b. To quantitatively assess the relative ambition and capability of LA net zero targets in England, through a combined carbon accounting and novel composite indicator approach.	Quantitative carbon accounting/scenario analysis of 311 LA net zero targets; development of a composite indicator framework including indicators for ambition/responsibility-taking and capability	Climate ambition and respective capabilities: Are England's local emissions targets spatially just? (Garvey et al., 2023)
3. What governance mechanisms can embed spatial justice into UK net zero policymaking?	c. To qualitatively assess the equity of LA climate action through a comprehensive range of stakeholder interviews.	Semi-structured stakeholder interviews (n=28)	'How could it be our responsibility?' The equity of Local Authority climate action in England (Submitted to *Local Environment* in June 2023)

Underpinning this, the objectives of the research were:

a. To construct a conceptual framework of 'spatial justice' in the context of the LCT, by synthesising interdisciplinary literature in this area.
b. To quantitatively assess the relative ambition and capability of Local Authority (LA) net zero targets in England, through a combined carbon accounting and novel composite indicator approach.

c. To qualitatively assess the equity of LA climate action through a comprehensive range of stakeholder interviews.
d. To draw out a series of policy principles and recommendations on how the UK's LCT can be rendered 'spatially just'.

Table 1 highlights the structure of the research, linking the research questions, objectives, methods and outputs. Objective (d) is discussed in the final chapter of the thesis (Chapter 5).

1.2.2. Research structure

A challenge of an alternative format approach is providing insights into the field of inquiry which are greater than the sum of their parts, and in integrating three pieces of research. However, the research was undertaken iteratively, that is, each piece of research fed into and informed the next, as highlighted in the following.

The review paper highlighted a growing tendency in the literature of using indicator frameworks to quantify dimensions of justice, in order to track the relative justice of policies for instance (see Füssel, 2010). It also suggested that such assessments necessarily tended to be *ex ante* or *ex post*, that is, static evaluations of planned or implemented policies, not the very process of transition itself. Similarly these assessments rarely evaluated the complex concept of 'capability', usually focussing on income-based metrics of relative inequality (Agbim et al., 2020). As Sen (2000, p. 108) notes, '[p]olicy debates have […] been distorted by over-emphasis on income poverty and income inequality, to the neglect of deprivations that relate to other variables'. A focus on unemployment has also been characteristic of approaches to regional development and policy (Armstrong and Taylor, 2000). This informed the focus in the present work on holistic indicators of relative equity, and how they can be used to evaluate ongoing processes of transition.

Distributional assessments commonly used in studies of equity typically focus on the outcomes of policies for consumers, rather than for the institutions involved in the delivery of transition processes. As Sandel (2010, p. 207) notes, '[d]ebates about justice and rights are often, unavoidably, debates about the purpose of social institutions, the goods they allocate, and the virtues they honor [sic] and reward'. There is arguably cause to consider the role and justice of institutions rather than individuals for this reason. To correct this prior gap, the analysis of net zero targets in England involved developing an

experimental composite indicator framework to track the capability of local institutions to deliver climate mitigation.

Similarly, the disparities in regional capabilities to decarbonise highlighted in the target analysis informed the design of the interview protocol for the final, qualitative piece of stakeholder research. Participants were asked how the capabilities of LAs could be improved and about the mechanisms that could achieve this. Policy and governance approaches which could embed spatial justice principles were identified in the review paper; in the stakeholder interviews some of these approaches were tested and evaluated with participants.

Figure 1 outlines the research questions underlying each chapter, and the linkages with the other analyses.

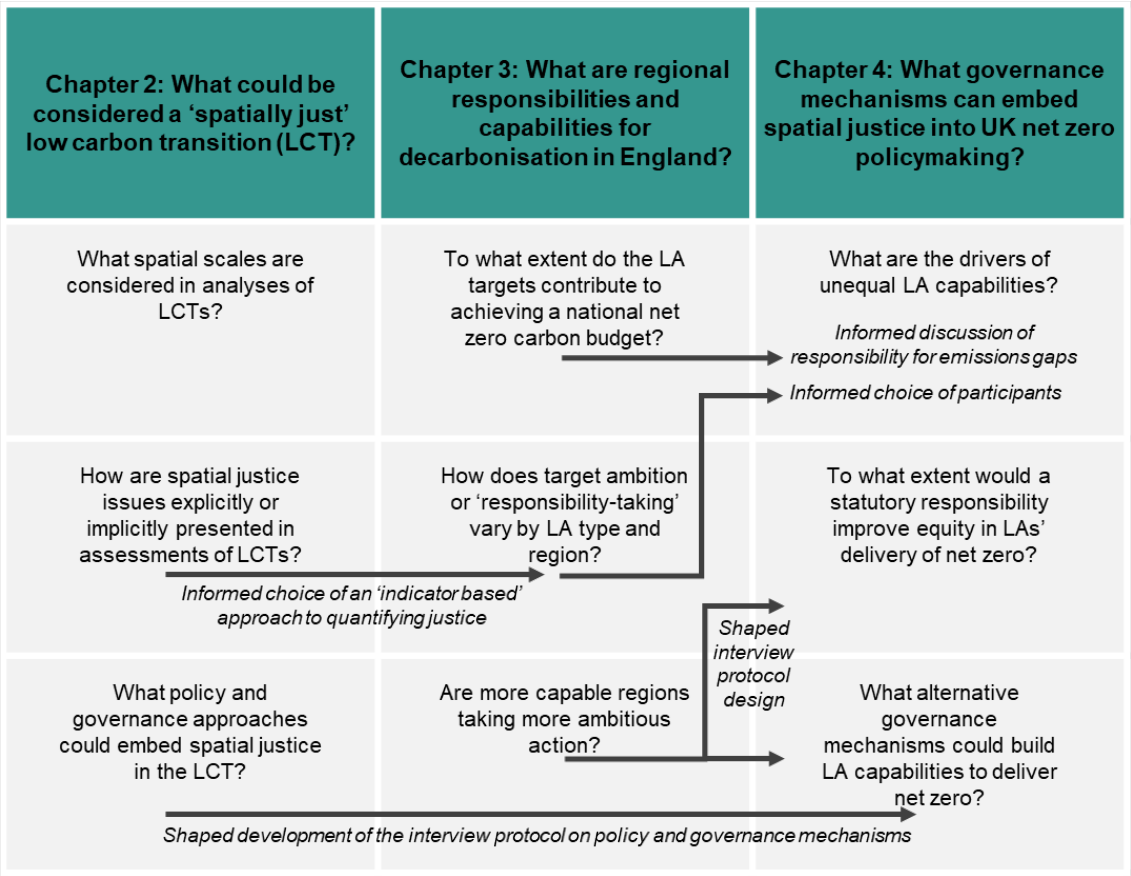

Figure 1. Linkages between the three pieces of research.

1.2.3. Interdisciplinarity in the research

The review paper highlighted the interdisciplinary nature of research in this field, sitting as it does at a nexus of spatial, sustainability and justice studies. This tripartite framing

of the research made it necessary to bring in different disciplinary perspectives. As Stock and Burton (2011) note:

> [o]ur contemporary social and ecological problems, including climate change […] necessitate solutions informed by multiple backgrounds that singular disciplines seem unable to provide.

The use of the terms multidisciplinarity, interdisciplinarity, and transdisciplinarity is popular and ever increasing in the academic literature, though often with little common understanding or shared definition (Stock and Burton, 2011; von Wehrden et al., 2019). The terms are generally considered to sit on a hierarchical scale of more or less integrated research, with multidisciplinarity representing the least, and transdisciplinarity the most integrated approach to bringing together different academic disciplines. As Stock and Burton (2011) define:

1. *Multi*disciplinarity has been defined as presenting knowledge which 'co-exists' across disciplines, rather than generating 'new' knowledge from the constituent disciplines;
2. *Inter*disciplinarity is defined by its problem-oriented focus, and attempt to generate new knowledge, and can involve evaluating 'existing accumulated knowledge from the perspective of a neighboring [sic] discipline';
3. *Inter-* becomes *trans*-disciplinarity when the level of integration of different disciplines increases, and the methods of achieving this integration become more 'cooperative', encouraging participatory methods, and the inclusion of non-academic participants in the research process.

Under such definitions this research could be considered interdisciplinary, as it takes a problem-oriented and integrated approach to synthesising knowledge from across disciplines. It goes beyond a simply multidisciplinary approach in its level of integration, but perhaps does not conform to definitions of transdisciplinary research which can require participatory inclusion of non-academic stakeholders in the research *design* process. A particular area of interdisciplinarity is in addressing the question of social versus spatial dimensions of injustice (Harvey, 1973), as discussed later in this chapter (Section 1.3.1.1).

The review of spatial justice in the LCT identified that the majority of literature in this area could be considered to fall within the disciplines of 'geography' and 'environmental studies' (24% respectively). Policy science, energy studies, social studies, economics and regional studies were also key contributors (more detail can be found in Section 6.1).

Disciplines are loosely defined, but generally indicate the disciplinary boundaries which needed to be crossed. This project draws on the fields of critical geography, regional studies, moral and political philosophy, as well as sustainability research more broadly. Interpretations of different disciplines and how they have been applied in this research are outlined below.

1.2.3.1. Critical geography

Since the term 'spatial justice' originates in the field of critical geography, the discipline was a key reference point. Critical geography is described as '[t]heoretically informed geographical scholarship, committed to Leftist politics, social justice and liberation through scholarly enquiry' (Gregory et al., 2009, p. 123). Definitions of, and approaches to, critical geography differ, with even David Harvey (a leading critical geographer) commenting:

> [w]hen recently asked to comment on the state of critical geography today, I answered that I thought the movement […] was having difficulties articulating any collective vision of exactly what to be critical of (apart, that is, from other geographers) (Harvey, 2006).

A common theme is the 'particular attention to the ways in which spatial arrangements […] can serve to produce inequality' (Harvey, 2006). Critical geography, as expressed in Harvey's work, tends to circulate around critique of the 'geographies of capitalism' (Rawding, 2016). As Soja (2010, p. 87) notes, spatial justice is typically critiqued by Marxist critical geographers, since for Marx 'distributive justice was essentially a diversion from the main problems of capitalist society […] all inequitable and unjust distributions are produced by capitalism itself'.

Critical geography is also noted for its radical action research framing, where 'critical geographies seek not only to interpret the world, but also to change it through the melding of theory and political action' (Blomley, 2008). Soja (2010, p. 192) more broadly defines *critical* theory as aiming to 'producing knowledge and understanding that have the potential to change the world for the better.' This problem-oriented focus is a unifying trait of research in this field, and its application in this study therefore addresses the fourth research gap as earlier identified.

The current research can be said to adopt a critical geographical approach through use of the concept of spatial justice, which questions the systemic nature of how socioeconomic advantage and disadvantage is distributed across space. Though the

present analysis does not claim to evaluate systems of capital and how these affect the delivery of spatially just transitions, nor take an explicitly political stance, the work offers a theoretically informed critique of the way in which the UK's LCT is unfolding.

1.2.3.2. Moral and political philosophy

Another way in which the critique is theoretically informed, is through reference to the fields of moral and political philosophy. Moral philosophy is a branch of philosophy dealing with ethics, and theorising what could be considered morally right and wrong behaviour. Political philosophy involves '[r]eflection on the nature of human community and government, and relations between the collective and the individual' (Blackburn, 2016). Moral and political philosophical theory is therefore expressed particularly in the discussion of responsibilities, capabilities, justice, and equity. In the context of the LCT, this concerns who is expected to act, and the ethical implications of this.

1.2.3.3. Regional studies

Another discipline which informs the current research is 'regional studies'. There is much debate over the definition of what constitutes a 'region' (from a 'world region' right down to a 'city region'). However, regional studies as a field is differentiated by its use of the 'region' as the spatial unit of analysis and its exploration of specifically subnational issues. Donald and Gray (2019) suggest that the regional studies literature can be 'divorced from the broader economic, social and ecological context' with a technocratic focus on a 'rather prescriptive narrative of growth imperatives'. Similarly Gibbs and O'Neill (2017) identify that the environmental agenda has not hitherto had a large presence in regional studies research, but point towards an emerging literature otherwise termed the 'geography of sustainability transitions' (Truffer and Coenen, 2012). Insights are utilised from the field of regional studies to bolster the subnational perspective taken within this research.

1.2.3.4. Sustainability studies

Though difficult to characterise, sustainability studies or research on the LCT quite broadly provide an integrating framework for insights from the above three disciplines. Research in this loosely defined 'field' can range from quantitative carbon accounting analyses, to social scientific and sociological research.

Though my approach is primarily based in sustainability studies, I aim to incorporate insight from the above mentioned disciplines and fields to explore the three interlinked dimensions of a) spatial factors and inequalities; b) the LCT; c) and justice issues.

1.2.4. Research philosophy and positionality

The research paradigm throughout the analysis could be defined as 'social constructivist'. That is, throughout the work, the knowledge synthesised or produced is not value-neutral, and is built from the bottom-up (Ormston et al., 2003). A social constructivist perspective makes consideration of positionality even more important, given the primacy afforded to the way in which meaning is socially constructed, and therefore how the position of the researcher can shape the construction of shared meaning. Positionality is 'the disclosure of how an author's racial, gender, class, or other self-identifications, experiences, and privileges influence research methods' (Massoud, 2022).

Personally, coming from an industrial city, an appreciation of the existential threat to the UK's industrial areas is a thread throughout the three papers. As Martin and Rowthorn (1991, p. xvii) note, 'the phenomenon of de-industrialisation manifestly has not occurred in a social or spatial vacuum'. They also play a pivotal role within the current agendas of both Levelling Up and net zero. It is worth recognising that my background cannot have helped but play a key role in motivating this line of inquiry. However, in addition to motivating the research, this positionality required care not to 'cherry-pick' narratives of North versus South, particularly in the framing of interview questions. Though Northern regions typically rank poorly on a number of quality of life metrics (IPPR North, 2020), this can be a simplification of regional inequalities. Moreover, 'the North' is a contentious geography to define. It is critical to recognise that inequalities can be the product of the metrics used to measure them. Therefore, throughout the project, care has been taken to avoid bias and to ensure that the identified trends are rooted in data.

It would also be remiss in a thesis about *spatial* justice not to consider the limitations of the geographical scope of the inquiry. As noted in the review of spatial justice, the exclusion criteria meant that only articles written in English were reviewed, for pragmatic reasons. However, as noted in the review, this linguistic bias translates to a geographical bias in the case study areas highlighted. Though out of scope for the current research, future work could valuably explore the issue of 'spatially just low carbon transitions' in other country contexts.

1.3. Context

This literature review is intended to provide an overview of the research in this space, but the reviews of the literature presented in each chapter necessarily provide a fuller exploration of issues relevant to each piece of research. Similarly, given the research takes a deliberately interdisciplinary approach, there are limits to the amount of attention that can be given to each discipline. The conceptual framing of the research is first outlined, with discussion of the just transitions literature, and the background to spatial justice theory, with detail on its relevance to the LCT. The review then provides background on the particular case of the UK's LCT and how it is playing out across different scales of governance and government. The review therefore provides both academic and policy context for the current research. The intersections of the net zero and regional development agendas are then discussed, with attention to the political dimensions of these issues.

1.3.1. Just transitions

In the following, I consider the literature on justice and just transitions more broadly, highlighting how it is an increasingly 'spatialized' perspective. 'Just transition' is the principle of ensuring inclusion in the move to a low carbon society, so that it occurs without 'leaving anyone behind'. It began in the North American trade union movement, but is now increasingly formalised through policy, for instance the Scottish Just Transitions Commission (Scottish Government, 2020) and the EU's Just Transition Mechanism (European Commission, 2023). The term is characterised by its 'labour-oriented' approach (Wang and Lo, 2021), and is typically applied to workers in fossil fuel industries that face uncertain future unemployment through the effects of climate policy.

Other permutations of 'justice' relating to the sustainability agenda include 'Climate, Energy, and Environmental' justice, together sometimes known as the CEE framework of justice (McCauley and Heffron, 2018). The environmental justice movement is the precursor of these, originating in the 1980s at a time of growing environmental consciousness. It particularly addressed issues of environmental waste disposal in the United States, where it disproportionately affected (and continues to affect) African-American citizens (Soja, 2010). Climate justice is a more recent term, emerging in the 1990s, and at its heart addresses the paradox of those least responsible for contributing to climate change being most affected by it. It is increasingly a focal point in international climate negotiations, for instance most recently in developments in establishing a

compensatory ‘Loss and Damage Mechanism’.[5] At the global scale, under climate justice principles there is also growing interest in the cross-scalar ways in which injustice can occur, with increasing research around ‘embodied justice’ (Healy et al., 2019). This recognises the impacts resulting from the global supply chains of goods and services, and how the site of consumption is often spatially (and environmentally) detached from the site of production.

The term energy justice is more recent still, and sets out an agenda for tackling inequities in how able people are to participate in systems of energy supply and demand. Jenkins argues that there is value in ‘energy justice’ as a discrete focus, in drawing more close attention to issues specific to the energy system (Jenkins, 2018). Arguably, any refining of the umbrella term ‘justice’ is useful in narrowing its scope and ensuring it is more likely to be applied in practice.

Though with varying emphases, any conceptualisation of justice is typically underpinned by the three core ‘tenets’ of distribution, procedure, and recognition, as advanced by McCauley et al. (2013). Distributional justice considers the way in which (environmental) goods or ills are spread across society and/or space. An example would be the way in which some local areas or communities are more affected by the siting of industrial activity than others, and suffer the attendant health risks from this. Procedural justice considers any inequities in how able certain groups are to participate in decision-making processes; a case in the context of the LCT would be in decisions over the local siting of a wind farm for instance (Simcock, 2016). Recognition justice is where there is acknowledgement of the way in which the culture, identity, history and power dynamic of a given social group or area shape what would be a locally appropriate development. An example would be in ensuring members of particular social groups or communities are appropriately represented in decision-making or deliberative processes around the siting of the wind farm.

In recent years there has been a growing scholarship which critiques the ‘three tenet’ or ‘triumvirate’ approach to justice as outlined above (Wood, 2023), and argues for the inclusion of cosmopolitan and restorative justice. Originating in the field of criminal justice studies, restorative justice considers the need for an offender to be responsible for repairing the harm against a victim (Hazrati and Heffron, 2021). The term has most notably been extended to cases of environmental harm, often from heavy industrial

[5] The 27th Conference of the Parties (COP27; a United Nations Climate Change Conference) reached an agreement to establish ‘“loss and damage” funding for vulnerable countries hit hard by climate disasters’ (United Nations Framework Convention on Climate Change, 2022).

pollution (McCauley and Heffron, 2018), but has – more conceptually - been proposed as a means of ensuring intergenerational justice for the impacts of climate change (Hazrati and Heffron, 2021). McCauley and Heffron (2018) suggest that restorative justice becomes a new third tenet, encompassing but displacing recognition justice. Cosmopolitan justice is a multi-scalar concept that considers the 'collective morality and responsibility for others that goes beyond borders', and argues for a conceptualisation of justice that focusses on individuals rather than discrete 'communities or nations' (Sovacool et al., 2019), The most common environmental applications of cosmopolitan justice include evaluating the impact of global manufacturing supply chains and waste (Sovacool et al., 2019), as well as individual contributions and responsibility for global climate change impacts.

Both restorative and cosmopolitan justice have relevance to issues of spatial and temporal justice. In spatial terms, restorative justice could be utilised to repair harm to specific regions, whilst cosmopolitan justice could argue for multi-scalar responsibility (for instance as elaborated in the 'embodied justice' debate). From a temporal perspective, restorative justice considers how to ensure fair outcomes across generations (for instance through 'proxy' organisations to represent the rights of future generations; Hazrati and Heffron, 2021). Cosmopolitan justice also has a strong temporal dimension in considering the rights of future generations as well as the legacy of historic responsibility that informs international debate around CBDR-RC. Distributional justice (across space) is the main way in which spatial factors typically figure in assessments of justice, but there are clear applications of the other 'tenets' of justice to spatial analyses. Procedural justice has a spatial component in that different democratic institutions may be in place in different areas, and certain communities may have less experience of engaging with decision-making processes. Similarly, recognition justice should acknowledge the role of regional identity in shaping the relative acceptability and desire for different transition pathways. This links to Sen's idea of the importance of 'relative justice', that comparison to other communities 'similarly placed' can be more powerful than absolute differences between them (Sen, 2000). As noted in previous sections, the equity principles of responsibility and capability sit within the concept of distributional justice, as a means of operationalising it.

Restorative justice has relevance to the current research, for instance in considering the legacy of local pollution from heavy industry that weighs in against any economic benefit from local jobs. It could also be applied to argue that organisations or other actors causing job losses due to the LCT should replace those jobs with an appropriate

substitute (McCauley and Heffron, 2018). Cosmopolitan justice has application in considering how regions of the UK have different global impacts through their consumption and associated emissions (as elaborated in Section 1.3.3.2).

Though restorative and cosmopolitan justice have clear relevance to the current analysis, in the interests of narrowing the scope of the inquiry to effectively concentrate on more directly spatial factors, my main focus is on the 'three tenets' approach. There is also a relatively greater body of literature to draw on from within the triumvirate approach. Similarly, in the following analysis there is necessarily more emphasis on distributional dimensions of spatial justice (particularly in Chapters 3 and 4), but with reference to procedural and recognition justice throughout (and especially in Chapter 2). This approach was taken in part due to the constraints of researching justice issues, in which there is a risk of scope creep but also practical challenges in collecting empirical evidence around very ethical issues. As noted, distributional issues are often the most 'visible' spatial forms of injustice. The 'spatial turn' (particularly in energy research) since the 2000s has been well documented (Bridge, 2018), and accordingly spatial perspectives on various aspects of environmental justice are viewed as increasingly important (Sovacool et al., 2017) as it becomes ever more apparent that transitions are unfolding unevenly across space. These emerging aspects of justice research are integrated in the application of spatial justice theory to the LCT, terming this approach 'spatially just transitions'.

1.3.1.1. 'Spatial justice': More theory than practice?

Spatial justice is a concept derived from the field of critical geography, and despite the emphasis in this discipline on action research, it is has been little utilised, perhaps because it is little understood. Spatial justice in its simplest sense refers to exploring issues of justice from a spatial perspective, assessing the role of space as a driver of systemic social inequalities. It is an extension of traditional social justice theory, but does not mean to supplant it, as noted by Edward Soja (2000, p. 352):

> I do not mean to substitute spatial justice for the more familiar notion of social justice, but rather to bring out more clearly the potentially powerful yet often obscured spatiality of all aspects of social life and to open up in this spatialized sociality (and historicality) more effective ways to change the world for the better through spatially conscious practices and politics.

Soja is the most notable recent theorist of spatial justice, and it is perhaps useful to adopt his definition of the term as representing 'a particular emphasis and interpretive

perspective' rather than a 'substitute or alternative to other forms of justice' (Soja, 2010, p. 13). As such, spatial justice draws on theory from the field of social justice, namely the work of the moral and political philosopher John Rawls, as well as geographers such as David Harvey (Bridge et al., 2013). As Morgan (2008, p.160) notes, '[a]lthough there is no single theoretical definition […] it seems difficult to disagree with Harvey's re-statement of Rawlsian theory as "a just distribution justly achieved"'.

The term has its original expression in the form of 'territorial justice', as coined by Harvey in his 1973 work *Social Justice and the City*. In this, Harvey identifies that he is uniting the often divided geographical and sociological imaginations (Harvey, 1973). This marks at once the key strength and contention in the term; that is, the debate over whether space is a driver of social inequality, or simply a descriptor of it. This is discussed in more detail in Chapter 2.

Soja's (2010) *Seeking Spatial Justice* has triangulated the question of spatial justice with contemporary debate on environmental justice, and aligns with a corresponding growth in the literature on spatial justice since the 2000s. The question is particularly foregrounded in Bouzarovski and Simcock (2017). Whilst the term has typically been affiliated with a liberal political stance, and its roots are arguably in radical political thought, this has not prevented its uptake in formal policymaking environments. For instance, the term is used in the EU's territorial cohesion policy, its approach to reducing regional inequalities across member states (Madanipour et al., 2022). In this way, the term can be seen as relatively fluid, being repurposed for various philosophical, political and policy ends.

In this project I therefore take forward the approach outlined by Soja and others in using 'spatial justice' as a critical analytical perspective through which to assess the socio-spatial changes emerging and likely to emerge as part of the UK's LCT. There is critical value in this as there are few studies applying the term to the case of the LCT.

1.3.1.2. Spatially just transitions: Operationalising spatial justice theory

This research aims to unite both the just transitions perspective with spatial justice theory, to evaluate whether the spatial distribution of benefits and burdens resulting from the LCT in the UK will be 'fair'. I explore the impacts from an institutional perspective rather than focussing on the effects on one given sector; that is, will certain regions

(broadly defined) be burdened more than others. Typical factors which could vary spatially include:

- Relative capabilities to decarbonise;
- Opportunities from new technologies and green sectors;
- Opportunity costs from having to decarbonise heavy industry;
- Impacts of industrial decarbonisation on regional economies;
- How evenly low-carbon infrastructure, investments and policy costs are distributed.

Rather than focussing on specific sectoral benefits or burdens, a whole systems perspective is employed (Bednar et al., 2017; Bouzarovski and Simcock, 2017; Olner et al., 2020; Sareen and Haarstad, 2018; Sovacool et al., 2019; Wells, 2012). This explores where the general burden for mitigation falls and whether this can be considered a 'just distribution' given regional responsibilities and capabilities.

The main focus is on distributional justice, but there will necessarily be consideration of procedural justice in terms of the capability of different actors in different regions to participate in LCT decision-making. There will also be reference to recognition justice in terms of identifying the capability of communities and regions to transition, and acknowledging that different decarbonisation pathways will be more or less acceptable. Similarly, the main focus is on climate change mitigation rather than adaptation. In the case of adaptation, another equity principle of 'vulnerability' to climate impacts may also be appropriate (Füssel, 2010); that is, areas more likely to be disproportionately impacted by climate impacts should be prioritised in terms of improving their resilience through adaptation measures. Though there is widespread recognition of the critical importance of adaptation alongside mitigation, in a UK context there is typically less available data or evidence on implementation on adaptation at the local and subnational scales (Grafakos et al., 2020). I therefore selectively focus on subnational *mitigation* in order to more fully draw out the justice implications, though the equity implications of subnational adaptation plans could be a valuable area for future research. Figure 2 provides an illustrative (and by no means exhaustive) breakdown of the dimensions of justice, highlighting those that are being explored in this research in order to outline the boundaries of the analysis.

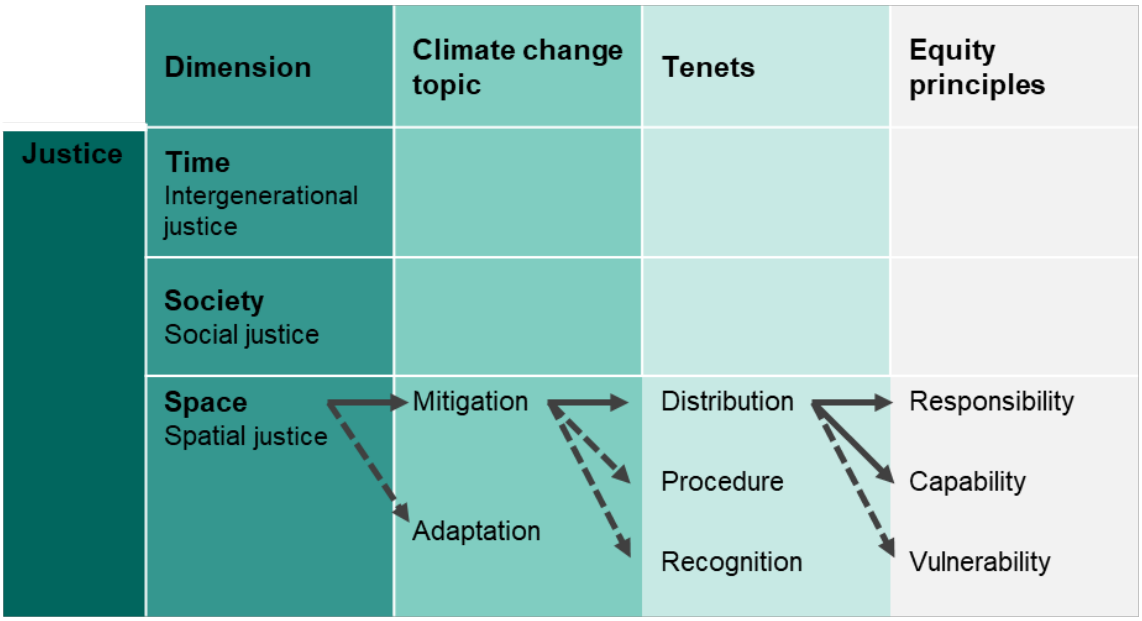

Figure 2. Overview of the various dimensions of justice, and the analytic focus of the current research (dashed lines indicate areas that were of interest, but not in the main scope of the analysis).

Perhaps the outstanding challenge is in the translation of the loosely defined concept of a 'spatially just transition' into an understanding of how this can be applied. Soja (2010) is a notable exception in applying the term to a practical case study, albeit qualitatively. The application of spatial justice to the question of LAs and how equitably they operate, harks back to the very origins of the term spatial or 'territorial' justice. Bleddyn Davies' first introduced the term spatial or 'territorial justice' in his 1968 *Social Needs and Resources in Local Services: A Study in variations in Provision of Social Services between Local Authority Areas* (Soja, 2010). This commented on the need to deliver services according to social need rather than based on simplistic measures such as population size.

The challenges of building a *quantitative* understanding of the spatial justice of the UK's LCT can be categorised under 4 themes: 1) choosing metrics; 2) choosing the scale; 3) data availability; 4) inequality vs inequity (vs injustice).

Firstly, as a normative, ethical, and generally ill-defined concept, it is hard to assign quantitative metrics or indicators to track spatial justice directly. This is why in the second piece of research (Chapter 3), proxy indicators are used for the equity principles of responsibility and capability. This leads onto the second issue, which is of choosing the appropriate spatial scale or unit of analysis. The choice of scale will determine the relative patterns of inequalities found; too small a unit of analysis and inequalities of a

greater order will be missed in peripheral areas, and too large a unit will disguise intraregional inequalities. As Nussbaum (2011) has critiqued, a prevailing focus on national metrics such as Gross Domestic Product (GDP) has historically obscured intranational inequalities. Aggregation to higher order scales can disguise inequalities occurring at lower levels, in what is known as the 'modifiable areal unit problem' (Bouzarovski and Simcock, 2017). As Harvey (1973, p. 99) notes 'a just distribution across a set of territories defined at one scale does not necessarily mean a just distribution achieved at another scale or a just distribution among individuals'. There are also issues of conflicting definitions of a 'region', where administrative, economic and cultural geographies may not align, and may be of various relevance to the research problem. Drawing boundaries can in itself constitute an 'unjust' process, as in the case of gerrymandering in the United States (Harvey, 1973). As Schafran et al. (2020, p. 59) note, 'system boundaries rarely respect geographical administration or academic discipline'. Units of data may similarly not accord with administrative boundaries (Pohoryles, 2007).

Thirdly, it may not be possible to explore intranational spatial inequalities given issues of data availability, or at least the availability of suitably granular data. Modelling assessments underpin decision-making on energy and emissions policy, but these models often lack regional resolution. This is often due to data availability and other technical constraints (McGregor et al., 2008). This makes assigning regional decarbonisation capacity difficult, especially given the poor representation of different policymaking powers (such as in the DAs), which leads to the assumption of a 'flat' level of implementation capacity (Li et al., 2016). Weak modelling at the subnational scale means that locally appropriate solutions may not be found or applied. Many argue that regional mitigation pathways should be developed in order to better prescribe emissions targets (Georgakaki et al., 2015). This could shape more nuanced (and therefore realistic) national mitigation strategies by attending to particular regional socioeconomic barriers and opportunities. Prescribing national targets based on national modelling therefore implicitly allocates responsibility to the largest energy-using regions (for instance industrial areas) without consideration of their relative capacity to decarbonise, or their economic and strategic importance. This idea is widely supported in the literature, for example where Balta-Ozkan et al. (2015) highlight the value of a regional perspective, and Fell et al. (2020) argue that there is policy interest in assessing the specific distributional outcomes of the LCT on a given area.

Lastly, there is a critical question around when inequalities become *injustices* or *inequities.* The terms are often conflated without interrogation. Though extensive discussion of the differences is beyond the scope of this inquiry, I characterise inequality as a 'descriptive difference' in a given metric (between regions for instance), whilst injustice or inequity are evaluative concepts suggesting that there is some degree of unfairness in the distribution (see Chapter 2 for further detail).

1.3.2. *Scalar* politics: The Multi-Level Governance of net zero in the UK

The governance of climate change mitigation and net zero involves many competing assumptions about who the correct actor or actors may be, and around what the appropriate scale for delivering decarbonisation is. Schafran et al. (2020, p. 12) note that there is:

> a popular tendency to assume that certain institutions or certain scales or modes of production are inherently better at governing all systems in all places. Totalizing ideologies can be extremely powerful - and far too tempting.

Certain scales are argued to be more efficient or fair. This is nowhere more evident than in the rise of the 'place-based' agenda, or the localism literature. In practice, delivering the changes required for net zero is going to require collaboration and coordination across scales and sectors, including both state and non-state actors.

Multi-Level Governance[6] (MLG) describes the way in which power and authority is distributed across different tiers of government and between different actors at each level. As Marsden et al. (2014) note, it is 'characterized by institutions [both governmental and non-governmental] and actors from a variety of levels continuously negotiating in loosely designed decision-making processes'. It has traditionally focussed on the relationship between the national and supra-national levels, rather than the national to subnational dynamic (Di Gregorio et al., 2019). MLG recognises that governance occurs at different levels and that there are interactions between levels to deliver governance outcomes of a given good (i.e. in this case net zero GHG emissions).

[6] Note that the concept of 'Multi-Level Governance' (MLG) should be distinguished from the 'Multi-Level Perspective' (MLP). The MLP originates in the field of socio-technical transitions studies, and 'understands transitions as arising from the interplay between multi-dimensional developments at three analytical levels: niches […], socio-technical regimes […], and an exogenous socio-technical landscape' (Geels, 2014). It is therefore a perspective which offers insight on how transitions unfold, rather than an insight on governance structures such as that the MLG perspective offers (though the two necessarily intersect to an extent).

Though the term ‘level’ is used in the MLG literature, the term ‘scale’ is also often used interchangeably. ‘Scalar’ and ‘spatial’ represent different dimensions of governance, the former vertical, the latter horizontal (i.e. between levels of government, and between regions) in Hsu et al.’s (2020) terminology.

In this review, each ‘level’ or ‘scale’ is considered in turn as it applies to the UK, evaluating the national, DA, regional, and local level governance arrangements around net zero. Particular attention is given to the formal responsibilities at each level, as well as more normative discussion around the opportunities and barriers associated with further potential devolution. Finally, I reflect on the role of non-state actors in the multi-level governance of net zero.

1.3.2.1. The national level

The innovative Climate Change Act 2008, at the time a world-first in climate legislation, first mandated that the UK achieve GHG emissions reductions of 80% against a 1990 baseline (CCC, 2020a). In 2019, the UK government committed to reducing its GHG emissions to ‘net zero’ by 2050 (CCC, 2020a). Net zero implies that GHG emissions are reduced to as low a level as practicable, with engineered removals (for instance via Carbon Capture Utilisation and Storage; CCUS) and nature-based solutions used as a last resort to offset residual emissions (Fankhauser et al., 2022). In 2020, this target was revised in response to advice from the UK government’s independent public climate advisor, the CCC, in their Sixth Carbon Budget advice (CCC, 2020). This was the latest in a 5-yearly cycle of reports setting out the requisite level of ambition for achieving climate change mitigation consistent with global goals, most recently to reflect commitments under the 2015 Paris Agreement to limit the global temperature rise to 1.5°C. This revised target suggested that an interim target of a 78% reduction by 2035 was necessary in order to achieve the cumulative emissions reductions consistent with an overall net zero carbon budget (CCC, 2020).

The UK climate mitigation governance framework therefore operates through two carbon accounting mechanisms, a long-term emissions reduction target (i.e. net zero by 2050) and a series of recommended carbon budgets which guide decarbonisation ambition over 5-yearly periods. The long-term target serves to set a level of ambition, but does not prescribe how the target is to be reached, leaving policy and sectoral decarbonisation pathways open to debate (Lockwood, 2021). The carbon budgets ensure that the overall reductions occur at a pace and scale which ensures that cumulative emissions are

consistent with net zero, since it is cumulative emissions which ultimately determine the global warming contribution. The carbon budgets also provide a metric against which national progress can be tracked (CCC, 2020a).

In 2019, UK GHG emissions were 41% below 1990 levels, whilst GDP grew 75% over the same period (CCC, 2020). However, such reductions have disproportionately been achieved through decarbonisation in the electricity supply sector, with the phase-out of coal-fired power plants (CCC, 2020). Since 1990, the UK's emissions have fallen at an average rate of 13 $MtCO_2e$/year across sectors. However, when considering sectors other than electricity supply, this reduction was only an average 7 $MtCO_2e$/year (CCC, 2020). The potential for further mitigation from electricity supply is limited, and there is therefore a critical need to ensure *economy-wide* decarbonisation occurs. Average emissions reductions must increase to 21 $MtCO_2e$/year to be consistent with achieving the Sixth Carbon Budget (CCC, 2020). However, the CCC anticipates that the UK faces 'either significant risks or a policy gap for 38% of the required emissions reduction to meet the Sixth Carbon Budget' (CCC, 2022). This underscores the need for substantive policy action to underpin ambitious target-setting.

The majority of powers over net zero are held centrally in the UK, with partial devolution to the DAs. As Nash (2021) note, whilst devolution has enabled ambitious target-setting by the Scottish Government, the means to achieve them are limited. This asymmetry is highlighted in the fact that Northern Ireland has the greatest devolved powers despite its smaller geography and population (Muinzer and Ellis, 2017).

As well as these issues of weak spatial coordination between the DAs, there are questions around sectoral coordination, with cross-departmental working noted as being limited within the UK government and civil service (Lockwood, 2021). Therefore, whilst many would consider the national scale the most 'appropriate' and efficient for delivering net zero, there are issues of vertical (between scales) and horizontal (between sectors, actors, and regions) coordination (Hsu et al., 2017) which could limit this efficacy and have implications for the justice of the transition. The national government is seen to hold ultimate responsibility for ensuring that policy towards net zero is delivered successfully and fairly. As Evans (2020) notes, '[w]ithout some level of coordination from Government, the UK risks pursuing a fragmented strategy towards Net Zero.'

1.3.2.2. The Devolved Administrations

The DAs have separate net zero targets and progress tracking against these targets. An estimated 23% of abatement required to achieve the net zero pathway recommended by the CCC will need to be delivered across the DAs (CCC, 2020). The DAs differ from one another, and from England, in terms of their: emissions reductions to date, emissions profiles by sector, net zero target dates, devolved powers over areas relevant to mitigation and much more (as detailed in Table 2). The Scottish Government has committed to achieving net zero by 2045, whilst Wales and Northern Ireland have pledged to reach net zero by 2050.[7] These targets were once again informed by advice from the CCC, acknowledging the variable sectoral opportunities and barriers to achieving net zero in each territory. As Nash (2021) note, the ambition of the DAs may be driven at least in part by a political desire to outcompete central government (that is, Westminster). Several authors suggest that ambition towards net zero may be a 'means' towards the 'end' of independence in the devolved states (Muinzer and Ellis, 2017). It may otherwise simply be a continuation of the socially progressive focus that has characterised Scottish and Welsh policymaking, given a traditional political affiliation to liberal or Labour parties. As Bradbury (2008, p. 4) notes, during the last century Scotland and Wales 'increasingly came to distinguish themselves by their support for social collectivism or national autonomy in contrast to the individualistic values attributed to the English.'

As well as differences in the absolute size of their emissions, there are critical differences between the DAs in terms of their sectoral emissions profiles, which presents varied regional opportunities and barriers for decarbonisation. In recognition of this, Northern Ireland has a separate target for methane reductions, targeting a reduction of 46% by 2050 to acknowledge the importance of agriculture to the devolved economy and the difficulties of decarbonising this sector (CCC, 2023).

In Scotland, progress in emissions reductions to date has largely been in the electricity supply and industrial sectors. However, as the CCC note, industry is the second highest emitting sector, but powers over this are reserved at the central UK government level (CCC, 2022a). They also suggest progress is lacking in the transport and buildings sectors, as well as ongoing challenges from natural sources with 80% of peatlands

[7] The CCC recently outlined advice for Northern Ireland's net zero target. They suggested an 83% reduction in emissions by 2050 against 1990 levels to recognise the difficulty of addressing Northern Ireland's methane emissions (CCC, 2023). It also addresses the country's need for substantial offsets in order to align with the CCC's broader 'Balanced Net Zero Pathway' (BNZP) for the whole of the UK.

degraded and tree planting rates falling behind targets (CCC, 2022a). In Wales, 85% of emissions reductions from 2016 to 2018 were driven by the power sector (CCC, 2020b), suggesting limited action in other sectors. Industrial emissions reductions have also largely been a result of reductions to output rather than decarbonisation efforts (CCC, 2020b).

In Northern Ireland, emissions sources are dominated by livestock-based agriculture, which accounts for 30% of national emissions, as opposed to 10% of UK emissions from agriculture (CCC, 2019). Northern Ireland is similarly a net carbon source, with 40% less forest cover than the rest of the UK (CCC, 2019). Though the smaller geographical size of Northern Ireland means there may be greater scope for developing infrastructure (for instance for Electric Vehicles; EVs), the lack of an active Assembly from 2017 to 2020 and since February 2022 presents issues of institutional capacity. Similarly, the setting of a separate target for methane emissions could also be interpreted as a scaling back of ambition, and reinforce a reliance on engineered removals to close the emissions shortfall in future.

As previously noted, the extent to which these targets can be realised in each territory can be questioned, given asymmetric powers between the countries of the UK (Royles and McEwen, 2015). Policy responsibility for decarbonisation, particularly on energy, is currently highly fragmentary across the DAs (Cairney et al., 2019; Georgakaki et al., 2015). For instance powers over large energy infrastructure are not devolved to Wales, despite the territory being a net electricity exporter (Georgakaki et al., 2015). The uneven distribution of responsibility and control to devolved governments means that narratives of a UK LCT must be plural.

Table 2. Overview of key characteristics of Devolved Administration ambition and action towards net zero (compared to that of England).

	England	***Scotland***	***Wales***	***N Ireland***
Source	(CCC, 2020)	(CCC, 2020; CCC, 2022a)	(CCC, 2020; CCC, 2020b)	(CCC, 2019)
Emissions as percentage of UK total, 2018 (%)	77.4	10.2	7.8	4.6
Emissions per capita (tCO_2e/pc; 2018)	6	10	13	13
Emissions reduction targets (against 1990 levels)	Same as overall UK target – i.e.: 78% reduction by 2035; net zero by 2050	75% reduction by 2030; 90% reduction by 2040; net zero by 2045	Net zero by 2050; net zero public sector by 2030; 2 carbon budgets legislated (2016-20, 2021-26)	48% reduction by 2030 (for CO_2 emissions); net zero by 2050 (for CO_2 emissions); 46% reduction by 2050 for CH_4 (methane)
Emissions reductions 1990-2018)	41%	40%	32%	17%
Legal framework	Climate Change Act 2008	Climate Change (Scotland) Act 2009; Climate Change (Emissions Reduction Targets) (Scotland) Act 2019	Well-being of Future Generations (Wales) Act 2015; Environment (Wales) Act 2016	Climate Change Act (Northern Ireland) 2022
Devolved powers	Controlled by central UK government	• Mostly devolved: agriculture; land use, land use change and forestry (LULUCF); waste; F-gases; **buildings (NI only)** • Partially devolved: buildings; surface transport; **electricity supply (NI only)**		

1.3.2.3. The 'regional' level

As noted, the UK has historically lacked an effective tier of regional governance (Shaw and Greenhalgh, 2010). This typically applies to the case of England rather than the DAs, given the greater relative size of its population and territory. A 'regional' tier is often considered necessary to negotiate and coordinate between the national and the local (Salon et al., 2010), particularly for complex issues like decarbonisation.

The 10 Combined Authorities (CAs) established since 2010 mark perhaps the closest attempt at regional governance in recent years. 'Devolution deals' give greater powers to metropolitan regions and form CAs, legal partnerships of two or more LAs (Sandford, 2019). Though CAs are viewed as an important new governance tool in bridging the gap between the local and national level in England,[8] it is difficult to evaluate their effectiveness given the variability in what powers and resources are granted in each devolution deal. However, the business case required in applying for a new devolution settlement requires that any funding aligns with net zero ambitions (Evans, 2020). CAs are also often granted more direct powers over sectors which can have an influence on emissions reductions. Many of the CAs have developed their own climate and net zero strategies, some of which integrate and coordinate the plans of their constituent LAs.

As well as providing a conduit for coordinating with multiple local governments, and distributing funding, the CAs are seen to play an important political role in being able to advocate for their region. The majority of CAs are *Mayoral* Combined Authorities (MCAs) governed by an elected mayor. The advocacy role of the MCAs was highlighted during the COVID-19 pandemic, during which time mayors argued against regional lockdown strategies that came without additional support (Walker, 2020). The contrast of the political affiliation of many of these so-called 'metro mayors' with that of central government creates both a drive for more progressive policy, but also introduces conflict; MCAs are sometimes seen as challenging the authority of central government on the basis of party politics (Blunkett et al., 2016).

Another less formal example of 'regional' governance has been found in the Local Enterprise Partnerships (LEPs). LEPs are 'business-led partnerships between local authorities and local private sector businesses' in England (Evans, 2020). There are 38 LEPs, but many have been integrated into CAs given their overlapping geographies. There is reason to believe this trend will continue (Department for Levelling Up, Housing and Communities [DLUHC], 2022). The roles of LEPs and their relative emphases on

[8] CAs are not in force in the DAs.

net zero vary regionally given this is not a statutory requirement for them (Evans, 2020; Pike et al., 2015). Five regional 'Net Zero Hubs' are also funded by the former Department for Business, Energy and Industrial Strategy (BEIS)[9] supporting LAs and other partners primarily with energy projects, though these are additional to LEPs (Greater South East Net Zero Hub, 2023).

The difficulty of establishing a 'middle' level in England is often attributed to the powerful role of regional identity (and therefore identity politics; Bradbury, 2008). The division of England's geography to representative administrative units is highly politicised, and subject to competing definitions of economic, cultural and material geographies (Gherhes et al., 2023). Though the CAs are often considered a promising form of regional governance, coordination and advocacy, their variability and recency challenge any evaluation of their effectiveness.

1.3.2.4. The local level

There are 398 LAs in the UK (see Table 3), and 11,930 town, parish and other smaller councils (LGiU, 2023).[10] LAs in England provide over 700 services, including (but not limited to) social care, schools, housing, planning and waste collection (Local Government Association [LGA], 2010). Under the two-tier system that operates in some areas, responsibility for delivering services is shared between the county council and the smaller district, borough or city councils that comprise the same geography (Institute for Government, 2022). In other areas, including the DAs, unitary systems are in place, where one council delivers all services.

LAs have an estimated potential to be able to influence a third of GHG emissions in their local areas (Evans, 2020). The scale of their potential influence makes LAs a powerful tool for delivering decarbonisation on the ground, and in coordinating the delivery of national policies. However, despite their long history of involvement in the sustainability agenda (Gibbs et al., 1996), there is no statutory responsibility for them to undertake climate mitigation (Bulkeley and Kern, 2006). Despite this, 79% of English LAs have set

[9] This is now the Department for Energy Security and Net Zero (DESNZ), as established in February 2023.

[10] This includes town, parish, community, neighbourhood, and village councils (LGiU, 2023). These very small councils have limited budget or power to deliver public services. They therefore often fulfil a management role for local amenities, and a consultative one, for instance by engaging with communities on local development matters (Baker and Sandford, 2020).

a target to achieve net zero GHG emissions by 2050 or sooner, for their operational and/or area-wide emissions.[11]

Table 3. Summary of Local Authorities by country of the UK.

Country	Tier system?	LA types	No. of LAs
England	2 tier	County council (upper tier)	24
		District, borough and city councils (lower tier)	181
	1 tier	Unitary authorities	58
		London boroughs	32
		Metropolitan boroughs	36
	Other	City of London Corporation and Isles of Scilly	2
	Total (England)		**333**
Scotland	1 tier	Unitary Authorities	32
Wales	1 tier	Unitary Authorities	22
Northern Ireland	1 tier	District, borough, city councils	11
Total			**398**

These commitments have perhaps been driven by 'peer pressure' and reputational concerns given the wave of commitments at particular climate policy flashpoints (e.g. in the lead up to COP26[12]), or by pressure from the bottom-up by community groups (Howarth et al., 2021a). Though these commitments are widely viewed as laudable, they are also considered unrealistic; systematic reductions in LA budgets since austerity

[11] Based on own analysis, as documented in Chapter 3.
[12] The 26th Conference of the Parties, held in Glasgow in 2021.

mean there are critical questions around the ability of LAs to deliver their statutory (let alone non-statutory) service commitments (Bulkeley and Kern, 2006). Gray and Barford (2018) report that part of the Department of Local Government and Communities (now DLUHC) dealing with Local Government lost half of its funding from 2010-2015. They also show that more deprived areas faced larger cuts in public service spending in England over this time (Gray and Barford, 2018).

In Scotland, public bodies (including local government) have a statutory duty to contribute towards meeting the Scottish net zero target for 2045, and to report annually on their mitigation and adaptation progress. The Sustainable Scotland Network (SSN), an arms-length body funded by Scottish Government, collates and synthesises progress from the annual reporting (SSN, 2023). In Wales, there is a requirement that public bodies contribute to sustainable development goals as outlined in the Well-being of Future Generations (Wales) Act 2015, and to report progress against wellbeing objectives annually (Welsh Local Government Association, 2023). Consultations are ongoing in Northern Ireland to determine whether there will be statutory carbon reporting for LAs under the new Climate Change Act (Northern Ireland) 2022. It therefore seems that reporting requirements are both more stringent and more standardised in the DAs at present. This implicitly encourages local climate action through establishing a clear evidence base against which to monitor progress.

In the case of England, the National Indicator (NI) framework required reporting on climate action from LAs between 2007 and 2011, after which they were removed by the coalition government (Cooper and Pearce, 2011; Howarth et al., 2021a). The indicator framework included metrics on LA operational and area-wide emissions reductions. LAs were encouraged to set targets for certain indicators, and 97% of LAs included one climate change metric as the basis for their improvement target (Cooper and Pearce, 2011). This goes some way to suggest the scale of climate reporting activity undertaken. Since the loss of the NIs, reporting has been viewed as ‘inconsistent’ (Evans, 2020). Moreover, it has involved the loss of in-house skills and expertise in LAs around carbon reporting. Whilst an obligation to consider climate impacts is now part of funding requirements (for instance in attaining Levelling Up funding), statutory requirements to act on climate are weak at this level. Local action could be seen as more shaped by social trends than by intentional policy direction from central government.

Local and regional bodies are acting independently of, or in spite of, this direction from central government. Though local action is viewed as important in achieving incremental gains where there is national policy inaction (Armstrong, 2019), there are limits to what

can be achieved by the local scale without the policymaking powers, resources, and mandate of central government. This is the pivotal argument of 'the local trap', the assumption that the local scale is ideal for governing many public policy issues, and that local action can solve the governance gaps left by national government (Catney et al. 2014). However, this means that more capable, typically affluent, areas are more able to secure the provision of public goods, whilst those without such resources are left under-provisioned. This exacerbates issues of socioeconomic inequality across communities or regions. In the case of net zero commitments, there is the assumption that under-resourced local government will fill the governance gap left by national government. This is problematic in terms of the burden it places on LAs in regions already dealing with socioeconomic deprivation and budgetary shortfalls for their statutory service areas (Gray and Barford, 2018).

There are therefore calls for clearer communication of the role of local government in delivering net zero, with some suggesting the potential for a statutory responsibility for climate mitigation, provided it was well resourced (Yuille et al., 2021). LAs will be critical in delivering the LCT on the ground, and implementing national policies. However, the current way in which they operate in a policy vacuum means that the local contribution to national net zero is at risk of being spatially varied and unfairly coordinated.

1.3.2.5. Non-state action

The primary focus of this work is on public actors, given their relatively greater degree of influence in shaping regional development and decarbonisation agendas and their democratic legitimacy and accountability. However, it is important to recognise the role of non-state actors in influencing UK climate policy approaches at both the national and subnational scales.

As Bulkeley and Betsill (2005) note 'new network spheres of authority' are emerging 'which challenge traditional distinctions between local, national and global environmental politics'. In Hsu et al's (2020) definition, 'non-state' actors can include businesses, investors, cities, civil society amongst others. There is a large and growing literature commenting on the rise of polycentric climate action, for instance the involvement of civil society actors (Gillard et al., 2017; Hsu et al., 2020; Jordan et al., 2015; Kythreotis et al., 2023). For instance, Smith and Christie (2021) provide a comprehensive mapping of both state and non-state climate actors in the UK. Smaller scale units of experimentation in climate governance point the way to what works or would work in other areas, enabling

the diffusion of best practice (Bulkeley and Castán Broto, 2013). Non-governmental organisations working closely with local governments (such as Climate Commissions) show how capacity deficits can be bridged by partnership working (Creasy et al., 2021). However, this reliance on informal, civil society action is frequently critiqued as it represents downscaled responsibility without downscaled power or resources (Catney et al., 2014).

The concept of 'Big Society Localism' (Catney et al. 2014) critiques the idea that there is a growing norm of public participation in governing public goods, meaning a smaller role for the state. Under this theory, responsibility is passed down, but this is unaccompanied by sufficient powers and resources to deliver on it (Kuzemko and Britton, 2020). As Gillard et al. (2017) note, 'the turn to non-state actors should not be considered a de facto solution to central state inaction'. In the case of community action as in the case of a larger role for local government, effective governance relies on the existing human and social capital of communities or areas (Garvey and Paavola, 2022; Thaler and Priest, 2014).

Whether the involvement of non-state actors has a positive, democratic role to play in good governance, or whether the very involvement of non-state actors in matters of public policy is problematic, are perhaps matters of political ideology. Much rests on preferences for differently 'sized' states, and *why* non-state actors feel the need to act.

1.3.3. The *spatial* politics of net zero in the UK

Previous sections have commented on the *scalar* politics of net zero in the UK and the arguments for and against certain roles for particular scales. In what follows I discuss the political implications of how net zero is unfolding across *space*.

1.3.3.1. Levelling Up and sustainable regional development

Recent years have seen renewed attention given to the issue of the UK's regional inequalities (McCann et al., 2021). This was expressed in the Conservative party manifesto for the 2019 General Election, which introduced an agenda to 'Level Up' the UK. This attention has been attributed in part with the net gain of 48 seats by the party (particularly of many traditionally Labour-voting 'Red Wall' seats; Uberoi et al., 2020).

The post-Brexit loss of European Union (EU) regional funds is also considered to have fuelled further regional disparities.

The term ‘Levelling Up’ increased in use during the ‘New Labour’ administration (1997-2007), when it was first applied to education policy in 2001. It was also argued that the North must grow but not at the expense of growth in the South (Morgan, 2008, p.161). However, it has recently become a more prominent, and some would say, more ‘ambiguous’ term (Newman, 2021). Many argue that it simply marks a reframing or rebranding of a historic debate on how best to reduce disparities in health, wealth and quality of life between regions. With the advent of the COVID-19 pandemic in 2020, policy attention was diverted away from the Levelling Up agenda, leaving many to question whether it was more of a ‘slogan’ than a substantial policy initiative (Tomaney and Pike, 2020). As noted in the Guardian at the time: ‘“Level up” is as close to meaningless as it’s possible for it to be without being written in Wingdings’ (West-Knights, 2020). The publication of the long delayed Levelling Up white paper (DLUHC, 2022) has resolved some of these queries, yet scepticism and criticism remain.

Levelling Up (or any future iterations of regional development policy) have direct implications for the net zero agenda. Regional economic growth has historically been promoted through large scale infrastructure projects, all of which would have a significant impact on the UK’s GHG emissions. Many of the existing Levelling Up funds (such as the Towns Fund) have weak criteria that any proposed development should ‘ensure future sustainability’ (DLUHC, 2021), and requirements to align developments with net zero are not stringent. An example of the tensions in managing both the net zero and Levelling Up agendas concomitantly is the proposed Cumbrian coalmine. Some argue that the need for local job creation has been promoted over climate considerations. There is therefore conflict between the need for regional economic growth opportunities and how compatible proposed developments are with the net zero agenda. Given that net zero targets are set at the national scale, emissions-intensive activities in one region will require compensatory mitigation in another, making the issue a question of CBDR-RC. That is, any carbon-intensive developments will by default shift the burden of mitigation to another region of the UK.

1.3.3.2. Producer vs consumer regions: Responsibilities and capabilities

Responsibility and capability are described as ‘equity principles’, that is, principles to ensure distributional justice (Höhne et al., 2014; Sasse and Trutnevyte, 2019). The

varied ‘responsibility’ to decarbonise between different jurisdictions is typically discussed at the international scale, in terms of the United Nations (UN) principle of CBDR-RC[13] (Pauw et al., 2019). This framework accounts for ‘different national circumstances’ in the ability to mitigate and/or support the mitigation efforts of other states (Voigt and Ferreira, 2016). In broad terms, responsibility recognises that those who have benefitted most from emissions intensive activities should be those liable to take action now to reduce emissions furthest and fastest in their own domains and to finance it elsewhere. The discussion of responsibility is critical given Newell et al. (2015) observe that disparities in assumptions of where responsibility lies result in ‘governance traps’ and climate inaction.

But there are critical questions over the *intranational* allocation of responsibility, particularly in terms of which areas bear the costs of mitigation and the implications of this for regional development. The burden of mitigating GHG emissions in the UK is unevenly distributed, mainly due to the geography of industrial activity, but also due to the carbon accounting and policy frameworks used (often implicitly) to allocate relative ‘responsibility’. Any decision allocating responsibility is dependent on the method of attribution, as previously discussed. As outlined in Eder and Narodoslawsky's (1999) typology, different principles of ‘responsibility’ can determine who is accountable to mitigate environmental pressures occurring at different spatial scales.

The ‘capability’ principle asserts that those with greater ability to mitigate should bear the burden of mitigation and take more ambitious action. Capability is the subject of much academic debate, particularly in the field of human development, under theorists such as Amartya Sen (2000) and Martha Nussbaum (2011). I depart in thinking about capability in terms of institutions as the central actors, rather than individuals (i.e. as is the case in the Human Development approach), though many of the principles underpinning capability theory are transferable. The term ‘capacity’ is often used interchangeably with ‘capability’. Schafran et al. (2020) note that Nussbaum originally used the term ‘capacities’, reflecting the Aristotelian basis of her work, but later used the term ‘capabilities’. As discussed in Chapter 2, Mayne et al.’s (2017) distinction is adopted. They outline that capability is more active, and capacity a more passive term, where capability is ‘an actor’s ability to take effective action to reduce carbon emissions’, whilst capacity is the ability of an actor to ‘cope and adapt’ (Füssel, 2010). Given that this is an exploration of mitigation (the ability to address sources of emissions) rather

[13] First outlined in Principle 7 of the 1992 Rio Declaration (Voigt and Ferreira, 2016).

than to ‘cope’ with climate impacts through adaptation, the term ‘capability’ is used throughout as the more relevant term.

This sense of who or where is most responsible for decarbonisation is entrenched by the mainstream carbon accounting approach which underpins most UK climate policy. Production-based emissions accounting approaches consider the GHG emissions that occur under a particular national jurisdiction (Barrett et al., 2013). By contrast, a consumption-based accounting approach allocates emissions ‘according to the country of the consumer, usually based on final consumption’ (Barrett et al., 2013). Considering the intranational implications of this debate, figures 3A and 3B provide heatmaps of the emissions associated with UK countries and regions when considered on both a production (3A) and consumption (3B) accounting basis. Whilst the emissions metrics and years vary slightly, the contrast in results gives a high-level overview of the implications of adopting either accounting approach.

Figure 3A suggests that Wales has the highest per capita production-based emissions (tCO_2 per capita; BEIS, 2020); this is generally attributed to the number of industrial facilities located there. By contrast, London has the lowest per capita production emissions for the opposite reason. Figure 3B indicates the household carbon footprints (tCO_2e per capita) for the UK (Ivanova et al., 2017). In their European study, Ivanova et al. (2017) note the particularly high ‘subnational heterogeneity’ in the carbon footprints of Italy, Spain, Greece and the UK, suggesting that income is one of the key drivers for the differences. Figure 3B suggests that the trend in production-based emissions is somewhat reversed at the regional level when considered on a consumption basis. This emphasises that whilst some regions produce more, others consume more, raising critical questions over the method of allocating emissions responsibility at the subnational scale.

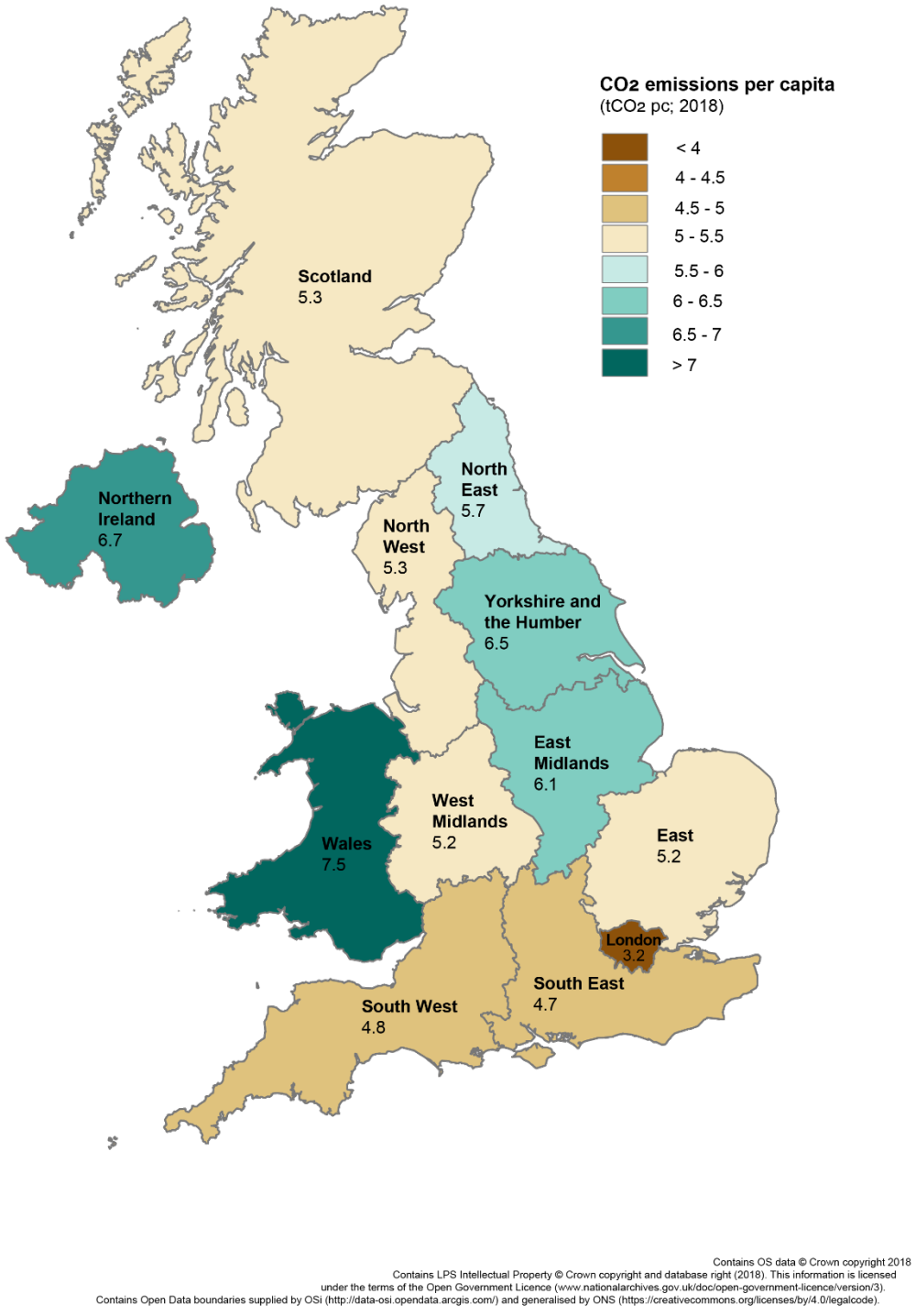

Figure 3A. Heatmap of UK carbon dioxide emissions per capita (tCO_2 per capita for 2018) at the NUTS2 (Nomenclature of Territorial Units for Statistics classification) regional disaggregation. Data derived from BEIS (2020).

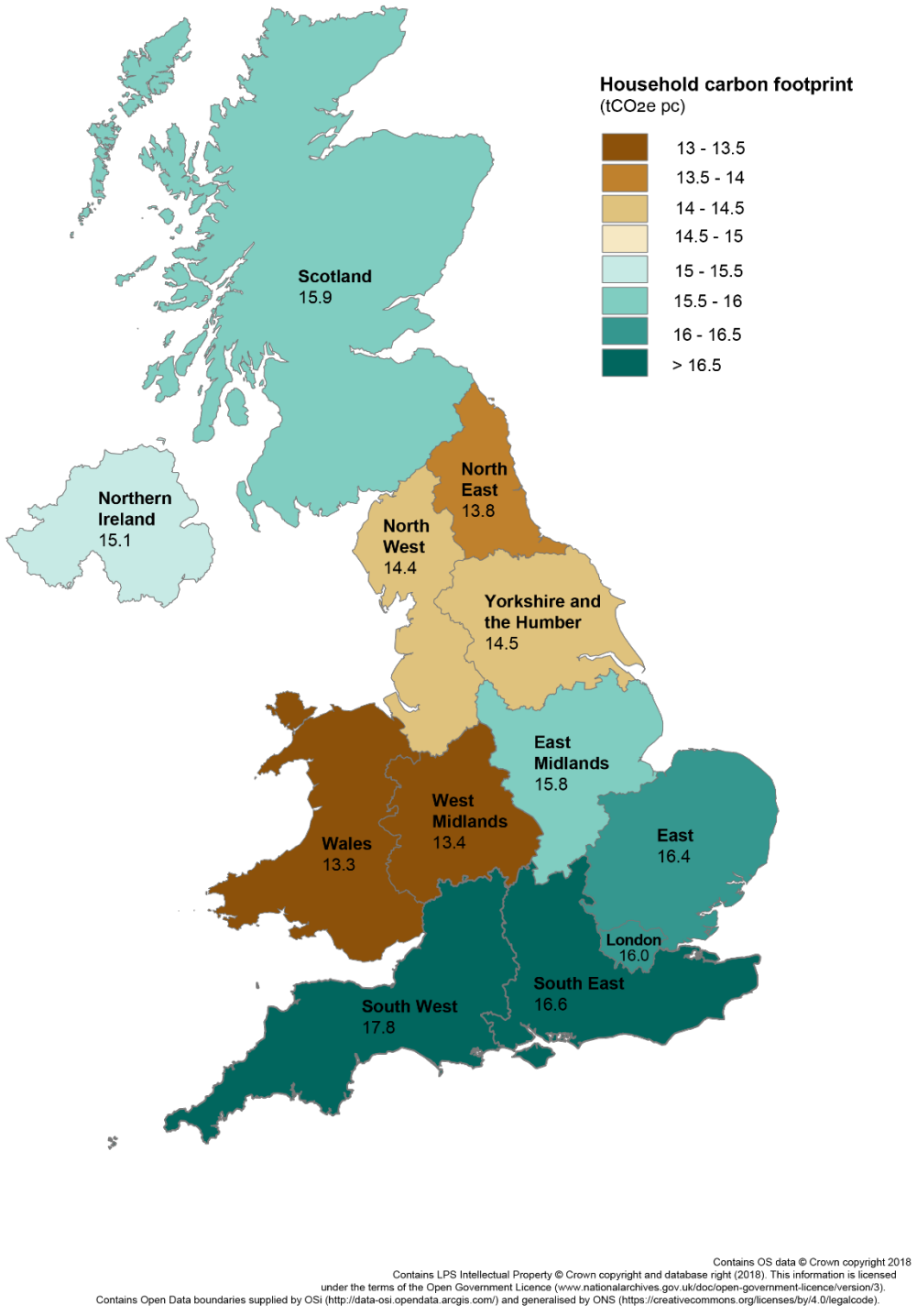

Figure 3B. Heatmap of UK household carbon footprints (tCO_2e per capita) at the NUTS2 regional disaggregation. Data derived from Ivanova et al. (2017).

National GHG emissions targets are frequently set on a production basis, which constructs an orthodoxy in the allocation of mitigation responsibility to industrial sites and regions in the UK. In essence this follows the Polluter Pays Principle. However, this approach fails to consider the underlying drivers of emissions growth and devolves responsibility to regions producing goods, rather than assigning responsibility to the regions driving final demand and consuming such goods. This pattern is in evidence at both the intranational and international scales. Caney (2010) suggests that greater consideration should instead be afforded to the Ability to Pay Principle. Industrial areas in any given country (typically developed states) are viewed as more 'responsible' for mitigation given their current high levels of emissions and their historic contribution to national emissions. However, historic responsibility does not necessarily translate into present-day capability, with high levels of socioeconomic deprivation in many industrial areas (Lodge et al., 2015). Industrial production delivers local benefits in terms of employment, but also can be seen to provide a strategic material and economic service at the macroeconomic level. Additionally, the need for materials for the development of infrastructure will only increase over the course of the LCT.

In essence, the very framework of UK climate policy implicitly burdens some areas of the UK more than others, highlighting the importance of taking a 'spatially just transitions' approach, focussing on places as well as sectors. Whichever way responsibility is divided, however the pie of the carbon budget is cut, the process is unavoidably political. Dividing responsibilities by place is arguably even more contentious than by sector, since place is tied to cultural identity, place attachments, and differing regional perceptions of acceptability, responsibility and capability. This merits the evaluation of such issues in this study, and warrants further critical consideration in future.

1.4. Research methods

Detailed documentation of the methodological approaches used can be found in each chapter of the thesis and the associated appendices. Therefore, rather than repeating this detail here, attention is instead placed on the advantages and limitations of the methods, and the novelty of their use.

1.4.1. The ‘semi-systematic’ review and thematic analysis

The first piece of research was designed as a review of the literature on spatial justice in the context of the LCT. This responds to research question one (‘what could be considered a ‘spatially just’ low carbon transition (LCT)?’). Sovacool et al. (2018) outline that there is a continuum of more or less robust literature review methodologies, with narrative reviews characterised by less rigour, and systematic reviews marking the most rigorous approach. Since an initial scoping study revealed the interdisciplinarity of this body of research, and therefore the incomparability of the diverse research methods employed, a full systematic review was deemed inappropriate. A semi-systematic or ‘integrative’ review is defined by Torraco (2005) as:

> a form of research that reviews, critiques, and synthesizes literature on a topic in an integrated way such that new frameworks and perspectives on the topic are generated.

It is arguable that there is considerable novelty in using this review approach due to its infrequent use and its strength in integrating a wide body of interdisciplinary research. Balzani and Hanlon (2020) apply this review approach to their study of perceptions of animal welfare by farmers, but (to my knowledge) this review type has not been explicitly applied in the current research context.

Given the lack of use of this review methodology, a critical challenge involved communicating the approach. To address this, I aimed to be fully transparent in the documentation of the method, publishing the PRISMA[14] flow diagram of the multi-stage search and screening process, as well as search strings and exclusion criteria. These are all attributes of full systematic reviews (and indeed many do not provide this level of detail in practice). The semi-systematic review was therefore made as ‘systematic’ as possible, following systematic (Liberati et al., 2009) and semi-systematic review guidelines (Torraco, 2005). A final sample of 75 academic articles were thematically coded using NVivo (Computer Aided Qualitative Data Analysis Software, CAQDAS; NVivo Plus v.12.6). An inductive approach was used given the exploratory nature of the research questions (Clarke and Braun, 2017), though content analysis was also conducted to collect descriptive data around the sample. A simplified codebook is

[14] PRISMA stands for Preferred Reporting Items for Systematic Reviews and Meta-Analyses. PRISMA criteria are primarily designed to improve standardisation in the reporting of approaches to systematic (and other) reviews.

provided as an appendix (in Section 6.1, subsection B) to indicate the coding approach and in the interests of transparency.

Though I aimed to ensure the review was as systematic as possible, the process of screening will always contain some degree of subjectivity in the selection of what is relevant. The exclusion criteria used were qualitative and thematic, and the screening carried out by a single researcher. Thematic coding using an inductive approach will also necessarily involve some degree of subjectivity. To overcome these issues, quantifiable exclusion criteria could be defined, and multiple authors could be used to carry out screening and coding with cross-referencing to improve reliability.

1.4.2. Emissions scenario modelling and the composite indicator framework

The next piece of research addressed the second research question of 'what are regional responsibilities and capabilities for decarbonisation in England?' To this end, I conducted quantitative scenario modelling and developed a composite indicator framework. Publicly available secondary data on the net zero targets of LAs in England (n=301, plus n=10 for the CAs) was gathered from the Place-based Climate Action Network (PCAN; Howarth et al., 2021a) and Climate Emergency UK (CEUK, 2022). The hypothetical implementation of these targets was modelled, using BEIS (2021) 'UK Local Authority and regional CO_2 statistics for 2005-2019' for LA baseline emissions data. These scenarios of implementation were then compared to datasets from the CCC (2020) on emissions in a conservative climate policy scenario, and in the case of achieving the net zero carbon budget (in line with the Sixth Carbon Budget analysis 'Balanced Net Zero Pathway' [BNZP] scenario). This provided a sense of whether LA targets were in keeping with the national carbon budget, of regional variation of their ambition, and of the importance of subnational action. Figure 4 provides an overview of the modelling approach undertaken.

The carbon budget results for each LA fed into the second stage of the analysis which deals with the equity principles of responsibility and capability as stated in the second research question. Composite indicators (Co-Is) integrate several individual indicators to provide an overview of a multidimensional concept (Organisation for Economic Co-operation and Development [OECD], 2013). Two separate Co-Is were built to monitor the level of ambition (termed 'responsibility-taking') and capability in each LA's climate action plan. The analysis of planned emissions reductions formed a constituent part of the ambition Co-I. A more spatial perspective could then be used in analysis of the

indicator results, by aggregating the LA results by region and comparing relative trends. This allowed statistical comparison of the relationship between responsibility and capability and how it varied across different regions.

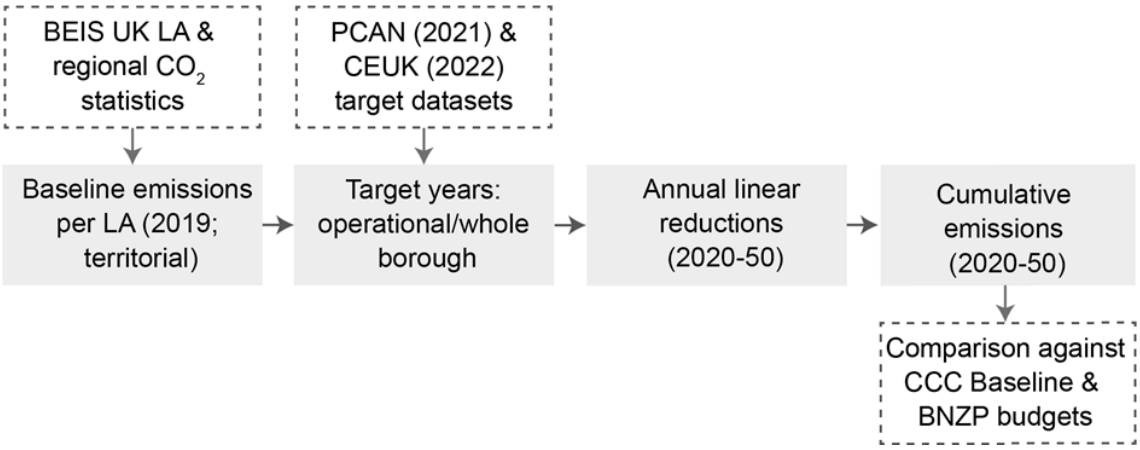

Figure 4. Modelling approach in creating scenarios of Local Authority target implementation.

The approach involved several limitations, necessitated by the complexity of monitoring over 300 targets. The analysis was limited to coverage of England, and to CO_2 rather than all GHGs. This was due to issues of harmonising datasets since the methodologies underlying certain datasets (for instance the Indices of Multiple Deprivation, IMD) differed between the DAs, and certain datasets were only available in terms of CO_2. The results necessarily present a static snapshot of how the targets are progressing, but further analysis could be undertaken to measure ongoing progress against the targets. Given the resource intensity of collecting such data (which is as of yet unavailable to the public),[15] this is perhaps an area for future work. Further work under a similar approach may indeed be valuable in the DAs given statutory reporting requirements, the associated public availability of data (in Scotland at least), and simpler administrative geographies.

[15] This is now being undertaken by CEUK, expanding their activities around the 'Council Climate Plan Scorecards' to create scorecards of 'Climate *Action*' (CEUK, 2023).

1.4.3. Stakeholder interviews and thematic analysis

A series of 28 semi-structured stakeholder interviews were undertaken to answer the third and final research question: 'what governance mechanisms can embed spatial justice into UK net zero policymaking?' The interview approach was novel in being 'cross-sectional' (Kythreotis et al., 2023), that is, aiming to represent perspectives from across the regions of England, different sectors, and crossing multiple levels of governance. Many interview analyses in this field choose a case study location and draw out transferable insights. I decided to synthesise perspectives across space and scales, to present the 'bigger picture' of governance issues across England, and to reflect perspectives on local government internal and external to councils. A particular novelty was in the focus on equity in LA climate action, and the discussion of the fairness implications of a *local* statutory responsibility (SR). These issues are only implicitly discussed in the literature and have not been explored empirically. In the interview protocol, the same closing questions were posed to all participants (i.e. around the value and fairness of a SR).

A purposive sampling strategy was used to ensure as representative as possible a sample of LAs (amongst other actors). The composite indicator results for LAs from the previous piece of research were used in order to identify councils of varying levels of capability and ambition. This informed an initial attempt at recruitment, with limited success, given councils with lower capability and/or ambition were less likely to have the resource to participate in a voluntary research activity. I subsequently took a broader approach, contacting stakeholders known to have relevant expertise using publicly available email contacts and through known gatekeeper contacts. I aimed to ensure the final interviewee sample had geographic coverage of the UK's regions through this purposive process. Snowball (or referral) sampling was also used to broaden the sample, and this provided insight into the working relationships between stakeholders.

The final sample included representatives for seven of the nine regions of England (namely the East Midlands, London, North East, North West, South East, South West, Yorkshire and the Humber). Broader national perspectives were also prominent in the interview sample. Of the interviewees that represented place-specific perspectives, five were from industrial and rural areas respectively, and six from urban areas, ensuring reasonable coverage of these different land use types in the sample. Interviews took place virtually over Microsoft Teams for convenience, and typically lasted up to an hour. Data analysis was conducted via NVivo Plus (v.12.6) using thematic coding. This coding approach was abductive, following an iterative process of generating codes (Vila-

Henninger et al., 2022), reflecting the emphasis on respondents' perspectives rather than any one theoretical model (as in deductive approaches). An illustrative summary of the codebook can be found in an appendix (Section 6.3).

As illustrated above, though every effort was made to ensure comprehensive geographic coverage in the sample, and the representation of varied council capabilities and levels of ambition, there were necessarily limitations. A key challenge was in the low response rate from interviewees. This was mitigated against by ensuring an appropriate amount of time was left for the administration of sending participant invites, as well as adopting a flexible participant recruitment strategy. As noted, there was also an issue in contacting councils which had less developed climate plans. Councils with the time and resource to develop sophisticated climate plans and set net zero targets were perhaps also those with most capability to respond to requests for interview. There is therefore a potential response bias which it is important to acknowledge, but which serves to support some of the key conclusions of the research.

1.5. Structure of the thesis

In the subsequent chapters the three pieces of research are presented, as follows:

- **Chapter 2** provides the semi-systematic review of the literature on spatial justice in the LCT, which sets out the theoretical framework for the discussion to follow.
- **Chapter 3** then provides an example of how the equity principles underlying the concept of spatial justice can be quantified and tracked in a case study of English LA net zero targets. Though ostensibly dealing with the local level, the case provides a springboard for comparing regional trends and issues. It also introduces a broader debate around the policy and governance mechanisms that could improve the current situation of voluntary mitigation by subnational actors in England.
- **Chapter 4** presents the interview analysis, which evaluates the equity of LA climate action in England, synthesising perspectives from across different regions, sectors and levels of governance. This builds on Chapter 3 in the discussion and application of the equity concepts of responsibility and capability.
- **Chapter 5** provides a critical discussion of the research findings, as well as a series of policy recommendations to improve the spatial justice of the current governance of climate change mitigation in the UK. It outlines the limitations of

the work as well as valuable directions for future research. Finally, the overarching conclusions of the project are detailed.

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2. A ‘spatially just’ transition? A critical review of regional equity in decarbonisation pathways

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2.1. Abstract

Spatial justice is a theoretical framework that is increasingly used to examine questions of equity in the low carbon transition (LCT) from a geographical perspective. We conducted a semi-systematic review to define a ‘spatially just’ low carbon transition, considering how spatial dimensions are explicitly or implicitly presented in assessments of the LCT, and the policy and governance approaches that could embed spatial justice. A sample of 75 academic articles was thematically coded. Spatial justice involves the fair distribution of *both* benefits and burdens associated with LCTs, and this often creates problems of equity given the geographic gap between regions that ‘win and lose’. The studies point to a research gap in exploring fairness implications that go beyond the employment impacts of transition. Acceptance of the LCT is shown to be contingent on perceptions of justice, particularly whether the most responsible and capable actors are taking action. There is similar concern that the LCT may not address, or may *reproduce*, existing patterns of injustice. This is particularly the case in terms of spatially inequitable land uses and where historic planning policy has had lasting socioeconomic impacts. Policy challenges to making LCTs more spatially just included administrative fragmentation across spatial scales and the lack of coordination in net zero policy. We identify that future transition policymaking could benefit from using spatially targeted interventions, and in adopting a whole systems approach. In this recognition of the multiple economic vulnerabilities of different regions, LCT policymaking can become both more effective and, critically, more just.

2.2. Highlights

- Spatial justice considers the fair geographic distribution of benefits and burdens.
- We conducted a semi-systematic review and thematic coding of 75 academic articles.
- Acceptability in the low carbon transition is dependent on perceived justice.
- Whole systems and embodied justice approaches were seen as more spatially just.
- Spatially targeted policies, devolved powers and targets were viewed as solutions.

2.3. Introduction

Over 100 countries have set, or are planning to set, net zero greenhouse gas (GHG) emissions targets (van Soest et al., 2021). Achieving this pace and scale of decarbonisation demands significant restructuring of national economies and societies (While and Eadson, 2019). Decarbonisation is often characterised as a uniform good, but increasing attention is being paid to the possible burdens associated with the low carbon transition (LCT) and how this might disproportionately affect already-vulnerable social groups (Golubchikov and O'Sullivan, 2020; Sovacool et al., 2021) and create newly vulnerable groups.

The LCT has potential to generate both benefits and burdens, and there is a strong 'winners and losers' narrative in the literature (Coutard and Rutherford, 2010; Pye et al., 2020; Roberts, 2003; Sayan, 2019; Sovacool, 2017; Sovacool et al., 2019; Wells, 2012). Previously, LCT studies have been largely 'aspatial' (Balta-Ozkan et al., 2015; Bouzarovski and Simcock, 2017; Cruz-Sandoval et al., 2020; Olner et al., 2020), though there is increasingly a so-called 'spatial turn' (Bridge, 2018) in assessments of LCTs. There is a key research gap in comprehensively exploring the spatial distribution of opportunity and opportunity costs associated with transition, and how these could intersect with existing geographical patterns of socioeconomic inequality. Spatial justice theory therefore provides additional value to the conventional 'CEE framework' of climate, energy and environmental justice (McCauley and Heffron, 2018), in applying an explicitly spatial lens to the geographically variable impacts of the LCT.

We adopt a semi-systematic review methodology appropriate to integrating the diverse and interdisciplinary body of literature in this area, following Balzani and Hanlon (2020).

The aim of this review is to explore what could be considered a ‘spatially just’ LCT. The three core research questions were developed through a scoping study of the literature, identifying the main descriptive (question 1) and evaluative (questions 2 and 3) research gaps in discussions of spatial justice.

Research questions towards this aim include:

1. What spatial scales are considered in analyses of LCTs?
2. How are spatial justice issues explicitly or implicitly presented in assessments of LCTs?
3. What policy and governance approaches could embed spatial justice in the LCT?

Section 2.4 provides an overview of spatial justice theory, and Section 2.5 outlines the methodology of the semi-systematic review. Section 2.6 presents the results and discussion, organised by the key themes drawn from the analysis of the literature, and responding to the above stated research questions. Section 2.7 outlines the conclusions of the analysis and directions for future research. As a review paper, rather than providing a comprehensive evaluation of several justice concepts, the following aims to assess the specifically spatial implications of justice in the LCT.

2.4. Context: Spatial justice theory

Spatial justice is an infrequently used theoretical framework that can be employed to examine questions of equity and fairness in the LCT from an explicitly geographical perspective. As noted by Sovacool et al. (2017), the spatial and scalar implications of just transitions are important areas for further research. Spatial justice theory has a long and interdisciplinary prehistory, which merits further exploration in the context of decarbonisation and the primacy of the just transition debate.

Spatial justice is conceptually rooted in the field of political geography, building on the work of key social justice theorists such as John Rawls, as well as critical geographers including David Harvey and Doreen Massey (Bridge et al., 2013). Rawlsian justice advocates for the fair distribution of social primary goods, and this has clear application to issues of spatial distribution (Jenkins et al., 2017; Mandle, 2009; Rawls, 1971). Therefore, the conceptual leap from social to spatial justice is not a large one. Harvey's 1973 work on urban social justice advanced the concept of ‘territorial social justice’, and responded to an earlier 1968 study documenting the spatial variation in social service

provision (Davies, 1968; Pirie, 1983). But it was work by Pirie in 1983 that provided conceptual clarity and the first direct use of the term ‘spatial justice’ (Pirie, 1983).

Bridge cites the ‘spatial turn’ of energy research since the 2000s (Bridge, 2018), and there has been corresponding growth in spatial environmental justice studies since this date. Edward Soja's *Seeking Spatial Justice* (Soja, 2010) documents a successful grassroots legal challenge to the public transport authority in Los Angeles, resulting in the reform of the mass transit system to favour the needs of the poorest residents of the city. This represented a triumph of spatial planning for social good, and has clear applications to environmental justice in considering how changes under the LCT should also improve social wellbeing. Soja therefore offers a linkage between spatial studies and contemporary debate on environmental justice. This issue is foregrounded in Bouzarovski and Simcock (2017), which provides a model point of departure for this review.

The lack of prior critical attention to this theoretical framework is perhaps attributable to weak consensus on its epistemological value. Criticisms of the term focus on the following four areas: a) its uncertain definition; b) the ‘causality’ of injustice; c) its perception as environmental determinism; d) disciplinary biases. Spatial justice ostensibly critiques the role of space or geography in driving or determining socioeconomic inequalities. However, there is considerable critique, particularly from the body of political geographers, that spatial justice is essentially ‘social justice in space’ (Pirie, 1983, p. 471). Indeed, whilst Pirie originated or at least popularised the term spatial justice, they argue that spatial dimensions are simply a descriptive characteristic of existing social inequalities, rather than a causal factor in their creation. Additionally, as Harvey noted in the early history of the term, in any case of socio-spatial ‘injustice’ the choice of scale will determine the relative distributional ‘justness’ (Harvey, 1973; Soja, 2010). There is similar criticism that an overt focus on the spatial dimensions of justice detracts from the discussion of the ‘vertical’ power structures and dynamics which underlie cases of inequality (Soja, 1980). Soja offers a resolution to the tension between space as social construct or product of class relations, and space as arbitrary descriptive structure, by proposing a ‘socio-spatial dialectic’ (Soja, 1980).

A further critique is in the characterisation of spatial justice as a species of ‘environmental determinism’, wherein geography controls an individual's life chances and quality (Soja, 1980). As Soja (2010, p. 4) highlights:

> this persistent asymmetry between social and spatial explanation reflects in part a long-standing disciplinary precaution amongst geographers against giving too much causal power to the spatiality of social life for fear of falling into the simplistic environmental determinism that plagued geographical thinking in the past.

'Luck egalitarianism' suggests that when people are affected by circumstances beyond their control (e.g. being born in a certain region) this is an injustice. Though Rawls has been criticised for holding this position, he writes that 'it is [not] unjust that persons are born into society at some particular position […] these are natural facts […] what is just and unjust is the way that institutions deal with these facts' (in Mandle, 2009, p. 24; Rawls, 1971). In this way spatial justice theory responds to accusations of environmental determinism in suggesting that it is socio-spatial institutions and power structures which co-constitute a geography of opportunity alongside geographical characteristics. Therefore space and the social institutions which constitute it should be a subject of further scrutiny by justice studies.

Some argue that there is no 'additionality' in the term in comparison to existing justice concepts, for instance those in the Climate, Energy and Environmental (CEE) justice framework (McCauley and Heffron, 2018). Further work justifying the critical value of this separate but complementary justice concept would therefore be useful, as in the approach taken by Jenkins (2018) outlining the additional remit of energy as well as climate justice. Whilst theoretical debate on the value of 'spatial justice' should inspire critical caution around use of the term, it is nevertheless a 'useful' concept in the context of the spatially differential quality of environmental justice issues. It is perhaps helpful to adopt Soja's definition of spatial justice as representing 'a particular emphasis and interpretive perspective' rather than a 'substitute or alternative to other forms of justice' (Soja, 2010, p. 13). Other discursive work suggests that space should be considered as 'a social product rather than a context for society' (Pirie, 1983), partially overcoming some of the above stated critique, in recognising the mutualistic relation between space and society.

In addition to the CEE framework, justice is frequently framed in three core terms: distribution, procedure, and recognition. The concepts have clear spatial implications and are therefore useful framings through which to discuss spatial justice. However, these spatial dimensions are not often documented in the literature, resulting in a research gap which we aim to address here. In the context of the LCT, distributional justice refers to whether the benefits and burdens of transition are allocated evenly across society (McCauley et al., 2013), and critically, across space. Procedural justice is

fairness in the opportunity to be consulted and included in decision-making processes, particularly around new energy developments in the case of the LCT (Martiskainen et al., 2021). Procedural justice may be spatially variable where there is less engagement with certain communities or regions, or democratic infrastructures are less in place within certain regions to enable this participation in LCT decision-making. Recognition justice is the acknowledgement of divergent identities, cultural histories, and power dynamics, and how these may interact with proposed changes under the LCT. Space is particularly important to recognition justice in terms of recognising specific place identities and how these may shape the acceptability of transition measures.

Equity principles can be considered as a means of achieving just outcomes, and in this review we address the core issues of responsibility and capability (Höhne et al., 2013; Sasse and Trutnevyte, 2019). Responsibility refers to fair burden-sharing by those regions which currently receive most benefit from a given activity or have most contributed to high emissions historically, whilst capability may be defined as the ability of regions to respond to the need to decarbonise or the possible burdens and costs imposed by the LCT.

In this project we therefore take forward the approach outlined by Soja and others in using ‘spatial justice’ as a critical analytical perspective through which to assess the socio-spatial changes emerging and likely to emerge as part of the LCT. However, spatial justice can be broadly defined in this context as ‘the fair geographic distribution of benefits and burdens associated with, and arising from, the low carbon transition’. Bouzarovski and Simcock (2017) provide an examination of spatial justice issues in the context of the energy transition, interrogating the household impacts of energy poverty, and identifying ‘that there are clear geographic patternings associated with energy poverty, as well as the geographically embedded and contingent nature of its underlying causes’. We follow the approach of Bouzarovski and Simcock (2017) in applying spatial justice to the LCT but depart in considering the whole system impacts of transition; that is, considering cross-sectoral and economy-wide impacts beyond energy supply and demand.

2.5. Methods and research design

We conducted a semi-systematic (or integrative) literature review, defined as ‘a form of research that reviews, critiques, and synthesizes literature on a topic in an integrated way such that new frameworks and perspectives on the topic are generated’ (Torraco,

2005, p. 356). Semi-systematic differ from ‘full’ systematic reviews in their emphasis on generating new, mainly qualitative, insights from interdisciplinary literature rather than a full capture and quantitative analysis of records. Although systematic reviews guarantee an objectivity, reproducibility, transparency and rigour (Haddaway et al., 2015; Sovacool et al., 2018) that cannot be provided by narrative review methods, a full systematic review was not considered appropriate for this research question. Several factors qualify the use of the integrative review approach in this study, namely:

a. the research area is highly exploratory (Haddaway et al., 2015) and there is limited available literature in this space;

b. the review takes a deliberately interdisciplinary approach, recognising the value of contributions from such diverse fields as geography, regional studies, ecological economics, and the humanities (as evident from a pilot literature search). Integrative reviews are seen as particularly useful where the available literature is interdisciplinary (Balzani and Hanlon, 2020; Torraco, 2005; Torraco, 2016);

c. the variability of methods in the relevant literature limits comparability and makes it difficult to perform meaningful quantitative meta-analysis (Snyder, 2019).

However, we have applied as far as possible the principles of a systematic review approach inasmuch as they improve the rigour of the research (Sovacool et al., 2018). A ‘continuum’ of more or less systematic review approaches is frequently cited (Sovacool et al., 2018), where this review aims to lean towards the systematic end of this continuum. The search was conducted with reference to the systematic review guidelines of Liberati et al. (2009), and with the integrative review guidelines of Torraco (2005; 2016).

We developed the research questions framing the analysis on the basis of a pilot search of the literature, which also helped to identify what the key research gaps are. It also provided opportunity to test the search criteria and strategy, and helped identify relevant terminology in the research area to inform the search terms (Snyder, 2019).

The literature search was initially conducted in February 2021, with a follow-up search in July 2021 to capture any later published articles. It is possible that relevant material has been published in the interim period between the date of the review and the publication

of this analysis. The search used the Web of Science and Scopus databases, as well as citation searching of key papers. The process is described in Figure 5.

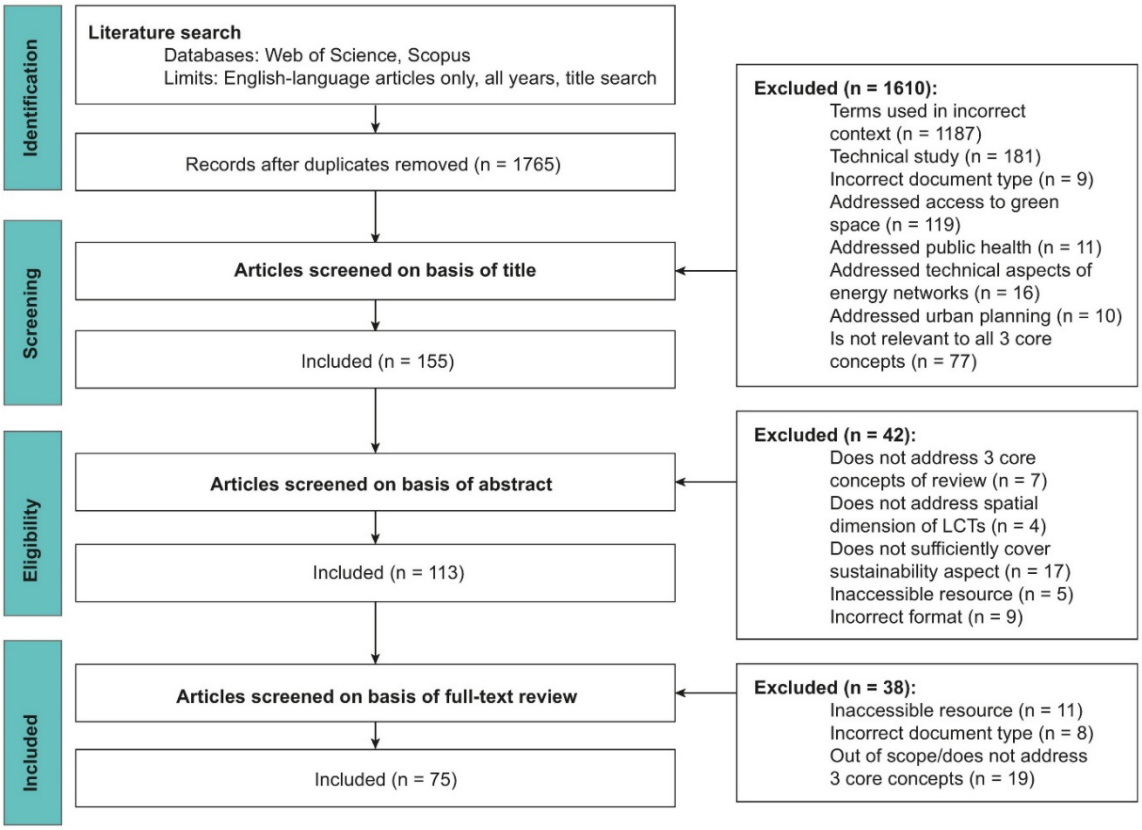

Figure 5. Flow chart of review process (PRISMA format).

On the basis of the pilot search, the key terms of the research questions and their synonyms were used. We identified 78 potential variants of the search criteria (i.e. synonyms), therefore we refined this selection through Boolean, truncation and wildcard search techniques (see Table 4).

The final sample included 75 records and the sample size was deemed sufficient given the specificity of the research area; similarly, the inclusion criteria meant that each study must explicitly address each of the 3 core dimensions of interest (spatial dimensions, justice, and the LCT). Meta-analysis of the final full-text sample (n = 75) was undertaken. A number of descriptive criteria were identified to help characterise the literature including case study location, the justice framework utilised, and methodologies employed.

Table 4. Summary of the search strings used, and the aspect of the research question they address.

Dimension	Element of search string
Spatial	TITLE: (spatio* OR spatial* OR geograph* OR "place-based" OR region* OR space OR scalar OR provincial OR polycentr* OR devol* OR decentral*)
Justice	AND TITLE: (justice OR just* OR "just transition" OR fair OR equal* OR *nequal* OR equit* OR inequit* OR injustice OR inclusive OR "climate justice" OR "energy justice" OR "environmental justice" OR disparit* OR democra* OR distribution* OR "social equity")
Low carbon transitions	AND TITLE: ("low carbon transition" OR "low carbon transitions" OR "low carbon economy" OR "low carbon" OR "net zero" OR "net-zero" OR "zero carbon" OR "zero-carbon" OR "carbon neutral" OR "sustainable development" OR "sustainable transition" OR sustainab* OR "climate change mitigation" OR "green recovery" OR decarbon* OR "energy system transition*" OR green* OR mitigat* OR "low-carbon transition" OR energy OR "energy system")

We took an inductive and exploratory approach to analysis of the final literature sample and performed thematic analysis using Qualitative Data Analysis Software (QDAS; NVivo Plus v.12.6). An inductive approach was considered appropriate due to the exploratory nature of the research question (Clarke and Braun, 2017). Thematic analysis was identified as more appropriate than content analysis, since the latter refers to a more quantitative method involving, for example, word count frequencies (Guest et al., 2014). We analysed the entire sample using an iterative thematic coding approach until we considered we had reached 'theoretical saturation' (where no new insights were being generated, and there was a sense of consensus amongst the themes identified).

2.5.1. Methodological limitations

Whilst every attempt has been made to ensure the review's rigour, transparency and validity, we acknowledge that there could be room for improvement and note the importance of reflexive critique in research design.

The review technique could have been more systematic (indeed classed as a full systematic review), had the exclusion criteria been more defined, and the records included in the final sample been subject to review by several authors rather than only the lead researcher. The exclusion criteria adopted are found in Figure 5, and included both functional and thematic criteria ranging from ‘includes key terms but in an incorrect context’ to ‘not encompassing the three core concepts of the review’ (e.g. spatial factors, justice issues, sustainability). Similarly, many important resources may have been omitted due to the linguistic bias in only selecting articles written in English. The final sample may also simply reflect disparities in where climate and LCT research is funded, rather than where spatial justice issues are most problematic and in evidence.

The final sample is necessarily a product of the search string, and perhaps notably missed many useful articles from the field of regional studies. A key methodological improvement could involve broadening the search criteria to better encompass disciplinary terminologies to ensure breadth of coverage in the final sample. However, the search string was deemed sufficient for the purposes of this analysis and in achieving a manageable sample size.

Whilst details of the search and screening process and the records in the final sample have been clearly documented to improve transparency, the findings of the review would not be clearly reproducible given the qualitative and ‘thematic’ nature of the analysis. That is, other researchers might identify other issues as more important, and there is a subjective dimension to the coding process. Similarly, the review was undertaken at a specific point in time, therefore the results could look different if the searches were run at a later period. This suggests the results may not be generalizable across time.

However, in adopting an integrative review approach, we hope to overcome the issue of disciplinary bias (Goodman and Marshall, 2018), and in employing full systematic review techniques we aim to achieve a level of research rigour as far as practicable (Sovacool et al., 2018).

The subsequent review is structured conceptually, drawing on the high-level categories that emerged from the thematic analysis. The review begins with a general

characterisation of the literature based on the meta-analysis, before considering the spatial scales of interest in LCT studies in response to research question 1. The subsequent discussion addresses research question 2 and considers distributional, procedural and recognition justice in terms of space, before examining how these issues feed into the acceptability of transitions in different regions, with reference to the equity concepts of capability and responsibility. We then consider issues such as the role of spatial planning and the legacy of previous transitions, before suggesting challenges and solutions for spatially just policy and governance approaches aligning with research question 3.

2.6. Results and discussion

The full-text screening resulted in a sample of 75 final studies, covering a range of disciplines with 24% in the field of geography, and with 85% published in the last 10 years (see Figure 6).[16] The small number of records found for the year 2021 may reflect that the search was conducted early in the year. During the screening process many studies had been excluded on the basis of an unclear conceptualisation of 'sustainability', and failing to consider issues such as climate change mitigation, decarbonisation or emissions (the aspect of explicit interest to this study in considering low carbon transitions in their broadest sense).

Similarly, whilst many papers provided descriptive studies of linkages between environmental pollution and spatial variables (for instance correlations with Gross Domestic Product, GDP), many papers did not explicitly include any acknowledgement of the justice issues which may have driven such distributional issues. This also formed another exclusion criterion. This reinforces the importance of drawing a distinction between in*justice* and in*equality*; that is, spatial inequalities do not mean de facto spatial injustices. The terms are generally used interchangeably in the literature however (Walker, 2009).

Healy et al. (2019) identify that 'injustice' is frequently used as an umbrella term for any environmental harm, which elides the different scales of harm and relative vulnerabilities for communities in the Global South as opposed to the North. Inequality can be understood as the descriptive difference in a socioeconomic variable between regions,

[16] See Appendix for further discussion of the meta-analysis results, the codebook and for the full list of studies included in the sample.

whereas injustice suggests a dimension of unfairness in the socioeconomic conditions certain regions face relative to others and in how one area is treated over another.

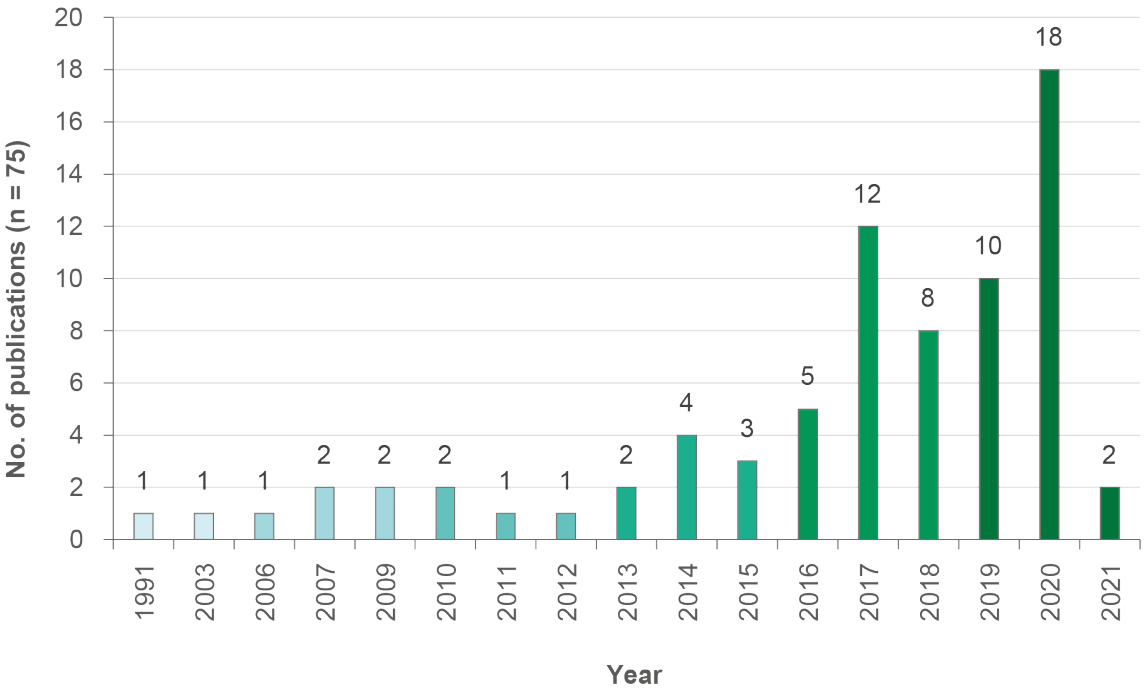

Figure 6. Bar chart outlining the number of records per year from the full-text sample (run in February 2021). No publication date exclusion criteria were applied in the search.

In addition to the 'vertical' question of spatial scale considered in the studies, the final sample also included a broad range of case study locations. Over three quarters of the papers featured a case study in a developed country, indicating a research gap in the consideration of spatial justice issues in the developing world, perhaps as a result of the unequal distribution of research funding between these regions. For instance, a recent study found that only 3.8% of global climate change research funding is spent on research in African countries (Overland et al., 2021). The majority of case studies were located in Europe (34%), the United Kingdom (UK) (23%), and North America (19%). This may be attributable to more clearly devolved subnational powers and administrative structures in these regions, making an intranational spatial approach of greater interest to exploring the LCT given the powers available to influence it. There may however be a geographical bias as a result of the linguistic bias (due to the exclusion criterion of only 'English language' articles due to the capacities of the research team).

Methodologically, the most common approach in the study sample was use of a ‘conceptual framework’ (n = 15), whilst seven studies provided indicator framework assessments. Many question the usefulness of theoretical frameworks given the climate emergency and continually rising emissions, debating how they may be operationalised or put into practice (Heffron and McCauley, 2017; Jenkins, 2018). This may in part explain the rising phenomenon of the ‘indicator framework’ methodology, which attempts to quantify and track progress and justice in an aspect of the LCT.

The studies had three main areas of critique towards previous research, pointing to ongoing research gaps, namely: a) aspatiality or a national scale bias; b) the use of income-based metrics to assess relative injustice; c) the predominance of the ‘green jobs’ debate in just transition studies.

The studies critiqued the aspatiality of previous research (Balta-Ozkan et al., 2015; Bouzarovski and Simcock, 2017; Cruz-Sandoval et al., 2020; Olner et al., 2020). A frequent argument was that a lack of geographical perspectives disguises the spatial phenomena that are environmental injustices. Other critique of the spatial approach of LCT analyses focussed on the disproportionate bias towards one scale rather than adopting a multi-scalar approach (Sovacool et al., 2021; While and Eadson, 2019). The national scale was frequently cited as the focus for many LCT studies when space was discussed (Agbim et al., 2020; Balta-Ozkan et al., 2015; Cole et al., 2017; Gibbs and O’Neill, 2016), with many suggesting this was due to the concentration of (policy) power at higher order scales (Bouzarovski et al., 2017; Forman, 2017). A multi-scalar approach was viewed as important in assessing the variable subnational impact of national policies (Baer, 2009).

A further critique lay in the predominance of income-based analyses in the existing literature, for instance the use of ‘expenditure metrics’ such as the energy expenditure-to-income ratio used to determine relative energy poverty rates (Agbim et al., 2020; Bouzarovski et al., 2017; Robinson et al., 2018; 2019). The choice of indicator or metric determines the patterns of injustice that are likely to be found. Whilst expenditure and income are important spatial variables, they are not the only or necessarily the most important explanatory factors in assessing injustice (Reames, 2016; Robinson et al., 2018; 2019; Sun et al., 2020). For instance, Reames (2016) show that patterns of racial segregation significantly influence exposure to fuel poverty.

In other critique of the prevailing focus of existing literature, Balta-Ozkan et al. (2015) drew attention to the primacy of the ‘green jobs’ narrative to the exclusion of other areas

of impact associated with the low carbon transition. Sareen and Haarstad (2018) critique the disciplinary and normative split between the supply-focussed sociotechnical transitions studies and the demand-side basis of justice analyses. Emerging scholarship is indeed addressing the supply-demand dichotomy in considering embodied injustices along both fossil fuel and renewable energy supply chains (Healy et al., 2019).

2.6.1. What spatial scales are considered in analyses of LCTs?

Spatial scale is a term which, like spatial justice, has lacked definition but has a long history of academic debate. Whilst extensive discussion of 'ontologies' of spatial scale are beyond the scope of this review paper, we summarise a few key perspectives as follows.

Several authors engage with what has become known as the 'politics of scale' (Marston et al., 2005; Moore, 2008), and with whether scale should be considered in a vertical, hierarchical, or nested model, or conceptualised as a 'flat ontology' (Marston et al., 2005; Shove and Walker, 2010). The multi-level perspective (MLP) has been viewed as typical of the 'nested hierarchy' model, and is a means of characterising sociotechnical transitions of significance to the LCT debate. MLP theory posits that transitions occur due to interactions at several levels including: niches, socio-technical regimes and the socio-technical landscape (Geels, 2011; Gibbs and O'Neill, 2016). However, flat (non-vertical) conceptualisations of scale suggest more agency for actors to exact change across scales and have been forwarded as a more accurate scalar model for LCT studies. Others suggest that scale is a socially constructed entity (Marston, 2016; Moore, 2008) and attention is drawn to its 'relational nature' thus making most definitions by nature reductive.

In response to the first research question, the studies in the final sample considered a wide range of spatial scales, from the local, community, neighbourhood, or city-scale, to the world 'region'. It is critical to note that any definition of 'regional' is conditional, as the term may describe any spatial subdivision of a larger whole; as noted by Sovacool et al. (2019), 'scalar categories are relational'. This corresponds with the above stated critique of any stable and bounded definition of 'spatial scale'. Similarly, administrative boundaries are not always the most relevant definition of space, given processes which occur outside the bureaucratic oversight of regional authorities and given transboundary activities; that is, administrative designations do not always match the lived reality of

communities (Pohoryles, 2007). However, the administrative definition of a region may be useful insofar as it indicates where devolved policy powers may lie (Cole et al., 2014).

Injustices are also dependent on the assumed spatial scale of the analysis, since there are inequalities both within and between regions. As a partial corrective to this, and building on the work of Amartya Sen, Fisher (2015) argues that 'justice must be comparative', that is, the relative injustices between regions in the UK for instance are of a different order to injustices between developing and developed nations. There are also issues of whether injustice can or should be monitored through objective or subjective metrics (Agbim et al., 2020). Lawhon and Patel (2013) note that 'the choice of scale influences whether injustices are found'. For instance, whilst London is one of the most affluent regions in the UK, the London boroughs are not ubiquitously wealthy and many have the worst poverty rates in the UK (depending on the assumed metric of 'poverty'). Therefore reductive binaries such as the 'North-South divide' in the UK, or even the Global North and South, are not always appropriate as conceptual shorthand for injustice. Similarly, Sauter et al. (2016) observe that intranational inequalities in carbon dioxide (CO_2) production can be greater than international inequalities, as driven by sectoral inequalities in their global study.

Available data at different spatial scales, as well as the use of data and metrics may determine the perception of relative spatial injustices. For instance, the aggregation of high resolution data can disguise important trends occurring at the subnational scale, often known as the 'modifiable areal unit problem' (Bouzarovski and Simcock, 2017; Li et al., 2016; Wei, 2010). Similarly, the 'social cost of carbon' (a measure of pricing marginal CO_2 emissions to reflect the social implications of future climate impacts) is found to double when estimated at the intranational rather than international scale. This is due to variations in income distribution within countries, highlighting regional vulnerabilities and therefore analytical sensitivities to assumed spatial scale (Anthoff et al., 2009; Baer, 2009).

In this way, the assessed studies considered a variety of spatial scales. However, there remains scope to correct the previous 'aspatiality' of LCT studies, as noted by work proposing whole systems approaches and for greater consideration of the spatial implications of energy justice (Martiskainen et al., 2021; Sovacool et al., 2017). There is similarly need to address the predominance of focus on the national scale, and to more critically consider the choice of 'injustice metrics'.

2.6.2. How are spatial justice issues explicitly or implicitly presented in assessments of LCTs?

2.6.2.1. Distributional justice across space

Spatial justice in the LCT can be defined as the fair geographic distribution of benefits and burdens associated with, and arising from, the low carbon transition. Distributional justice refers to the 'physically unequal allocation of environmental benefits and ills' (McCauley et al., 2013) and is therefore an inherent feature of spatial justice theory. Successive studies addressing spatial justice similarly employ a rhetoric of benefits and burdens. For instance, Jenkins et al. (2016) highlights the need to distribute both fairly in order to ensure a just transition. There is often disproportionate focus on the burdens of transition (Antal et al., 2020), which has somewhat been reshaped by debate over 'green recovery'. 'Green recovery' is a policy discourse common in the wake of the COVID-19 pandemic, hoping to stimulate economic growth whilst also achieving reductions in emissions. In seeking policy support, many parties have framed transitions activities in terms of economic co-benefits and exploited potential to channel countercyclical investment towards decarbonisation (Goh, 2020). It is in essence a multiple benefits approach to economic development, comparable to previous attempts to implement a 'Green New Deal' – a package of public policies that address climate change whilst improving wellbeing.

A spatial justice perspective builds on the just transitions literature in identifying that the benefits and burdens of transition may not be distributed equally across space – for instance, new opportunities may not arise in the same places where there have been opportunity costs (While and Eadson, 2019). There is the additional need to ensure that any negative consequences of transition do not exaggerate existing patterns of deprivation, as there was a key concern in the literature that the LCT could reproduce existing inequalities.

Debate in the assessed studies around the spatial distribution of benefits and burdens associated with LCT shaped a narrative of regional 'winners and losers' (Coutard and Rutherford, 2010; Pye et al., 2020; Roberts, 2003; Sayan, 2019; Sovacool, 2017; Sovacool et al., 2019; Wells, 2012). Though many studies are unclear as to the specific actors and/or regions that fall into either category, 'winners' ranged from regions which have a cost-optimal allocation of the remaining burnable coal reserves (Pye et al., 2020) to children who benefit from the phaseout of nuclear energy in Germany due to lower risks associated with waste disposal (Sovacool et al., 2019). 'Losers' included Nordic oil and gas regions (Sovacool, 2017) and other areas with high concentrations of heavy

industry and/or fossil fuel production, or else regions with plentiful clean energy resources but with local opposition to exploiting such opportunities (Sovacool, 2017). Roberts (2003) goes so far as to suggest that the winners and losers of environmental change and social injustice are comparable groups. A paper titled ‘Regional winners and losers in future UK energy system transitions’ (Li et al., 2016) identifies that the regions characterised as ‘winners and losers’ will be dependent on the precise socio-technical scenarios and policies implemented at the national scale, as determining where investments (particularly in the energy system) are directed. From a justice perspective, ‘winners and losers’ narratives take issue with the very creation of ‘losers’ or the further penalisation of ‘losers’ from the current socioeconomic status quo. From a spatial perspective, this narrative addresses the idea that certain regions are more susceptible to further ‘losses’ from transition policies.

A similar trend was in the discussion of ‘left behind’ places which returned seven direct references in a word query of the sample, a term commonly found in the regional development literature and generally describing areas facing multiple deprivation. Demeterova et al. (2020) note Europe's ‘fiscally weaker’ and ‘lagging’ regions, despite efforts via the European Territorial Cooperation (ETC) initiative (or Interreg) to improve cohesion between European Union (EU) states across borders and scales. They also highlight that such regions are likely to be more vulnerable to climate impacts, therefore reinforcing ‘existing spatial inequalities’. They argue that there is a need for ‘regionally anchored definitions of success’, that is, regional development pathways specific to the context rather than a prescribed national definition of sustainable development. This accords with arguments for recognition justice as is later discussed. Others cite the just transitions commonplace of ‘leaving no one behind’ (Cruz-Sandoval et al., 2020), a truism challenged by several authors, who critique the assumption that everyone is starting from the same place. It could perhaps be argued that there are pre-existing socioeconomic ‘losers’ who risk becoming more vulnerable as a result of transition policies.

Lihtmaa et al. (2018) cite the post-industrial regions of former socialist countries such as Estonia, where although access to subsidies was ostensibly even, the take-up of subsidies reflected pre-existing regional inequalities. In essence, there is a suggestion that certain communities and regions already face post-industrial deprivation and are not therefore starting from a position of equality; there is then the risk of ‘double deprivation’ from transition policies. Comparably, the UK’s ‘levelling up’ agenda (announced during a 2019 election campaign) ostensibly aims to even out current regional inequalities

across the country (Grantham Research Institute on Climate Change and the Environment, 2020). This particularly concerns relative differences in productivity levels and standards of living. The rhetoric acknowledges the uneven starting places of regions, but suggests there is a normative or target ‘end state’ that all regions can and should reach.

Discussion of benefits arising from the LCT primarily centred around employment opportunities, building on the just transitions literature focus on fossil fuel jobs. Further to the discussion of where new jobs will be created was a deeper debate around how the transition will affect opportunity structures for different regions, particularly a concern over the spatial equality of opportunity (Bouzarovski and Simcock, 2017; Cruz-Sandoval et al., 2020; Manderscheid, 2012; Roberts, 2003). Finio et al. (2019) similarly refer to the ‘geography of opportunity’. There is an assumption in much of the green jobs literature that such opportunities will be created in the areas where they are most needed, and that skills will be transferable between industries old and new (Evans and Phelan, 2016; Sovacool, 2017; Sovacool et al., 2019). There was also concern over the relative quality of the new transition jobs, and whether they provide an adequate or desirable substitute (Yenneti et al., 2016). There is an element of environmental determinism in the frequent discussion of how the location an individual chooses to live in, or is born into, informs their life chances; as Bouzarovski and Simcock (2017) note ‘where a person lives seems at least as significant as the socio-economic group that they are part of’, and Robinson et al.'s (2018) conclusion that ‘where you live matters in addition to who you are’.

More than the specific new burdens generated by the LCT, there was therefore a concern with how they would interact with existing socio-spatial inequalities and injustice. Several authors drew attention to how some regions are more vulnerable, and are intrinsically more sensitive to issues such as electricity price rises (Bouzarovski et al., 2017; Carley et al., 2018; Sovacool et al., 2019). For instance, Sovacool et al. (2019) identify that the UK smart meter rollout could drive rising household energy costs when users cannot respond to energy data by changing tariffs, reinforcing vulnerability in households facing fuel poverty. At the national scale, regional socioeconomic inequalities are driven by rising energy costs where energy bills are used as a means to fund the development of low carbon infrastructures (Sovacool et al., 2019). Sovacool et al. (2019) cite the potential for cost pass through to consumers in LCT activities as diverse as French nuclear decommissioning and Norwegian Electric Vehicle (EV) subsidies. This has led to calls to fund low carbon energy systems via a general taxation approach (Owen and

Barrett, 2020). Carley et al. (2018) adopt a ‘vulnerability scoping’ method applied to the United States (US) renewables rollout to assess these types of distributional impact.

Geographical differences may lead some regions to benefit more from the resulting low carbon infrastructure than others. For instance, where network structure affects the accessibility and price of different energy carriers, particularly affecting rural and otherwise peripheral regions that are dependent on certain fuel types and who may be less able to access subsidies (Golubchikov and O’Sullivan, 2020). Bouzarovski et al. (2017) also note this vulnerability due to spatial dependencies on certain fuel types, noting the case of ‘post-communist’ states where rises in electricity tariffs drive use of ‘affordable fuels such as coal and firewood’. This vulnerability is compounded by pre-existing socioeconomic disparities such as inefficient housing stock. Policy was viewed as a key means of controlling the spatial distribution of this type of burden, particularly in issuing financial and technical compensation and assistance (Füssel, 2010).

In the discussion of burden distribution, a recurring concern was how industrial regions specifically may be adversely and disproportionately impacted by transition policies. As either regions which have suffered from the economic fallout of deindustrialisation in many developed states, or else regions where polluting industrial activity is still concentrated, such regions can be seen as more vulnerable to the policy cost burdens of industrial decarbonisation. For instance in Vandyck and Van Regemorter's (2014) case study of the impact of a Belgian energy tax, they find that ‘due to the sector composition, GDP in the region that hosts more energy intensive industries […] decreases’. Another source of vulnerability stems from the importance of the industry to regional employment – similar to the Company Town model in the US, where industry constitutes the main employer for the region. Regions dependent on single industries or companies for employment are disproportionately vulnerable to climate policy and transition (as well as other forms of economic shock), given the negative economic spill-over effects into the local economy if industry is forced to become less productive (Green and Gambhir, 2020; Olner et al., 2020). Rising electricity prices also have an indirect spatial impact here when they affect the competitiveness of industrial regions and in turn their employment base (Carley et al., 2018), carrying the risk of industrial offshoring.

The studies also explored a number of other typologies of ‘space’, for instance the difference in injustice between rural and urban land uses (Bouzarovski and Simcock, 2017; Bouzarovski et al., 2017; Mueller and Brooks, 2020; Roberts, 2003; Scarpellini et al., 2019; Setyowati, 2021). Rurality was considered ‘under-explored’ and a predictor of spatial injustice (Mueller and Brooks, 2020). Rural communities were seen as both more

vulnerable and less able to benefit from some of the opportunities arising in the course of the LCT. For instance, rural regions are typically more susceptible to energy poverty due to limited access to energy services and a dependence on oil for heating for example (Robinson et al., 2019). Similarly, rural areas are seen as less able to benefit from the transition to EVs and policy incentives to support this (Chatterton et al., 2018; Fell et al., 2020). The systematic privileging of urban areas was suggested, in the argument that policy prioritises areas of concentrated and homogenous deprivation (Robinson et al., 2018). However, specific opportunities for rural areas in the LCT include the potential for decentralised energy generation technologies (Balta-Ozkan et al., 2015).

Several studies considered the geographic gap between benefits and burdens in the LCT as a public good problem, concerning the fair spatial distribution of environmental externalities but also opportunities (Sovacool et al., 2019). This issue may manifest in more or less tangible forms, for instance in dispute over energy infrastructure siting, or else the distribution of policy costs for infrastructures which may serve one region better than another. This is particularly relevant when considering renewable energy infrastructure siting for instance, where questions have been raised over the viability of placing the infrastructure in an area that meets local resistance whilst ostensibly serving national decarbonisation needs (Balta-Ozkan et al., 2015; Sovacool et al., 2021). This scalar mismatch in interests, where a new infrastructure is ‘locally unwanted’ but nationally needed (Mueller and Brooks, 2020), is often articulated as ‘NIMBYism’ (or ‘Not In My Backyard’). This relates to the scalar problem framing of climate change as a ‘global’ issue, and therefore not a cause for local responsibility-taking (Chapman and Pambudi, 2018).

The literature on the distributional justice issues of the LCT accord with current policy proposals (for instance around Levelling Up and green recovery) that reflect concern around socio-spatial inequalities. Yet there is a key research gap in considering the types of policy and governance tools which could bridge the disparity in where benefits and burdens are distributed to inform this policy agenda. Overall, the degree of interest in questions of distributional justice is well reflected by the number of records in the sample discussing it. This perhaps points to an imbalance in the literature in terms of the preoccupation with distribution over other dimensions of justice (for instance recognition and procedural justice).

2.6.2.2. Procedural justice within regional transitions

In the context of the LCT, procedural justice is the fair opportunity to be consulted on proposed developments and to engage in the planning process. Procedural justice may refer to both participating in processes of responding to environmental ‘bads’, but also the fair opportunity to secure the provision of environmental ‘goods’ (e.g. access to green space, ecosystem services, pro-environmental subsidies, renewable energy developments; Mayne et al., 2017; Sovacool, 2017; Zhai et al., 2020). Lihtmaa et al. (2018) cite Meadows' ‘success to the successful systems trap’ whereby communities or social groups with pre-existing social capital are better placed to benefit from the LCT, for instance in access to subsidies. This contributes to a vicious cycle working against social mobility, and perpetuating existing socioeconomic power structures. There are also disparities in the spatial distribution of other forms of capital. In the case of community energy cooperatives for example, there may be a lack of financial capacity to contribute, or else a lack of knowledge or skills to initiate the project (Catney et al., 2014; Yildiz et al., 2015). So-called ‘human capital’, the knowledge and skills individuals possess (Ostrom, 1995), is therefore a constraint to collective action, particularly in terms of transition activities which require technical expertise.

Conversely, environmental harms are more likely to occur in more deprived areas, given a lack of social capital and the potential for less resistance to the harms imposed. As Mueller and Brooks (2020) note:

> industries siting locally unwanted land uses know they face costly opposition, and therefore choose to target areas with lower social and financial capital, where local opposition has historically been less effective.

Social capital is spatially varied, meaning different regions and communities have variable capacity to respond to the placement of burdens during the transition. Whilst such issues are applicable to environmental assessments in general, this highlights the importance of attending to spatial dimensions in assessing the relative justice of transition policies and measures.

Procedural injustice may occur when affected communities are not appropriately consulted on potential LCT developments. This may result when the definition of ‘those affected’ is incorrectly drawn or in drawing spatial boundaries as a means to define a ‘community’ (Simcock, 2014). Walker (2009) indeed argues that geography has a key role in the ‘inclusions and exclusions of environmental decision-making’, influencing the ability of citizens to participate in decision-making meetings virtually, or even have time to attend such events. In broad terms, citizens' assemblies are an increasingly popular

governance tool which go some way to address such issues of procedural injustice. The assemblies are being used as fora by which citizens can participate in local and regional decision-making around climate mitigation and adaptation, amongst other social issues (Wells et al., 2021). The assemblies aim to include a representative cross-section of civil society in creating regional LCT development pathways, therefore the recruitment process renders this a means of achieving recognition justice.

In this way, the design of procedural justice mechanisms has significant implications for achieving recognition justice, and there is a co-dependence between the two. That is, procedural justice involves *recognising* those who are affected by a given development and who have the power and authority to influence LCT decision-making (Bulkeley, 2012), and recognition justice is enacted by fair *procedures*.

2.6.2.3. Recognition justice and place identity

Recognition justice 'acknowledges the distinct identities and histories of people in relation to the energy system and seeks to eliminate forms of socio-cultural domination' (Setyowati, 2021). In transition studies recognition justice therefore becomes a means of accounting for cultural context and determining developments which are 'locally appropriate'. Failure to consider recognition justice can lead to localised resistance to proposed developments. As Devine-Wright (2011; in Sayan, 2019) suggest, 'place-protective actions […] arise when the siting of […] energy technologies […] threaten place-based identities'. This is evident in local objections to wind energy developments in rural areas (Devine-Wright, 2009), and conversely in local encouragement to fossil fuel developments in ex-mining regions (Evans and Phelan, 2016).

Several studies identified that there was a need for caution in that existing 'place identities' could present a barrier to transition policies, where certain regions are heavily characterised as sites of fossil fuel production; for instance, Evans and Phelan's (2016) case study of resistance to transition in an Australian coal mining region. The 'stigmatization' and 'misrecognition' of place can drive undesirable development, meaning certain areas and land uses face consistent marginalisation (Dwi Cahyani et al., 2020). Rudolph and Kierkegaard (2019) notably discuss 'territorial stigma' as both a result of and as driver of undesirable development.

'Place-protective' actions have the potential to delay renewable energy projects and other important transition policy measures. For instance, in a case study of a Canadian

transboundary region a proposed cooperative system of governance received little support due to concerns over the loss of place-based identity (Bélec and Buckley, 2014). There is similarly a need to consider historic identity and how this may shape the acceptability of different transition policy measures. In Japan, a risk-aversity to certain energy developments is observed given the definitive experience of Fukushima (Chapman and Pambudi, 2018).

Recognition justice is particularly important in regions where communities experience a close cultural connection to their landscape, to the extent that place becomes non-dissociable from identity (Buhangin, 2013; Yenneti et al., 2016), and where radical environmental change risks creating a sense of 'solastalgia' (Mueller and Brooks, 2020). Recognition justice therefore draws attention to the need to consider non-monetary place attachments – that is, where a sensibility of place and local value is important in shaping what kind of transition is acceptable or even desirable.

Table 5 provides a summary and case studies of the spatial justice implications of each of the main justice dimensions, before the discussion moves onto the equity principles of acceptability, responsibility and capability.

Table 5. Spatial aspects of core justice dimensions.

Dimension	Spatial justice implications	Case studies
Distribution	Benefits and burdens of the LCT could be unevenly distributed across space, intersecting with pre-existing, and creating new, inequalities	• Oil and gas producing regions facing ongoing socioeconomic impacts – e.g. Nordic regions (Sovacool, 2017). • Industrial and post-industrial regions will be disproportionately affected by climate policy; modelling of a Belgian energy tax reduced GDP in industrial regions (Vandyck and Van Regemorter, 2014), and rising energy costs may force industrial offshoring (Carley et al., 2018). • Post-industrial regions facing 'double deprivation' from transition policies, since they are starting from a position of inequality (Lihtmaa et al., 2018). • Electricity price changes as part of funding low carbon energy infrastructures may exacerbate existing energy poverty (e.g. in post-communist states with inefficient housing stock; Bouzarovski et al., 2017).

		• Funding LCT measures may pass through costs to consumers, as in the case of French nuclear decommissioning (Sovacool et al., 2019). • Differential access to subsidies may further impact 'low-performing' regions, as in the case of Estonia (Lihtmaa et al., 2018). • Certain 'types' of space (e.g. rural areas) are structurally less able to benefit from subsidies, for instance for EVs (Chatterton et al., 2018; Fell et al., 2020), and urban areas are systematically prioritised (Robinson et al., 2018).
Procedure	Regions may face variation in opportunities to engage with decision-making around low-carbon developments	• Locally unwanted development is more likely to occur in areas of lower perceived resistance, i.e. lower social capital (Mueller and Brooks, 2020). • Communities affected by a development may not be appropriately consulted due to definitions of the 'affected population' being drawn around arbitrary spatial boundaries (Simcock, 2014). • Certain regions and social groups therein may be less able to contribute to local LCT projects (e.g. energy cooperatives) due to the spatially varied distribution of social, financial, and human capital (Catney et al., 2014; Middlemiss and Parrish, 2010; Yildiz et al., 2015). • Citizens' assemblies may provide fora for public input to regional development pathways and LCT planning for their region, as well as enabling a fair representation of views from a cross-sector of civil society (Wells et al., 2021).
Recognition	Regions have distinct 'place identities' and histories which should be acknowledged in the development of regional LCT pathways	• Without recognition of local acceptability, proposed developments are likely to encounter resistance, for instance in local objections to wind energy developments (Devine-Wright, 2009) or local preference for coal developments in ex-mining areas (for instance in some regions in Australia; Evans and Phelan, 2016). • Place identity should be acknowledged as a potential barrier to LCT measures, for instance risk-aversity to certain types of energy development such as nuclear energy in Japan (Chapman and Pambudi, 2018). • Perceived place identities may be exploited where locally undesirable developments are allowed by virtue of having been carried out there before, undermining local preference and desired regional development pathways (Dwi Cahyani et al., 2020). • Past transitions may render certain types of development more or less socially acceptable (Cowell, 2020).

2.6.2.4. Acceptability, capability, responsibility

The above discussion of the spatial implications of the LCT has drawn attention to the importance of visible distributional, procedural and recognition justice in rendering the transition 'acceptable'.

A key finding across the study sample was that the acceptability of the LCT will be dependent on justice, particularly in who receives benefits or burdens (Többen, 2017). Acceptability is a litmus criterion for the viability of the LCT, with low acceptance resulting in public mistrust, or at worst, active protest (Evensen et al., 2018; Sasse and Trutnevyte, 2019; Sovacool et al., 2019). As Yenneti et al. (2016) note, 'the lack of trust can make even "environmentally good" renewable energy projects face resentment.' This is particularly important at the intranational scale, where disparities in those receiving more benefits than burdens may be more immediately 'visible'. For example, there is a significant body of literature exploring the distributional and potentially regressive outcomes of energy taxes (Vandyck and Van Regemorter, 2014), with some proposing general taxation and other approaches as means to improve fairness (Büchs et al., 2021; Owen and Barrett, 2020).

Another key conclusion was that it was the *perception* of justice that counted, rather than any more substantive form of justice. This ties to the concept of perceived responsibility, which feeds into 'discourses of delay' rhetoric around the need for others to take action first (Lamb et al., 2020), and the leader/laggard or 'prime mover' problem. This runs against the trend of indicator framework studies for instance, in suggesting that rather than justice being clearly quantifiable, the impression of relative justice may be the more powerful. Tools identified to mitigate low acceptance involve substantive consultation procedures, which are reflected in the body of work on 'procedural justice' (Yenneti et al., 2016). This is reflected in Simcock (2016), who draws attention to the importance of perceived procedural justice at the local scale in the case of siting community wind projects.

Just as acceptability was dependent on perceived justice in LCT policy measures, a sense of justice was dependent on the recognition of differential capabilities and responsibilities to decarbonise. As Mayne et al. (2017) note 'people are more likely to accept climate change mitigation and adaptation policies if they reflect a fair balance of responsibility, capability and need'. Mayne et al. (2017) and Sasse and Trutnevyte (2019) suggest that capacity and responsibility are 'equity principles', which go beyond the

conventional justice framework of distribution, procedure and recognition (Sareen and Haarstad, 2018).

Capability refers to the ability of different regions or actors to do more to mitigate (Sasse and Trutnevyte, 2019). Responsibility, by contrast, refers to the duty of different regions or actors to mitigate, often reflecting cumulative historic emissions (Sasse and Trutnevyte, 2019). Whilst it is important to note that capability and responsibility do not always align, in historic perspective developed states that have benefitted from more years of fossil fuel production are generally more able to afford mitigation costs. With the offshoring of industrial production however, states in the Global North may have lower domestic emissions, therefore emphasising the importance of an embodied perspective wherein developed states account for the emissions associated with the goods and services they consume, even if they cannot exercise control over the factories themselves.

A critical debate in the literature is whether capacity or capability is the more appropriate term. Whilst Füssel (2010) deem it a 'notational convenience', Mayne et al. (2017) suggest that capability is:

> an actor's ability to take effective action to reduce carbon emissions and which therefore includes its legal powers, policy instruments, financial/technical/human/social resources, as well as the trust that other actors place in it to act.

By contrast, capacity is the more passive ability of an actor to 'cope and adapt' (Füssel, 2010). We refer in this analysis primarily to 'capability' given we are addressing the changes required to achieve a low carbon transition, rather than only the impacts of both transition and climate change.

Capability is spatially differential, which can create issues when responsibility for net zero policymaking is devolved to regional authorities of variable power with the same deliverables expected (Barbour et al., 2011). In the UK, there is significant variation in the ability of different local authorities to both access and implement government funding grants (While and Eadson, 2019). Local authorities challenged by existing issues of multiple deprivation and socioeconomic inequality will have less operational capability to coordinate low carbon policy measures, reinforcing existing regional inequalities (Lihtmaa et al., 2018). At the household level, there are similar disparities in capability. For instance in the ability of different households to access subsidies and utilise them (While and Eadson, 2019); as Sovacool et al. (2019) note, 'the tenants can't put up solar panels because they don't own the roof'. Differential capabilities therefore suggest a

need for caution in assuming the power of individual, and voluntary, action (Coutard and Rutherford, 2010; Mayne et al., 2017).

Issues of injustice arise where there is a conflict between capability and responsibility, particularly where the most responsible and capable do not act first or go furthest. Indeed, Füssel (2010) find that 'there is a double inequity between responsibility/capability and outcome vulnerability to climate change'. That is, those least responsible and least capable are most vulnerable. There is therefore an ethical rationale in identifying the most capable and responsible to act and allocating duties to mitigate on such a basis. This is reflected at the international scale in the United Nations (UN) principle of Common But Differentiated Responsibility (CBDR), which in full also references 'respective capabilities' (Cole et al., 2014).

Whilst justice may be dependent on the most responsible taking the most action, there is significant controversy in how to determine relative responsibility. Equitable carbon accounting typically considers the cumulative historic emissions of an individual country (Grübler and Fujii, 1991). There are fewer considerations of responsibility which address the subnational scale however, despite the fact that the intranational dynamic acts as microcosm for the issues playing out on the global stage and international contentions over responsibility-taking.

Issues may arise where those most historically responsible are least capable of decarbonising in the present day (for instance industrial regions), and therefore become vulnerable to contemporary climate policy. Current competitiveness issues and climate policy costs cause financial precarity in industrial regions, hinder investments in mitigation technologies and create instability in the regional employment base. So whilst industrial areas have generated and continue to generate the majority of production emissions, it is debatable whether they bear responsibility or even have the capability for future decarbonisation. In this way the characteristic and historic economic activity of regions has a set of ethical questions for present day climate policy.

2.6.2.5. Temporal justice and its implications for spatial planning

A critical insight from the study sample was the way in which the LCT may interact with existing and historic land use paradigms, and what this may mean for future transitions. This raises critical questions of intergenerational, *temporal* justice and how it intersects with questions of spatial justice.

Cowell (2020) argues that historic land use could affect the relative acceptability of proposed developments, noting that ‘already industrial’ areas are likely to be considered more acceptable for further development or even reindustrialisation. This overrides questions of recognition justice which ask what type of *future* development pathway might be preferable for such regions rather than relying on the template of the past. For instance Chateau et al. (2021) write of the spatial implications of ‘sociotechnical imaginaries’. Cowell (2020) similarly notes that:

> the research shows the powerful tendency of certain categories of land use to reproduce over time, with an industrialised past helping to legitimise an industrialised future, hemmed in very often by societal desires to protect ‘pure’, rural spaces from such fates.

This seems to suggest that there is potential for the replication of existing power structures (in both political and technical senses of the word). This was considered true of both fossil fuel and renewable infrastructures, rationalising the common controversy where wind projects have been proposed in ‘symbolically clean’ rural communities (Cowell, 2020). The distinction drawn in the literature between ‘pure’ and ‘polluted’ land use carries an implicit morality judgement. This ties to the work of Mary Douglas and ‘matter out of place’ in suggesting that there is an ethically ‘correct’ place for pollution (Coenen et al., 2012). Sayan (2019) argue that the ‘discursive construction of an area as wasteland’ results in disproportionate burden being placed on certain communities. This highlights the importance of recognition and procedural justice in allowing affected regions to ‘self-determine’ their LCT pathway rather than allowing policy precedent to determine what is acceptable. As noted previously, this can be realised through citizens' climate assemblies (Wells et al., 2021). The differential treatment of regions based on their land uses becomes a justice issue where certain groups are disproportionately and recurrently affected by burdens of environmental harm.

The sample literature frequently noted the sense of environmental determinism in how regional economies and opportunities are continually shaped by their natural resources. This determinism in spatial justice theory has, as noted, been a source of critique. Regional development theory such as the core-periphery model attempt to explain persistent socioeconomic inequalities between regions (Bouzarovski and Simcock, 2017; Chapman and Pambudi, 2018; Fell et al., 2020). Other literature in the field of regional studies considers the problem of regional lock-in to certain industrial activities and development pathways (Coenen et al., 2015; Hodson, 2008).

Current regional socioeconomic inequalities may result from past policy decisions (particularly spatial planning policy), meaning attention must be paid to historic injustices and spatial vulnerabilities which could be exacerbated by LCT policy decisions. Although many studies were excluded from the sample on the basis of their exploration of green space accessibility (which was deemed a narrow interpretation of 'sustainability'), several studies considered how urban planning was a factor in spatial injustice. Planning controls the distribution of environmental goods and bads, and the accessibility of infrastructure and services. This may be a more or less visible phenomenon, for instance in the case of US Superfund sites and their spatial distribution (a cornerstone of the environmental justice movement), or less visibly in terms of access to amenities, differences in costs of living, and vulnerability to climatic extremes (Sanchez and Reames, 2019).

Historic policy decisions were seen as critical in shaping present day opportunity structures and injustice. Extremes in this were indicated by case studies of American cities such as Baltimore (Finio et al., 2019). Cole et al. (2017) find that there is spatial inequality 'across multiple aspects of social deprivation' in South Africa, as 'a legacy of the racial segregation of Apartheid'. Similarly Cruz-Sandoval et al. (2020) discuss the legacy of colonialism in creating unequal spatial forms and therefore perpetuating socioeconomic disparities. The whole systems approach to injustice recognises the importance of considering cross-temporal injustices associated with transition, that is: past injustice, present injustice, and the potential for new injustices to be created alongside transition (Kanger and Sovacool, 2022).

This emphasis in the literature highlights the importance in designing spatially just policy to deliver the low carbon transition in a way which recognises and responds to a legacy of past spatial injustice.

2.6.3. What policy and governance approaches could embed spatial justice in the LCT?

We first consider what challenges exist to the development of spatially just policy, before identifying spatially just policy approaches as suggested by the study sample.

2.6.3.1. Challenges to spatially just policy

Existing policy has been critiqued as spatially regressive (Bouzarovski et al., 2017; Chatterton et al., 2018). It has also been suggested that LCT policy risks embedding place-based difference and reproducing existing power structures (Golubchikov and O'Sullivan, 2020). For instance, in the UK there is competition between regional authorities for inward investment, which is regressive in a context of variable capability between authorities (While and Eadson, 2019). A sector-based approach to industrial policy further creates issues of regional prioritisation when industries are spatially concentrated; however, there have been suggestions that sector-specific policy can address social inequalities when focussing on foundational industries in already-deprived areas (i.e. when the sectors targeted align with the areas in need of most social benefit; Hansen, 2022). Similarly, attempts to target specific socioeconomic groups bypass justice issues endemic to certain regions.

There is further concern that policymaking for the LCT could be adversely affected by the spatial and equity assumptions of energy system and energy-economy models used to inform decision-making (Pye et al., 2020). There are further issues around transparency and the prioritisation of cost-optimisation approaches (Li et al., 2016). A partial corrective exists in using public or expert surveys to complement and feed into any modelling activity (Fell et al., 2020), and in the use of 'spatially explicit' models (Li et al., 2016).

LCT policymaking is further challenged by data and knowledge limitations (Balta-Ozkan et al., 2015; Bednar et al., 2017; Cole et al., 2017; Füssel, 2010), particularly at the subnational scale (Bouzarovski et al., 2017; Cooper et al., 2020). Additionally, there are questions over how to quantify or value intangibles such as opportunity costs or environmental harms (Pye et al., 2020), an activity which is inherently uncertain. Similarly, how indicator frameworks hoping to monitor the relative justice of the transition can account for less tangible criteria such as vulnerability (Robinson et al., 2018; Robinson et al., 2019).

Several studies drew attention to the coordination issues between scales of governance and between regions. This frequently led to a sense of administrative fragmentation, which does and could prevent the effective (and fair) delivery of transition policies (Balta-Ozkan et al., 2015; Leibenath et al., 2016; Rega and Bonifazi, 2014; Roberts, 2003; While and Eadson, 2019). Issues also included different definitions of sustainable

development between regional and national governments (Coutard and Rutherford, 2010).

2.6.3.2. Spatially targeted policy interventions

To correct the identified shortcomings of policy in reproducing spatial injustices and with ineffective governance systems, several studies noted the potential for more spatially targeted policy interventions to shape context-specific solutions (Agbim et al., 2020; Chlebna and Mattes, 2020; Cole et al., 2017; Forman, 2017; Mischke and Xiong, 2015; George and Reed, 2017).

Existing top-down frameworks were viewed as 'both economically inefficient and socially divisive' (Roberts, 2003). Demeterova et al. (2020) argue that spatially resolved policymaking is more efficient as more cognisant of 'regional capabilities'. Other studies point to the need for spatial nuance in international or other wide-ranging policies, for instance in the case of a global carbon price (Liu et al., 2016). Spatially targeted interventions could be more mindful of recognition justice issues, in identifying the need for individualised development pathways for different regions (Demeterova et al., 2020) and the fact different communities each have their own vision of net zero (Chateau et al., 2021). There is simultaneously a need for cohesion in the direction and pace of travel, but the means to get there is open to debate.

Examples of spatially resolved policymaking include regional target-setting, for instance in California's legislation of GHG reduction targets for its metropolitan regions (Grübler and Fujii, 1991). An important corollary to any target-setting practices was the need for monitoring via appropriate indicators (Agbim et al., 2020; Bouzarovski et al., 2017; Carley et al., 2018; Füssel, 2010; Wells, 2012), which could be hampered by regional data availability. Others called for interregional redistribution to improve the justice of LCT policymaking, for instance via tax revenues (Barinova and Zemtsov, 2020; While and Eadson, 2019). That is, interregional burden and benefit sharing, such as 'pro-poor distributive policy' (Cole et al., 2014). Several authors argued for greater governance power to be devolved to various scales, including: the regional (Balta-Ozkan et al., 2015; Mischke and Xiong, 2015; Scarpellini et al., 2019; While and Eadson, 2019), the city (Sovacool, 2017), or the community-level (Bednar et al., 2017; George and Reed, 2017).

Recognising the issue of benefit and burden sharing, several policy tools exist to bridge the gap between the regional 'winners and losers' of transition. For instance the use of

Community Benefit Agreements (CBAs) which ensure any developments endow the affected communities with financial compensation or 'in-kind' benefits (Green and Gambhir, 2020; Mueller and Brooks, 2020). The growing embodied injustice movement (Healy et al., 2019) also represents a mechanism by which to acknowledge the justice issues along the supply chain and close a cognitive gap of accountability between sites of production and consumption (as discussed further in Section 2.6.3.4).The principle of burden-sharing is enshrined (at least notionally) in international climate policy (Chen et al., 2020; Pye et al., 2020), but there are issues surrounding the assumption of responsibility and the ethical basis for allocating this.

In addition to discrete policy interventions, there are a number of governance approaches and paradigms which suggest ways for the LCT to be more spatially just; namely, the localisation or decentralisation movements, embodied justice assessments, and the whole systems approach. Table 6 summarises these approaches and the dimensions of justice and equity that they address.

Table 6. Summary of policy and governance approaches to ensure spatial justice in the LCT.

Policy approach	**Justice and equity issues addressed**
Interregional redistributions and benefit sharing	• **Distribution:** although a retrospective corrective measure, interregional redistribution (for instance of tax revenues) would rebalance uneven tax bases across regional governments allowing areas to better invest in LCT measures. • **Capability:** this approach recognises the variable financial capital available to different regions, and hence ability to invest in the LCT.
Community benefit agreements	• **Distribution:** where LCT developments have impacts on specific communities, CBAs help to mitigate or at least compensate for these impacts (for instance in the siting of low-carbon energy infrastructures which can be spatially expansive). • **Responsibility:** CBAs mark 'responsibility-taking' on the part of the developers, and recognising that communities may not be able to reject proposed developments given the need for socioeconomic development.

Consumption-based emissions policies	• **Distribution:** consumption-based emissions accounting and policy recognises that certain regions face the burden of hosting industrial facilities, whilst their populations are not those driving consumption. • **Responsibility:** emissions policies of this kind ensure that the beneficiary of final consumption must take ownership of the externalities associated with that consumption. • **Capability:** by ensuring that any GHG emissions targets are set on a consumption basis, greater responsibility is placed with the final consumer or beneficiary who may be more able to cover the costs of climate externalities.
Whole systems policy assessments	• **Distribution:** by evaluating the impacts of LCT policies across multiple policy jurisdictions, policymakers can better account for existing socioeconomic vulnerabilities and appropriately target interventions to address these. • **Capability:** this kind of assessment can also identify those who are more able to contribute to the financing of LCT measures.
Regional target-setting	• **Recognition:** target-setting at the regional scale would allow for more context-specific action, and the creation of more nuanced regional development pathways. • **Responsibility, capability:** regional target-setting would recognise the different capabilities and responsibilities of regions to decarbonise, for instance in identifying the historic beneficiaries of polluting activities.
Citizens' assemblies	• **Recognition:** citizens' assemblies to inform low-carbon regional development pathways allow recognition of regional place identities. • **Procedure:** the assemblies allow the representation of views from a fair cross-section of civil society by design. • **Acceptability:** such assemblies allow the relative acceptability of different transition measures in a given region to be openly debated.
Devolution	• **Procedure:** the devolution of clear powers, funding and responsibility to regional governance bodies could give agency to such organisations to effectively coordinate LCT activities at a more nuanced scale. • **Responsibility, capability:** clear devolution of policy powers and funds would allow regional bodies to act on their duty to decarbonise and give sufficient institutional capability to carry this out.

Decentralisation and community governance	• **Procedure:** for some transition measures (for instance energy generation), it may be appropriate to support the role of communities as 'prosumers' where they could accelerate the deployment of low carbon technologies. • **Capability:** more support would be required for communities with less social capital or other form of resource to initiate such projects.

2.6.3.3. Localisation – and democratisation?

The need for the spatial alignment of benefit and burden may also be in part behind the decentralised energy generation movement, which reflects broader interests in polycentric governance as a tool to overcome public good distribution disparities by emphasising local and plural centres of experimentation (Bouzarovski and Simcock, 2017). The decentralised energy, localisation, or prosumer movements mark a literal closing of a geographic gap between sites of production and consumption, and a local accountability for the externalities of their consumption behaviours (Golubchikov and O'Sullivan, 2020).

The study sample drew frequent attention to the potential for community-scale governance of LCT measures, but the normative framing of the local as inherently more 'just' should be interrogated. Localised governance is frequently advocated for its effective use of local knowledge, greater community ownership of projects and attentiveness to local needs (Bouzarovski et al., 2017; Snyder, 2019).

The move towards decentralised energy production is often construed as more democratic (Chapman and Pambudi, 2018; Forman, 2017; Sasse and Trutnevyte, 2019; Wahlund and Palm, 2022). It is seen as particularly applicable in more dispersed or rural populations, and is often relevant for developing nations with less pre-existing energy infrastructure (Setyowati, 2021). Emery (2019) suggest that more distributed energy resources could be more flexible, cost-effective and provide co-benefits.

However many critics warn of the 'local trap', the assumption that local action is intrinsically more effective (While and Eadson, 2019). Lawhon and Patel (2013) indeed argue that attention to the local scale can divert from issues of global responsibility. Similarly there is an argument that localised governance exaggerates issues of variable social capital across communities, with those more capable of self-organization most likely to realise the benefits of the LCT (Mayne et al., 2017). Where there is a normative

expectation of community action this creates issues of justice, particularly when there is downscaled responsibility without downscaled resources (Thaler and Priest, 2014).

This draws attention to the need for multi-level governance systems with national oversight, mechanisms for subnational redistribution, and flexible implementation at the local scale. There is a similar assumption that any form of devolved governance is intrinsically more 'just', which several authors question (Finio et al., 2019; Fisher, 2015; Healy et al., 2019).

2.6.3.4. Whole systems justice

The potential spatial mismatch in the distribution of benefits and burdens associated with the LCT raises the question of 'whole systems' or 'embodied' justice; does progress in the LCT for one region or community result in burden for another, and how is it possible to shape a chain of accountability? Whole systems justice refers to the consideration of justice and ethical impacts across the supply chain for a given product or activity, or across all domains of economic activity (Martiskainen et al., 2021); it also considers the potential for injustices across both space and time (Kanger and Sovacool, 2022). Many studies argued that a 'whole system' or 'integrated' approach to the LCT is more just, rather than treating transition activities as a series of discrete policy areas (Bednar et al., 2017; Bouzarovski and Simcock, 2017; Sareen and Haarstad, 2018; Sovacool et al., 2019; Olner et al., 2020; Wells, 2012). This involves greater cross-sectoral and cross-scalar integration of transition policies to improve fairness (Golubchikov and O'Sullivan, 2020; Lihtmaa et al., 2018; Rega and Bonifazi, 2014). As Fell et al. (2020) note, this is partly due to the greater prevalence of economy-wide decarbonisation targets which demand assessment of distributional impacts beyond the impact of a specific policy, but rather the package of policies required to deliver the LCT.

A whole systems approach is of particular importance for spatial justice, in that certain regions are more vulnerable to multiple deprivation; in some areas there is layered socioeconomic (dis)advantage. The most deprived regions face overlapping vulnerabilities (Agbim et al., 2020; Fell et al., 2020; Golubchikov and O'Sullivan, 2020; Lihtmaa et al., 2018; Roberts, 2003; Robinson et al., 2019; While and Eadson, 2019). This is reflected in the 'double energy vulnerability' debate of Robinson and Mattioli (2020) addressing energy and transport poverty. A whole systems approach would also better account for issues of cross-scalar injustice (Healy et al., 2019).

‘Embodied injustices’ were a growing area of concern, with significant spatial justice implications. Embodied injustice can be considered a form of whole systems injustice focussing specifically on the spatial and ethical implications of supply chains. Whilst whole systems justice draws attention to the different sectors of the economy, embodied justice takes a more ‘vertical’ approach in identifying the implications across space from one given activity or policy. It identifies that there are cumulative injustices along supply chains, that is, injustice may not only occur at or within one spatial scale. Sovacool et al. (2019; 2021) and others question the embodied injustices inherent in the supply chains of even renewable technologies. Droubi et al. (2022) call particularly for attention to communities of extractive activities. For instance the ethical implications of smart meter use in the UK, when such a low carbon technology depends on rare earth mineral extraction in the Global South (Sovacool et al., 2019). Sovacool et al. (2019) calls this the ‘spatial externalization of deleterious environmental and social effects’. The concept of embodied justice is therefore an attempt to make ‘visible’ the environmental externalities associated with consumption, particularly in the Global North (Sovacool et al., 2021), and an attempt to avoid the offshoring of ethical consequence.

Embodied justice is particularly important in the context of transnational corporate actors, and an increasingly globalised business world, in providing territorial anchors of accountability. The UN Guiding Principles on Business and Human Rights identify that private actors have a duty of care regarding their operational and supply chain impacts (Mayne et al., 2017). Zuindeau (2006) similarly highlight the importance of taking an international perspective to deal with questions of transnational accountability. An embodied justice perspective may be supported by carbon accounting methodologies such as carbon footprinting. Consumption-based emissions accounting identifies the cumulative impacts along the supply chain associated with the consumption of a good or service. In this way, the mainstreaming of currently alternative carbon accounting frameworks could improve national responsibility-taking in addressing the emissions associated with domestic consumption.

To close the cognitive gap between sites of production and consumption, acknowledge the environmental externalities inherent in consumption, and create accountability, Healy et al. (2019) suggest that energy law and policy should incorporate embodied injustice concerns. In practice this could mean cooperative policies such as international carbon pricing (Sovacool, 2017).

Similarly, the majority of carbon accounting frameworks employed in national policy are based on territorial or production-based accounting. This form of accounting carries an

implicit bias against industrial regions with higher direct emissions, and the regional economies that are supported by large energy and employment-intensive industries. This raises the question of whether responsibility should lie with the producers or consumers. Furthermore, industrial areas in developed states often face a double burden of existing socioeconomic precarity (as a legacy of past deindustrialisation and global market pressures), as well as new climate policy costs (for instance the UK steel industry requiring government loans to pay its Emissions Trading System [ETS] costs). In global terms, production-based accounting systems in developed states essentially act to transfer responsibility to developing states (Liu et al., 2016). An embodied justice perspective might therefore relocate responsibility to the end consumer.

In this way, by taking a broader perspective across scales and stages in the supply chain, a more comprehensive account of the potential justice issues resulting from the LCT can be built, resulting in more spatially targeted policy interventions.

2.7. Conclusions

This review aimed to explore what could be considered a ‘spatially just’ low carbon transition, and responds to a growing body of theoretical and empirical literature in this area.

Our first research question considered the spatial scales adopted in LCT studies. This is necessarily complicated by questions around the ‘relational’ quality of space and uncertain definitions of ‘scale’. There was a consensus critique of the use of national scale assessment exclusively, with proposals for multi-scalar approaches to more effectively identify issues of interregional injustice. A central difficulty in assessing spatial justice was determined in the dependence on both the choice of spatial disaggregation and of the metric used to quantify injustice.

The second research question aimed to evaluate how spatial justice issues were presented (explicitly or implicitly) in assessments of the LCT. Whilst a large part of the literature considered distributional justice issues, a growing body of work explored the important issues of procedural and recognition justice. Particular contributions from the review include highlighting the influence of *perceived* justice on levels of acceptability in transition measures, which was in turn predicated on a sense of fair ‘responsibility-taking’. Norms in policy and carbon accounting frameworks were seen as important in shaping how responsibility and capability were assessed, with the risk of disproportionate

burden being placed on industrial production sites rather than the sites of consumption, emphasising the importance of a whole systems or embodied justice perspective, which informs an important future research agenda.

The final research question responded to these manifold justice issues, by exploring the policy and governance approaches which could embed principles of spatial justice in the LCT. Though descriptions of specific policy tools are on the whole limited, several mechanisms were identified such as community benefit agreements or interregional tax redistributions to more effectively share benefit across space, as identified in the work on distributional justice. Or the use of citizen climate assemblies to guarantee fair consultation and representation to address issues of procedural and recognition justice.

Despite being a review, the analysis poses a novel contribution to the literature is comprehensively synthesising the spatial justice issues inherent in the LCT. The whole system and interdisciplinary approach also overcomes issues of siloed social or technical research in the literature, or a limited focus on one aspect of transition (for instance employment). Though the inherent bias towards case studies in the Global North has been noted, the review has highlighted how spatial justice issues may appear internationally. A key strength of review articles is in their identification of research gaps, and avenues for further research (Snyder, 2019). The studies were predominantly centred on developed nation case studies, meaning there is a critical research gap in exploring the implications of spatial justice for developing states; this may be due in large part to the broader landscape of research funding, a problem endemic to climate research (Overland et al., 2021; Wahlund and Palm, 2022). There is therefore further scope to explore how issues of spatial justice manifest in different country contexts as a result, particularly focussing on the types of justice issues facing regions in the LCT, given states are at very different stages of transition.

Further consideration should also be given to the ‘politics’ and social construction of scale, and how this may alter assessments of spatial justice (for instance in identifying where power in LCTs lies). The whole systems and embodied justice literature was seen to fill a key gap in resolving some of the geographic public good gaps between sites of production, consumption, benefit and burden, by shaping a sense of cross-scalar accountability. This is a research space that would benefit from further empirical analysis.

In practice, there is strong need to move beyond accounts of injustice to substantive policy tools which can embed spatial justice. A basic policy advancement which is already occurring in some parts of the world is the recognition that all policy has a spatial

dimension, whether explicit or not. This supports calls for policy evaluation to keep pace. This is significant also in that transition is not a ‘future’ event, but a current process, and one already having disparate and inequitable effects on nations, regions and communities.

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3. Climate ambition and respective capabilities: Are England's local emissions targets spatially just?

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3.1. Abstract

To date, 79% of Local Authorities (LAs) in England have a climate plan to reduce their greenhouse gas emissions by 2050 or sooner. Yet questions remain over the collective impact of these plans and targets in terms of their contribution to a national net zero carbon budget given that the LA targets are voluntary and largely uncoordinated. There is therefore scope to explore if and how the LA target-setting process could be improved. We evaluate regional ambition in the emissions targets of 311 English LAs. We assess whether the subnational targets are aligned with a national net zero carbon budget and whether LAs take proportionate action based on their respective capabilities. It is also unclear whether LAs have the resources to implement the often highly ambitious targets they have committed to. Using a composite indicator approach, we assess the relative capability of different LAs to decarbonise, as well as the degree of ambition they are demonstrating. We find that many LAs are not taking as much action as other LAs that may have less capability to act. This suggests that burden-sharing between regions and LAs is inequitable. We offer a series of policy recommendations to improve the fairness and effectiveness of the LA target-setting process as a climate governance mechanism, including establishing a statutory target-setting requirement with appropriate resourcing, and introducing a national net zero indicator framework to monitor progress. This framework could be used in England, or in other countries, to assess progress. It would also allow funding and resources to be better directed to regions and LAs that require more support to reach net zero emission targets, rendering the transition more 'spatially just' and enabling its delivery.

3.2. Key policy insights

- The English LA targets contribute to achieving a national net zero carbon budget. However, there is still a 1.2 $GtCO_2$ gap in achieving this by 2050.
- The most ambitious LAs did not necessarily score highly in terms of capability.
- Seven of the ten LAs with the highest capability scores were in London; the least capable LAs were more dispersed.
- Greater standardisation, oversight and coordination could improve the effectiveness and fairness of LA target-setting, and help direct resources from the central government to less capable LAs and regions. This could render the targets 'spatially just' and enable their delivery.
- This could be achieved by developing a statutory target-setting requirement and national net zero indicator framework such as the one laid out in this paper.

3.3. Introduction

A notable recent climate governance paradigm has been the proliferation of net zero greenhouse gas (GHG) targets at the local scale. A majority of United Kingdom (UK) local authorities (LAs) have committed to achieving net zero GHG emissions by 2050 or sooner, rendering many targets more ambitious than national policy. However, these targets are essentially voluntary and are unaccompanied by national oversight, questioning the credibility of this ambition in light of varying regional[17] capabilities to decarbonise.

In 2021, the UK committed to a 78% reduction in GHG emissions by 2035, in line with the Climate Change Committee's (CCC) national level Sixth Carbon Budget advice (Department for Business, Energy and Industrial Strategy [BEIS], 2021a). 82% of UK councils[18] have a target to reach net zero operational GHG emissions,[19] whilst 62% have

[17] Though definitions of 'region' vary, we use the term to refer to the nine administrative regions in England (including London, the North East, North West, Yorkshire and the Humber, East Midlands, West Midlands, South East, East of England and the South West). We aggregate trends to the regional scale when appropriate to simplify comparisons between English regions.
[18] We refer to 'Local Authorities' (LAs) or 'councils' interchangeably and as shorthand for all local authority types, though in practice they vary in terms of administrative functions, statutory responsibilities and sizes. We similarly refer to 'net zero' targets as an umbrella term (though LAs use varying terminology, see Supplementary Material, Section 2.4).
[19] Operational targets mean councils commit to act on emissions produced through their activities and estates, whilst area-wide targets mean acting on all the emissions produced within a given area. Targets are largely set for Scope 1 (direct) and 2 (indirect via purchased electricity) emissions, rather than Scope 3 (indirect supply chain emissions).

an area-wide target for net zero and 61% of councils have a target for both sources.[20] Whilst the UK's national target for net zero emissions by 2050 is ambitious, we found that 56% of UK LAs have an operational target and 26% have an area-wide target to meet net zero *before* this date.

The CCC provides guidance to the UK government on 5-yearly carbon budget levels (i.e. the amount of GHG emissions that can be produced on a cumulative basis in line with long-term emissions targets such as net zero). Whilst these budgets are legislated at the national scale, there is no clear structure for devolving responsibility to deliver these emissions reductions at the subnational scale. Similarly, there is little guidance as to how responsibilities should be distributed between central government, the Devolved Administrations (DAs) of Scotland, Wales and Northern Ireland, and LAs, or a sense of the relative scale of the duties of each actor.

LAs represent one of the smallest scales of government in the UK (except town or parish councils), and are formed of elected councillors, as well as council officers responsible for delivering services. To fulfil their statutory responsibilities or 'duties', councils often work in partnership with other private or public organisations across different scales. The 333 LAs in England provide over 700 services (Local Government Association, 2010), with legislative powers in several key sectors that have implications for net zero including transport, buildings (through planning powers), energy and waste (UK100, 2021).[21]

However, climate action is not a statutory responsibility (Bulkeley and Kern, 2006). Uncertainty over roles and responsibilities have been cited as drivers of inaction to date (Creasy et al., 2021; Yuille et al., 2021). Additionally, there are currently ten Combined Authorities (CAs) in England, legal partnerships of two or more LAs, nine of which have a directly elected mayor. CAs are proposed as an important new climate governance mechanism, but their powers vary due to differences in the way devolution deals were negotiated (UK100, 2021). This further complicates how responsibility for delivering a net zero carbon budget is downscaled.

The voluntary nature of net zero targets is perhaps highlighted in the fact that a third of councils with 2030 targets have not created or updated climate plans (Howarth et al., 2021a), creating a gap between stated ambitions and action on implementation (Yuille et al., 2021). Councils are estimated to be able to influence a third of emissions in their

[20] These estimates are from the authors' own analysis of the target data. For further methodological information see Section 3.4.1.1.
[21] For detailed discussion of the types of powers available to LAs, see UK100 (2021).

local area due to their role in service delivery (CCC, 2020a), but they have no statutory requirement to do so. This makes the delivery of the UK's national net zero target at least partly contingent on voluntary action (CCC, 2020a).

This paper aims to evaluate whether the spatial variation in the ambition of LA net zero targets is fair. Spatial justice as it applies to the low carbon transition can be defined as the fair geographical distribution of benefits and burdens arising from transition (Garvey et al., 2022). Similar to the UNFCCC principle of Common But Differentiated Responsibility and Respective Capabilities,[22] a spatially just approach to local emissions targets would mean that those LAs that are more 'capable' are taking proportionate action. A spatial justice framing is chosen given the UK is one of the most regionally unequal of all developed countries (McCann, 2020), and there is a current political agenda to 'level up' the UK's subnational regions (HM Government, 2022). There is a need to ensure that subnational climate mitigation does not result in exacerbating regional inequalities in the UK.

Our first research question asks: to what extent do the LA targets contribute to achieving a national net zero carbon budget? We develop emissions scenarios of English LA target implementation and evaluate whether their cumulative impact is consistent with CCC net zero carbon budgets. Secondly, we question how target ambition varies by LA type and region, to assess whether there are inequalities in responsibility-taking. We finally explore whether regions capable of undertaking greater decarbonisation are taking more ambitious action, via LAs, using a composite indicator framework to explore and compare the ethical concepts of responsibility, ambition and capability.

3.3.1. Words speaking louder than actions? The target-setting phenomenon

With the worldwide growth of local climate commitments, whether in the form of quantitative emissions reduction targets or so-called Climate Emergency Declarations,[23] there has been corresponding growth in research assessing the intent and effectiveness of such commitments. There has typically been a weighting in the literature towards qualitative evaluation (Gudde et al., 2021; Howarth et al., 2021a; Ruiz-Campillo et al., 2021; Yuille et al., 2021); the quantitative carbon accounting approach of this analysis aims to correct this research gap.

[22] As first outlined in Principle 7 of the 1992 Rio Declaration (Voigt and Ferreira, 2016).
[23] A Climate Emergency Declaration (CED) is typically a public statement made by an individual or institution, acknowledging the climate crisis and the need for urgent action.

There is reasonable consensus across the literature in the gap between commitments and action, at the local, national and international levels. Other analyses support this by providing quantitative evaluation. Such 'progress tracking' has a long prehistory (Allman et al., 2004; Gibbs et al., 1996; Reckien et al., 2014). In their recent review of global net zero targets, Hale et al. (2022) find that only 20% of the recent round of targets are robust (detailing their 'timing', 'coverage', 'use of offsets' and 'governance'), and indicate that although 'net zero' is conceptually ubiquitous it is limited in practice. Howarth et al. (2022 [preprint]) evaluate the cumulative ambition of local targets, finding that the LA targets have the potential to exceed national net zero ambitions. However, this analysis is restricted to urban authorities and does not therefore explore regional differences in ambition. Armstrong's (2019) United States case study finds that local energy action could exceed that targeted at the state level. Local areas are shown to have at least the ambition to bypass any conservatism of national, higher-tier targets (Roppongi et al., 2017), a premise this analysis tests.

The literature on subnational climate action is typically oriented around the urban or city-scale (Bulkeley and Betsill, 2005; Castán Broto et al., 2019; Grafakos et al., 2020; Reckien et al., 2018; Russell and Christie, 2021; Salvia et al., 2021). However, this ignores the role of large rural counties, of regions with industrial facilities outside the boundaries of metropolitan city regions, and results in a partial approach to emissions coverage when net zero demands action from authorities of all types and across the urban-rural dichotomy (CCC, 2020a). Therefore, we consider *all* English LAs to shape a more inclusive and representative approach.

Whilst questions of responsibility, ambition and capability are important to discussions of net zero emissions targets and pathways, there have been few attempts to quantify these concepts at the subnational level. This study takes a spatial justice-based approach in assessing disparities in subnational mitigation ambition and capability. In the following sections, we outline the methods and data used (Section 3.4), before presenting the results – structured by the three stated research questions (Section 3.5). We finally discuss the findings, proposing a series of policy recommendations and areas for further research (Section 3.6), and outline our conclusions (Section 3.7).

3.4. Methods

The modelling involved three dimensions: 1) analysing LA target ambition; 2) exploring the cumulative impact of the LA targets in context of national carbon budgets; and 3)

constructing composite indicators (Co-Is) for each LA to assess their relative level of ambition and capability.

3.4.1. Analysing Local Authority target ambition

3.4.1.1. Compiling a LA target database

Two datasets provided detail on LA emissions targets: one constructed by the Place-Based Climate Action Network (PCAN, Howarth et al., 2021a), and another by Climate Emergency UK (CEUK, 2022). We cross-referenced each dataset to ensure reliability. Target data verification was undertaken in March 2022, therefore it is possible that this dataset may change in future and cannot be considered a fixed entity given ongoing commitments by authorities. We limited our analysis to England due to issues of harmonising datasets for emissions and indicator data from each DA. We filtered the sample to LAs with data available across all sub-indicators to ensure consistency, resulting in a sample of 311 English LAs from a total possible 343[24] (Sandford, 2021). For further detail on the authorities included, see the Appendix, Section 6.2 (subsections 2 and 3). The final sample represents 96% of England's carbon dioxide (CO_2) emissions in 2019. County councils are comprised of multiple LAs and were excluded to avoid double counting administrative areas.

3.4.1.2. Building emissions reduction pathways for English Local Authorities

To model the impact of LAs achieving their committed net zero targets, we adopted the BEIS (2021b) 'UK Local Authority and regional CO_2 statistics' for 2005–2019, and assumed 2019 as a standardised baseline year for the start of emissions reductions. The precise trajectory of emissions reductions was rarely specified in LA climate plans. We therefore assumed that LAs would implement linear emissions reductions between the baseline year (2019) and target year. LAs setting an interim target were the exception.

[24] Both figures include Combined Authorities.

3.4.1.3. Operational vs area-wide targets

The target dataset includes net zero dates for LA council operations and for reaching area-wide[25] net zero. 192 LAs in the sample had both target types. By contrast, 30 LAs had neither target. 78 of the LAs had an operational target but no area-wide target, suggesting the relative ease in setting the former target type. Only one LA had only an area-wide target. In many cases it was unclear whether the area-wide target included the council's own operations. The most common target date for both types was 2030, and in the case of 167 LAs the date was the same for both targets. Operational targets were modelled as reductions in the public sector emissions as a fraction of the area-wide emissions. Therefore, where LAs had both operational and area-wide targets they were applied simultaneously whilst ensuring double counting did not occur. For both target types we assumed that emissions levels remained constant at their target values after their target date had been reached.

3.4.2. Local CO_2 targets in context of national carbon budgets

Modelling the emissions reduction profiles of the LAs allows an accounting of their cumulative emissions between 2020 and 2050, and a comparison with the national net zero carbon budget. To establish how future LA emissions compare to a business-as-usual case, the Sixth Carbon Budget baseline emissions scenario was adopted (CCC, 2020b). The CCC's 'baseline' scenario assumes that 'no further climate action is taken beyond today' (CCC, 2020c, p. 20). Our baseline emissions scenario is therefore based on estimates of conservative policy action at the national scale. The baseline scenario provides a sense of the scale of national emissions LAs are mitigating, and therefore of the value of local action in a potential future context of unambitious national policy.

The baseline scenario can be contrasted against the CCC's 'Balanced Net Zero Pathway' (BNZP), which we also adopt as a reference scenario. The Sixth Carbon Budget analysis sets out four pathways to reach net zero emissions by 2050, reflecting various uncertainties in technological innovation and societal change that could occur to get there. The BNZP is a balanced product of these four distinct scenarios that 'keeps in play a range of ways of reaching that target' (CCC, 2020c, p. 13). We scaled the CCC's BNZP to the England level. See the Appendix, Section 6.2 (subsection 2.3) for more detail on the reference scenarios.

[25] As previously noted, 'area-wide' emissions are those occurring within the administrative boundaries of a given LA.

3.4.3. Constructing composite indicators

Co-Is integrate multiple indicators into one index, and ‘measure multi-dimensional concepts’ (OECD, 2013). Table 7 outlines the structure of the Co-Is used in this analysis. 2019 is chosen as a baseline year in most datasets, since this is when the majority of LAs set targets. A comprehensive literature review informed the choice of indicators for the two Co-Is: ambition and capability (Eder and Narodoslawsky, 1999; Frumhoff et al., 2015; Höhne et al., 2014; Newell et al., 2015).

Responsibility and capability are viewed as key ‘equity principles’ in climate action (Höhne et al., 2014) and are enshrined in the UNFCCC framework of Common But Differentiated Responsibility and Respective Capabilities. These principles are drawn from international environmental law to determine the ‘fair share’ of climate mitigation that states should be implementing (Rajamani et al., 2021). We consider how the concept of ‘fair shares’ of climate mitigation can be applied to the subnational scale, through applying the concepts of capability and responsibility to English LA net zero targets. Responsibility is most commonly conceptualized as *historic* responsibility. However, the socioeconomic fortunes of formerly productive regions have changed considerably, meaning these regions are less likely to be able to take responsibility for their current, let alone historic, emissions. Responsibility is therefore expressed through the indicator of ‘ambition’, suggesting the levels of responsibility-*taking* by LAs in England.

Table 7. Overview of indicators in the ambition and capability composite Indicators (Co-I).

Co-I	Dimension addressed	Indicators
Ambition	Action to date	Historic reductions in LA CO_2 pc emissions (2005-2019); (BEIS, 2021b)
	Future action	Projected future reductions (2020-2050); (own analysis)
Capability	Socioeconomic baseline	Indices of Multiple Deprivation 2019; (Ministry of Housing Communities and Local Government, 2019)
	Economic capability	LA spending power (2019/20); (Brien, 2022)
	Likelihood of implementing plan	CEUK Climate Plan Quality Scores; (CEUK, 2022)
	Technical capability	Percentage of LA area emissions in scope of council control; (BEIS, 2021b)

3.4.3.1 Ambition

The ambition Co-I is constructed from mitigation action by LAs (2005–2019) and projected future action (2020–2050). Historic reductions were assessed using the BEIS CO_2 dataset, and percentage reductions are then transformed into percentile ranks. The larger the reductions to date, the greater the rank. The second indicator ranked the difference in cumulative CO_2 emissions between 2020 and 2050 between the baseline and implemented targets scenario. This suggests how ambitious LAs are going to be should their targets be implemented. In this case, the greater the rank, the greater the planned mitigation.

3.4.3.2. Capability

Capability refers to the variable ability of different actors or regions to decarbonise. Four indicators of LA capability to decarbonise were chosen, based on the literature and best available data. The Indices of Multiple Deprivation were used as a measure of LA social

capital and of the relative ability to mitigate due to baseline socioeconomic challenges (Ministry of Housing, Communities and Local Government, 2019). Local authority spending power was used as a metric of economic capability (Brien, 2022). To suggest how likely LAs were to implement the targets they had committed to, we adopted the scores from CEUK of the quality of climate plans (CEUK, 2022). To indicate technical capabilities, we use the fraction of total area emissions that are considered within the scope of the LA's control. This suggests the administrative control LAs have over emissions within their area, therefore how capable they are to influence them. We disaggregated the fraction of emissions in control to the industrial and transport sectors, as the most variable sectors. In all cases, raw values were normalised with a percentile rank method. In each case, the higher the value, the more capable the LA.

3.4.3.3. Using the composite indicators

After the construction of the respective Co-Is, analysis was carried out to determine statistical relationships between the indicator sets. Descriptive analysis on the datasets was conducted, including the D'Agostino-Pearson statistical normality test. This allowed trends and notable cases in the data to be established. A Spearman's r correlation was then conducted to determine the relationship between the ambition and capability scores. For further detail on the approach taken to construct and statistically evaluate the Co-Is, see the Appendix, Section 6.2 (subsections 4 and 5).

3.4.4. Methodological limitations

The need to harmonise across datasets to develop each indicator resulted in using CO_2 rather than more comprehensive GHG estimates and excluding the DAs. A critical assumption of the scenarios is that GHG removals will be implemented; this is an area of uncertainty given the lack of widely available commercial GHG removal technologies. The choice of indicators and equal weighting approach in the composite indicator (Co-I) framework may be sources of uncertainty (see the Appendix, Section 6.2, subsection 4).

3.5. Results

3.5.1. To what extent do the LA targets contribute to achieving a national net zero carbon budget?

3.5.1.1. Operational vs area-wide targets

Predictably, the achievement of area-wide targets would result in emissions reductions of an order of magnitude greater than operational targets alone (Figure 7).[26] As would be expected, there is a noticeable change at the year 2030, marking the significance and frequency of this target date. Though improving on baseline projections, the operational targets fail to make a substantial difference to achieving the CCC's BNZP. This underlines the importance of LAs having targets which aim to influence area-wide emissions (though LAs should be considered as contributing to and facilitating other reductions in the area, rather than being solely responsible for delivering them). Ambitious operational targets could be considered preparation for later area-wide action.

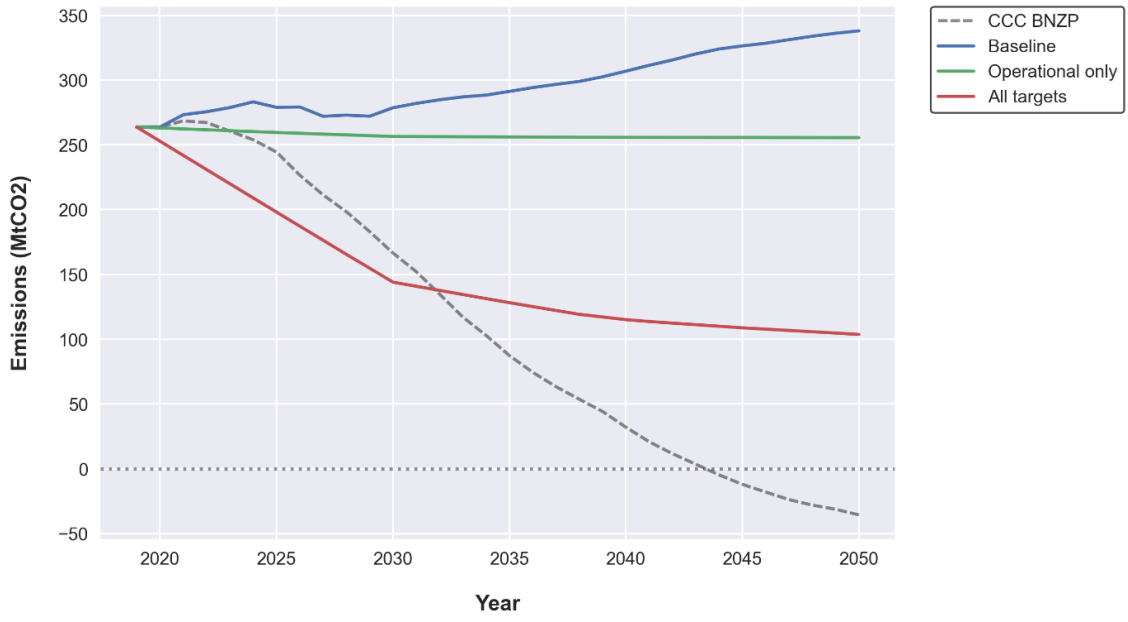

Figure 7. Comparison of emission pathways in each target scenario, assuming constant emissions after the achievement of original net zero targets. 'CCC BNZP' refers to the Sixth Carbon Budget 'Balanced Net Zero Pathway' (n = 301).

[26] Unless explicitly noted, references to the 'final sample' include the 301 LAs excluding the CAs. For results for the CAs, see Supplementary Material, Section 3.

There is a gap of 1.2 $GtCO_2$ between the cumulative budget of the 'all targets' scenario and a cumulative budget consistent with the net zero pathway. However, the 'all targets' scenario is a 51% reduction against the baseline budget. The emissions gap for net zero widens to 4.7 $GtCO_2$ if only the operational targets are met, but the scenario still marks a 14% reduction in cumulative emissions against the baseline case. This indicates that whilst the LA targets are ambitious, they are not sufficient if relied upon to reach a national net zero carbon budget. This may be due to the lack of LAs with area-wide targets, or with no targets at all.

We also assumed constant levels of emissions after LAs achieve their net zero targets, to reflect uncertainties in the achievement of the current targets and in what course of action LAs might pursue after reaching these initial targets. Similarly, the assumption of constant emissions allows for a continuous time series to 2050, which enables the comparison of cumulative emissions. However, it may be that in reality LAs set even more ambitious targets which further reduce their residual emissions after their original target dates. Additionally, this presents a scenario in which LA action is the dominant driver of national mitigation, and further gains would likely be made through specific sectors, and as driven by national policy. For instance, the achievement of the LA targets would be affected by the decarbonisation of the national electricity grid.

Responsibility for achieving a net zero consistent carbon budget is ultimately within the remit of national government, but the purpose of this analysis is to consider the scale of impact that local action could have in delivering this, in the absence of any assumed national policy action. By the very act of setting area-wide net zero targets, LAs are implicitly suggesting that they can feasibly decarbonise those areas, but given the lack of local powers, there are clearly areas which will need to be covered by national policy. In practice, a range of actors and sectors will need to decarbonise, and there is a role for central government in coordinating these emissions reductions.

3.5.2. How does target ambition vary by LA type and region?

3.5.2.1. LA type

Figure 8 shows the aggregated emissions reduction pathways of the sample by LA type. The 2020-2050 emissions for each type of LA are indexed against their total 2019

baseline emissions. The results suggest that unitary authorities[27] display the greatest ambition, particularly in terms of the pace of reductions, with 2030 evidently a key date for this authority type. This may be due to the single tier structure of unitary authorities, where decision-making is in the ownership of one authority, rather than split between tiers (see the Appendix, Section 6.2, subsection 1). Metropolitan boroughs and CAs also appeared ambitious, perhaps reflecting relatively greater powers. Slower progress was suggested by district authorities, perhaps reflecting the issues in allocating responsibilities for decarbonisation between the district and county level.

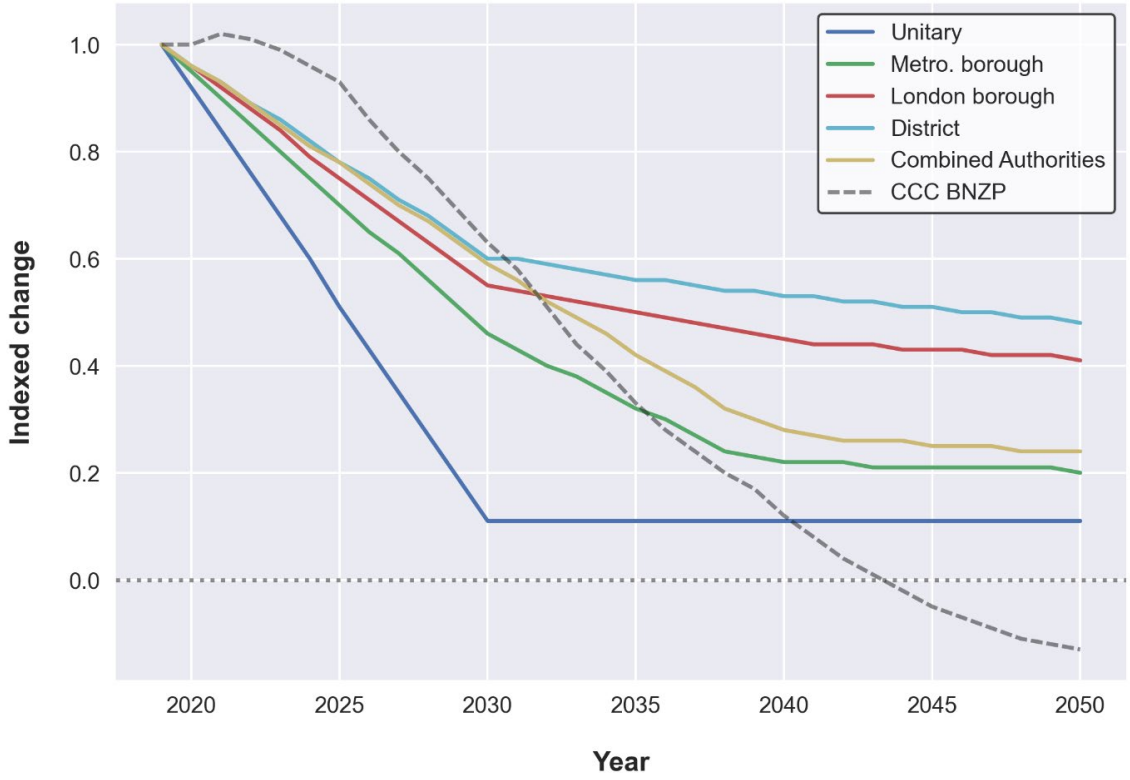

Figure 8. Comparison of emissions reduction pathways aggregated by LA type, and compared against the CCC BNZP scenario (sample: n = 311, in which unitary authorities: n = 54, metropolitan boroughs: n = 36, London boroughs: n = 33, district authorities: n = 178, and CAs: n = 10; indexed to 2019 = 1.0).

3.5.2.2. Regional variations in ambition

Figure 9 reveals considerable variation in the indexed aggregated ambition of LAs between nine different regions in England. The 2020–2050 emissions for all LAs within each region are indexed against the total 2019 regional baseline emissions. The LAs in

[27] Unitary authorities are single tier authorities that deliver services which county and districts typically carry out in tandem. For further detail see Section 1 of the Supplementary Material.

the South West region displayed the greatest ambition in terms of the cumulative reduction pathway, followed by the North West, and Yorkshire and the Humber. Demonstrating a slower pace and scale of reduction were the East of England, the East Midlands, and the North East.

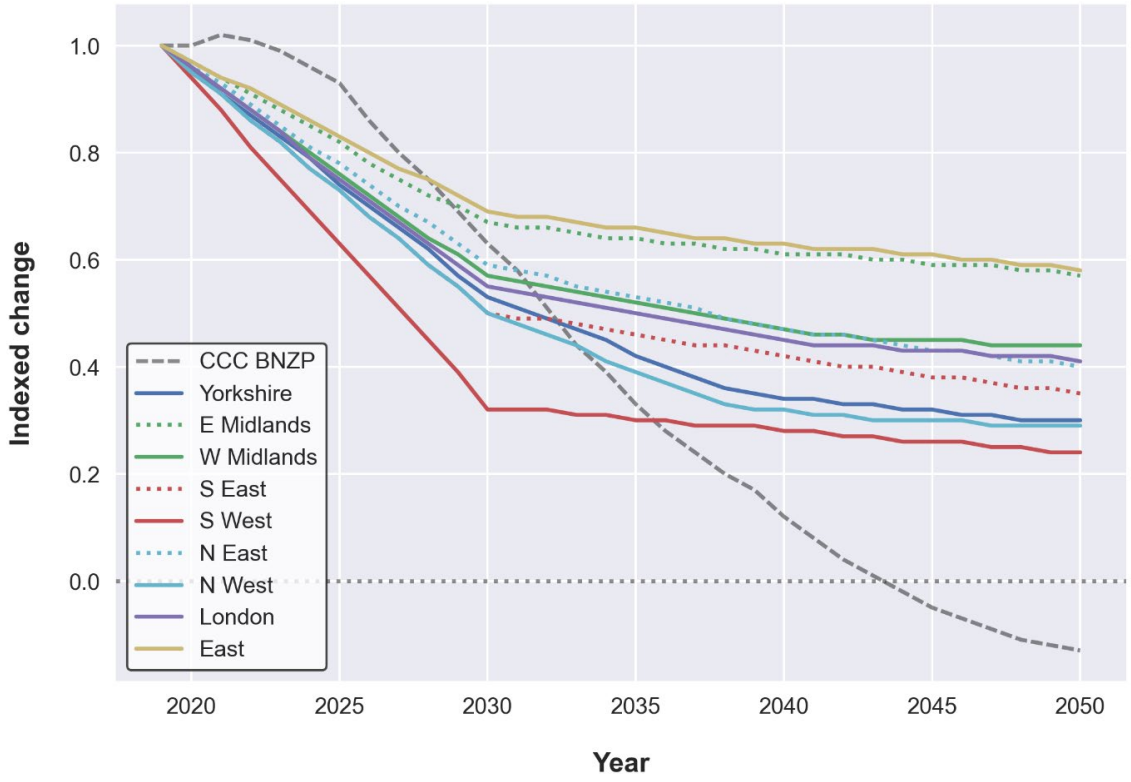

Figure 9. Comparison of emissions reduction pathways aggregated by region against the CCC BNZP pathway (n = 301; indexed to 2019 = 1.0).

3.5.3. Are regions capable of undertaking greater decarbonisation taking more ambitious action?

Statistical tests of correlation (see the Appendix, Section 6.2, subsection 5) showed that there is a very weak positive correlation between the capability and ambition scores (r = 0.29); however, the positive correlation was statistically significant (*p* = 3.45e-07). This suggests that higher capability is moderately associated with higher ambition.[28]

[28] Statistical normality of sample scores was conducted using the D'Agostino-Pearson test. The capability sample was normally distributed, but the ambition sample was non-normal. Since the data was non-parametric, the Spearman's r correlation coefficient was calculated to determine relationships between the scores.

Nevertheless, as noted, this is not a strong positive correlation, and there are several regional anomalies.

Though it is difficult to identify definitive patterns in the comparison of Co-Is scores, there are certain regional trends. Notably, seven of the ten LAs with the highest capability scores were in London, with two in the South East and one in the South West. The ten least capable areas were in the North West (n = 4), East Midlands (n = 2), East of England (n = 2), and West Midlands (n = 2). With respect to ambition, half of the ten lowest ambition scores were in the East of England, two in the East Midlands, and three in the West Midlands. Extreme low scores indicate limited action relative to the scale of emissions, suggesting action is not proportionate to responsibility. By contrast, the highest ambition scores were largely concentrated in the South; for instance, four of the ten top-scoring regions were in London, three in the South East, two in the East of England and one in the South West (Bristol). London presents an interesting case: in terms of indexed ambition, London boroughs as an authority type appeared less ambitious overall (Figure 10). There are therefore extremes of ambition within London, which accords with understanding that it is an area with significant intraregional socioeconomic inequality which could impact the capability to respond to a non-statutory area like climate mitigation.

When comparing the scores across the two Co-Is, it is apparent that several regions are more ambitious than they are perhaps capable of. In Figure 10, a low score suggests that ambition is greater than the capability to take action; a high score suggests a capable region may not be taking action proportionate to its capability. This suggests that many LAs may be demonstrating more ambition than they are perhaps capable of. That is, relative to other LAs or regions with the same level of ambition, their capability score is lower, suggesting potential issues with delivering that level of ambition. These regions with divergence between ambition and capability are geographically dispersed. This variability suggests a more complex picture of regional ambition and capability than a simple North–South dichotomy. Regions that are taking less action than they are perhaps capable of are also dispersed. This gap could be due to a lack of ambition (resulting from a lack of resources and/or political support), or higher initial emissions which render action less effective. The comparison of Co-I scores suggests a clear need for further action on the part of certain LAs, and greater national coordination and resourcing of the target setting and *implementing* process.

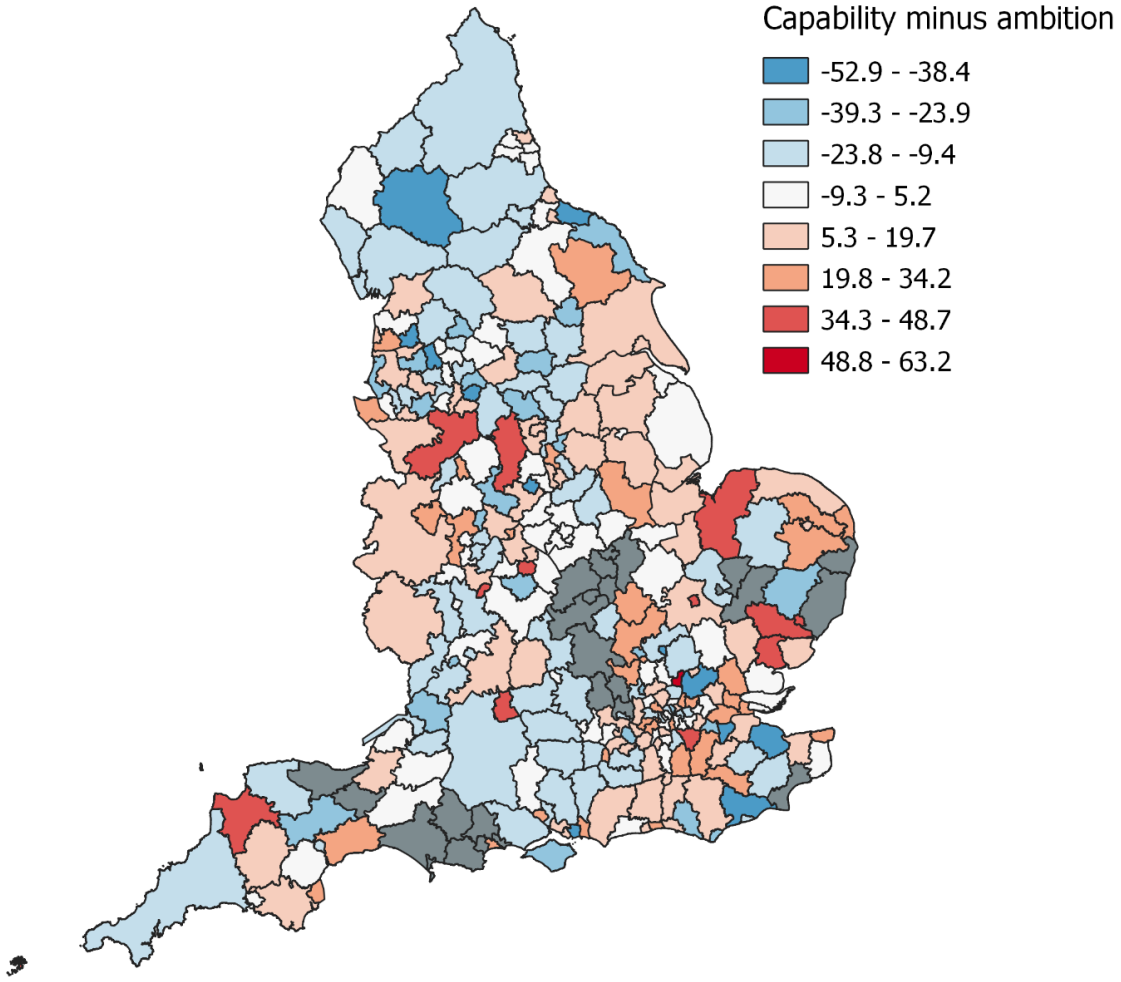

Figure 10. Choropleth indicating the difference between capability and ambition scores by LA (n = 301).

3.6. Discussion

3.6.1. Local ambition in national context

The results highlight that although the majority of LA targets are ambitious, and more ambitious than their equivalents at the national scale, they do not collectively achieve a net zero carbon budget. A common target date was 2030, meaning the targets assume a constrained time horizon for available action. This relatively near-term focus is exacerbated by a challenging operating context of global conflict and a cost-of-living crisis, which is only likely to worsen the capability of LAs to respond to a 'non-statutory' responsibility such as climate (Bulkeley and Kern, 2006). Similarly, whilst the targets demonstrate considerable ambition, the capability Co-I scores suggest that their implementation is often not realistic. Low capability may be driven by different indicators

within the overall Co-I, but the areas highlighted are generally associated with higher socioeconomic deprivation which may challenge action in non-mandatory areas.

Operational targets suggest a greater degree of realism, given the control LAs can exert over their own emissions, but their contribution to a national net zero carbon budget is relatively minimal in carbon accounting terms. Operational emissions reductions are often energy-oriented, particularly in terms of renewable energy procurement, and energy efficiency in council properties. LAs have limited capacity to act on broader energy issues given the centralized nature of energy policymaking in the UK and the privatisation of municipal energy companies (Bale et al., 2012; Bulkeley and Kern, 2006). However, others suggest there may be scope for greater involvement of LAs in renewable energy provision, given the rising interest in forms of decentralised energy (Fudge et al., 2016), and in the role LAs could play in supporting energy efficiency in small-to-medium enterprises (Bradford and Fraser, 2008).

The emissions gap between the delivery of LA targets and the national net zero budget may be driven by the LAs with no target (n = 30) or those which had set targets which were unambitious relative to their initial emissions. Indeed, our findings differ to those of a forthcoming research article (Howarth et al., 2022 [preprint]), which suggests that LA climate targets (if implemented) would exceed delivery of the CCC net zero carbon budget; this may be due to their assumption that residual emissions would only be 5% (rather than 11% as used in the CCC's and our own analysis here). The existence of the gap also raises questions over who would be responsible for closing it. For instance, does central government ultimately hold the responsibility for delivering net zero emissions? Or should it be a combination of the local and national in the 'interactive federalist' model proposed by Sovacool (2008)? Responsibility is necessarily delimited by the actual powers available at the subnational scale, and at the moment, this would suggest central authorities should take action as they are the only ones with the powers and resources to do so, and since LA targets are essentially 'voluntary'.

Local action is often viewed as a means of incremental change and challenge whilst waiting for national action (Hsu et al., 2020; Marsden et al., 2014), and as a means of overcoming perceived conservatism and political 'gridlock' at the national scale (Armstrong, 2019). However, others see the need for central government resourcing for substantive change to occur (CCC, 2020b). In cases where the scale of the issue being addressed better suits national governance (for instance industrial decarbonisation or cross-boundary issues such as transport), central government could assume responsibility for this to ensure there are no gaps in economy-wide decarbonisation.

The concept of multi-level governance is frequently proposed as an appropriate scalar framework for climate governance (Betsill and Bulkeley, 2006). We found that LA targets were marginally more ambitious than the CA targets, meaning there is value to multi-level coordination. Marsden and Anable (2021) suggest that this form of governance would address cross-boundary issues for priority sectors such as transport, improving policy coherence, and highlighting that there is no 'optimal' scale for allocating carbon budget responsibility. It is important to note that LAs operate in neither sectoral, scalar nor spatial siloes, and are generally actively engaged in national and international state and non-state networks, partnerships with civil society, and national policy programmes. For instance, Smith and Christie (2021) highlight the extensive networks between state and non-state climate actors across scales, including LAs in the UK. On a more formal basis, LAs frequently engage with multiple government departments as the delivery bodies for many national policies, and the recent Local Net Zero Forum is an attempt to streamline communications between the two scales on activities surrounding net zero (Department for Levelling Up, Housing and Communities, 2022).

LAs are therefore integrated through partnerships with many actors and sectors at multiple spatial scales. However, whilst LAs do work in partnership to deliver many statutory services, delivery of climate mitigation is seen to suffer from a lack of policy coordination, particularly when considering formal relationships between the state and local government. This was highlighted in a recent House of Lords motion debating the cross-governmental coordination of net zero policymaking (Smith, 2021). As Hsu et al. (2017) note, there is a need for greater vertical (cross-government) and horizontal (cross-regional and cross-sectoral) alignment on subnational climate action. The budgetary gap found in this analysis suggests that there is indeed a role for top-down oversight and coordination in the setting and delivery of net zero emissions targets.

3.6.2. Spatial justice in regional ambition

One benefit of having a system of national oversight of local targets would be in monitoring regional differences in ambition, to ensure that equitable action is taken by English regions. London generally led in terms of ambition and capability. The Greater London Authority is seen as playing an important coordinating role in devolving responsibility between different London boroughs (Howarth et al., 2021b), suggesting that a nested institutional structure may be important in guiding and allocating levels of ambition for particular LAs. Yet ambition loses significance at the local level when initial emissions are low. Whilst London LAs are taking action, and are capable of doing so,

this may also reflect their lower baseline emissions (due to a relatively small amount of industrial activity in this area).

In contrast, the East Midlands region had low capability and ambition scores, as well as high initial emissions. This suggests that there is a need to target support to LAs or regions with higher emissions that are not taking proportionate action, which may in turn be due to a lack of capability. There were particular gaps between the scores in traditionally industrial areas, which highlights the persistent importance of patterns of industrial activity to achievement of net zero goals. There was generally a slower pace of emissions reductions in the East of England, East Midlands and North East, which could reflect a lower perceived ability to decarbonise and the influence of industrial actors. It has been noted that industrial areas tend to lack the governance resources of 'elite world cities' (Pearce and Cooper, 2013).

The gaps in capability and ambition are significant, and they suggest full implementation of the targets is unlikely without a change in policy or support. Nevertheless, where capability is low but ambition high, it suggests a political willingness to act despite a lack of available funds or other resources. This gap analysis provides an evidence base for greater support to be directed to specific LAs or regions.

3.6.3. Governing effective regional targets

There is consensus in the general merit of the local target-setting approach, given any action of this kind is 'additional' to national policy requirements. However, the process could be empowered through a number of structural changes. These include creating a statutory target-setting requirement with appropriate central government resourcing, and reintroducing a national net zero indicator framework to effectively monitor progress against such targets.

The voluntary target-setting could be interpreted as filling a governance gap in the lack of devolved responsibility for climate action at the local level, but a key barrier to local climate action is the lack of statutory responsibility for it (Yuille et al., 2021). Introducing a statutory requirement for LAs to set a net zero-consistent GHG emissions reduction target could give LAs the authority for climate action, and simultaneously create a reporting requirement (Bale et al., 2012). However, this approach would require more resources be allocated from central to local government to help deliver the targets. There

is often a normative expectation of local action, without the appropriate downscaling of resources to match (Gillard et al., 2017; Newell et al., 2015; Thaler and Priest, 2014).

The National Indicators (NIs) represented standardised 'top-down' oversight of emissions monitoring and encouraged target-setting by LAs (Dixon and Wilson, 2013). 97% of LAs were reported to have prioritised at least one of the climate change 'improvement targets' (Cooper and Pearce, 2011). Given the variability in GHG emission inventorying and reporting practices between LAs, the reintroduction of the NI framework could be a means of improving the accuracy of progress monitoring. A complete national emissions inventory disaggregated to the local scale would enable an assessment of how well various mitigation efforts 'fit together', ensuring complete emissions coverage. It would also facilitate iterative policymaking, where the effectiveness of different interventions could be measured and monitored.

3.6.4. Limitations and directions for future research

Further empirical research with practitioners could aim to understand the complexities of delivering mitigation at the local scale (Pearce and Cooper, 2013), while building on existing qualitative work in this area and improving the representation of 'capability'. Action on adaptation is notably lacking in most local climate plans (Grafakos et al., 2020; Reckien et al., 2014, 2018; Salvia et al., 2021), therefore further research should address this policy gap. Although something not considered in the present analysis, political party affiliation of local leadership may be an explanatory factor for the variation in ambition (Howarth et al., 2021a). Analysis of this kind is complicated by electoral churn, the presence of coalition administrations, and boundary changes, all of which would complicate attributing climate plans to any one political party. Further analysis could also valuably explore the relationship between per capita emissions and how this affects regional ambition or capability.

3.7. Conclusions

Whilst Local Authority (LA) net zero commitments (as essentially voluntary targets) are laudable and generally ambitious, they collectively fail to meet the scale and pace of decarbonisation required to be consistent with a national net zero budget. The national net zero target currently has no devolved governance, and this shapes considerable uncertainty in terms of what type of action, and how much of it, LAs are expected to take.

The voluntary and variable LA targets are a product of this uncertain scalar policy framework and of historic dynamism in the role of regional (i.e. subnational) institutions within national policy in England. Our composite indicator (Co-I) analysis reveals that half of all LAs in the sample were not taking as much action to decarbonise as they were hypothetically capable of, suggesting a lack of spatial justice in English regional climate governance.

To improve the fairness and effectiveness of delivery of LA net zero targets in England, we propose introducing a statutory target-setting requirement (to ensure equal participation in mitigation action), and the introduction of a national net zero indicator framework. Such a framework could enable monitoring of progress and iteratively guide policy development and local resourcing. Specifically, such improvements to the target-setting process would provide an evidence base for central government through which it could more effectively direct funding to those LAs that need greater support in delivering their targets. Currently, ad-hoc pots of funding are distributed through a competitive process which further disadvantages those LAs with less capability to start with (Bale et al., 2012). In this way, LAs, working with the targeted support of the national government, could begin to ‘level up’ the capability to decarbonise in those LAs or regions that most need to.

Though there are singularities in the structure of English subnational governance, the high-level conclusions of the analysis have transferability to other country contexts. This is important given the global nature of the local net zero target-setting trend. For instance, the proposed indicator framework could be applicable to different countries, and improve effectiveness and fairness in the governance of subnational climate commitments. There is particular potential in the framework in jurisdictions where subnational powers are stronger.

Whilst the LA target-setting phenomenon in England represents notable action at the local scale and demonstrates a commendable degree of ambition, there are perhaps limits to local action without national oversight and resourcing. There is therefore a need for scalar and spatial coordination of subnational net zero targets – that is, multi-level governance of the targets and their delivery. This could contribute to fair governance in delivering the UK’s net zero carbon budget, in recognising the spatially differentiated capabilities to mitigate in the English regions.

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4. ‘How could it be our responsibility?’ The equity of Local Authority climate action in England

Research article, in peer review as:

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4.1. Abstract

The majority of English Local Authorities (LAs) have set targets to achieve net zero greenhouse gas emissions by 2050 or sooner, despite having no formal responsibilities to do so. However, the realism of LAs achieving these targets under a context of constrained budgets and operational pressures is questionable. This analysis applies the international ‘equity’ framework of Common But Differentiated Responsibility and Respective Capabilities to the case of English LAs. The research evaluates responses from 28 semi-structured interviews with stakeholders from across levels of government, different sectors, and regions of England, to provide both internal and external insights into the work of LAs on climate action. We evaluate the drivers of inequalities in capabilities to implement climate action between LAs, and how these inequalities could be reduced through a number of governance interventions. Though the introduction of a statutory responsibility is frequently discussed in the literature, its perceived viability and equity has not been empirically assessed with stakeholders. We therefore evaluate stakeholder perspectives on whether this would be a fair mechanism for allocating responsibility to the local scale. We find that economic, social and political aspects of capability are inter-dependent, and that current governance arrangements tend to reinforce patterns of inequality in capability. We offer a series of policy recommendations to improve equity in burden-sharing between LAs, finding that funding reform, and a well-designed and well-resourced statutory responsibility could be both effective and fair.

4.2. Policy highlights

- The governance of local climate action in England reinforces existing inequalities in economic, social and political capability between Local Authorities (LAs).

- Though councils are currently taking action voluntarily, further support is required to ensure councils can equitably meet their net zero ambitions.
- A statutory responsibility would improve equity in burden-sharing for mitigation between councils, provided it was well designed and resourced.
- A statutory responsibility could introduce a reporting component that would provide an evidence base to target greater support to councils that need it.
- Equity-based funding systems were proposed as means of respecting the variable capabilities of different LAs.

4.3. Introduction

There is a common focus on the value of local and subnational climate action in the literature, yet in practice climate governance in the United Kingdom (UK) is highly centralised (Lockwood, 2021). The Climate Change Committee (CCC) provides guidance on the level of five yearly carbon budgets in line with the UK's long-term target of reaching net zero greenhouse gas (GHG) emissions by 2050 (CCC, 2020). But beyond recommending comparable targets and budgets for the Devolved Administrations (DAs), the UK government does not cascade responsibility for delivering decarbonisation to the subnational scale (Marsden et al., 2014; Marsden and Anable, 2021). There are tensions between the sense that all scales of government should be taking action, including subnationally (Howarth et al., 2021), the lack of a clear framework for how local and regional actors will be resourced to do this, and of central government's conceptualisation of this role (Hsu et al., 2020).

There is currently no statutory responsibility (SR) for Local Authorities (LAs) to deliver climate change mitigation[29] (Bulkeley and Kern, 2006). However, since the establishment of the UK's net zero target, there has been significant growth in voluntary local target-setting. In England, 79% of LAs have set a target to reach net zero by 2050 or sooner for their operational and/or area-wide emissions (Garvey et al., 2023),[30] and these targets are often more ambitious than their national equivalents. Yet the realism of LAs delivering these plans and targets, whilst subject to significant operational pressures is questionable (Gray and Barford, 2018). The lack of SR also means there is

[29] Though there is no overarching statutory climate mitigation duty or reporting requirement, councils do have to consider climate impacts under statutory planning policy rules (Howarth et al., 2021a).
[30] Operational emissions refer to GHG emissions produced within council owned estates, whilst area-wide emissions are those occurring within the entire administrative boundary of the LA.

considerable regional variability in the ambition of planned decarbonisation across different LA areas.

The UNFCCC principle of Common But Differentiated Responsibility and Respective Capabilities (CBDR-RC) is typically applied to the international scale. However, the concept has increasing relevance to the subnational scale. Just as Mayne et al. (2017) present the first application of the 'international climate justice framework' of CBDR-RC to subnational energy policy in the UK, this analysis aims to apply these principles to the local delivery of net zero in England. The lack of capacity or capability[31] for LAs to deliver climate action has been well established in existing research (Gudde et al., 2021; Kuzemko and Britton, 2020; Yuille et al., 2021). However, few studies explicitly consider the drivers of variation in capability, and the equity implications of this. A SR is frequently discussed in the literature as a potential solution to uneven local climate action (Bulkeley and Kern, 2006; Evans, 2020), but has not been empirically examined for its effectiveness or equity to our knowledge. Depending on its design, a SR could either: a) ensure equitable climate action between councils, or b) create additional pressures for those councils with less capability to engage with the low carbon agenda. We therefore contribute particular novelty in our evaluation of the equity implications of such a mechanism.

In this analysis, we examine the drivers of the unequal distribution of capability in LAs, the equity of enforcing responsibility through a statutory duty, and governance mechanisms to build capabilities across LAs. We aim to address the following research questions:

- What are the drivers of unequal LA capabilities?
- To what extent would a statutory responsibility improve equity in LAs' delivery of net zero?
- What alternative governance mechanisms could build LA capabilities to deliver net zero?

To do this, we draw insights from a series of 28 semi-structured interviews with stakeholders involved in delivery of net zero from across levels of government, sectors, and regions of England. England was chosen as it is the only country in the UK without

[31] Whilst often used interchangeably, we define 'capacity' as the more passive sense of a given actor's ability to 'cope and adapt' (Füssel, 2010), but 'capability' as an actor's more active 'ability to take effective action to reduce carbon emissions', following Mayne et al. (2017). We use the term capability throughout given our discussion of the agency of LA actors, and as aligned with the terminology of CBDR-RC.

any form of current or future SR for climate action at the LA level.[32] However, the governance structure of England poses challenges when considering the international transferability of insights from the research. England is highly centralised, and LAs have relatively few powers and resources by comparison to local governments in Europe (Bulkeley and Kern, 2006). Nevertheless, the application of CBDR-RC to the subnational scale may be *conceptually* relevant to other country contexts.

In the analysis that follows, section 4.4 reviews the literature, and section 4.5 details and justifies the methodological approach. In section 4.6 we present the results of the interview analysis, and in section 4.7 discuss the policy and governance implications of this, before presenting our conclusions in section 4.8.

4.4. Literature review

4.4.1. Local climate action in England

There are a total 333 LAs[33] in England, providing over 800 services ranging from social care to waste collection (Evans, 2020). Some areas operate under a two-tier system, whereby responsibility for service delivery is split between county councils and smaller district, borough or city councils (Paun et al., 2022). Other areas are covered by one of ten Combined Authorities (CAs), legal partnerships of two or more LAs, which work together as a regional body.[34] Though there are many voluntary net zero targets and commitments by English LAs, there is no national oversight of the target-setting. This governance gap has instead been filled by informal non-state actors, such as Climate Emergency UK (CEUK, 2022), a non-profit organisation. CEUK has undertaken scoring of council climate action plans, creating a league table based on multi-criteria analysis (CEUK, 2022). This, and academic analyses, are the main accountability mechanisms to date to monitor and report against council climate action.

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[32] Scottish public sector bodies have a SR to contribute to the national net zero target and to report annually against this, whilst in Wales public bodies must contribute towards the Sustainable Development Goals and undertake annual reporting (Welsh Local Government Association, 2023). In Northern Ireland, a consultation on whether to establish statutory emissions reporting for LAs is ongoing as part of the new Climate Change Act (Northern Ireland) 2022.

[33] Town, parish and other smaller councils also form part of local governance structures in England, but are not often the subject of critical analysis (see Russell and Christie, 2021). However, given the limited powers and resources of these councils, we presently focus on larger LAs.

[34] Though CAs are notable new forms of subnational governance, in this analysis we focus on the role of LAs, given their greater number and their more comparable powers and structures. We do however represent the views of CA stakeholders on the role and function of LAs.

Perhaps the most-cited barrier to LAs, in any service area, is a lack of funding. LAs' main sources of revenue funding are from central government grants, council tax, and business rates (Atkins and Hoddinott, 2020). After the 2008 recession, and the advent of the coalition government in 2010, LAs faced severe budget cuts. The amount of tax raised locally in the UK is limited compared to European states, meaning LAs are more reliant on central government funding; this has been the main area of funding cuts, with reductions of 37% between 2009-2019 (Atkins and Hoddinott, 2020). The state of LA funding matters for delivering climate action – both mitigation and adaptation – since budgets for non-statutory areas are often the first to be relinquished when LAs are trying to find funds to cover statutory commitments such as social care (Borrowman et al., 2020).

The idea of LA climate action being hampered by a lack of capability is not a new one, with Allman et al.'s (2004) study drawing attention to this issue. But capability has several dimensions, which vary between studies. For instance, Kuzemko and Britton (2020) identify political authority, finance, personnel, and knowledge as some of the most important factors in determining sustainable energy capacity. By contrast, Tang et al.'s (2010) analysis of local climate plans in the United States identifies state mandates as the most effective driver of better-quality plans. Though a concept typically assessed qualitatively, council capability has been quantified in the academic literature, often through use of indicator frameworks (Garvey et al., 2022). Salvador and Sancho (2021) use an indicator approach to quantify the organisational capacity of an LA. The plural nature of capability is also highlighted in Garvey et al. (2023), in which a composite indicator framework is used to integrate several different metrics of council capability including technical, socioeconomic, financial, and political, and applied to the case of English LAs.

Kuzemko and Britton (2020) provide a springboard for the current analysis in their consideration of the 'sustainable energy capacity' of LAs and CAs in England. Kuzemko and Britton's (2020) analysis focussed on LAs that are already 'reasonably active' in this space, whilst our focus is on *why* some LAs are more active. We also consider capabilities to deliver broader climate change mitigation as opposed to sustainable energy, in light of the UK's net zero target-setting phenomenon. Castán Broto and Westman's (2017) global analysis of local sustainability initiatives found that there is a gap in their consideration of 'principles of justice and equity'. Rather than the equity of the initiatives LAs undertake, our focus is on how equitably LAs are *treated* by the national scale in the configuration of climate governance in the UK.

4.4.2. CBDR-RC at the subnational scale

The principle of CBDR-RC was first outlined in the 1992 Rio Declaration at the United Nations (UN) Earth Summit (Pauw et al., 2019), and presented as a framework to recognise 'different national circumstances' in the capability to mitigate GHG emissions (Voigt and Ferreira, 2016). It serves to recognise that those states that have benefited most historically from emissions-intensive activities should be most liable for taking action in the present day, and to support and finance decarbonisation in other states. As noted, though typically an international concept, there is increasing interest in how this principle can be applied at the subnational scale. For instance, Mayne et al.'s (2017) application of CBDR-RC principles to the case of UK energy policy explores how roles, responsibilities and capabilities are distributed between different energy actors and whether this is fair, as preconditions for effective climate mitigation.

This draws attention to the so-called 'equity principles' of responsibility and capability which are commonly used to operationalise justice concepts (Höhne et al., 2014; Sasse and Trutnevyte, 2019). The addendum 'Respective Capabilities' to the CBDR-RC framework suggests that responsibility should be allocated with recognition of how able a given actor is to decarbonise. The application of CBDR-RC subnationally presents several challenges. Firstly, given the centralised nature of the UK government, powers at the subnational scale are limited. This means there is little ability to devolve responsibility to subnational bodies, without accompanying devolution of powers and resources (Perry et al., 2021). Similarly, any process to allocate responsibility will be influenced by assumptions around the appropriate scale at which to act, or where ethical duties lie (Frumhoff et al., 2015; Mayne et al., 2017). Arguably, the UK government is legally responsible for meeting the GHG targets as set out in the Climate Change Act 2008 (Muinzer and Ellis, 2017). There is therefore a tension between legal and ethical conceptualisations of 'responsibility'. However, this does not remove the need to allocate responsibility, as without it national decarbonisation risks being 'incoherent' (Marsden and Anable, 2021).

Though discussions of responsibility typically take place at the level of the nation state, the place-based agenda points to potential responsibilities for the local level. Others critique this decentralised approach to delivering net zero as problematic, relying as it does on the variable capabilities of local areas and institutions. This is mirrored in concern that increasing non-state and civil society action is ultimately a reflection of a governance gap. That is, informal actors are taking responsibility for the governance of public goods given perceived inaction by national government (Gillard et al., 2017; Hsu

et al., 2020; Jordan et al., 2015; Kythreotis et al., 2023). Catney et al. (2014) term this trend towards greater public participation, non-state action and decentralisation 'Big Society Localism'[35] whereby more voluntary informal action means a smaller role for the state. This idea is seen as the corollary of austerity and of the 'retreating welfare state' (Wittmayer et al., 2016), or otherwise termed 'austerity localism' (Tingey and Webb, 2020). Though the increasing involvement of non-state actors in the delivery of net zero is an important and notable phenomenon (Smith and Christie, 2021), in this analysis we focus on the role of public actors (LAs) as entities to which formal responsibilities and powers could be devolved or shared[36] by national government.

4.5. Research design and methods

We conducted a series of 28 semi-structured interviews with stakeholders with expertise in UK climate policy and governance during August-November 2022. We used a purposive sampling approach, coupled with a referral sampling approach. We aimed to recruit a vertical (across levels of governance) and horizontal (across regions) distribution of participants (Table 8). We also aimed to interview participants from a variety of sectors (e.g. public – councils and government departments; third – NGOs and non-profits; and academics). This 'cross-sectional' approach (Kythreotis et al., 2023) provided both internal and external perspectives on the role of local government.

We developed an interview guide based on the research questions, and adapted it according to the background of the interviewee (Bryman, 2012; Rapley, 2004). All interviews were conducted remotely using MS Teams, including a pilot interview to test the interview guide. The final sample was determined when a range of stakeholder views had been represented.

Example interview questions included:

- How do you think that local action can be supported?
- Do you think that climate action should be a SR for LAs?
- What policy or governance approaches could ensure that responsibilities for delivering net zero are fairly distributed between regions?

[35] The term 'Big Society' references the Conservative Party General Election manifesto of 2010, which marked a renewed interest in the ideology and idea of 'active citizenship' (Maschette and Garnett, 2023).
[36] By devolved we imply *partially* devolved, since it is unlikely and unfeasible that climate mitigation powers could (or should) be entirely devolved.

Table 8. Summary of interviewees by sector, region, and level (n=28).

		Sector		
		Public (P)	**Third (T)**	**Academic (A)**
Level	**Local (L)**	10	1	-
	Regional (R)	5	1	1
	National (N)	2	-	-
	NA (-)	-	6	2
Sub-total		**17**	**8**	**3**

Interview data was transcribed manually and thematically analysed using NVivo Plus (v.12.6; Computer Aided Qualitative Data Analysis Software). Coding was repeated until theoretical saturation was reached (Clarke and Braun, 2017). Interviewees were assigned pseudonymous identifiers, which are used throughout the discussion of the results (see Table 8). For instance, an interviewee that is a council climate officer would be described as 'PL' (for *public* sector, *local* scale).

4.6. Results

4.6.1. What are the drivers of unequal LA capabilities?

The interview responses indicated that the capabilities of English LAs to deliver net zero depend on a number of factors, including: the relative levels and types of funding, differences in staffing, and political factors.

4.6.1.1. 'Like Glastonbury tickets': Economic capabilities

Funding was perhaps the key reason cited by interviewees for differences in local government capabilities, and, vice versa, differences in capability critically affected councils' access to funding. Stakeholders critiqued the central government bidding process, with several interviewees drawing the same analogy, comparing access to such

funding to buying Glastonbury tickets (PL5, PL6). Criticism was around the short notice and competitive structure of the bidding process, which served to reinforce inequalities in council capabilities:

> if […] you've got shed loads of staff that's quite easy. But it's just me […] and I will end up writing a bid on a Sunday (PL9).

Predictably, councils with a successful track record of attaining public funding saw less of a problem with the current system, often attributing their success to their experience working in different sectors: 'I know how to play the game' (PL4). This highlights the importance of prior capabilities in the form of sufficient staff resource and experienced officers, in securing funding and thus creating greater capability in future.

Some interviewees identified that current political instability at the national level, and a perceived lack of clarity in government guidance were both factors in shaping a culture of risk-aversity in many councils. A third sector interviewee described councils as being 'more cautious than ever' (T3). A significant component of this risk-aversity was financial, since many councils cited not being able to risk the legal costs of implementing a low-carbon initiative that may contravene national guidance. This was seen to limit experimentation to councils with existing capability ('30k losing a court battle, you'd rather spend that 30k putting it into your public services', T6). Therefore, greater funding not only allows councils to implement projects, but fundamentally reshapes the culture of council working so that they can 'afford' to be more innovative. In this way, economic capability has a more powerful role than simply funding a given project.

4.6.1.2. 'It's not just about money, it's about people as well':[37] Social capabilities

Closely intertwined with varied funding, was the varied social capability of councils. Interviewee responses suggested that greater overall council funding for staffing could facilitate: a) larger and more specialised council climate teams; and b) comparative advantages in recruitment and retention. More staff resources enabled more proactive than operational, 'reactive' working (PR1). However, some interviewees argued the case for streamlined teams, with climate action integrated throughout the council's departments to prevent any artificial 'siloes' of action.

As well as the quantitative number of staff, and the resource behind it, interviewees identified qualitative differences in successful councils. For instance, several

[37] PL1 interviewee.

respondents noted the importance of longstanding work on council climate action as a factor in success and ambition. Many interviewees attributed the impact of the 2008 recession and loss of the National Indicators (NI) framework[38] with having reduced staff resources around climate action in most councils (‘10 years ago was the last time that local authorities were really engaging with the sustainability agenda because of policy change’, PL4). Some LA interviewees considered that those councils that have been able to consistently resource and gain stable political support for their climate operations are now better placed to act on net zero, reinforced by another LA interviewee’s comment that: ‘[i]t's not you know, a new agenda for us’ (PL3). This ‘institutional memory’ allowed councils to be ‘hitting the ground running’ (PL9). Several interviewees commented on how the loss of in-house capability has meant many councils turn to consultancies to produce climate strategies and research, reinforcing a lack of capability given a lack of future ownership over the data or tools used in the research.

Respondents frequently raised the question of whether LAs were making use of their existing powers, and whether this was reliant on staff expertise. For instance, Nottingham’s Parking Levy was often cited as a successful example of using existing powers. However, other interviewees voiced frustration with the assumption from central government that all councils could replicate such a scheme, given not all LAs will have the expertise or capabilities to do so. As a third sector interviewee commented, ‘the government makes it difficult to sometimes use those powers’ (T1). Therefore it is not necessarily the case that some powers are insufficient to deliver low-carbon projects, but that staff experience, funding and political support are required to enable use of these powers. This highlights the co-dependence of many aspects of council capability.

4.6.1.3. ‘Not in their interest to be that helpful’: Political capabilities

Interviewees identified that important political factors in ensuring a council’s capability were ‘stable leadership’ (PL3) and supportive councillors (‘[y]ou can push so much up-water, but there has to be a level that goes downstream’, T6). However, respondents also voiced suspicion that political affiliation that aligns with national politics smooths the way for greater funding and insight, both at the LA and CA level. Several council staff commented on suspicions or ‘rumours’ (PL10) that funding allocations were more favourable to Conservative LAs. But others indicated that Conservative LAs were less

[38] The NI framework previously required LAs to report climate action against a number of metrics (Dixon and Wilson, 2013); this was abolished after 2011, leading to a loss of climate teams within councils (Cooper and Pearce, 2011; Howarth et al., 2021a).

likely to be more ambitious than national policy, for instance in only setting net zero targets for 2050, ensuring their policy messaging is consistent with that of national government: ‘they think, okay, if that's what the government is saying, that's what we're sticking to’ (T3). At a smaller scale, interviewees noted that differing political affiliations constrained cooperation between LAs and their higher tier authorities (e.g. county councils). One interviewee suggested that ‘[i]t's kind of politically not in their interest to be that helpful to us’ (PL9). This apparent protectionism around action on net zero risks further inequalities between LAs due to their politics.

4.6.2. To what extent would a statutory responsibility improve equity in LAs’ delivery of net zero?

Perhaps the most common reason interviewees cited for introducing a SR was that it ensured climate action was a priority within councils, protecting climate roles, teams and institutional memory against future budget cuts. As one officer commented, ‘it’s easy for the non-statutory duties to be potentially side-lined’ (PL3). It was also seen to confer ‘legitimacy and credibility’ (T5) on LAs in their implementation of net zero projects. This would prevent climate teams being seen as ‘nice to have’ rather than ‘essential’ (PL8), meaning more than only large, affluent councils have the capability to retain climate teams. Many interviewees also suggested that a SR could level the playing field of council climate action, with one respondent noting that ‘there's barriers to ambitious councils and then there's you know no accountability for unambitious councils’ (T1). Depending on the requirements and design of the SR, it was seen by interviewees as being able to establish a mitigation ‘floor’ or ‘level of service’ (T1), whilst ambitious councils could go further.

Some interviewees voiced critiques of a SR, seeing enforced commitments as redundant given the existing willingness of LAs to act: ‘it doesn't need a mandate from national government which implies that they [LAs] don't know what to do’ (PR1). Others suggested administrative burden and ‘red tape’ (PR2) could be a sticking point. Some respondents questioned the ethical implications of an SR, suggesting that it would implicitly devolve responsibility purely to LAs. This could shape a politics of blame which does not recognise the limited capabilities of councils to act on area-wide emissions in particular:

> [w]hy should it be and how could it be our [LAs’] responsibility? It's a responsibility of the private sector and of the people pumping out carbon left, right and centre (PL5).

The perspective of many interviewees on whether a SR would be appropriate or equitable hinged on its definition, intent, and resourcing. As one central government interviewee queried, ‘is it everything, at the same time, and therefore nothing in material terms?’ (PN1). The SR could be a loosely defined legal duty, a formal emissions target, a reporting requirement, mandate the publication of a strategy document, or some combination of the above. The most common condition of a SR was for accompanying funding, with an academic interviewee noting that ‘responsibility is only useful with power […] and funding more to the point, and capacity’ (A1). Several interviewees saw it as important to have funding and powers in place before the SR itself was introduced, to ensure that councils could build capability, and that funding would need to cover staffing costs for carrying out additional reporting. The ability of a SR to improve equity in LAs’ delivery of net zero would therefore be highly contingent on policy design and sequencing.

4.6.3. What alternative governance mechanisms could build LA capabilities to deliver net zero?

Interviewees critiqued the current public funding system for the way it reinforces existing patterns of capability; that is, it is highly dependent on having the staff resource to produce an evidence base and put together bids in a short window of time. Applying for funding requires funding, creating a catch 22 or ‘treadmill’ (PN1) situation, with some councils pre-emptively deciding not to apply for advertised funds (‘we don't even have the capacity to manage a consultant to apply for it on our behalf’, PL10).

Some interviewees expressed a desire for more equitable allocation systems and greater local control over the distribution of funding. One proposal to improve equity in funding was from changing the short-notice, competitive allocation system for one-off projects, to one of continuous equal distribution. One interviewee proposed a means-tested system: ‘[h]ow about just equally share it? But maybe I get a bit more because it's harder in my area’ (T6). In essence, this proposes a funding scheme following a principle of CBDR-RC. Other suggestions involved population-linked funding, or regional funding distributed down through CAs or county councils, giving a greater degree of local control over how the funds were spent rather than ‘trying to shoehorn our need into nationally set funding restrictions’ (PR2).

By contrast, a bottom-up led reform proposed by interviewees was a collaborative bid process, where LAs are paired with others successful in accessing funding, in order to overcome differences in capability whilst also addressing cross-boundary emissions.

4.7. Discussion

4.7.1. Respecting capabilities at the local scale

Perspectives from interviewees generally highlighted that the current landscape of subnational climate governance in England does not address differences in local capability. As previous analysis of LA targets has suggested, there is significant regional variation in mitigation ambition, which ultimately reflects LA capabilities (Garvey et al., 2023).

Though economic drivers were often viewed as the most important factor driving variable capabilities, political factors were presented as the overall 'determinant' of capability. Political affiliation can play an important role in influencing how much funding is received, how it is spent, and in the strategic direction of the council around climate. Political support from officials was an enabler of more ambitious action; several studies predating the net zero target-setting phenomenon draw attention to the importance of supportive individuals such as senior officials (Allman et al., 2004), 'policy entrepreneurs' (Bulkeley and Kern, 2006), and climate 'champions' (Pearce and Cooper, 2013).

As well as the political support *within* a council, the political interactions *between* councils, higher tier authorities and national government were critical in determining overall ambition. Where the political affiliation of a council 'matched' that of the higher tier authority (e.g. a county council) or national government (i.e. Conservative), this was seen as facilitating greater support and therefore capability for climate action. This supports Hsu et al.'s (2017) notion of the important role of vertical alignment between subnational actors. Recent evidence has suggested that the government allocation of Levelling Up funds has disproportionately benefitted Conservative LAs (McCann et al., 2021). There is therefore a risk that politics could be a driver of further unequal capabilities between LAs, though further empirical evidence is needed to determine whether this is also true of net zero funding.

Political affiliation was seen as a potential constraint on ambition where Conservative councils were not expected to set targets more ambitious than national government. This has the potential to create a situation in which Conservative LAs are more able to meet

less ambitious targets, whilst LAs run by other political parties set more ambitious targets with less chance of being funded, thus risking damage to the credibility of their net zero commitments. As Ruiz-Campillo et al. (2021) note, for 'government institutions, credibility depends on achieving consistency between words and deeds'. This reinforces the need for a standardised, transparent target-setting and monitoring mechanism, based on *science* not politics, and which recognises pre-existing capabilities.

National political factors were also a key factor in determining overall economic capabilities, with particular criticism around central government's preference for a competitive bidding system. Competition funding aligns with a neoliberal, market-led philosophy that may serve interests of economic efficiency, but underserves the needs of local government. It perpetuates councils with less capability being less able to successfully bid, deepening inequalities in capability. Lockwood (2021) observes this approach to energy and climate policy since the 1980s, and Gillard et al. (2017) suggest it can be a response to 'constrained public finances'. This is a critical ongoing consideration given current pressures on public spending in the UK.

The analysis also highlighted the importance of differences in institutional memory, which is a product of different economic, social and political capabilities over time. A key driver of inequalities in progress was policy churn such as the removal of the NI framework (Dixon and Wilson, 2013). More capable councils were able to sustain activities around climate mitigation through retaining climate staff, meaning they were better placed to perform well within the current resurgence of the low carbon agenda. As Roppongi et al. (2017) note of Tokyo, 'historic accumulation' of capacity has enabled innovative action around emissions reductions. This serves to show how inequalities in capability are reinforced over time. This finding accords with that of Kuzemko and Britton (2020), who suggest the importance of 'knowledge capacity' as a driver of 'policy capacity' and how 'embedding staff and knowledge' can grow other forms of capacity.

4.7.2. Differentiating responsibility at the local scale

Interviewees criticised the way in which 'piecemeal' national guidance (Evans, 2020) is a barrier to local climate action, feeding into a culture of risk aversity. The literature describes a trend towards the 'polycentric' and therefore experimental nature of local action (Bulkeley and Castán Broto, 2013; Castán Broto et al., 2019; Creasy et al., 2021; Gillard et al., 2017). However, a lack of policy certainty is ultimately constraining this innovation. It reinforces an uneven environment in which only the more capable LAs can

‘afford’ to experiment and test the boundaries of national policy. A well-resourced SR was seen as having the potential to improve equity by levelling the playing field of local climate action, and guaranteeing a minimal level of mitigation ambition from councils whilst leaving more ambitious LAs with the scope to go further. This principle is highlighted in the arguments put forward for an ‘interactive federalist’ model of environmental governance (Sovacool, 2008), the benefits of which are flexibility in how local objectives are met whilst guaranteeing a baseline of action to ensure national targets are comfortably reached. A SR would therefore establish accountability and oversight for the targets set and commitments made by councils. The Climate Change Act (2008), as a national SR, has rendered debate around climate policy ‘more structured and evidence-based’ (Averchenkova et al., 2021); a local SR could similarly introduce new norms of reporting and the standardisation of commitments.

A key part of any proposed SR would be its establishment of a reporting convention similar to the NI framework. This could allow the construction of an evidence base for the equity-based funding system (as proposed by interviewees). Transparency and reporting on the current state of LA resourcing could also embed principles of CBDR-RC into the SR, by reflecting how underlying capabilities have shaped greater action in some areas. The CCC also recommend a ‘fully funded’ duty ‘to act in accordance with Net Zero by delivering climate action plans within a common reporting system’ (Evans, 2020). This draws attention to the most commonly cited caveat for any local SR – that of increased and differentiated resourcing, as a prerequisite and precursor to any SR being introduced. This highlights that with downscaled responsibility there needs to be downscaled resource (Catney et al., 2014), and that capability and responsibility are to some degree interdependent.

4.7.3. Avoiding the ‘local trap’

The broader question raised by the discussion of limited and variable local capabilities and a SR is whether it is right to assume a central role for local climate action, and if not, what kind of local roles, responsibilities and funding there should be. The literature and many interviewees commented on the so-called ‘local trap’, which challenges the assumption that the local scale is necessarily best for carrying out climate action (Catney et al., 2014). Shaw and Greenhalgh (2010) critique the ‘excessive localism’ of a council based approach, whilst Muinzer and Ellis (2017) also question the idea of the ‘right scale’ for climate action. This responds to a mainstream narrative in place-based research, which often fails to consider the variation in local capabilities. For instance, in the case

of industrial areas, interviewees implicitly suggested that there may be a mismatch between the capabilities of the LAs and the scale of emissions; it may not be appropriate to set statutory area-wide targets for this reason. Industrial decarbonisation was broadly viewed as within the remit of national government, and as highly dependent on national decisions around infrastructure, with limited scope for LA engagement in this process. There is therefore a potential sectoral separation between the policy areas that local or national government could or should cover.

Many of the proposed reforms to local climate action rely on top-down interventions, but bottom-up 'workarounds' for LAs include partnership working to overcome resource constraints, and internal standardisation of the role of council climate officer (perhaps coordinated by the Local Government Association as a membership body). However, much of the academic literature considers there is a ceiling to local action without additional support from national government. As Borrowman et al. (2020) note, '[c]ouncils cannot hope to decarbonise their local areas without the backing of ambitious national policy frameworks.' LAs cannot always reform their ways of working on climate from within, since many of the powers LAs hold are determined by central government (Harvey-Scholes, 2019). There are inherent national barriers to local action. Armstrong (2019) note that LA action is largely 'low-impact', and Marsden et al. (2014) note the 'pragmatic incrementalism' of local actors. The achievement of the national net zero target demands action at pace and scale from actors across scales. Therefore whilst laudable, the current commitments and actions of LAs face a saturation point without more proactive, clear support from central government.

4.7.4. Limitations and directions for further research

The current research prioritised mitigation as this is the focus of the UK's national climate policy framework and is of more relevance to the targets most LAs have set, namely around 'net zero'. Climate adaptation is typically underexplored in local climate action plans (Grafakos et al., 2020), and therefore further research could explore stakeholder perspectives on the role of LAs in delivering adaptation. Another limitation could be how well the sample represents a variety of LAs of different resources and capabilities. Though we attempted to contact a cross-section of LAs with more or less developed climate strategies, the sample will necessarily include participants from LAs with more capability to respond.

4.8. Conclusion

The analysis considered how the current paradigm of Local Authority (LA) climate action aligns with the principles of Common But Differentiated Responsibility and Respective Capabilities (CBDR-RC). The analysis identified that economic, social and political factors were critical determinants of overall capability, and that the current governance arrangements for local climate action tended to reinforce patterns of unequal capability. Though economic factors are typically cited as the most important dimension of overall capabilities, it was shown that political factors act as an overall 'determinant' of capability, and that economic, social and political capabilities are to a large degree interdependent. It was found that a statutory responsibility (SR) could have the potential to improve equity in local action, provided the mechanism recognised variable council capabilities through careful design and appropriate resourcing. Though a SR could level the playing field of local climate action and ensure more equitable burden-sharing, others questioned whether it would lead to a culture of blame and undue assignment of responsibility to one scale. This points to an ongoing debate around the 'correct scale' for climate mitigation (Schafran et al., 2020) and to what extent the assignment of responsibility depends on political, legal, and ethical ideologies of allocation.

Funding reforms proposed to overcome disparities in capability included the equitable distribution of funding, recognising the various needs of different councils and endorsing the principles of CBDR-RC in the funding allocation system. The findings have direct relevance to current UK policymaking in this area, particularly given the newly created Office for Local Government, which could offer greater oversight of LA performance on climate change (Kenyon, 2022). Though addressing the English context, there are nonetheless transferable insights from the present analysis in the form of the subnational application of principles of CBDR-RC. International comparative analysis of capabilities and governance frameworks for local climate action could be a valuable area for future research.

Many interviewees drew attention to the ongoing action of LAs in the absence of substantive government guidance, support or formal responsibilities. It is therefore critical to recognise the value of the incremental action that councils are taking, though noting that without further, active central government support it will remain incremental, and perhaps, inequitable.

4.9. References

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5. Discussion and conclusion

The following chapter synthesises the key findings of the thesis, and draws together insights from all three chapters. It aims to critically reflect on the contribution of each piece of research, both individually and as a whole, to the academic literature and beyond.

I first detail the aims, research questions and objectives of the thesis and how these have been met by the three analyses. I then present the key findings. To avoid duplication of the insights presented in previous chapters and to encourage a more integrated consideration of the contribution of the whole body of work, I present the findings thematically rather than by how they meet each research question. This allows a more expansive and applied discussion of how the research responds to the current policy context, rather than how it fulfils purely academic criteria.

A subsequent section presents a series of policy recommendations synthesised from across the three pieces of research, as well as exploring the potential research impact from the project. A reflection on the limitations of the research then follows, as well as discussion of how they could inform a future research agenda. I finally present concluding remarks about the overall contribution of the research.

5.1. Aims, objectives and research questions

The research set out to explore how the conceptual framework of ‘spatially just transitions’ could be defined and operationalised to ensure the fairness of the United Kingdom’s (UK) low carbon transition (LCT). The three key research questions and objectives, and how they were met are outlined below.

5.1.1. What could be considered a ‘spatially just’ low carbon transition (LCT)?

The first objective involved the construction of a conceptual framework of spatial justice, as it applies to the Low Carbon Transition (LCT) through a synthesis of interdisciplinary literature. This is presented in the review paper in Chapter 2. This offered theoretical novelty in defining spatial justice as an under-used theory in the context of the LCT, correcting a prior research gap and extending the work of Bouzarovski and Simcock (2017). It also contributed methodological novelty in signposting the concept of the ‘semi-systematic’ review and applying it to this issue area. Anecdotally, the reception to this

type of review has been positive, with others signalling their intent to use such an approach. The process of peer-review pushed better definition of this review type but also underscored its novelty.

5.1.2. What are regional responsibilities and capabilities for decarbonisation in England?

The second objective was the quantitative assessment of relative ambition (i.e. responsibility-taking) and capability in Local Authority (LA) net zero targets. This used a combined carbon accounting and composite indicator approach, building on the insights of the review paper. For instance the trend of indicators being used to operationalise and measure relative 'justice' (as in Salvador and Sancho, 2021). The quantitative assessment of the equity principles of responsibility and capability marked a methodological novelty.

5.1.3. What governance mechanisms can embed spatial justice into UK net zero policymaking?

The third objective was to consider the equity of LA climate action, drawing on stakeholder interviews. This presented an empirically novel evidence base of practitioner views on the fairness of the local delivery of net zero, building on the previous chapter in its qualitative application of Common But Differentiated Responsibility and Respective Capabilities (CBDR-RC) and on the framework offered by Mayne et al. (2017). The research marked a conceptual novelty in its in-depth discussion of the equity of a statutory responsibility (SR), and synthesis of stakeholder perspectives on this issue; this is not something often considered in depth in the extant academic or policy literature. It also offered a discussion of alternative governance mechanisms to improve the equity of local climate action, including proposals for funding allocation mechanisms informed by the principles of CBDR-RC, greater local or regional control over funding distribution, and collaborative bidding processes.

It also contributed to the policy debate as part of achieving the fourth research objective, which was to outline a series of policy and governance principles and recommendations on how the UK's LCT can be rendered 'spatially just'. I aim to meet and discuss this objective later in this chapter (see Section 5.3).

5.2. Key findings

The research has outlined the inequity of the current landscape of climate action and governance at the subnational scale in England, if not the UK more broadly. This risks a spatially unjust transition if governance continues within the status quo. In what follows I outline three key findings from the research, organised by themes to integrate discussion of the three pieces of work.

In brief, it was found that achieving spatial justice requires making assumptions about scale, and moreover the correct roles and responsibilities for different levels of government in light of their respective capabilities (Mayne et al., 2017). The research in entirety drew attention to how these assumptions are both political and ethical in nature, and in large part dependent on the prevailing governance ideology of the time. For instance, in the current UK context, the dominance of 'small state' Conservative politics is perhaps one of the reasons behind a lack of commitment to what role subnational actors should play in the transition. Subnational actors' perception of a lack of national action on climate mitigation means that they are taking action regardless (albeit incrementally and without coordination; Armstrong, 2019).

The second main finding was that spatial justice necessitates considering *temporal* justice. That is, in the application of equity principles to the case of the English regions in particular, notions of historic responsibility and present-day capability come into conflict. Current capabilities are shaped by historic patterns of industrial and regional development, determining the potential future opportunities in these areas under the LCT (Cowell, 2020; Sayan, 2019). This was particularly highlighted in the case of industrial decarbonisation, and points towards a need to recognise the tension between areas with opportunities for new industries and those burdened with the legacy or ongoing emissions of the old industries.

The final key finding is around the need for substantive subnational carbon (and other) accounting frameworks. The variable, voluntary nature of subnational climate mitigation efforts is matched by variability in the approaches to carbon accounting. Several issues were raised around the way in which emissions are measured and reported, targets are set, progress is monitored, and the way in which local action is financially supported to do so via central government. Whilst the review work highlighted the value of indicator approaches, the target analysis and interview research in tandem suggested the need for:

a) *standardised* emissions accounting and reporting frameworks;

b) science-based target-setting, over the current paradigm of symbolic or politically motivated targets; and

c) continuous and transparent monitoring of *action* rather than mere intent, particularly through using new indicators and metrics.

The following expands on these findings in greater depth.

5.2.1. Finding 1: Achieving spatial justice requires making scalar assumptions

A recurring commentary throughout the research has been around the importance of the politics of scale as a determinant of subnational action (Bulkeley and Betsill, 2005; Marsden and Anable, 2021). That is, in the UK at least, decisions are typically made nationally and unilaterally, shaping norms of responsibility for climate mitigation at the subnational level (Blunkett et al., 2016; Lockwood, 2021; Peck et al., 2013; Pike et al., 2015; Russell and Christie, 2021). Throughout the research it became clear that it was problematic to discuss the idea of 'local responsibility', since there are no formal duties for the local scale, particularly if considering LAs (Bulkeley and Kern, 2006). This was seen to be the result of new govern*ance* norms, austerity conditions and 'Big Society' ideologies within central govern*ment* (Catney et al., 2014; Gillard et al., 2017; Wittmayer et al., 2016). A further problematic is financial, namely that any devolved responsibility is expected to be accompanied by devolved resource (Thaler and Priest, 2014), leading to a lack of political commitment to such devolution. Even the Combined Authorities (CAs) suffer from a reported lack of finance (Evans, 2020). Yet the expectation of local climate action is implicit, and to some degree necessary given the role of LAs as delivery bodies for national policies (Argyriou et al., 2012). The presence of public sector decarbonisation reporting and resourcing in Scotland lends greater credence to the potential role for LAs or the local scale in climate mitigation in England.

Chapters 3 and 4 in particular identified that without a clearly articulated role for local government, voluntary action remains variable and a product of pre-existing capabilities. With greater decentralisation of climate governance to the subnational scale, there is greater reliance on existing patterns of capability, which are regionally varied. In other words, a spatially just transition requires decisions about the role of each scale. For instance, Chapter 2 identified that a lack of administrative coordination between levels risks spatial injustice in the transition. Similarly, as Mayne et al. (2017) explore, the 'roles' of different actors within transition processes involve making ethical judgements,

something which the central UK government appears to be unwilling to do. Establishing roles for different subnational actors is at heart a political process. The very unwillingness of UK government to allocate formal responsibilities to the local scale is aligned with the neoliberal political ideology of the 'Big Society'. 'Big Society' has long been an ideology associated with Conservative government, dating back to the 1980s (Maschette and Garnett, 2023). The extent to which 'Big Society' ideals are affiliated with conditions of austerity could be further interrogated (Tingey and Webb, 2020; Wittmayer et al., 2016). This is particularly important given ongoing pressures on public spending and likely future constraints. However, whatever the driver, this abrogation of responsibility-sharing risks a governance gap in national mitigation efforts. A *laissez-faire* attitude to how decarbonisation will be exacted across scales and geographies will result in a failure to meet emissions targets.

Though not a focus of the current research (which primarily considered the roles of subnational state actors), the role of non-state action would be a valuable area for further research. Indeed, Hsu et al. (2020) note that non-state actors have potential to 'bridge the ambition gap left by insufficiently ambitious [Nationally Determined Contributions, NDCs]'. The literature establishes that although the practice of non-state climate action is in itself laudable, with benefits beyond the technical contribution to national decarbonisation, the presumption of non-state action is problematic. My previous research into the role of community groups in delivering flood management comes to a similar conclusion (Garvey and Paavola, 2021). This is particularly around the way in which a governance gap over a given issue area (whether it be flood risk or climate change) leads to voluntary non-state action, which is in turn problematically reliant on the pre-existing capabilities of different areas and communities. Different questions arise when considering the role of private enterprise as a non-state actor. Here, it may be expected under the Polluter Pays Principle and notions of CBDR-RC that companies take action to abate at least their own emissions, given their financial benefit from such environmental externalities. My previous research into voluntary corporate climate commitments through the Science-Based Targets initiative (SBTi; Giesekam et al., 2021) also revealed commonalities with voluntary LA climate commitments. Namely, that commitments are driven by large capable actors who could accrue reputational benefit from signing up, carbon reporting practices are uneven, and there is a lack of accountability. As such, comparative analysis of the various rationales for voluntary climate commitments by non-state actors could be a valuable area for further research.

As noted in the interview research for Chapter 4, there are seemingly endless networks and informal bodies set up to 'coordinate' and support voluntary LA action, including around capability building. However, these often impose an opportunity cost on already stretched council resources. Such activities are reliant on council climate officers having the time to engage, and many interviewees noted the limits to this capacity. Many interviewees also pointed towards the need for top-down oversight and coordination, as the only arrangement having the legitimacy to direct LA action. This was a particular criticism of the Climate Emergency UK (CEUK) scoring exercise, in its informal nature and demands on officer time. However, the sense that central government does not 'trust' local government, and the currently adversarial relationship between local and national could present barriers to any top-down imposition of monitoring or policy change. Communication between the two scales is seen as poor, supporting the findings of Kuzemko and Britton (2020). Furthermore, when it did occur, it was often characterised as being unilateral from central government. Improving *bilateral* communication between levels of government could therefore be a critical area for reform. The recently announced Local Net Zero Forum (Department for Levelling Up, Housing and Communities, 2022) was ostensibly set up to achieve this, but stakeholders had either not heard of the initiative, or were not clear on how it was progressing. Others noted the value of the Department for Business, Energy and Industrial Strategy (BEIS) Net Zero Hubs (Greater South East Net Zero Hub, 2023), particularly as a conduit with national government, but the presence of the hubs is regionally variable. As a result, a stable, cross-parliamentary channel of communication and coordination from central government could have a future role in delivering local action. The need for a degree of central government involvement in local climate action was ultimately seen as necessary, and could be configured as a 'backstop' role.

The research has therefore highlighted that there are both spatial and scalar dimensions to the equity framework of CBDR-RC. Policy and governance mechanisms need to recognise:

> a) that different responsibilities are appropriate for different scales – i.e. there is no one 'right' or 'correct' scale (Muinzer and Ellis, 2017; Schafran et al., 2020), and that this should reflect the relative capabilities of different levels of government; and,
>
> b) that different responsibilities are appropriate for different regions (i.e. industrial regions), and that this should be cognisant of varying capabilities.

The matrix diagram (Figure 11) illustrates this tension. The research highlighted the indissociable nature of space and scale, responsibility and capability, and that decision-making needs to incorporate consideration of both principles to meet the criteria for equity (Sasse and Trutnevyte, 2019). This was particularly highlighted in the discussion of historic responsibility versus present-day capability (as discussed in Section 5.2.2). The research also pointed to a number of mechanisms which could ensure equity in the allocation of responsibilities, and in building capabilities (see Section 5.3).

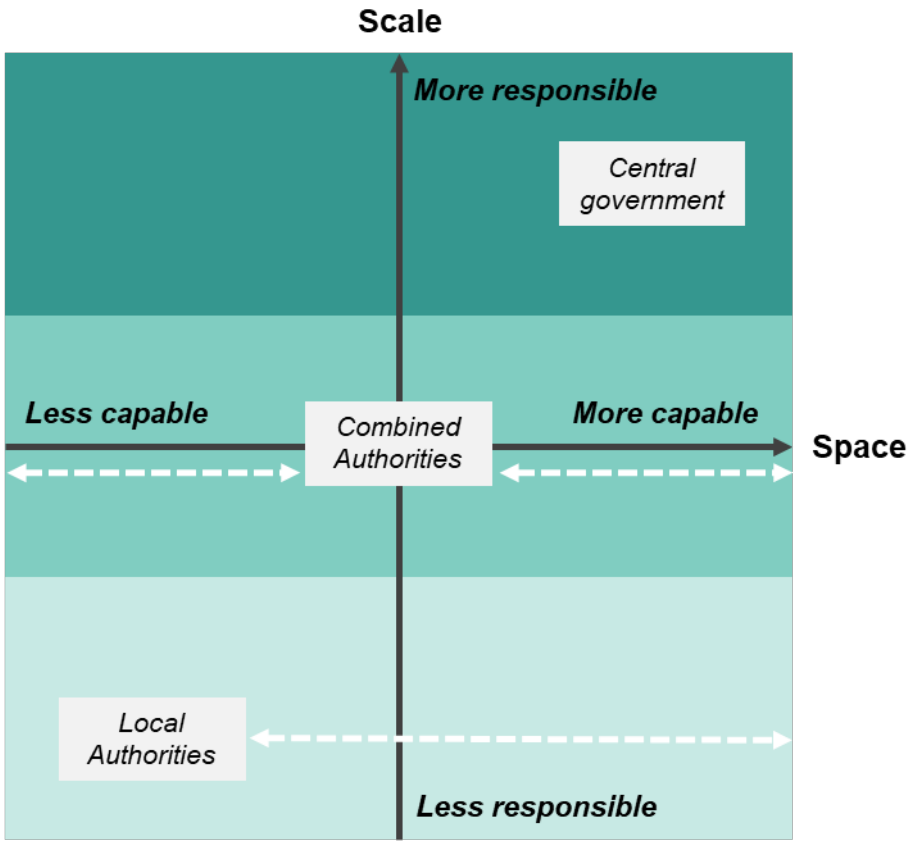

Figure 11. Infographic summary of the relationship between the equity principles of responsibility and capability and how they interact with space and scale. (White dashed arrows suggest a continuum of more or less capable forms of each type of regional or local actor).

The three pieces of work have therefore further problematized the idea that there is any singular 'right' or 'correct' scale for delivering climate mitigation (Muinzer and Ellis, 2017; Schafran et al., 2020) and further cautioned against the 'local trap' (Catney et al., 2014). The work instead formulates a sense that different scales and spaces contribute differentially to subnational climate action. This aligns with theory around Multi-Level Governance, and particularly resonates with Marsden and Anable's (2021) comment that, '[t]he lack of clear recognition of the need for multi-scalar allocation of emissions

responsibilities is allowing an incoherent approach to unfold.' This could be extended to say that it is also allowing an *unjust* approach to unfold. In essence, the research highlighted that any discussion of spatial justice necessarily involves a recognition of something which could be termed 'scalar justice'.

5.2.2. Finding 2: Spatial justice is inextricably linked to temporal justice

As noted above, the interaction between historic responsibility and present-day capability was of recurring interest in the research. This highlights tensions between spatial and temporal notions of justice (Sasse and Trutnevyte, 2019).

Intergenerational justice is the most common conceptualisation of temporal justice in relation to climate change mitigation. It describes the need to recognise in the present day the ethical debt owed to future generations (Gosseries and Meyer, 2009). Just as CBDR-RC (as a principle of spatial justice) is typically conceptualised at the international scale, so are calls for intergenerational justice (as an expression of *temporal* justice). There is therefore a novel future research agenda in considering the subnational implications of temporal justice. Temporal justice at the subnational scale could mean attending to different desires for regional development pathways, including ones which may break from industries of the past, invoking ideas of recognition justice (Chateau et al., 2021). This also integrates considerations of procedural justice to ensure regional preferences are well represented, for instance via citizens' assemblies (as noted in Chapter 2; Wells et al., 2021). Broader concepts beyond the 'tenets' including that of cosmopolitan justice similarly reflect the importance of this temporal dimension, and suggest the need to protect the rights of future generations (Sovacool et al., 2019).

In a paraphrasing of Rawls (in Sandel, 2009), just because it's the way things have been done, it doesn't mean it's the way they ought to be (or indeed how people want them to be). It could mean recognising that though regional ancestors benefitted from heavy industry, it does not hold inhabitants of that region accountable for these historic emissions, though they are burdened with a legacy of industrial emissions today. As highlighted under notions of restorative justice, there is also a case for remediating the harms of heavy industrial pollution that have historically affected such communities (Hazrati and Heffron, 2021). As Chapter 2 highlighted, to achieve spatial justice there is a need to recognise historic (i.e. temporal) patterns of injustice, particularly around land use, planning and how this shapes norms of future use (Cowell, 2020).

As discussed in Chapters 1 and 2, part of the difficulty in the equitable treatment of industrial regions within UK climate governance is the orthodoxy of the current carbon accounting approaches that underpin climate policy (Kuriakose et al., 2022; Marsden and Anable, 2021). Though there is no national policy framework explicitly penalising industrial areas of the UK, they are implicitly disadvantaged through the production-based framing of climate policy, which means emissions-intensive regions will incur greater costs via policies such as Emissions Trading Systems (ETSs). Industrial decarbonisation poses opportunities for some regions, and opportunity costs for others, and it is clear that the so-called 'Green Industrial Revolution' (HM Government, 2020) will not follow the same spatial patterns as the last. That is, some regions are able to benefit from the development of new green technologies and industries, whilst others face the burden of decarbonising existing 'old' industry. Success in managing the transition will hinge on whether old industrial regions can host industries of the future. Without careful management, different regions of the UK risk becoming temporally divided – that is, some left in the past, particularly with regard to their industrial structure.

Though the overall trend is towards deindustrialisation in the UK, areas of historically high emissions are broadly similar today as industrial areas have remained in similar locations (as discussed in Section 1.3.3.2). Therefore, when considering how to allocate responsibility, it is not unreasonable to assume industrial areas have the most burden to bear. However, when comparing with present-day capabilities this introduces a critical equity issue given the capabilities of industrial areas are generally lower. Speaking in terms of LA capabilities to decarbonise their area-wide emissions, this is often due to a combination of: an inability to influence private sector emissions; being socioeconomically affected by long-running processes of deindustrialisation, with weaker regional economies; and having fewer council tax revenues due to this socioeconomic deprivation. Private industry can be considered only indirectly under the influence of even national government, with many key industrial sites under international ownership. Nationalisation of key heavy industries (as was the case in the 1980s) allows greater control over the regional impacts of a given industry's changing fortunes. It could be said that the horse of industrial emissions has long bolted from the stable of government control – the door to international ownership was left unlocked by a long era of deindustrialisation and the devaluation of industrial assets.

The difficult interactions between historic responsibility and current capability highlight the need to consider both equity concepts in tandem, not as isolated issues. It also

requires debate around temporal as well as spatial issues of justice, particularly in attention to how this plays out at the subnational scale.

5.2.3. Finding 3: Subnational carbon accounting requires substantive reform

The importance of carbon accounting in the configuration of equitable climate action and governance in the UK has been established in the previous sections, and warrants further discussion. Carbon accounting approaches and assumptions have particular relevance for industrial emissions, continuing the discussion of the previous section.

Improving the equity of climate governance at the subnational level in the UK will rely on a robust evidence base, something that is currently lacking. Stakeholders in interview research identified that data collection efforts on baseline LA greenhouse gas (GHG) emissions as well as progress in decarbonisation were variable, methodologically inconsistent, and often reliant on the work of consultancies (echoing Evans, 2020). A number of tools and initiatives have been introduced to attempt to standardise the process of LA reporting in particular, for instance the 'Setting City Area Targets and Trajectories for Emissions Reduction', or 'SCATTER' tool, and one from the Local Government Association (LGA; CEUK, 2021). Yet given the late introduction of these mechanisms different LAs have different approaches and uptake of formal initiatives is variable. Some interviewees saw the existing BEIS LA emissions data as adequate, whilst others didn't think it was disaggregated enough. There was general consensus that the loss of the National Indicators (NI) framework had impacted the consistency of climate data collection in the UK (Dixon and Wilson, 2013).

The issues affecting subnational carbon accounting can be categorised as issues of: a) emissions monitoring; b) target-setting and progress monitoring; and c) equity and transparency. Each is elaborated on below.

5.2.3.1. Emissions monitoring: Prioritising action over intent

A key critique from interviewees was around the inconsistency in data collection and the usefulness of data that is collected. A particular criticism was that data is not operationalised. Interviewee suggestions for improving the value of carbon data included using carbon budget frameworks and using new metrics of progress monitoring. For instance, more than one interviewee cited measuring and tracking the kilometres of cycle lanes a LA introduces as a more tangible metric of mitigation progress. The Climate

Change Committee (CCC) appears to endorse this approach, with the recent release of its Monitoring Framework, providing a set of holistic indicators for sectors as well as for cross-cutting issues such as fairness (CCC, 2022). This type of metric was seen to reframe the process of decarbonisation, drawing attention to the positive, multiple benefits consequences of mitigation, rather than simply becoming a carbon accounting procedure. Some similarly cite what they call the politics of 'carbon control' (Jonas et al., 2011), or 'technocentric' approaches to sustainability (Creasy et al., 2021; Smith and Christie, 2021) in which carbon accounting seemingly becomes an end in itself. However, such a focus away from carbon could arguably lead to incremental steps, and the prioritisation of actions which provide the most public impact rather than reducing emissions at scale. A focus on metrics of GHG emissions perhaps means a focus on the mitigation actions which will deliver the greatest quantitative emissions reductions.

5.2.3.2. Target-setting and progress monitoring: Establishing science not politics-based targets

The net zero targets that have been set by LAs suffer from many of the same problems that affect corporate carbon reporting, such as an unclear baseline emissions date. However, corporate climate action and emissions reduction targets are longstanding, and have undergone some standardisation; for example, through the International Organisation for Standardisation and Monitoring, Reporting and Verification (MRV) organisations such as the Carbon Disclosure Project. More recently, in light of accelerating net zero commitments by firms, the SBTi has aimed to create a standardised target-setting process for firms aligned with 1.5°C (Celsius) temperature pathways. However, the SBTi lacks a framework for monitoring progress and participants still exhibit significant variability in their reporting practices (Giesekam et al., 2021). This analogy indicates that some issues affecting LA commitments are systemic to net zero target-setting (Rogelj et al., 2021), and suggests that local climate action could benefit from some of the same mechanisms for oversight, standardisation and MRV that are required in corporate climate action (Evans, 2020).

For instance, what was evident from both the target analysis and the interview research was that many net zero target dates had been chosen for political reasons, rather than being science-based (Howarth et al., 2021). Many stakeholders either admitted or suggested that the targets for their council were arbitrary, or unrealistic. Unless LAs or other actors provide evidence of the rationale and process of *setting* the targets, there could be reason to doubt the validity of the commitments. This is reflected in a current

reframing from recognising intent to recognising *action.* This is most manifest in the approach of CEUK, which has moved from a position of scoring climate action plans (intention to decarbonise), to scoring mitigation action (CEUK, 2023). This raises the question of whether to measure action against stated targets, but there is the corollary that this penalises regions that have set more ambitious targets. This is a more complicated process, but perhaps fairer, if criteria for scoring action are collectively agreed.

5.2.3.3. Equity and transparency: Creating new indicators

As highlighted above, there was general interest in new metrics to monitor progress in climate mitigation efforts. Chapter 2 noted the increasing use of indicator frameworks to track relatively normative ethical concepts such as 'justice' and 'equity' (Füssel, 2010). Suggestions from interviewees in the stakeholder research also included measures to improve the documentation of the equity of climate mitigation efforts. For instance, in reporting the resources LAs have in their climate teams alongside reporting of their action to date. This could be termed 'fair disclosure' that recognises the varied capabilities of different actors. New indicators that measure equity alongside those designed for 'carbon control' (Jonas et al., 2011) could be a progressive step forward.

Section 5.3.2 further outlines policy and governance proposals for reform to current processes of carbon accounting to improve the equity and effectiveness of current subnational climate mitigation efforts.

5.3. Towards spatially just policymaking: Policy and governance recommendations

In the following I draw out a number of policy and governance recommendations from the research. The three high-level proposals include: 1) establishing a subnational statutory responsibility (SR); 2) standardising and operationalising subnational carbon accounting; and 3) implementing equity-based funding allocation systems.

5.3.1. Recommendation 1: A subnational statutory responsibility

Notwithstanding criticisms and concerns voiced by interviewees around the potential for a local SR, there could be value in implementing one if appropriately designed. Its main

role would be in establishing a baseline requirement of climate mitigation to hold LAs to account where their efforts are not proportionate to their capabilities. Similarly, a SR could ensure the clear communication of roles and responsibilities between levels of government, introducing active coordination between levels. Central government would necessarily have the deciding role in the implementation and management of an SR, as it holds the ultimate democratic legitimacy and legal powers to do so. Interviewees voiced concerns that a potential local SR could push responsibility to the local level, letting other actors 'off the hook' for climate action. Indeed, any partial allocation of responsibility implies a judgement of who is more duty bound to act or can act most effectively. This raises the question of whether there should be a SR for all public actors, beyond the level of councils (for instance encompassing schools, CAs, and others). The use of such a tool in Scotland suggests its feasibility, and the potential fairness of such coverage.

Similarly, given the concerns of council climate officers around the potential additional burden of a SR, and its unintended consequences in assigning 'blame', the SR would be more acceptable if co-designed with LAs. This would improve a sense of procedural justice. As noted in Chapter 2, acceptability in LCT measures is determined by a sense of *perceived* justice – that is, are others taking proportionate action, and do actors see what is being demanded of them as fair? As mentioned previously, interviewees noted that there is little trust between local and national government, and that means of communicating between the two levels are limited. Any additional requirement imposed from the top-down would need to be carefully brokered for this reason, to render any new requirements acceptable.

5.3.2. Recommendation 2: Improving subnational carbon accounting

A number of reforms to carbon accounting can be drawn out from the research. The first is around the standardisation of data collection protocols at the subnational level. Standardised reporting criteria would ensure that council emissions and mitigation action can be compared like for like. This could encompass both baseline emissions and progress in reducing emissions. Decisions on which criteria are appropriate and feasible to report against should be negotiated between local and national government, and LAs would require resourcing to complete any additional reporting requirement (where appropriate). This would have the added benefit of building capabilities and institutional memory within councils, and avoiding locking data into proprietary arrangements with consultancies.

This could be part of a SR (either a SR to report, or as part of a broader SR). As previously discussed, reporting data on the resources held by each council with regard to climate action could be a means of improving equity and recognition justice. Data on the size of climate teams within different councils is currently lacking, and could offer valuable insight into why certain LAs are more able to progress with their emissions reductions. These data collection and reporting reforms would necessarily need to be conducted and coordinated by a body with national oversight and legitimacy. This could point towards a role for the Local Government Association, which has already conducted a comprehensive survey of its members on this subject (LGA, 2022). Alternatively, it could be a role for the newly created Office for Local Government, which is ostensibly aiming to compare LA climate change mitigation performance (Kenyon, 2022). The Scottish SR provides a model for standardising data collection from public sector bodies, with the Sustainable Scotland Network coordinating data collection and reporting (SSN, 2023).

A second aspect of reform to current LA carbon accounting, is around the operationalisation of data. Part of the noted value of the NI framework was in its standardised process, and continuous updates. One interviewee argued that data collection is redundant if it is not updated, a criticism which was also levelled at the CEUK climate plan scoring. The landscape of LA climate targets is a mobile one, and therefore any static assessment of progress is likely to quickly become out of date. This calls for dynamic, continuous progress assessment to provide real-time insight into whether the subnational contribution to national climate commitments is on track. Updates could appear resource-intensive to conduct however, which points towards the value of systems that automate reporting (for instance the use of indicator dashboards).

Another means of operationalising the data, particularly in communicating progress in mitigation action, and in focussing on action over intent, is by creating new metrics (e.g. the number of Electric Vehicle charging points installed). This is complicated by the fact that the measures that could or should be taken in different LA areas will vary. For instance, the length of cycle lanes installed in one urban area may be a useful indicator, whilst the amount installed in a rural district would be less utilised and therefore less useful as a metric. This could be resolved by reporting against higher order categories, such as public transport use, or documentation rationalising which are priority actions according to the context. Reporting action alongside transparent disclosure of LA resources would convey a fair picture of how and why different LAs are performing differently.

As mentioned in Chapter 3, the proposed improvements to carbon accounting could take the form of a new ‘National Net Zero Indicator Framework’, modelled on the NI framework. This would allow continuous oversight of the picture of national mitigation and would allow data to better inform policy. This could be a process managed by an independent quasi non-governmental organisation (QUANGO) such as the Office for National Statistics. This new evidence base could allow the equitable targeting of funding, and would allow iterative progress monitoring of policy, allowing approaches to be tailored according to their relative success and impact on emissions. The construction of an evidence base is not only valuable for improving equity, but also in ensuring target *delivery*.

Not achieving even the most unrealistic net zero target poses damage to the credibility of local action. Therefore a science-based target-setting process could add value and accountability for local climate targets. SBTi requires targets to be validated, which could add robustness to the target-setting process. Carbon budget based approaches are also seen as aligning local target-setting with the national picture of mitigation. For example, Kuriakose et al. (2022) identify how carbon budgets could be downscaled to the subnational level.

However, there is a need for caution around the term ‘science-based’, with recent calls to question the seemingly ‘apolitical’ nature of targets of this kind. Tilsted et al. (2023) identify that so-called ‘science-based’ targets are influenced by political assumptions within the construction of global emissions scenarios, around allowable temperature rise and overshoot, reliance on removal technologies and geopolitical judgements of mitigation responsibility. Though the term ‘science-based’ makes a claim to objectivity, there is yet a need to recognise the subjective (often ethical) judgements which can unavoidably feed into scientific assessments. In the case of the LA net zero targets, as illustrated in Chapter 4, many were either selected on political grounds, without reference to temperature warming pathways or without alignment with national or international climate goals. This highlights the ‘socially constructed’ nature of the targets, which also supports the use of a social constructivist lens throughout the inquiry.

Though the term could be interrogated further, I here adopt ‘science-based’ to refer to a protocol for net zero target development that generally improves standardisation and comparability between targets.

Additionally, capability reporting could form part of target-setting and validation, identifying which LAs require more support and which could go further according to science and equity based criteria.

Though these posited changes to subnational carbon accounting and oversight could be substantial, they would together mark a significant progression in the net zero data ecosystem, and could have value beyond guiding local climate action. Figure 12 outlines how this process of data collection and utilisation could occur in practice.

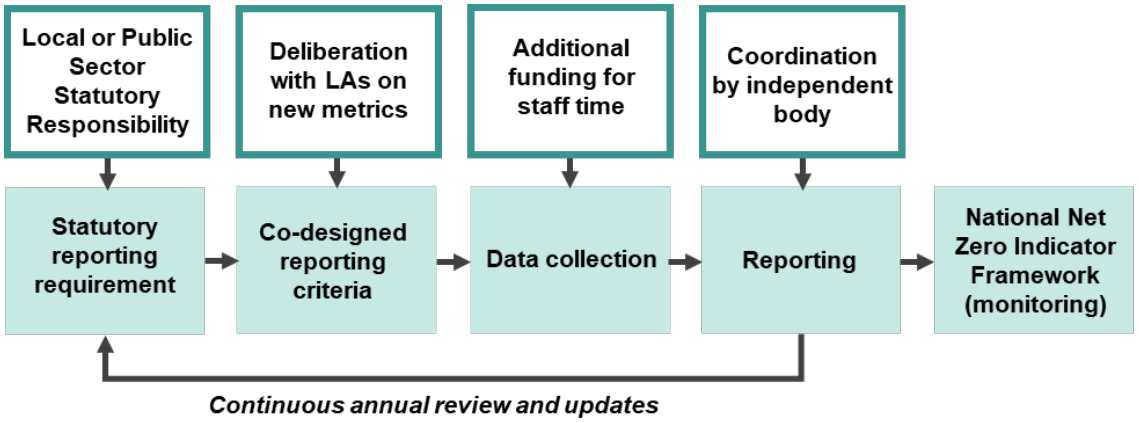

Figure 12. Illustration of a sequence of reforms to subnational carbon accounting.

5.3.3. Recommendation 3: Equity-based funding

Leading on from the discussion of an 'equity evidence base' is the proposed reform to subnational funding systems. In the interview research, stakeholders mentioned that it appeared that funding was allocated based on political affiliation. Levelling Up theoretically aimed to fund areas which were in greater need of regional development, but several studies have shown that this hasn't occurred in practice, with suggestions that funding has been politically allocated (McCann et al., 2021). Empirical evidence that indicates the same has occurred with net zero funding is lacking, perhaps in part because net zero and Levelling Up funds appear increasingly linked, as noted in the stakeholder interviews. However, stakeholders proposed a number of equity based funding mechanisms, which could better follow the principles of CBDR-RC. For instance, means-tested funding (i.e. based on measures of deprivation or disclosed resources within councils), population-linked funding, and regional funding that is distributed by regional bodies (for instance through CAs or county councils). Such mechanisms would need to

be evidence-based to counter any suggestion that such an approach would reduce efficiency.

The three recommendations outlined above can be considered as a sequence of reforms, or a 'policy package', working in tandem to deliver greater equity and effectiveness in subnational climate mitigation.

5.4. Contribution to the literature

The research gaps identified in Section 1.1.1 of the introduction are summarised below for reference:

- **Gap 1:** Aspatiality and scalar 'traps': the need to take a spatial lens to the LCT, moving away from studies polarised between purely national or local perspectives.
- **Gap 2:** Spatial biases: the need to move beyond singular case study locations and a focus on urban areas.
- **Gap 3:** Sectoral biases: the need to take a whole systems perspective on the justice of the LCT.
- **Gap 4:** Raising more questions than answers: the need to find solutions for issues of equity in the LCT, by making concrete policy and governance recommendations.

The research responds to previous gaps in the academic literature through: a) its cross-scalar approach (Gap 1, Chapter 4); b) its evaluation of the LCT issues facing all regions (not only urban areas; Gap 2, Chapters 3 and 4); c) taking a whole systems approach to the evaluation of LCT impacts, rather than focussing on energy or employment alone (Gap 3; Chapter 2); and d) proposing a series of policy solutions which could be actionable by the UK government (Gap 4; Chapter 5).

Perhaps the clearest contribution of the research to the academic literature is in its exploration of the value of spatial justice theory to the study of the LCT. Prior critique of spatial justice scholarship is that it is infrequently defined and therefore hard to apply (Morgan, 2008). As noted, Soja's (2010) *Seeking Spatial Justice* has hitherto marked the main articulation of how this theoretical, ethical concept can be used as a framework to analyse real-world injustice. The current analysis furthers theoretical work on spatial justice by applying the concept to a new real-world case study – that is, the case of the UK's LCT.

The research has offered a methodological contribution to the academic literature in its development of composite indicators to track equity, an emergent trend signposted in the review paper. The research finally offered empirical contributions to the literature in gathering together a broad range of in-depth stakeholder views on issues of equity in the LCT as it plays out at the subnational scale. Perhaps the most important empirical contribution of the work however is in its integration with current policy agendas.

The review paper highlighted the need to move beyond accounts of spatial injustice to the policy mechanisms that could feasibly address such issues in the real world (Chapter 2; Gap 4). Building on an important body of conceptual work on spatial justice, there is a need to operationalise the concept. In this way, the two latter pieces of research aimed to provide concrete governance recommendations that would feed into the current policymaking environment around delivering subnational net zero.

The establishment of the Office for Local Government and its potential role in evaluating local climate action is perhaps most clearly aligned with the current work. The research offers evidence and argument for the inclusion of principles of equity in designing climate mitigation policy that affects the local level. The focus in this work on CBDR-RC also shapes calls for Levelling Up policies to be oriented around substantively *building* local capabilities, rather than simply allocating grants on the basis of existing capabilities. The policy impact of the work will be promoted through the creation of policy briefs outlining chapters 3 and 4. These will be disseminated amongst interview participants (which include representatives of local, regional and central government, as well as policy organisations) and others.

In all, the research as a whole presents a body of evidence that defines, illustrates and operationalises the concept of a ‘spatially just transition’. Chapter 2 provides a conceptualisation the spatial dimensions of distributional, procedural and recognition justice. From a mainly distributional perspective, Chapters 3 and 4 provide evidence as to how capabilities and ambition vary spatially in the case of UK local government. However, these chapters also provide insight into the spatial aspects of *procedural* justice, highlighting the ways in which the very processes of distribution (for instance competitive funding mechanisms) are unfairly biased against certain regions. Spatial dimensions of recognition justice are also present in the attention brought to how political affiliation often determines access to resources for mitigation in the UK. Recognition justice is also active in acknowledging the disproportionate challenges which face industrial regions in their attempts to decarbonise. Therefore though the boundaries of this work are primarily drawn around issues of distributional justice, the relevance of the

work to the other ‘tenets’ of procedural and recognition have been implicitly highlighted throughout.

The research highlighted the need to consider temporal as well as spatial dimensions of justice. Notions of restorative justice problematise debate around responsibility, by extending the discussion beyond simply who is responsible for mitigation, to include who is responsible for repairing the damages resulting from past (and future) emissions production. This temporal dimension adds complexity, for instance in considering *how* future generations may be remunerated for ongoing emissions production and diffuse climate impacts. This also links to notions of cosmopolitan justice, which ties together temporal and spatial justice in considering the rights of future generations across scales. Though the scope of the inquiry was largely centred around a ‘triumvirate’ approach to justice, the work has clear application to broader notions of justice, which could be further and more comprehensively articulated in future research.As noted, the international transferability of the work is necessarily limited by the singularity of English subnational governance structures and weak powers and finances at this level (Bulkeley and Kern, 2006). However, the work remains of international relevance given its definition of spatial justice as it applies to the LCT, its discussion of CBDR-RC at the local scale, and in its methodological developments (particularly the use of a semi-systematic review approach and development of composite indicators). Furthermore, the drawbacks of the current research in terms of its narrow geographical scope (see Section 5.5) provide a springboard for a future research agenda around the international application of spatially just transitions theory (Section 5.6).

5.5. Limitations of the research

A number of limitations challenge the comprehensiveness of the research, ranging from the methodological to the practical. Though the methodological limitations are detailed in each chapter, it is worth drawing further attention to certain issues. A key limitation was the restricted geographical scope of the research. In the case of the semi-systematic review, the articles analysed disproportionately focussed on case studies from the Global North. Similarly, the linguistic bias of the search criteria (necessarily including only English language articles) could be seen to result in a geographical bias in the sample of articles analysed.

In the evaluation of LA net zero targets, the analysis was restricted to England, given the disparities in the datasets used to construct the indicators. For instance, whilst there are

datasets for the Indices of Multiple Deprivation (IMD) for each Devolved Administration (DA), the methodology behind their construction differs from country to country. Similarly, a focus on England was appropriate given the different policy environments under which the targets were set, even between the countries of the UK. The targets analysis could also be critiqued for the uncertainties inherently involved in constructing composite indicators. There is necessarily an element of subjectivity in decisions around which metrics should quantify a 'dimension' of an overall concept. The capability indicator in particular is an initial attempt at quantifying what could be considered an ethical concept. The indicators are also limited by their static nature. Future capability metrics could be co-designed with LAs, and be continuously updated to more fairly reflect progress. This could point towards a direction for future research.

The interview analysis was also restricted to consideration of England only, but this was due to the differing policy environments, particularly with regard to the SRs already in place in the DAs. The interview research could also be seen to suffer from a response bias; that is, participants from better resourced LAs were more likely to respond to interview invites given greater capacity to engage in voluntary outreach activities. This was despite efforts through the sampling strategy to approach LAs from a spectrum of different capabilities or levels of climate ambition, as identified from the targets analysis work.

A practical constraint on the research was the word counts journals put forward, which curtailed comprehensive discussion of some issues, many of which have been expanded on in this chapter. The following attempts to discuss how these limitations could be resolved through a future research agenda.

5.6. Directions for future research

There are a number of directions for future research that the work points towards, both in shaping an ongoing research agenda and correcting the limitations of the current research.

An implicit limitation in the body of research presented here is its focus on mitigation. As noted in Chapters 3 and 4 particularly, analysis of local climate commitments typically focus on mitigation. There is therefore a remaining research agenda in undertaking similar analysis focussed on adaptation commitments (Grafakos et al., 2020).

As findings 1 and 2 discussed, there is a need to consider the role of each level of government in climate mitigation, particularly in areas where emissions are dominated by industrial sources. A valuable direction for future research could be in exploring the equity implications of sectoral versus spatial carbon budgets or targets.

Chapter 2 also identified that administrative fragmentation could lead to spatial injustices during the transition. The UK's landscape of subnational climate governance is highly fragmentary, and national guidance has been described as 'piecemeal' (Evans, 2020). There is therefore scope to consider how the UK's LCT can be equitably coordinated across both regions and levels of government.

A key area for expanding the current research is in greater attention to the international transferability and implications of the work, potentially through comparative analysis. Review articles are noted for their value in identifying areas for future research (Snyder, 2019). The review paper presented in Chapter 2 suggests that there is particular potential in evaluating issues of spatial justice as they occur in Global South countries as well as the case studies highlighted in the Global North. Comparative analysis of the spatial justice issues affecting countries at different stages of transition could provide policy and governance insights to improve equity in such transitions. Other areas which would benefit from international comparison include how local capabilities for climate action vary between countries. The powers and finances of UK LAs are noted for being far weaker than in European states (Bulkeley and Kern, 2006). Comparative analysis with states in the European Union could generate interesting insights into how local climate governance can be empowered. Similarly, international evidence could be important in considering what equitable local funding mechanisms already exist. Analysis of how LA capabilities vary between England and in the DAs – given the presence of the SR – could also be of note for studying varied governance approaches in a UK context.

Finally, as previously noted, England lacks a regional tier of governance. There are many notable examples in the literature of how this regional level can function effectively in delivering and coordinating climate mitigation. For instance, in case studies from the Netherlands, Canada and Tokyo (Roppongi et al., 2017). Further research could explore the value of a regional governance tier, and whether it contributes to more effective subnational climate policy.

5.7. Concluding remarks

The research opened with the statement that the UK is the most regionally unequal of all developed states, and this beginning frames the end of the thesis. This research has found that though the very term 'low carbon transition' (LCT) invokes the future, change, progression, there is the all too real risk that the UK will *remain* regionally unequal, if not more so, as it decarbonises. Spatial justice as it applies to the LCT has been defined in this work as minimising the geographic gap between those who benefit and are burdened by the transition. But current subnational governance structures in the UK tend to exacerbate existing patterns of inequality in capability. There is similarly evidence that regions which are more capable are not taking proportionate climate action, whilst those with least capability are taking more responsibility. This presents a picture of inequitable burden-sharing between the English regions, one which is reinforced by the current fragmentation and inertia in national policymaking around net zero.

The work of Soja (2010, p.1) marks an 'exploration of spatial justice as a theoretical concept, a focal point for empirical analysis, and a target for […] political action.' The present research has also aimed to achieve the same in its: a) articulation of spatial justice theory as applied to the case of the UK's LCT; b) gathering of diverse perspectives on how equity can be embedded in the governance of the LCT in the UK; and c) call for policy and governance reforms to improve equity and the effective delivery of the subnational LCT.

The research has put forward recommendations for a local statutory responsibility (SR) that is cognisant of the inherently different capabilities of councils and the need to avoid the partial allocation of responsibility to one actor. In this way, a well-resourced public sector SR could be valuable, using the Scottish SR as a model. Secondly, the research recommended widespread reform to the way in which subnational carbon accounting is carried out. It identified a need for standardised emissions monitoring, science-based target-setting, and progress monitoring against a wide range of metrics (including new equity indicators). This is imperative if climate action at the subnational level is to be taken as seriously as policy initiatives at other levels of government, which have established Monitoring, Reporting and Verification (MRV) protocols. Such reforms would provide a robust evidence base, which could underpin the third recommendation – a system of equity-based funding for LAs, which would recognise variable capabilities to decarbonise.

Perhaps the main limitation of the research is in its UK focus. However, internationalising these applications of spatial justice theory could constitute a valuable future research agenda. Many question the very need for further academic debate around justice given the pressing need for action on climate mitigation. Given the urgent need to act at pace and scale in reducing global GHG emissions, in future there is a clear need to focus on research that explores how spatial equity in the LCT can be achieved in practice, rather in debate over its very definition.

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6. Appendices

6.1. Appendix to Chapter 2

A. Meta-analysis results

The following documents the emerging characteristics of the literature, as derived from the meta-analysis (file classification of the full-text sample in NVivo).

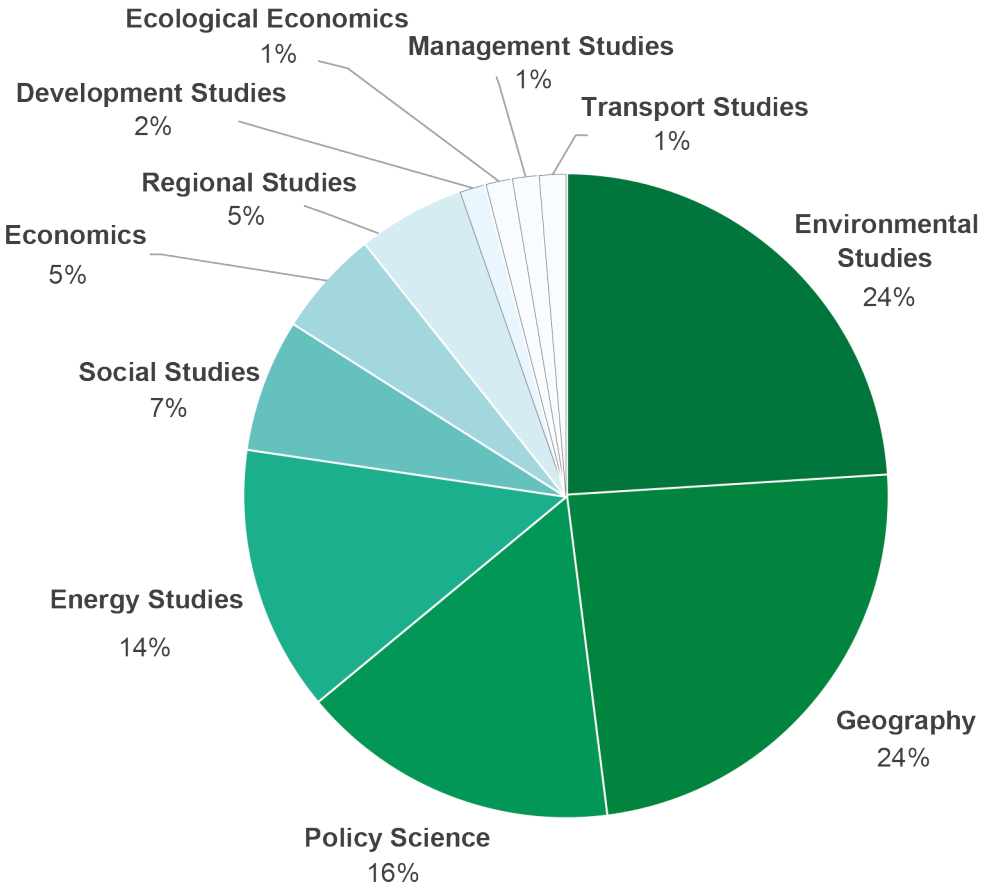

Figure 13. Pie chart indicating the proportion of the sample in each disciplinary category.

The records in the full-text sample were from a variety of disciplines, with 24% from geographical journals, 24% from environmental studies, and 16% from policy studies. There was necessarily some level of judgement involved in characterising the disciplinary framing of the records.

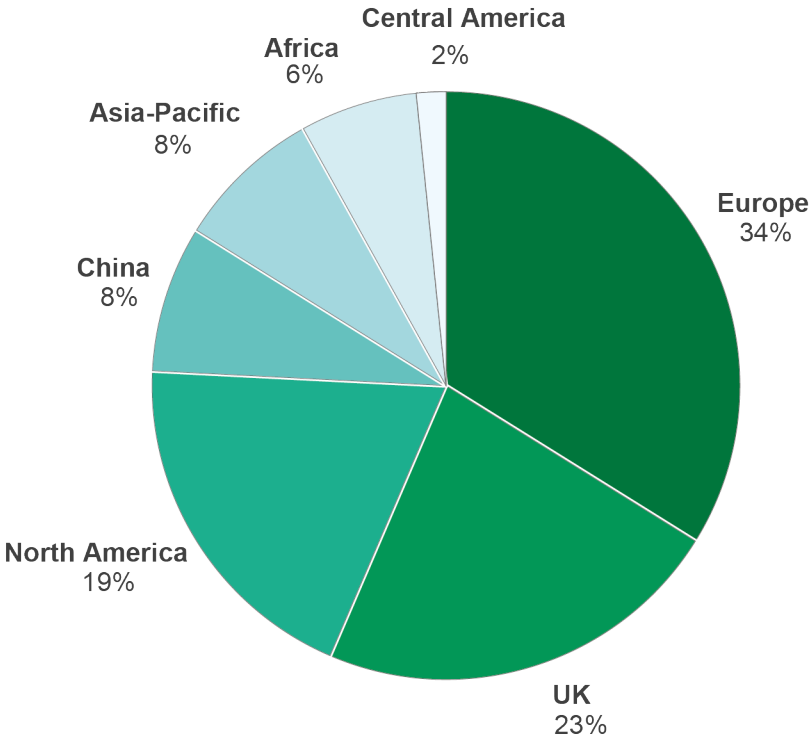

Figure 14. Pie chart outlining the most common countries or geographical regions featured as case studies in the full-text sample.

In the sample there were more studies based in countries where there are perhaps more defined intranational or regional structures or where policy powers are more clearly devolved. For example, in the federal structure of the US.

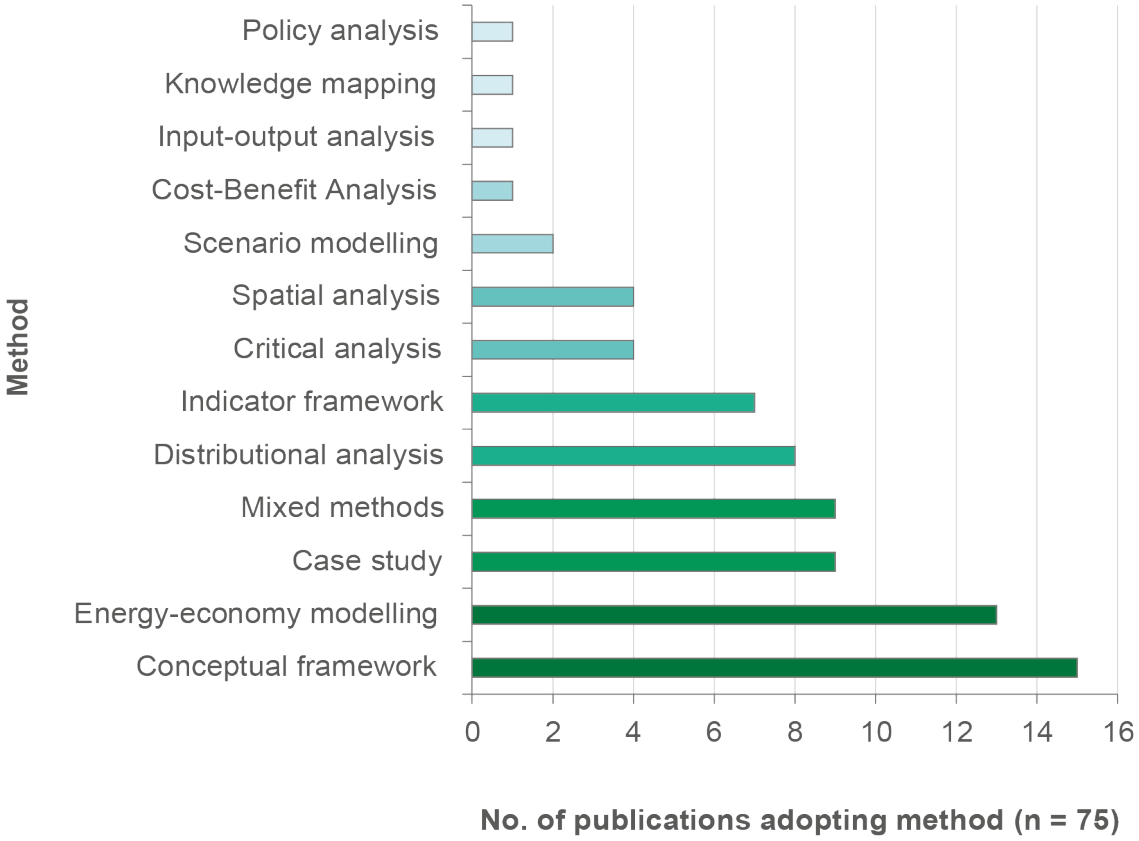

Figure 15. Bar chart outlining the number of records using a specific research method (N.B. the description of method is necessarily reductive).

The most common methodological approach was a conceptual framework, followed by indicator frameworks developed to simultaneously track justice and sustainability. This perhaps reflects a growing interest in how justice can be measured and monitored as well as the rise of innovative indicator frameworks and composite national metrics.

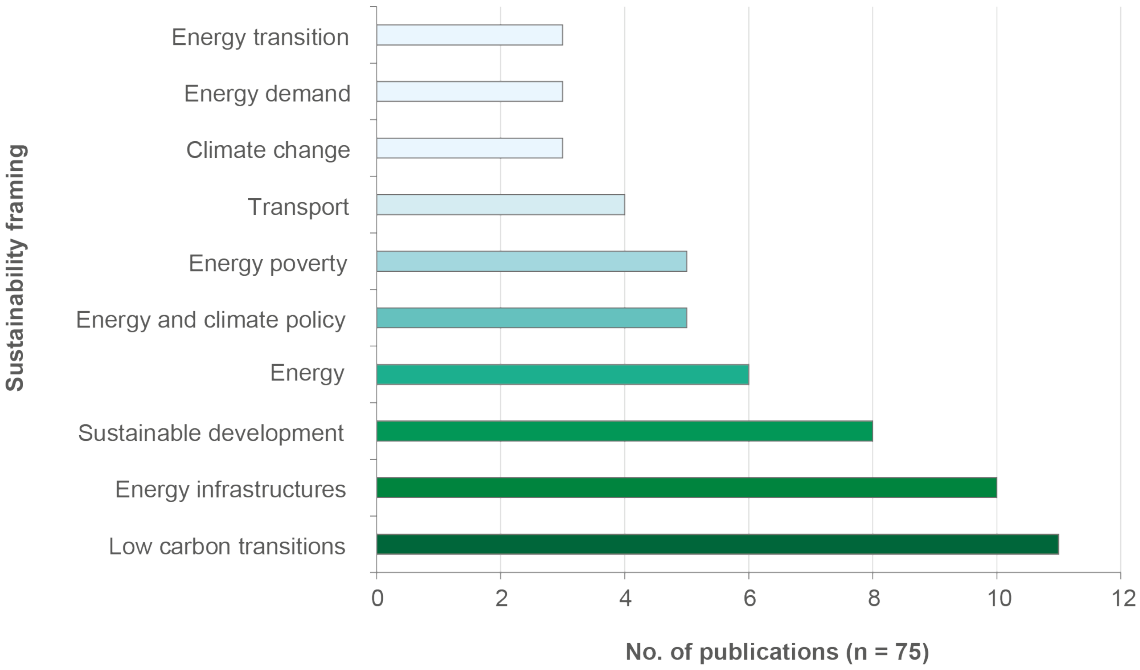

Figure 16. Bar chart outlining the 10 most common aspects of the LCT featured in the records of the full-text sample.

The papers consider varied aspects of the LCT. A key framing was sustainable development, but energy infrastructure was another topic where spatial justice issues were considered key.

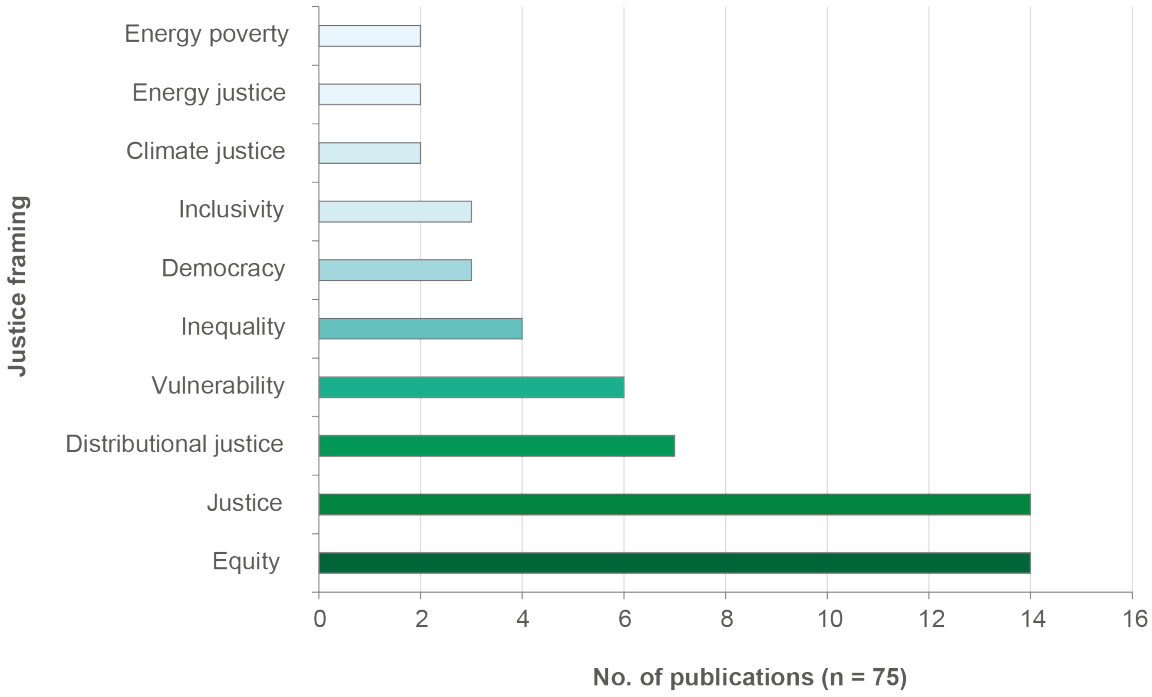

Figure 17. Bar chart outlining the 10 most common justice framings used in the sample records.

Figure 17 highlights the varied justice framings adopted by studies in the sample. It is worth noting that many of these terms were apparently used interchangeably or else with fairly loose definition.

B. Summary codebook

After sorting, we identified 23 high-level codes, with 126 sub-codes in the full-text sample.

Table 9. Summary of selected analytic codes from the thematic analysis.

High-level code	Sub-code
Acceptability of transitions	Acceptance as dependent on perception of justice
	Dependent on perceived responsibility
	Acceptable if linked to existing patterns of socioeconomic/industrial development
	Risk of push-back to transition policy measures
Argument for considering the LCT as a 'whole systems' problem	
A spatial approach as providing greater context-specificity in policymaking	
Characterisations of regional differences in the LCT	Differences between urban/rural
	Employment opportunities
	Differences in how benefits are distributed
Entrenched spatial patterns based in historical decision-making	
Critique of existing research	'Aspatiality' of approach
	Assuming the same 'starting point' for all in society
	Using exclusively expenditure-based metrics
	Conflict between sociotechnical and justice perspectives
	Focus on employment aspects of LCT alone
	Lack of empirical evidence to support justice studies
	Lack of multi-scalar approaches
	Lack of knowledge of subnational areas/focus on the national scale
Critique of modelling approaches (and their treatment of space)	Characterisation of households/users and their behaviour
	Equity principles or distributional impact not accounted for in modelling
	More focus on temporal than spatial aspects
Dependence on how a region is defined	
Environmental determinism	
Policy intervention types	Regionally targeted/distributive policies
	Enabling individual/household action
	Redistributive or equity-based policy
	Need for novel policy tools

	Policy as addressing symptom not cause
Existing patterns of socio-spatial inequality	The 'privileging' of certain geographies/socio-demographies
	Rebalancing the economy/levelling up
Financing the LCT	Distributional financing approaches
	Energy cost distributions
	General taxation approach as more equitable
	Justice implications of who bears the costs
	Scalar dimensions of funding (e.g. central/local government)
Decentralised energy movement	
	Democratisation of LCT infrastructures
LCT governance issues	How to distribute benefits as well as burdens
	How modelling feeds into decision-making
	Administrative fragmentation
	Argument for regional scale governance
	Argument for city-level governance
	Argument for community-based governance
	Assumption that devolved units of governance are more effective
	Coordination issues between scales of governance
	Differential policy ambition between scales
	Existing policies as spatially regressive/unjust
	How to allocate responsibility via policy
	Implicit geographical bias in existing policy
	Justice outcomes as dependent on the policy mechanism used and its design
	Lack of regional-scale governance arrangements
	Need for cross-scalar *and* cross-sectoral policy integration
	Need for monitoring approaches and indicators
	Need to involve relevant regional scale actors
	Polycentric governance approaches required
	Scalar mismatch
	Deciding the scale where responsibility lies
	Spatially differential access to subsidies
	Variable economic power of different regions
	Variable policy powers in different regions/at different scales

	Voluntary subnational action and experimentation
Negative spatial implications of the LCT	Differential capacity to decarbonise
	- Administrative deficits
	- Variability in levels of social capital
	Differential employment impacts
	- Need for caution around the 'replacement' jobs generated and how they match to existing skills and regions
	Differential vulnerability to structural change
	Disproportionate impacts on (post)industrial areas
	Distribution of policy cost burden
	Energy infrastructures as spatially-contingent
	LCT could compound existing inequalities
	LCT will lead to regional inequalities/uneven development
	Risk of 'left behind' places
	Opportunity costs will differ regionally
	Sectoral differences in regional opportunities
	Winners and losers narrative
Justice concept framing	Accountability
	Capacity
	Conflict between responsibility, capacity, vulnerability
	Consideration of power dynamics
	- Reproduction of existing power dynamics
	Responsibility
	- Cumulative responsibility
	- Common But Differentiated Responsibility
	- Perceptions of relative responsibility
	- Negotiated responsibility
	'Justice' dependent on the most responsible acting first
	Distributional justice
	Distributional/procedural/recognition justice framework
	Embodied justice
	Energy justice
	Equity principles
	Inclusivity

	Intergenerational or temporal
	Just ‘opportunity’ debate
	Moral debate
	Procedural justice
	Recognition justice
	Environmental justice as a social justice issue
	Whole systems approaches as more ‘just’
	Multiple deprivation
	- Intersectionality
	- Overlapping economic vulnerabilities
LCT policy	Place-based difference embedded by policy
	Sectorally targeted policy interventions
	Socially targeted policy interventions
	Spatially targeted policy interventions
	- Industrial clustering
	- Directing public investment to regions
	- Spatially resolved emissions targets
Place identity	
	Solastalgia
Public good problems	
	Ostromian theory
Justice in supply and demand	Accessibility of energy supply infrastructures
	Equity in remaining fossil fuel production capacity
	Need to consider justice issues in energy production vs consumption
	Relative quality of energy infrastructures
	Siting decisions around energy infrastructures
	Variability in the cost of energy/electricity
Technical limitations	Comparability of regions due to metrics/administrative boundaries used
	Dependence of results on the scalar method used
	Loss of detail in aggregation to macroeconomic or national level
	Quantification of ‘intangibles’
	Unavailability of data
	Uncertainties

Future LCT pathways	Opportunity for different regional development pathways
	Potential for lock-in or path-dependency
Scalar theory	Core-periphery theory
	Cross-scalar injustices
	Multi-Level Perspective
	Place-based governance
	Transitions management theory
	Uneven development

C. Study sample references

The following provides references for the studies contained in the final sample (n = 75).

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6.2. Appendix to Chapter 3

1. Local Government in England

Local Authorities (LAs) in England can be two-tier, in which responsibilities are shared between county and district councils (the latter representing a subdivision of the county councils and delivering 'neighbourhood services') (Institute for Government, 2022). There are also single-tier regions in which one authority is responsible for delivering local government services, for instance in the case of unitary authorities, the London and metropolitan boroughs (Institute for Government, 2022). Table 10 provides a description of the different types of LA in England, and how the tiered and Combined Authority (CA) systems allow LAs to work in partnership and share responsibilities for service delivery.

Local government is funded by three main routes in England, namely government settlements, council tax revenues, and business rates. Approximately half of all LA revenues in 2019-2020 were from council tax income, a quarter from business rates, and another quarter from government grants (Institute for Government, 2022a).

'Devolution deals' during the 2010s (see the Devolution Register; Local Government Association, 2022) giving greater powers to metropolitan regions in the form of Combined Authorities have marked a significant change in governance structures over recent years (Sandford, 2019). CAs can be proposed from the bottom up via the Local Democracy, Economic Development and Construction Act 2009, or created on recommendation by the Secretary of State through the Cities and Local Government Devolution Act 2016. Table 10 provides definitions of each type of LA structure in England (HM Government, 2023).

Table 10. Overview of LA types and the tiered and CA systems.

<table>
<tr><th>System</th><th>LA type</th><th>Description</th></tr>
<tr><td rowspan="2">Two-tier</td><td>County Councils</td><td>Providing services across the whole of a county region, including: education, transport, planning, fire and public safety, social care, libraries, waste management, and trading standards.</td></tr>
<tr><td>District Councils (also Borough and City Councils)</td><td>Working across a smaller area, where responsibilities for service delivery are shared with the county council. Typical services district councils are responsible for include: rubbish collections, recycling, council tax collections, and housing and planning applications.</td></tr>
<tr><td rowspan="3">Single-tier</td><td>Unitary Authorities</td><td rowspan="3">A single authority delivering all the services county and districts typically deliver in tandem. Where Combined Authorities are in operation, LAs may share responsibilities with this larger regional body (e.g. the relationship between London Boroughs and the Greater London authority). Unitary Authorities are similar in structure and function to Metropolitan Boroughs (but can differ in their electoral system for instance).</td></tr>
<tr><td>London Boroughs</td></tr>
<tr><td>Metropolitan Boroughs</td></tr>
<tr><td colspan="2">Combined Authority</td><td>This refers to a legal partnership of two or more LAs (of varying types) working together as a quasi-regional body.</td></tr>
</table>

2. Methods: Further information

2.1. Sample description

Table 11 provides a summary of the breakdown of the final sample by LA type, and Figure 18 provides an overview of the LAs included in the final sample by type. CAs were analysed separately given their overlapping administrative boundaries with their constituent LAs, and county councils were excluded from the sample for the same reason (neither are therefore shown on Figure 18).

Table 11. Summary of final sample of Local Authorities by type.

Authority type		**No. in England**	**No. in final sample**	**Percentage represented in final sample (%)**
Two-tier authorities	**Sub-total**	**205**	**178**	**87**
	County council	24	0	0
	District council	181	178	98
Single-tier authorities	**Sub-total**	**128**	**123**	**96**
	Unitary councils	59	54	92
	Metropolitan boroughs	36	36	100
	London boroughs	33	33	100
Combined Authorities		**10**	**10**	**100**
Total		**343**	**311**	**91**

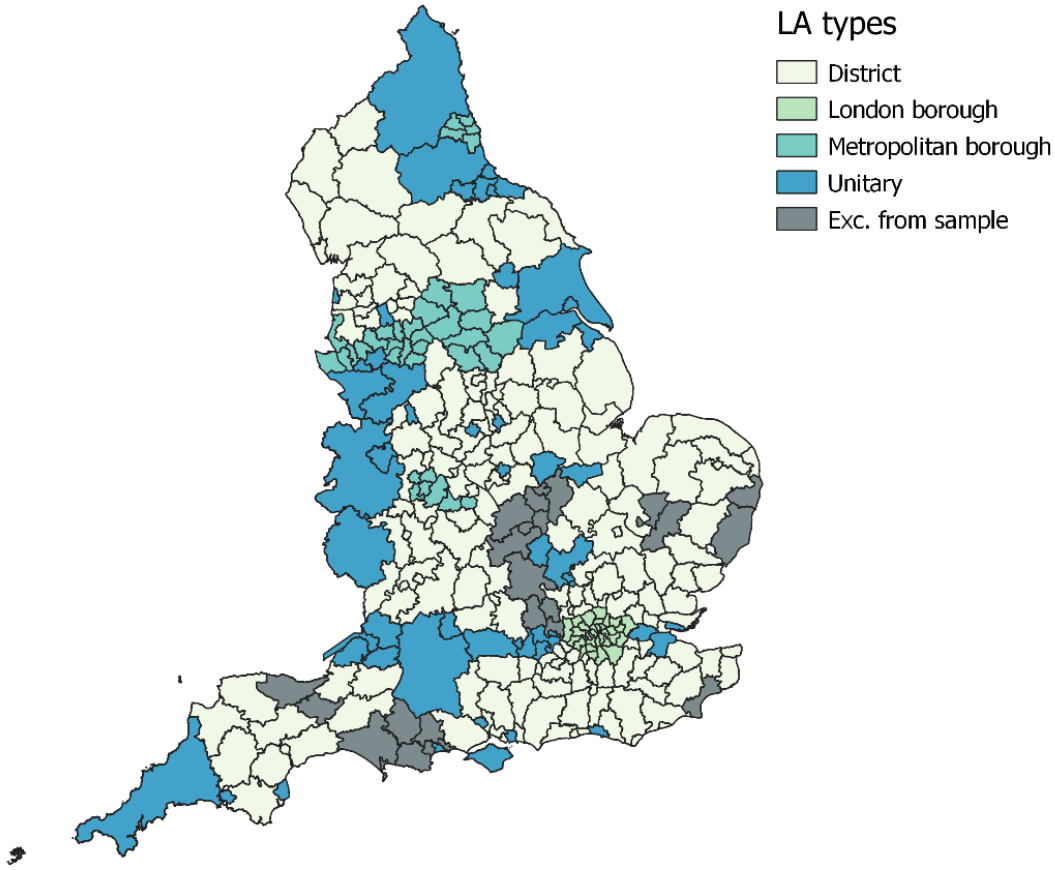

Figure 18. LAs included in the sample, by type.

2.2. Exclusions from the sample

Authorities which had undergone recent restructuring were removed from the final sample, since they could not provide continuous time series data. For example Northamptonshire Council (previously formed of seven districts) has been dissolved into two unitary authorities (North and West Northamptonshire). For further information on local government boundary redefinition see Sandford (2021). The majority of changes to council structure have occurred in 2019 and 2021 under the Local Government (Structural and Boundary Changes) Order 2019, meaning the changes have a significant impact on LA carbon commitments. Future research could encompass these boundary changes more effectively. Authorities of varying types were removed due to these changes (Table 12).

Table 12. Summary of authorities removed from the sample due to local government restructuring.

New authority	Councils having undergone restructuring
Buckinghamshire Council	Buckinghamshire County, Aylesbury Vale, Chiltern, South Bucks, Wycombe
Cumbria County	Prospective changes in 2022
Dorset	Weymouth and Portland, West Dorset, North Dorset, Purbeck, East Dorset, Christchurch
East Suffolk	Waveney, Suffolk Coastal
Folkestone and Hythe	Renaming of Shepway (but covers a smaller area)
North Northamptonshire	Corby, Kettering, East Northamptonshire, Wellingborough
Somerset West and Taunton	Taunton Deane, West Somerset
West Northamptonshire	South Northamptonshire, Northampton, Daventry
West Suffolk	St Edmundsbury, Forest Heath

2.3. Modelling the Local Authority emissions targets

We harmonised carbon dioxide emissions data for the years 2005-2019, using the BEIS (2021) 'UK Local Authority and regional CO_2 statistics' to the final list of LAs included in the sample. We included data on per capita emissions, territorial emissions by sector, and the fraction of emissions in the scope of the LAs control. To model the impact of LAs achieving their committed net zero targets we assumed a standardised baseline year of 2019.

In the PCAN dataset (Howarth et al., 2021) which documented the year of declaring a climate emergency, 94% of authorities committed in 2019, with only 2% of the sample committing in 2018, and 4% in 2020. Of the emergencies declared in 2020, the majority took place in the first quarter of the year. This therefore means that 2019 could be considered an appropriate baseline, despite some later adopters. Since 2019 is the latest

year for which CO_2 data exists as well as being the year in which the majority of commitments took place, this was chosen as a standard baseline.

In order to compare local emissions performance to national carbon budget guidelines, we adopted a baseline reference scenario. Whilst the BEIS Updated Energy and Emissions Projections (2021a) incorporate the emissions savings associated with existing and planned government policy, the projections only extend to 2040 and are aggregated to the whole of the UK. By contrast, the Climate Change Committee baselines project to 2050 and are disaggregated to the England level (CCC, 2020). Whilst the BEIS projections suggest an 18% reduction in emissions between 2020 and 2040, the CCC projections suggest a 28% increase in emissions from 2020 to 2050. Therefore the CCC projections were adopted. For a summary of each emissions scenario adopted or constructed see Table 13.

The CCC 'baseline' scenario assumes that 'no further climate action is taken beyond today', and incorporates current climate policy but not 'unfunded' or proposed policies (CCC, 2020a, p. 20). A baseline that takes account for the effects of potential future UK climate policy would have necessarily have involved making numerous, uncertain assumptions about the direction of government climate mitigation policy. Therefore, the CCC baseline is used for simplicity as a counterfactual scenario of conservative climate action.

Table 13. Characteristics of the emissions scenarios.

Scenario purpose	Name	Assumptions	Sources
Reference scenario	Baseline	• No climate action assumed beyond existing policies; • Based on BEIS Energy and Emissions Projections, which account for projections of future economic growth in the UK amongst other variables (e.g. population).	BEIS, 2021a; CCC (2020, 2020a)
	BNZP	• 'Balanced' achievement of national net zero; • Incorporates uncertainties in technological and societal change; • Downscaled to the England level for this analysis.	CCC (2020, 2020a)

Analytical scenario	All targets	• Implementation of all LA targets (both whole borough and operational), with adjustment for double counting where both targets were in place; • Assumption that emissions remain constant when the target has been reached.	(BEIS, 2021); authors' analysis
	Operational only	• Implementation of LA operational emissions targets (where they have been set); • Based on reductions per LA to BEIS (2021) 'public sector' emissions data.	(BEIS, 2021); authors' analysis

2.4. Removals, offsets, and residual emissions

Whilst the targets were frequently framed in terms such as 'net zero' or 'carbon neutral', there is considerable ambiguity and interchangeability in the use of such terms. Carbon neutrality refers to the practice of not increasing greenhouse gas (GHG) emissions, and may encompass the use of offsets to achieve this. Conversely, net zero implies a reduction in GHG emissions to a level in line with a 1.5°C (Celsius) temperature rise, and only allows the use of removals in order to reduce residual emissions that could not practicably be eliminated.

Excluding GHG removals (e.g. Land Use, Land-Use Change and Forestry – LULUCF - sinks and engineered removals), CO_2 emissions in England decrease by 89% between 2020 and 2050 in the CCC's Balanced Net Zero Pathway. Since removal capacity is variable between regions, and LAs take differing approaches to how offsets and removals are involved in meeting their net zero commitments, we assume a reduction in absolute LA emissions of 89% in line with the relative ambition level for England as a whole. This also applied to the council operational emissions targets (i.e. they would reduce by 89%). All emissions are measured in carbon dioxide emissions (as CO_2) rather than all GHGs (CO_2e), due to the need to harmonise between a wide range of disparate datasets, where CO_2 was a common unit. Whilst some councils (for instance Cotswold District Council) specify no reliance on offsets to achieve their target, this was the exception.

3. Combined Authorities: Method and results

Since CAs cover an area equal to 30% of England's 2019 CO_2 emissions, it is therefore important to represent them. In the case of the Cambridgeshire and Peterborough and West Midlands CAs, member councils included county councils which overlapped with other members such as district councils. To mitigate the risk of double counting, we used scores for the lower level authorities to comprise those of the CAs.

To calculate the emissions reduction pathways associated with the CAs, we calculated the sum of the constituent member LAs' emissions in 2019, then applied the target set by the CA to this baseline total. In the case of the North East CA and the Tees Valley CA, there were no targets set. In this instance we assumed that the total CA area emissions remained constant between 2020 and 2050, to ensure the fair comparison of all CAs against the baseline. In all other cases, the operational emissions targets were the same as the whole borough targets. We also calculated whether the sum of the CA members' targets would be more ambitious than the CA-wide target.

Eight of the ten current CAs have net zero targets, meaning that in some cases the LAs have more ambitious targets and plans than the CAs they constitute. 49% of the individual LA operational emissions targets were more ambitious than those for the CAs (12% were less ambitious, 38% had the same target dates). For the whole borough targets 28% of the member LAs had set more ambitious targets than the CA, 25% had set less ambitious targets, and 48% had adopted the same target dates.

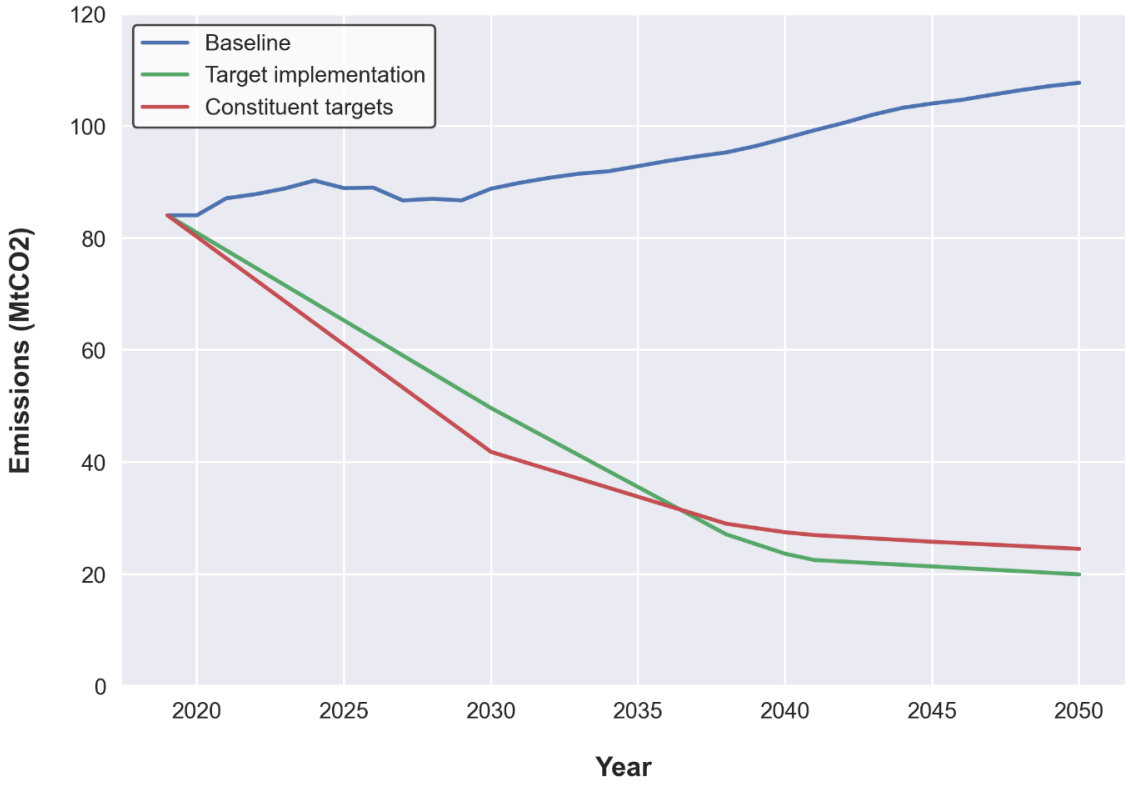

Figure 19. Comparison of CA emissions reduction pathways, indicating the difference between assuming the constituent targets of CAs or target implementation at the CA level (n=10).

The constituent LA targets reduce the cumulative emissions associated with the CA targets (2020-2050) by approximately 1% or 15 $MtCO_2$ (Figure 19). This indicates that they are marginally, but not significantly, more ambitious. This may reflect those CAs which have not set a target, indicating that CAs cannot be assumed to be a wholesale vehicle for greater ambition. The trajectory of emissions reductions suggest that the 2030 target date is more popular in the case of constituent LAs, whilst a later date nearer 2040 is more common with the CAs. This may suggest that in terms of perceived ability to act, it may be that CAs are not necessarily less ambitious, but perceive greater complexity in coordinating the moving parts of their constituent authorities.

4. Composite indicators: Method

The following provides further detail on the steps taken to construct the composite indicators (Co-Is) of ambition and capability. After the compilation of the indicator datasets for each LA, LAs with missing data were excluded from the sample in a process known as case deletion. This is an acceptable method where the missing values are for

a random sub-sample. Since the majority of the LAs with missing values had been restructured, the data is missing completely at random (MCAR) and not dependent on any other variables of interest. We used normalisation to harmonise the units in each of the separate indicators. We adopted a ranking method which reduces the impact of outliers. Indicators were transformed into rankings, to allow more consistent aggregation, then into ranked percentiles.

Equal weighting (EW) was applied to the sub-indicators, given there is likely to be considerable subjectivity in evaluating which is more important to normative concepts such as ambition and capability. Common approaches to weighting for Co-I construction include expert elicitation and the Analytic Hierarchy Process (AHP). There is precedent for using an equal weighting approach however, for instance in Kondyli (2010). Since EW approaches may induce double counting if there is correlation between indicators, statistical correlation between the indicators must first be tested. Spearman's correlations were conducted between the indicators to determine levels of correlation (see also Section 5.3). Figure 20 provides a correlation matrix, indicating the strength of correlation between each of the indicators comprising the Co-I. There are no strong positive correlations between any of the indicators, which provides further justification for the equal weighting approach (strong positive correlations are considered to have an r-value between ±0.5 and ±1.0).

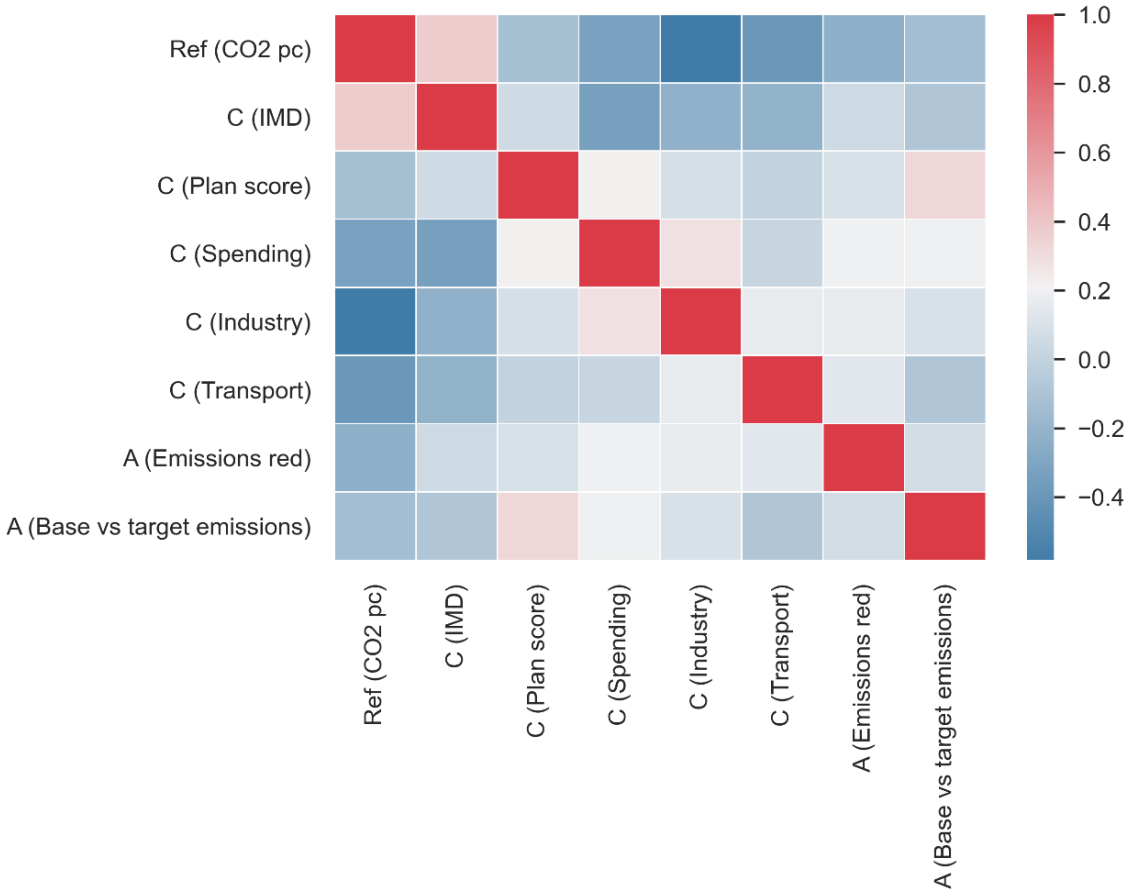

Figure 20. Correlation matrix of relationships between indicators in the Co-I (where values represent the Spearman correlation coefficient, r). 'C' and 'A' denote the capability and ambition indicators respectively. 'Ref' refers to the emissions per capita reference indicator.

The Co-I is 'static', that is, the indicator data is for 2019. Equations 1 and 2 outline the approach in constructing the Co-I. Table 14 defines the relevant variables in each case.

$$I_{y,c} = Rank(x^{n}_{y,c}) \quad (1)$$

Equation 1 indicates that to calculate a normalised indicator value (I), for each Local Authority (c), and indicator (y), a ranking method was applied to the raw values (x) in the indicator.

$$CoI_c = \sum(I_{y,c} \cdot w_{r,y}) \quad (2)$$

Equation 2 outlines that the Co-I is constructed by weighting the normalised indicator values (I y, c) according to the equal weighting convention (r). These values are then

summed to produce the overall Co-I score per LA (Co-I, c). This approach was adopted for both the Co-Is, though the number of indicators used in each varied.

Table 14. Variable documentation. Based on OECD Co-I guidance (OECD, 2008).

Variable	Description
y	Indicator
$x_{y,c}^{n}$	Raw value of indicator (y) for LA (c) for (n) indicators
$w_{r,y}$	Weight of indicator (y), r indicates weighting method (equal weighting)
$I_{y,c}$	Normalised value of indicator y for LA (I)
CoI_c	Value of Co-I for LA
$I_{y,c} = Rank(x_{y,c})$	Ranking raw indicator values per LA

4.1. Limitations of Composite Indicators

Co-Is are seen to be either simplistic or misleading if inappropriately constructed or misinterpreted (OECD, 2008). They are subject to the uncertainties and assumptions of their construction. They may disguise or minimise the significance of trends in individual datasets (OECD, 2008). To minimise the risk of inappropriate construction, the approach has been fully and transparently documented. There may also be debate over which indicators to valuably include in such an analysis. Normative concepts such as ‘ambition’ or ‘capability’ could arguably be measured via a number of equally valid metrics or indicators. Similarly, there could be cause for a different weighting system for each of the indicators, which could be informed by a stakeholder elicitation exercise. However, we feel that the correlation matrix presented provides sufficient evidence for an equal weighting approach.

5. Composite indicators: Statistical tests

5.1. Descriptive statistics

Table 15 outlines key descriptive statistics of the Co-I score samples.

Table 15. Summary of descriptive statistics for the capability and ambition Co-I score samples (n=301; 1 d.p).

	Min	Max	Mean	Median	Mode	Std. deviation
Capability	13.6	87.4	49.7	50.2	43.0	13.1
Ambition	3.5	91.5	49.4	50.5	59.0	21.2

5.2. Normality

Normality visualisations and tests were conducted to explore whether the sample differed from a normal distribution. Figures 21 and 22 outline the frequency distributions of the Co-I scores, and Figure 23 provides a comparative scatter plot.

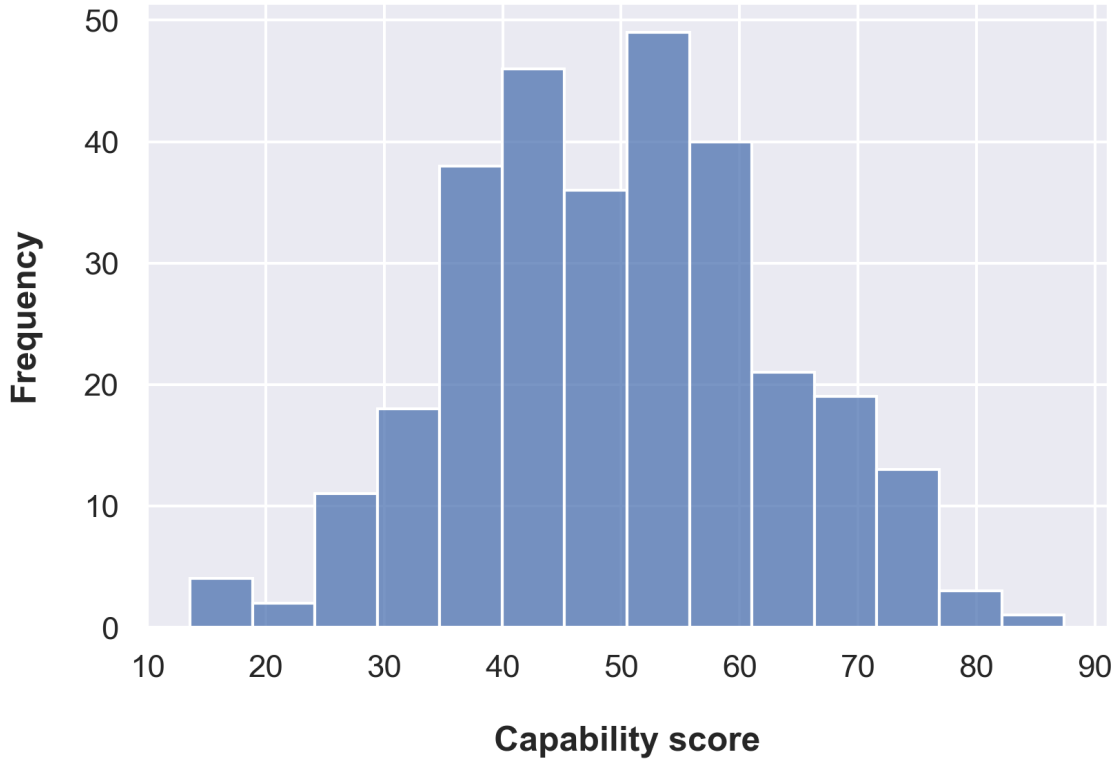

Figure 21. Capability score histogram.

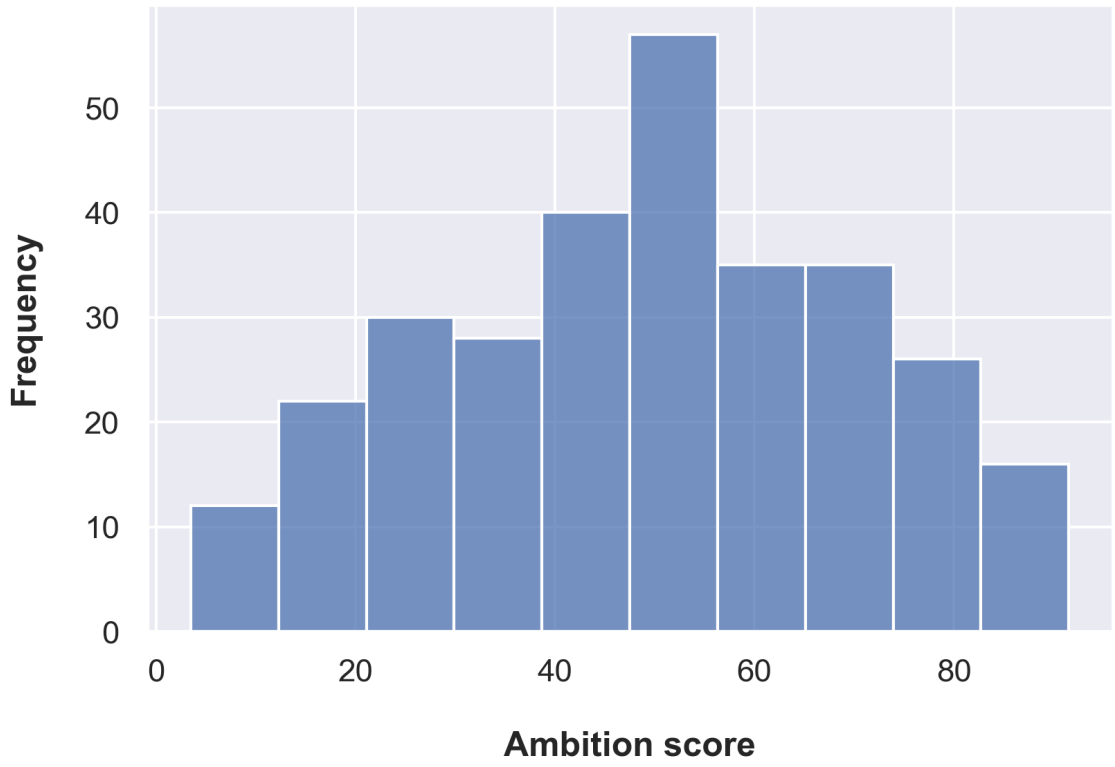

Figure 22. Ambition score histogram.

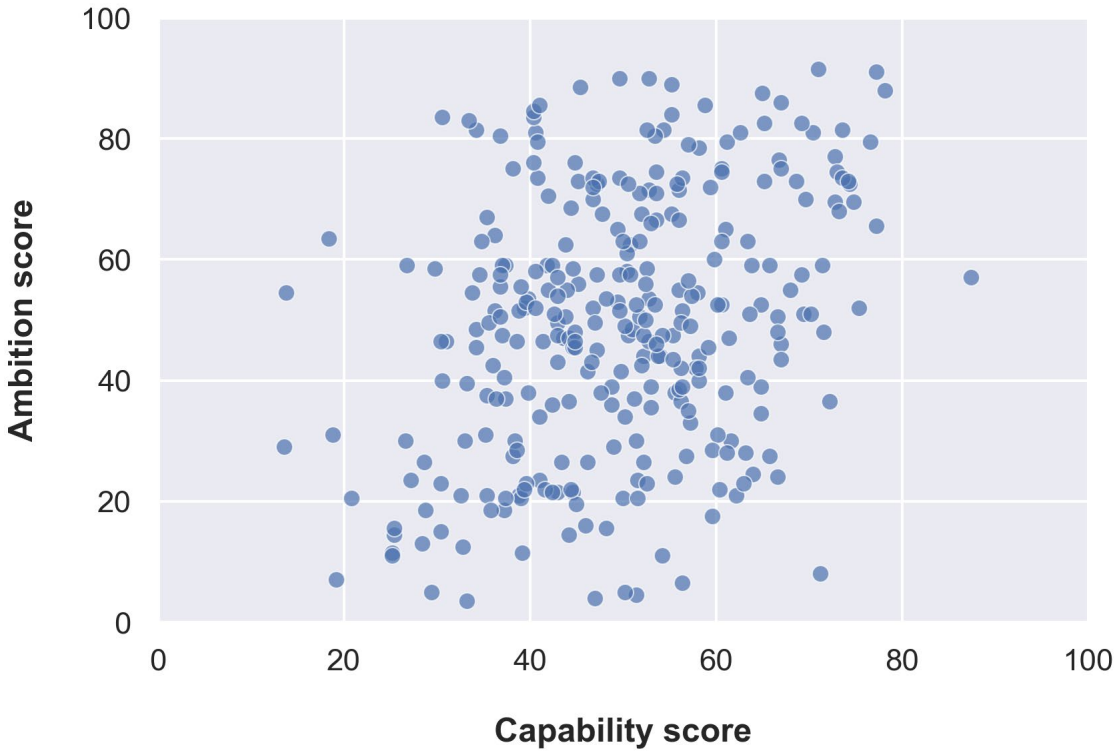

Figure 23. Scatter plot comparing capability and ambition scores.

Statistical normality tests were conducted using the D'Agostino-Pearson test. The null hypothesis ($p>0.05$) stated that the values in the sample follow a normal distribution. The alternative hypothesis ($p\leq0.05$) stated that the values in the sample do not follow a normal distribution.

The p-value of the capability sample score ($p=0.81$) was above the significance threshold, meaning the sample was normally distributed, confirming the null hypothesis. However, the p-value of the ambition sample score ($p=5.33e-05$) was below it, suggesting a non-normal distribution and rejecting the null hypothesis.

A further test for skewness was performed, with the null hypothesis ($p>0.05$) that the values in the sample are not skewed, and the alternative hypothesis ($p\leq0.05$) that the values in the sample are skewed. Table 16 outlines the results of the skew tests. The z-score for the capability sample is below 1 and near 0, with a p-value above 0.05, meaning this sample is reasonably symmetrical, confirming the null hypothesis. However, the z-score for the ambition sample is below -0.5 with a p-value above 0.05, meaning there is moderate skew in these score results and the null hypothesis should be rejected.

Table 16. Summary of skew test statistics (z-score) and corresponding p-values for the Co-I score samples (3.d.p).

Variable	z-score (skew)	p-value
Capability	0.010	0.992
Ambition	-0.656	0.512

5.3. Evaluative statistics

The relationship between the capability and ambition scores was tested. Since the data was non-parametric (non-normally distributed) the Spearman's r correlation coefficient was calculated. This adopted the null hypothesis ($p>0.05$) that the capability and ambition scores are not correlated, and the alternative hypothesis ($p\leq0.05$) that the capability and ambition scores are correlated. There was a very weak positive correlation between the capability and ambition scores ($r=0.29$) which was statistically significant ($p=3.45e-07$). An r value of ±1.0 is considered a perfect correlation, where any value

between ±0.5 and ±1.0 is considered a strong correlation. This means the null hypothesis can be rejected.

6. Composite indicators: Additional results

Figure 24 presents the Co-I scores averaged by region.

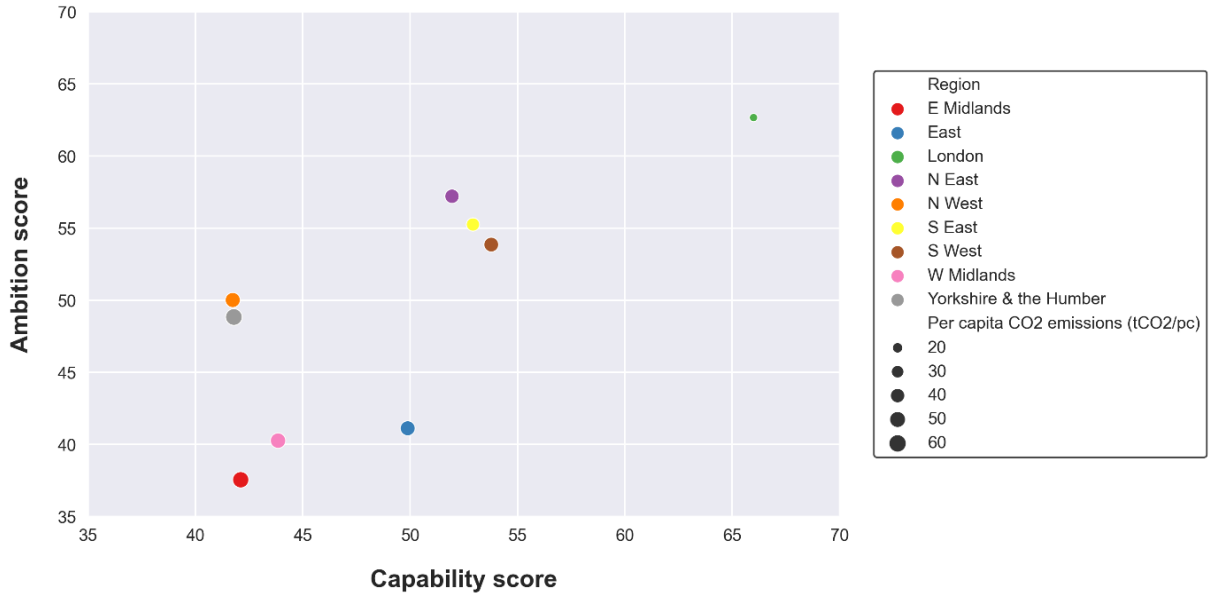

Figure 24. Average Co-I scores by LA region (n=9).

Figure 25 presents the underlying per capita CO_2 emissions indicator. The ten lowest per capita emissions were in the London region (7/10), in the South East region (2/10) and in one rural North Eastern LA. The highest per capita emissions suggest a more mixed picture, including several rural LAs, and sites of industrial activity.

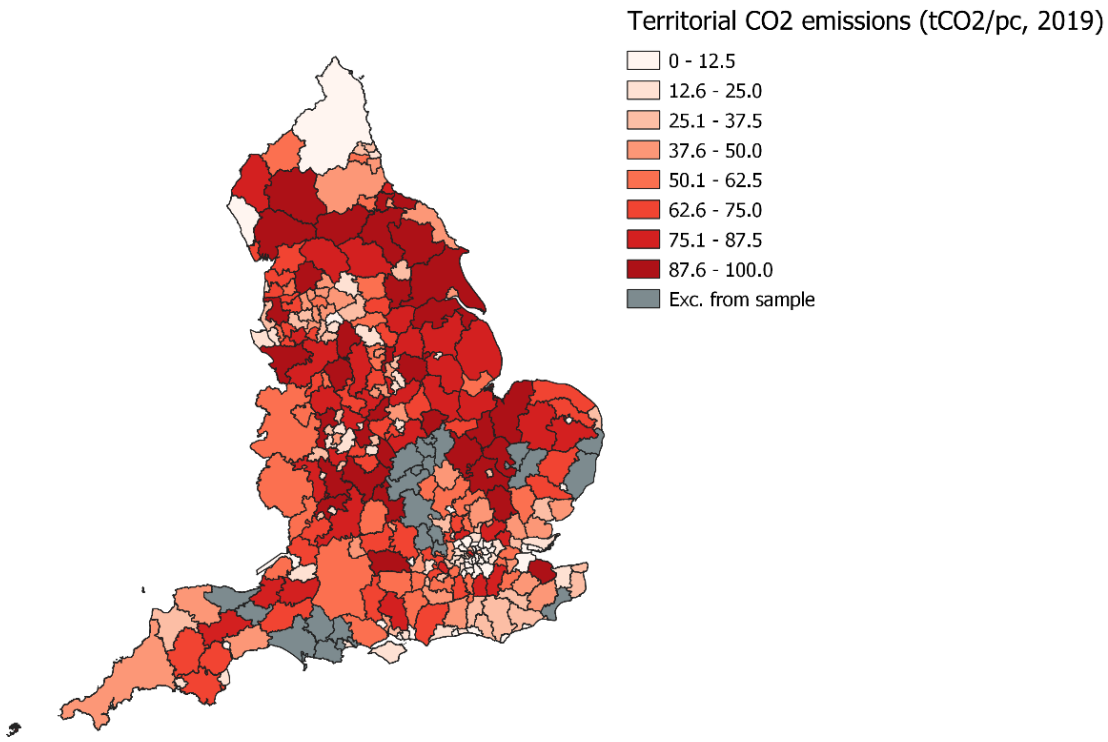

Figure 25. Choropleth indicating the relative distribution of per capita emissions by LA (n=301).

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6.3. Appendix to Chapter 4

Table 17 presents an illustrative summary of descriptive and analytic high-level and sub-codes identified during the thematic coding of the interview data.

Table 17. Summary of descriptive and analytic codes from thematic analysis.

High-level code	Sub-code
Barriers to local action	Election cycles
	Financial
	Higher level political support
	Institutional control over area emissions
	Knowledge
	Lack of trust from central government
	National inaction as an excuse for local inaction
	Need for feasibility studies to be in place
	Policy uncertainty and change
	Powers
	Resources
	Risk-aversity
Capability	Capable areas supporting less capable areas
	Contribution of universities
	Processes which reinforce existing capabilities
	Spatial variations
	Subnational CBDR-RC
Climate Emergency UK	Critique of method
	Not recognising action taken
Combined Authorities	Convening and enabling role
	Political affiliation gains extra support
	Regional leadership
Emissions reporting and monitoring	Need for consistency for comparability
	Need for new metrics
Funding issues	Awareness of funding
	Complexity
	Dependent on officer skill

	Lack of climate officers
	Level of overall funding
	Need for self-sustaining finance
	Public funds are decreasing
	Removal of EU funding
	Revenue funding for officers
	Spatially unequal distribution of funding
	Timescales
Importance of local government involvement in net zero	
Industry	Clean growth vs. decarbonisation opportunities in different regions
	Climate policy as burden to industrial areas
	Lack of local control over industrial decarbonisation
	Preferences for sectoral vs. place-based decarbonisation
	Sustainability as solution to deindustrialisation
Institutional characteristics	Alignment of councillors and officers
	Institutional culture
	Institutional memory
	Institutional remit
Interactions between scales	Certain scales as more efficient
	Competitive processes as efficient
	Local alignment with national politics/policy
	Local engagement with national government
	National perspectives on the local
	National scale unaware of local action
	Need for national intervention
	Need for oversight
	Political ideology preventing devolution
	Regional to local relationship
Legitimacy of public actors	
Levelling Up	
Net zero targets	Ambition spurs action
	Argument for budgets not targets
	Justifications for no target being set

	Need to focus on delivery
	Questionable valuable in term ‘net zero’
	Reliance on offsets as problematic
	Symbolic role
	Unclear definition of scope
	Unclear reason for choice
	Unlikely to meet under current approach
Peer diffusion	
Place identity	Community culture as driving action
Perceived responsibilities	
Policy and governance approaches	Deliberative processes
	Improved data collection
	Improved guidance and definition of net zero
	Information provision
	Integration of policy agendas
	Legislation
	Multiple or co-benefits framing
	Need for formal networks
	Need for standardised climate officer role
	Place-specific solutions
	Reporting mechanism
	Subnational carbon budgets
	Targeted funding for councils
Statutory responsibilities	As focussing minds
	Conditional
	Need to be clearly defined
	Would prioritise climate action
Strengths of local government	Close to communities
	Competition drives ambition
	Critical role in planning decisions
	Flexibility
	History of working in an area
	Working in spite of national government