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Contents

1 Introduction

In the modern world increasing emphasis is being placed on our ability to live 'sustainably,' as it has become clear that our current patterns of consumption are damaging to our environment, and may lead to disastrous outcomes. Global warming and climate change have arguably become the most omnipresent threats in the global consciousness, and have precipitated what is termed the 'low carbon,' or 'energy' transition. This movement focuses on the reduction of carbon emissions via various measures, one of the key elements of which is a move from a fossil fuel based energy system to one that is based on renewable energies. (European Commission, 2017) There has been an increasing focus on urban centres as important sites for interventions for reducing carbon emissions, as both their populations and emissions dwarf those of rural areas, a disparity which is only set to increase as the proportion of the population living in cities rises. (European Commission, 2016) This has come with a corresponding expectation that local governments should take greater responsibility for low carbon transitions; and there is increasing debate around the role that municipal governments should play, are able to play and are playing in the urban and global transition. (Marvin & Hodson, 2009)

Therefore, scrutinising the role of local government in bringing about urban transitions is important for two reasons. Firstly, if local governments are to take a lead role in achieving the low-carbon transition, then these processes should be analysed to promote ongoing learning for bringing about successful transitions. Secondly, historical analyses of energy infrastructures and energy transitions have already demonstrated that they can be socially transformative on a grand scale, and it is not difficult to imagine that a modern energy transition has the potential to be equally transformative. (Hughes, 1983) Therefore, it is critical to analyse what sociotechnical systems are being brought about and how, not just to support the successful realisation of transitions, but also to promote just ones. To successfully achieve just transitions means critically examining the potential effects of these sociotechnical systems and how they may be distributed differently across a heterogeneous population: a distribution that has the potential to divide the population into transition winners and losers, or perhaps, more positively, represents an opportunity to build a more equitable society. The 'low-carbon transition' should be analysed as an ongoing moment of breakdown and change, where continuous decision making shapes the sociotechnical systems we will find ourselves with. No decisions are value neutral, and

consequently, these systems should be considered to be an enactment of certain values. It therefore becomes important to see why some decisions are made as opposed to others, what doors are opened and which are closed, and finally, who benefits and who loses out. (Beck, 1992; Jasanoff and Kim, 2013; Levenda et al., 2018; Laird, 2013; Miller, Iles & Jones, 2013; Richter et al., 2016) In recognition of the importance of supporting the transition processes, and doing so in the interests of energy justice, this thesis will attempt to gain an understanding of the role of local government in urban transitions by conducting a case study of Bristol City Council, the municipal government of Bristol, a city in the South West of England. The city was Europe's 'Green Capital' in 2015, (European Commission, 2015) a title which is awarded by the European Commission as recognition for *"a consistent record of achieving high environmental standards ... and ambitious goals for further environmental improvement and sustainable development."* (European Commission, n.d.) It also has the most ambitious targets for the reduction of carbon emissions of the UK's 'core cities', aiming to be 'carbon neutral' by 2030, which is far beyond the national target of 80% emissions reduction by 2050. Two factors that make Bristol an interesting site for analysis. (Taylor, 2018)

The case study will address the research question "**How does Bristol City Council imagine Bristol as a 'sustainable' sociotechnical system and construct its own role as a governing body in pursuing this transition?"** This question will be answered in three parts by conducting a documentary analysis of various types of documents that were published by the council. The first and second part will use the lens of sociotechnical imaginaries to understand how sustainability is constructed as a goal and what pathway is to lead to its achievement. Part of this will be scrutinising how other narratives, values and normative goals are built into this sociotechnical imaginary. This will lead us into the second part, which analyses how imaginaries of sustainability have become entangled with imaginaries of the city as a whole. Finally, the thesis will turn to how Bristol City Council constructs its own role as a governing body in bringing about this sociotechnical imaginary, exploring how the council acts or seeks to act to realise this transition in the particular material, social and political context it is embedded in.

2 State of the Art

The first section of this literature review will outline the contribution that STS has made to the study of transitions, focusing on transitions as the change of large sociotechnical systems, and highlighting important interdisciplinary approaches or those from other disciplines where appropriate. Of particular interest is work from other disciplines that takes theoretical contributions from STS work, or that focuses on transitions in the urban environment, as this is not an area that has received extensive attention in the STS field. Finally, the review will cover the application of the theoretical concept of sociotechnical imaginaries to the study of transitions or sociotechnical change. Topics of relevance to the achievement of just and equitable sociotechnical transitions, in addition to successful ones will also be addressed. The aim of discussing work that analyses transitions as sociotechnical change is not only to show the work being done in this field, but also to demonstrate that the analysis of sociotechnical imaginaries in-the-making can potentially be fruitful when it is performed with reference to lessons already learnt concerning the process of sociotechnical change. Relating lessons-learnt from historical case studies, and work on justice in sociotechnical transitions may allow us to identify the potential for failure, conflict, or the production of inequalities embedded in sociotechnical imaginaries. Identifying these points, particularly in the planning stages of large-scale infrastructural change, may provide the opportunity to challenge assumptions concerning the capability of technologies, question the distribution of opportunities and burdens throughout society, and in an ideal world, make changes that will lead to a more successful and just transition. At the very least, analysing sociotechnical imaginaries, and their transformation between planning, and the realisation of infrastructure will provide a good foundation for understanding the relationship between imagination and realisation, and enrich analyses of the processes of sociotechnical change.

2.1 Theorising Sociotechnical Change

There are a large number of theories that approach the move towards more sustainable ways of living as a sociotechnical transition. The wide array of theories deployed is perhaps unsurprising considering the diversity of disciplines that are producing literature on sociotechnical transitions, with the behavioural sciences, innovations studies, political science,

economics, sociology, geography, urban studies, and science and technology studies representing only a handful of the traditions that are contributing to the body of literature. (Sovacool & Hess, 2017) Theories that were developed to analyse and explain the emergence, evolution, and diffusion of technologies or innovations throughout society are now being used or reconfigured to study the transformation of large scale sociotechnical systems. (Geels, 2005a; Hommels, 2005; Markard, Raven, & Truffer, 2012; Paredis, 2011; Sovacool & Hess, 2017) This includes constructivist approaches that were developed in social studies of science, such as the social construction of technology (SCOT), (Bijker, Hughes, & Pinch, 1987) actor-network theory (ANT), (Latour, 1999) and the large technical systems (LTS) approach, (Hughes, 1983; Hughes, 1987; Hughes, 1998) as well as the concept of sociotechnical imaginaries, which also seek to explain why technological developments occur in particular ways. (Jasanoff & Kim, 2009) Each of these perspectives has made a contribution to the transitions literature independently, and there is also a greater body of literature that uses more than one of these perspectives in tandem or integrates them with approaches from other disciplines. (Brunn & Hukkinen, 2003; Graham & Marvin, 2001; Guy, Marvin, Moss, 2016; Lepratte, 2016) This includes their further integration with some of the dominant approaches in the sociotechnical transitions literature, a number of which find their foundations in these approaches to begin with. This is particularly true of the multilevel perspective (MLP), and the governance perspectives that are associated with it: transition management (TM), and strategic niche management (SNM). (Geels, 2005a; Hommels, 2005; Markard, Raven, & Truffer, 2012; Paredis, 2011; Sovacool & Hess, 2017)

2.1.1 Actor Network Theory and Sociotechnical Change

ANT has been used more widely than SCOT in the study of transitions, and has been deployed in a number of different ways in order to analyse the emergence of sociotechnical systems. It has been directed towards policy and the analysis of the role of governance in sociotechnical change, and has been used in work that scrutinised the role of financial markets in energy transitions; other work based in ANT has turned to the transformation of practices for sociotechnical transitions. Perspectives that aim to contribute to policy analysis include Iskandarova's (2016) exploration of the role of policy in determining the final form of the Wave Hub, a centre for marine energy; and Yang's (2015) analysis of the development of solar farms in southern Taiwan. In both of these case studies, the outcomes of governance were shown to be a product of the networks of human and non-human actors that co-evolve alongside each other,

and generate effects through the collective agency of these networks. Yang demonstrated that the establishment of solar PV in Taiwan was highly dependent on 'translators,' in this case the magistrate of the county government and his green energy team, that were able to 'redesign' solar PV artifacts from Western countries, and embed them successfully in a new context. This process was highly contingent on these actors forming new heterogeneous sociotechnical networks by *"connecting local knowledge with expert knowledge and by connecting sites of agriculture and aquaculture with PV equipment workshops."* (Yang, 2015, p. 360) The agency to successfully form new sociotechnical networks in the form of solar farms, was therefore a collective form that was built between these 'translators' and the black-boxed PV equipment. Iskandarova (2016) identified similar forms of collective agency in her study of the development of the Wave Hub in the UK, in this case she presented policy as having effects only through networks of human and non-human actors with collective agency. Iskandarova also challenged the conceptualisation of policy as an inert 'macro context' that is seen in a number of other approaches. Instead, she demonstrated that policy co-evolves with the shape of the Wave Hub, which was shaped by the networks that policy was embedded in, but also had a reciprocal effect on the shape of that policy. This contrasts to other approaches that posit a one way relationship, where policy acts on the sociotechnical system, but experiences no reciprocal effects. It is this emphasis on relationality and reciprocity that has led to ANT being seen as a promising, and underutilised theoretical framework for analysing the relationship between governance and the development of sociotechnical systems. (Hess & Sovacool, 2020; Hommels, 2005; Iskandarova, 2016; Yang, 2015) In addition to the role of policy and governance, recently, an argument has been made for the use of ANT approaches for scrutinising the role that financial markets play in the shaping of energy systems. The concept of performativity (MacKenzie, Muniesa & Siu, 2007) has been of particular interest for looking at how various economic assemblages act as a force for sociotechnical change. (Cointe, 2015; Cointe & Nadaï, 2018; Silvast, 2017; Webb, 2014) The concept of performativity has been used to analyse how feed in tariffs have contributed to the current status of renewable energy in Europe. (Cointe, 2015; Cointe & Nadaï, 2018) The same concept was also used in a case study of attempts to fund district heating in the UK. This study argued that the current neo-liberal economic paradigm that prevails in that context, drives a focus on financial incentives to encourage private investment, and by doing so includes and excludes particular options regarding the shape of energy infrastructure. (Webb, 2014) Each of these cases argues for an increased consideration of markets as an intrinsic component of

sociotechnical systems in transition. (Cointe, 2015; Cointe & Nadaï, 2018; Silvast, 2017; Webb, 2014)

ANT has also been used to scrutinise day to day practices, and how they might best be conceptualised in the analysis of transitions. ANT-inspired approaches often critique dominant conceptualisations of what is a relevant actor, which is typically a human adult that acts according to economic rationales. In their critique of the dominant imaginary of the rational, adult energy consumer, Strangers, Nicholls and Maller (2014), advocate for the consideration of non-traditional actors within the home; for example, pets, plants, teenagers, and children. They present energy consumption as a product of assemblages of agency between these heterogeneous actors, and argue that this conceptualisation may have value when designing interventions for changing energy practices. Approaching energy practices as resulting from distributed forms of agency is also an important theoretical underpinning of the work of Pallesen and Jenle, (2018) who explore the attempt to configure a rational economic actor by designers of a smart grid. They found that attempts to configure consumers do in fact generate some that act according to the script provided for them, but that it falls short of the conditions needed to create a reliable grid. Instead, a spectrum of consumers with different calculative agencies are generated that respond differently to the economic signals provided to them. In recognising the important effects generated by systems designers, while also highlighting their limitations, these authors attempt to build a bridge between social practice scholars and system designers. They address some of the critiques currently leveled at conceptualisations of energy consumers as rational economic actors, but also emphasise the need to inscribe consumers into the design of energy markets, and call for a meaningful construction of usable models by social scientists.

2.1.2 Large Technical Systems Theory and Sociotechnical Change

LTS shares similarities with ANT in the respect that the large technical systems of LTS are conceptualised as 'seamless webs,' or heterogeneous networks of material artefacts, institutions, and practices. (Hughes, 1983) This body of literature has largely focused on the emergence, and stabilisation of sociotechnical systems, and pays less attention to their destabilisation and change. (Davies, 1996; Gökalp, 1992; Hughes, 1983) However, there has been some work done that analyses, and theorises sociotechnical change from a LTS perspective, work that has moved

from historical analyses, to attempts to analyse current conditions for sociotechnical change, and even generate forecasts for policy advice. (Davies, 1996; Hirsch & Sovacool, 2006; Jørgensen, 2005; Markard & Truffer, 2006; Sklarew, 2018; Sovacool, Lovell & Ting, 2018; Summerton, 1994) Jane Summerton (1994) provided the first major treatment of sociotechnical change in her anthology, which analyses historical changes in several large sociotechnical systems, including railways, airlines, roads, telecommunications, and electric power networks. In this work, Summerton makes the important argument that these systems are never truly black-boxed, and that the need to respond to outside challenges, and incorporate new goals into systems can have the effect of undoing closure, and prompting reconfiguration of the system. Sovacool, Lovell and Ting (2018) later made an effort to meaningfully expand on these theoretical insights by adding additional phases of the life of large sociotechnical systems. In addition to those originally outlined by Hughes (1983), they include the phases of contestation; reconfiguration; and stagnation and decline, which emphasise the processes of change that mature sociotechnical systems may go through. They emphasise that stability is as much of a product of continuous work as system change, and that there are challenges that may disrupt this work and lead to the transformation of these systems. (Sovacool, Lovell & Ting, 2018) Efforts to identify forces for sociotechnical change have highlighted the importance of economic forces, alongside other social and political forces, as an important driver for sociotechnical change. (Davies, 1996; Markard & Truffer, 2006) There have also been efforts to analyse the governance of these systems from an LTS perspective, (Coutard, 1999) with some, more recent work analysing the role of policy in energy transitions, and particularly criticising the dominance of economic policy in attempts to achieve energy transitions. (Jørgensen, 2005) The LTS approach has also been combined with the advocacy coalition framework from policy studies to demonstrate how infrastructural, and policy choices can lead to system lock-ins. System lock-ins that can occur according to, and entrench pre-existing interests and power dynamics. (Sklarew, 2018) This is an important addition to other LTS work that analyses how changes in large sociotechnical systems accompany societal change, and address questions of power. (Allen & Hecht, 2001; Hughes, 1983; Van der Vleuten, 2004) While LTS was born from the history of technology, there has begun to be a noteworthy shift towards the analysis of current conditions for sociotechnical change. The work of Fischer and Praetorius (2008); and Sauter (2008), address the potential of different technologies to play a role in the transition towards more sustainable energy systems. Fischer and Praetorius (2008) analyse the actor networks surrounding carbon capture and storage (CCS) in Germany, in order to generate some predictions concerning the role it might

play in providing a bridge to a low-carbon future. They find that CCS might provide an incremental bridge between the current fossil fuel systems, and an energy system based on renewables; however, they find that more work needs to be done on a number of points, not least to address concerns that the technology may contribute to a longer-term lock in to the current energy system. Sauter (2008) instead turns to the role of microgeneration technologies in the UK electricity system, and argues that the barriers to a change to a more distributed energy system are institutional, rather than technical in nature. The author sees these barriers as emerging as a result of the competitive regulation of domestic energy markets, which create high levels of risk for those wishing to invest in these technologies. Sauter then proposes that taxation, and regulatory change could increase the share of microgeneration in the UK energy mix. This orientation towards learning lessons for future sociotechnical change is shared by Graham and Marvin (2001), who aim to develop a comprehensive approach for understanding urban change and use it to explain the simultaneous fragmentation of infrastructures and the urban landscape. Constructing a framework from LTS, ANT, political economy, and relational urban theory the authors see the city, technologies and infrastructures as being so interlaced as to be inseparable, and argue that urban change can only be explained by analysing the interplay between them. They argue that only by acknowledging this intertwinement, and embedding this understanding into urban design can infrastructural, and therefore urban, transitions be achieved in a socially equitable way.

2.1.3 The Social Construction of Technology and Sociotechnical Change

Analyses of the emergence of large sociotechnical systems from a purely SCOT perspective remain limited, particularly when considering the study of transitions, whereby a dominant large sociotechnical system is dramatically transformed over time. This dearth has been attributed to the approach lending itself more to detailed case studies of the emergence of single technologies. (Graham & Marvin, 1996) However, there are some noteworthy exceptions, and there have been important efforts made to develop the SCOT approach and to advocate for its use for looking at larger systems, and their transitions. (Hess & Sovacool, 2020; Hommels, 2005; Markard, Raven, & Truffer, 2012; Paredis, Sovacool & Hess, 2017) Sovacool (2008) seeks to contribute to the development of energy policy for achieving sociotechnical change, by using SCOT to analyse how international cooperation occurs in the realisation of a large-scale international energy project. Other authors have taken the city as the site of analysis, including

Aibar & Bijker (1997) in their study of the how interactions between 'relevant social groups' shaped the Cerdà Plan for the extension of Barcelona between 1854 and 1860; and the multitude of authors in a more recent contribution that offers case studies of sociotechnical transitions in several different European cities. (Guy, Marvin, Moss, 2016) Further work combines SCOT with other approaches, including LTS, ANT, and approaches from economics and innovation studies. (Brunn & Hukkinen, 2003; Graham & Marvin, 1996; Guy, Marvin, Moss, 2016; Hess & Sovacool, 2020; Sovacool & Hess, 2017) In the case of Brunn and Hukkinen's (2003) paper, this comes from the conviction that while SCOT gives important insights into why certain technologies become paradigmatic, evolutionary economics is better equipped for studying the outcomes of this change, and ANT offers richer explanations of the stabilisation of artifacts or the closure of controversies. Graham and Marvin (1996) also combine an economic perspective with the SCOT, in their analysis of the relationship between the development of telecommunications and the urban environment. The authors go beyond using the city as a site of analysis, and instead analyse it as a sociotechnical system that co-evolves with the telecommunications system. Combining SCOT with a political economy approach allowed them to integrate SCOT's more 'in the moment' analysis of individual agency, with a more structural understanding of power by modelling the effect of the capitalist system on the ability to exercise agency. (Graham & Marvin, 1996)

2.1.4 Dominant Approaches in Transitions Studies

While each of these perspectives have made a contribution to the transitions literature, they have not been deployed extensively, and more recent work is particularly limited. However, both SCOT, and the LTS approach have made important theoretical contributions to some of the most prolific perspectives in the sociotechnical transitions field, including strategic niche management (SNM), and the multilevel perspective (MLP). These two perspectives share the conceptualisation of dominant sociotechnical systems as regimes that are destabilised and changed by the formation of niches, or protected spaces where innovation can occur, a conceptualisation that borrows from SCOT, LTS, evolutionary economics, and innovation approaches. The production of these niches is conceptualised as a form of sociotechnical experimentation, which relies on market forces and competition to overcome sociotechnical lock-in, and lead to sociotechnical change. They share these features with several other theoretical perspectives that are important in transition studies, but do not have roots in STS,

including transition management (TM), and the technological innovation system (TIS) approach to transitions. (Geels, 2005a; Kemp & Loorbach, 2006; Kemp, Schot & Hoogma, 1998; Markard, Raven, & Truffer, 2012; Smith, & Raven, 2012) The two approaches differ in the respect that SNM conceptualises regime change largely as bottom-up. Change comes from the successful production of a protected niche, that is isolated from market forces in the early stage, which ultimately allows the innovation produced in the niche to challenge and replace the regime. SNM focuses on how the successful establishment of these niches may occur, with early SNM focusing on the internal processes that could ensure the establishment of a successful niche, processes which included the formation of expectations and visions, and their interpretative flexibility; the construction of social networks, including the involvement of regime actor; conscious and continuous learning in multiple areas from successive projects; and the phased exposure to market forces. (Geels, 2005a; Geels & Raven 2006; Hoogma, Kemp, Schot & Truffer, 2002; Kemp, Schot & Hoogma, 1998; Markard, Raven, & Truffer, 2012; Schot & Geels, 2008; Verbong, Geels & Raven, 2008) The predominantly technological focus of SNM has attracted criticism, and there are authors who advocate for redirecting 'experiments' in niche formation away from technological experimentation. Instead they advocate for experimentation that holds a particular social vision in mind, and explicitly experiments with particular forms of social organisation. In other words there should be greater focus on experimenting with the 'social' component of sociotechnical change than there is currently, and the goal of experimentation should be the achievement of a social aim, not to use a *technology* to achieve an end goal. A number of authors in SNM point out that actors are frequently expected to participate in sociotechnical change but are rarely explicitly involved in experimentation processes. Furthermore, the authors argue that there is often great faith placed in the ability of technology to solve a problem, and little effort placed in finding social solutions. (Hegger, van Vliet, J. & B.J.M. van Vliet, 2007; Ieromonachou, Potter & Enoch; 2004) SNM has also been critiqued for focusing too strongly on bottom-up models of transitions; however, this has begun to change as processes identified in MLP have begun to be integrated into SNM. This means that there is now greater attention paid to the influence of external processes on the successful development of niches instead of an exclusively bottom up approach. (Schot & Geels, 2008)

MLP contrasts to SNM, and has contributed to its theoretical development in some key ways. In MLP transitions in socio-technical systems are composed of three levels: the landscape, the regime, and niches. The landscape is defined as the influences and elements that are outside of

the actors' sphere of influence or that change very slowly; the regime is the stabilised sociotechnical system; and niches are largely characterised as 'protected spaces' where alternative sociotechnical systems begin. (Geels & Schot, 2007) Despite early criticism that it shared the bottom-up perspective of early SNM work, in MLP the niche innovations successfully replace, or are integrated with the regime as a result of processes occurring at all levels of the sociotechnical system. (Geels, 2005a; Geels & Raven, 2006; Geels, & Schot, 2007; Loorbach, Frantzeskaki & Avelino, 2017; Markard, Raven, & Truffer, 2012; Schot & Geels, 2008; Sovacool & Hess, 2017) The relationships between these levels has attracted increasing attention in the MLP literature, which has revealed the complexity of these interactions and any resulting transition pathways. Transitions don't just occur due to innovation at niche level taking over the regime, but also depend on pressures leading to the destabilisation of the existing regime, and often succeed through the support of powerful actors from both inside and outside of the dominant regime. (Diaz, Darnhofer, Darrot & Beuret, 2013; Geels, et al., 2016; Kivimaa, 2014; Smink, Negro, Niesten & Hekkert, 2015) These processes are chaotic, non-linear, evolve via a number of pathways, require continuous work, and may fail at any point, particularly as regime actors will often resist change to the regime. (Diaz, Darnhofer, Darrot & Beuret, 2013; Geels, 2014; Geels et al., 2016; Hess, 2016) Several typologies of transition pathways have been developed, which seek to categorise the kinds of pressures that will lead to a transition, and the type of transition pathway that will emerge. (Geels and Schot, 2007; Geels et al., 2016) Berkhout, Smith and Sterling (2005) highlight two important differentiating factors that lead to different transitions: the degree to which the transition is an intended change; and the degree to which the transition can be achieved using resources available to the regime, and can be co-opted by it. The degree of coordination, and whether the resources for change are internal or external to the regime delineate four ideal types of transition: reorientation of trajectories, endogenous renewal, emergent transformation, and a purpositive transition. Geels and Schot (2007) also place emphasis on the ability of regime actors to be the orchestrators of transitions, but did not discuss intentionality as an important factor. They defined four types of transition pathways that depend on the relative timing of landscape pressures and niche developments, which can largely be differentiated according to whether incumbent regime actors remain in place or are displaced by niche actors. In the first case regime actors remain in place by adapting the regime to landscape pressures themselves in the absence of niche innovation, or by integrating niche innovations into the regime. (Geels, 2006a; Geels, 2006b; Geels & Schot, 2007; Smith, 2006) Alternatively, a niche innovation can come to replace the regime, either because it is already

fully developed when regime failure occurs, or through a process of development and competition where several undeveloped innovations will co-exist until one comes to dominance. (Geels, 2005b; Geels & Schot, 2007; Köhler et al., 2019) de Haan and Rotmans (2011) instead performed a conceptual development of a typology of transition pathways, rather than building on historical case studies in the style of Geels and Schot (2007). The authors argue that society is in a constant state of flux and that what differentiates transitions from this flux is that it occurs in particular *patterns.* They conceptualised three 'patterns' that might lead to a transition: empowerment, which replacement from within; reconstellation, which is replacement from without; or adaptation, that they define as the reconfiguration of the incumbent regime in response to social need. The narrative of any transition pathway can then be told as a linked series of these patterns, termed 'concatenations.' A later study by Geels et al., (2016) reconfigured the earlier typology outlined by Geels and Schot (2007), and moved away from a focus on landscape changes to place greater emphasis on the struggles that occur over both technological and institutional change. These struggles are central to the definition of the transition pathway, and actors' changing beliefs, alliances and goals contribute to their non-linearity. The authors also advocate for greater attention to be paid to static landscape characteristics, such as *"constitutional structures, policy styles, ideologies, and economic structures,"* as having important explanatory power for different enactments of transitions in different national contexts. This is a noteworthy shift away from the earlier framework, which focuses on landscape changes rather than investigating the influences of stable landscape features. (Geels et al., 2016, p. 901)

Each of these typologies is an attempt to elucidate and define the type of interactions that occur between the different levels as they are defined in MLP, and how they might shape transitions. There is still some thought that there is a need for greater analytical tools to truly gain an in-depth understanding of these dynamics, and this has prompted a consideration of alternative theoretical frameworks and how they might be usefully introduced to MLP. ANT has been of particular interest in this regard, and has been found theoretically enriching for several reasons. Firstly, ANT has been used to enrich the understanding of the distribution of agency in transitions, and how actor-actor interactions bring about transitions. (Åm, 2015; Diaz, Darnhofer, Darrot & Beuret, 2013; Sørensen, Lagesen & Hojem, 2018) Furthermore, the use of ANT alongside MLP arises frequently from the criticism that MLP is too hierarchical in its approach to transitions. This is a characterisation that has never been fully accepted by Geels,

who is in many ways the pioneer of MLP, but nonetheless this criticism persists, and also resonates with empirical issues admitted by Geels himself; for example, the difficulty of meaningfully defining the different levels empirically, and the danger of the landscape becoming a kind of theoretical bin. (Geels, 2011) Several authors have used ANT, or concepts that derive their main theoretical features from ANT, to address these issues, largely by using one of the core concepts of ANT, which is that no agencies, relationships, or hierarchies are assumed to be stabilised or defined apriori. (Åm, 2015; Jørgensen, 2012; Sørensen, 2015; Sørensen, Lagesen & Hojem, 2018) For example, in arenas of development, the process of transition begins in processes of sense-making between actor constellations, rather than having pre-defined structural features of technologies or institutions that engage in the relevant activities. Instead the arena of development in which the transition occurs has boundaries that are continuously in flux. (Åm, 2015; Jørgensen, 2012) This aims to encourage the breakdown of preconceived notions concerning the relevant actors, and distribution of agency in transitions, and promote a more critical understanding of the dynamics of transitions.

2.2 The Urban and Sustainability Transitions

At this juncture, it is useful to draw together literature that focuses on the urban environment, to situate this project with work that focuses on the role of the urban in the low carbon transition. Cities have come to play an increasingly important role in the low-carbon transition, and so increasing attention has been paid to cities both as sites in which transitions may originate; and as actors in and of themselves that may play a role in changing systems at regional, national, and international scales. (Kivimaa, et al., 2017; Graham & Marvin, 2001) Taking a sociotechnical perspective on urban transitions necessarily means taking into account the materialities of a city: its infrastructures, and the technological options available to it. However, it also means gaining an understanding of the institutional conditions of the city, the variety of actors in that context, as well as the networks into which the city is embedded, and the resources available to it; whether financial or otherwise. (Coenen, Benneworth & Truffer, 2012) Furthermore, it means going beyond simply exchanging 'bad' technologies for 'good' technologies to achieve low carbon transition, and scrutinising how relevant technologies are integrated into urban practices and cultures, as well as social norms and values. This is important for understanding how changes in infrastructures or technologies in cities might play a role in achieving low-carbon transitions by emphasising the necessity to achieve 'transitions

in practice.' (Dodson, 2014; Shove, Walker & Brown, 2014; Walker & Cass, 2007) Therefore, literature that approaches the urban and low-carbon transitions as sociotechnical is highly diverse and highlights various different aspects of the dynamics of this change.

2.2.1 The Multilevel Governance of Urban Transitions

A key question in work on transitions within cities, and the role of cities in national and the global low-carbon transition is the role of governance. Approaches to governance differ with regards to the levels of governance they focus on; the variety of actors that are considered relevant; and which actors are considered able to influence others within the framework. However, increasingly, theories of governance have moved away from more traditional conceptualisations of governance structures that consist of separate, hierarchical levels of local, national and international government; and governance is instead considered to be a product of the interactions between multiple actors that can go far beyond the boundaries of the city, and includes both governmental and non-governmental actors. In studies of urban transitions, the most prominent framework that takes this relational perspective is the multilevel governance perspective. The multilevel governance perspective defines two types of interactions: 'Vertical' or 'Type I' interactions; and 'Horizontal' or 'Type I' interactions. 'Vertical' or 'Type I' interactions are those that occur between formal and hierarchical governance structures, whereby the decision-making of local governments is shaped by their interactions with state actors or international governing bodies, and the conditions that are created by them; for example, through defining national policy, making regulations, or dictating the funding available to local councils. In contrast, 'horizontal,' or 'Type II' interactions occur between spheres that can be considered less formal or hierarchical in nature, such as those between the governments of different cities, and includes the influence of non-governmental actors. This influence is rarely uni-directional, and instead actors often exercise mutual influence to simultaneously shape different 'levels' of governance. (Bulkeley & Betsill, 2013) The take-away of the multilevel governance perspective is that no decision-making is done completely in isolation of the influence and interests of other actors, and governance outcomes occur as a result of the interplay of these factors. (Ehnert et al., 2018) Understanding these dynamics is important for understanding how issues of power and conflict might shape transitions, and to ultimately identify factors that are supportive of both successful and just transitions. In particular, the multi-level perspective highlights the need for interactions between spheres of influence that

were previously considered separate, and the development of synergies between them. Otherwise, situations can arise where the priorities held and decisions made by one group of actors can hinder the transition efforts of others. (Bulkeley & Betsill, 2005; Dale et al., 2019; Emelianoff, 2014; Ehnert et al., 2018; Haarstad, 2016; Jaglin, 2014; Kern & Bulkeley, 2009; Verdeil, 2014)

The multilevel governance perspective emphasises the wider political conditions, and discourse in which local transitions must take place. Hodson & Marvin argue that one impact of national, and international level discourses on urban sustainability transitions is visible in the increasing pressure on regional governments to increase the economic competitiveness of cities. (Hodson & Marvin, 2009; Späth & Rohracher, 2010) National discourses largely position economic competitiveness as a product of the correct technological innovation strategies, and this means that economic competitiveness, and low-carbon transitions are frequently coupled in highly technological and innovation focused visions of 'green economies'. They also point out that the limited capacities of local governments to implement transition projects independently increases the necessity to engage other actors, and form visions for the future through processes of negotiation and contestation with outside actors. (Hansen & Coenen, 2015; Hodson & Marvin, 2009; Späth & Rohracher, 2010) A number of case studies have found that policies adopted at the national level can shape local efforts. National governments not providing the right legal support through legislation and regulations can limit the power of local governments to achieve their goals; for example, by limiting the ability of local governments to impose legally binding building codes. (Bulkeley & Betsill, 2005; Bulkeley & Betsill, 2013; Jaglin, 2014; Verdeil, 2014) They can also shape local efforts by shaping the financial resources that are available to local governments, due to the important effects financial considerations have on the capacity of local governments to act. (Bulkeley & Betsill, 2013; Bulkeley & Kern, 2006; Dale et al., 2020; Emelianoff, 2014) Frequently, the alignment of policy, which affects the financial resources available to local governments, and their legal powers is achieved due to shared priorities, and strong leadership at several levels of government. Successful action at local level is frequently attributed to this alignment, and the lack of alignment, or decreasing alignment of priorities between different levels of government over time that limit the ability of local governments to act. (Dale et al., 2020; Verdeil, 2014) This is also true when considering the effects of international government decision making, with the EU's liberalisation of its energy markets being blamed for reducing the direct influence of local governments by causing their

withdrawal from the provision of energy services. (Bulkeley & Kern, 2006; Emelianoff, 2014) However, it has also been noted that what constitutes supportive or non-supportive government decision making highly varies according to the individual features of a particular nation or city. In the multilevel governance literature, a great deal of importance is attributed to features such as size, the degree of decentralisation of government, and other factors like the features of the private sphere, and sociohistorical, or socioeconomic context. (Bulkeley & Betsill, 2013; Emelianoff, 2014) It is also noteworthy that there have also been cases where the most significant local efforts arose in defiance of, and even because of a lack of national action and support. (Gore & Robinson, 2009) This has led to calls to undertake policy alignment at multiple scales, but also to recognise the highly context-dependent nature of governance and its role in enabling transitions. (Dale et al., 2020)

'Vertical' interactions are not only important for the creation of particular legal, regulatory or socioeconomic environments. Another key element of governance that is being scrutinised as an important enabling factor for transitions is the flow of actors. These actors can be human, technological or a piece of policy; as well as discourses, values, practices, and expertise. These flows have been scrutinised both between 'vertical' levels of government and 'horizontal' or 'networked' ones, which have increasingly been of interest in the literature. This body of work introduces another layer to the understanding of how transitions may be achieved by going beyond the development of best practices to understand how their implementation may be supported or limited according to the capacity to circulate people, technologies, values and best practices in useful ways, and the contestation that can occur during these processes. (Bulkeley, 2006; Bulkeley & Betsill, 2013; Dale et al., 2020; Emelianoff, 2014; Haarstad, 2016; Jaglin, 2014; Kern & Bulkeley, 2009; McCann, 2011; Peck, 2011; Verteil, 2014) Several authors have demonstrated that policies often diffuse beyond the city in which they originate and are adopted, frequently in an adapted form, in new contexts. (Bulkeley, 2006; McCann, 2011; Peck, 2011) While others have demonstrated that non-governmental actors are equally important for the production and diffusion of policy, as well as expertise. (Bulkeley & Betsill, 2013; Emelianoff, 2014; Haarstad, 2016; Jaglin, 2014; Kern & Bulkeley, 2009; Verteil, 2014) For example, Emelianoff found that the formation of alliances between environmental NGOs and municipal governments was key for the development of transition policy (2014). She also found that private enterprises were a powerful force for a successful urban transition, particularly when they already had expertise in renewable technologies and were engaged in environmental issues. (Emelianoff,

2014) This point is emphasised when considering the relative failure of private energy firms to influence transitions in Verteil's case study of Amman in Jordan. (2014) In this case the small size of private energy firms in Jordan and their lack of 'vertical' or 'horizontal' connections limited their ability to export their expertise and influence transitions in a meaningful way to bring about an energy transition that was low-carbon in nature. (Verteil, 2014) Furthermore, multiple transition visions may coexist, and be generated by actors beyond the boundaries of the city. In the case of London, this became obvious through two visions that emerged around hydrogen technologies. The vision of London's mayor was to position the city as a leader in governance, and innovation by implementing a set of strategies that would develop London as a 'hydrogen economy,' while serving a wide array of social interests. Another vision concerning hydrogen technologies emerged independently, and was formed by multinational interest outside of the city including BP and Daimler-Chrysler. This vision focused on London as one of a number of European cities that acted as 'showcases' where particular technologies are tested and configured to fulfil the needs of other 'exogenous' actors, including international commercial interests. The attempt to implement both visions required the enrollment of a wide variety of actors, and so negotiation according to the interests of a wide variety of actors. (Hodson & Marvin, 2009)

This body of work has also given hints as to how the urban, and urban governance may be co-produced with sustainability transitions in the respect that the desire to undergo low-carbon transitions drives the formation of new connections with both governmental and non-governmental actors, both within the boundaries of a nation and beyond. Simultaneously, successfully undertaking transition increases cities' attractiveness to other actors who want to engage in these kinds of networks activities. Through these mechanisms cities can gain greater autonomy, and increase both their national and international influence, which gives municipal governments a greater ability to influence political decision making at other scales. In this respect, urban sustainability and new systems of governance are being co-produced as cities play a greater role in driving both local transitions, and those on a global scale. (Bulkley & Betsill, 2007; Broto, 2017; Bulkeley & Betsill, 2013; Rohracher, & Späth, 2014; Verdeil, 2014)

In summary, in the multilevel governance perspective the governance of urban transitions is defined by three main factors. Firstly, the shape of a transition is defined by how local government policy interacts with, and is shaped by the context of national and international

policy. National and international policy are not considered to be completely inert landscape features that are unalterable by local actors, but nevertheless have important effects. This policy context is important for shaping the capacities of local governments, which in turn contributes to the second important contextualising factor in the multilevel governance perspective: the circulation and contestation of visions by different human and institutional actors within the boundaries of a particular urban environment as an exercise of power. In each urban environment there is a unique collection of actors that exercise power to shape transition outcomes according to their capacities, values and interests. In each case, the capacity and power of various actors to enact their vision is highly contextual and plays an important role in driving diverse transition outcomes. This landscape of actors has significance beyond the circulation and contestation of visions. The connections between them and the network that is formed also shapes transitions by enabling the circulation of important resources, including human actors, expertise and money. This is the third important contextual factor that emerges in multilevel governance perspectives on transitions in the urban environment.

2.2.2 Engaging with Materiality, Sociotechnical Urban Transitions

Multilevel governance work can largely be defined as being focused on institutional actors, and the interactions between them, and can be criticised in the respect that the accounts generally neglect other sociotechnical characteristics of cities and the infrastructures that are relevant for transitions. Analysing the effects of these characteristics, including the material aspects of cities is important for understanding the multitude of divergent transition pathways that emerge in different contexts. (Bulkeley, Castán Broto & Maassen, 2013) This is where sociotechnical perspectives come to the fore, and demonstrate that it is not just social forms of exchange that need to be facilitated, the obdurate social and material orders of sociotechnical infrastructures need to be disrupted. In MLP and SNM this depends on the development of innovations that destabilise, replace or are integrated with existing regimes. These may be technological, or can be social in nature, as is the case with innovations in forms of financing, policies, norms or particular practices. These perspectives come with their own shortcomings, particularly with regards to understanding how these processes may be achieved within particular cities, and the factors that shape the capacity of cities to 'innovate' in the way mandated by MLP and SNM. This has led to important theoretical developments, largely stemming from the integration of geographical theorisations of space. (Coenen, Benneworth &

Truffer, 2012; Marvin & Hodson, 2009; Raven, Schot & Berkhout, 2012) This body of work emphasises the context dependencies that arise in the pursuit of transitions, as demonstrated by the following quote:

> *a spatially explicit MLP is important since ... any transition to sustainable development will require interaction between spatially distributed actors, institutions and economic structures that exercise power within and across heterogeneous and uneven spaces of innovation* (Raven, Schot & Berkhout, 2012, p. 65)

In this understanding, transitions evolve through very different pathways or not at all, according to a variety of different factors that extend beyond the interactions between, and decision making of powerful actors. Theories from geography, and particularly economic geography build on understandings of niches, regimes and landscapes that define them according to the timescales over which they can change, and their structuration: the embeddedness and stability of particular beliefs, practices, institutional arrangements etc. They add a definition of each of these levels according to a particular conceptualisation of space that goes beyond the consideration of purely physical dimensions. Space is also relational and is defined by the density of connections in networks that include social and economic entities, as well as the physical networks of infrastructure. These sociospatial relations and the enactment of power that occurs through them is as important as their physical positioning, because each of these elements plays a role in defining the flow of important resources like human actors, expertise and capital to cities, which shapes the capacity of cities to undergo, and influence transitions. In this understanding, it is these networks that creates the highly individualised nature of cities, and the diversity of transition pathways. Based on this understanding of space, conceptualise spatial aspects in MLP by defining the landscape, regime and niche according to relational spatial proximity, or the density and stability of relations, and also use this proximity as an indication of power. The landscape and regime both typically have a high degree of proximity and power, with the landscape acting across the regime, while the networks of the regime are internal to the incumbent sociotechnical system. In contrast, the niche generally exhibits low relational proximity due to the emerging nature of the networks of actors, and has a lesser degree of power within an emerging sociotechnical system. (Coenen, Benneworth & Truffer, 2012; Dale et al., 2020; Raven, Schot & Berkhout, 2012)

A number of case studies have revealed important spatial aspects that contribute to the ability of cities to undergo transitions. In part, and similarly to the factors highlighted in the multilevel

governance perspective, this depends on institutional arrangements and policy environments that define the flow of resources through networks. (Raven, Schot and Berkhout, 2012) However, it also depends on elements like the physical proximity to important resources, whether to renewable energy sources like biomass, or important industrial or research clusters. (Huang, Castán Broto, Liu & Ma, 2018; Raven, Schot and Berkhout, 2012) It also depends on the embeddedness of entrenched interests in particular spaces, or in other words, the strength and stability of particular sociotechnical regimes. Regimes, which often define the capacity of cities to transition, as demonstrated by the advantages that developing cities like Dezhou, China have in leapfrogging energy infrastructures that are reliant on fossil fuels. (Yu & Gibbs, 2018) The lack of powerful embedded institutions facilitates the development of new carbon-neutral infrastructures, as does the ability to institutionalise new sustainable practices to change the urban 'selection environment' encountered by new sustainability measures. (Barns, Durrant, Kern & MacKerron, 2018) Sociotechnical accounts also emphasise the need to disrupt particular practices to achieve transitions, and obduracies in consumption practices are considered as critical as obduracies in physical infrastructure. (Dodson, 2014; Huang, Castán Broto, Liu & Ma, 2018; Shove, Walker & Brown, 2014; Walker & Cass, 2007; Yu & Gibbs, 2018) Other pieces of work have highlighted the importance of actors that are termed 'intermediaries' for maintaining and managing transitions in particular contexts. Firstly, by assisting in generating contextual visions of cities and regions as they currently exist, and integrating this contextual understanding into visions of possible pathways to a viable low-carbon future. They then build and maintain the necessary social networks for implementing this transition, often by managing the conflicting imaginaries of the future that can be articulated around particular technologies in one city, in order to maintain political networks and allow continued action. Local government actors often play important roles as these intermediaries. (Hodson & Marvin, 2013; Hodson, Marvin & Bulkeley, 2013; Gustafsson & Mignon, 2018; Kivimaa, 2014; Kivimaa, Boon, Hyysalo, & Klerkx, 2019) Finally, emerging perspectives emphasise the linkages and interactions between multiple systems, and the need to engage in multi-system analyses for achieving urban transitions. For example the transformation of transport systems, and the design of cities are both important for achieving low-carbon transitions, and may share points of lock-in, or points of leverage for achieving transitions. (Hodson, Geels & McMeekin, 2017; Rosenbloom, 2020)

2.2.3 Integrating Multilevel Governance and Sociotechnical Perspectives

These two perspectives highlight different aspects of transition processes in the urban environment, and each comes with important shortcomings. An appreciation of the sociotechnical characteristics of cities and the infrastructures is frequently lacking from governance perspectives. Equally, sociotechnical perspectives, have been criticised for neglecting the political and contested nature of transitions, including the exercise of power. This holds true even for TM and SNM perspectives, which have a focus on governance for the successful generation of niches. (Bulkeley & Betsill, 2005; Coutard & Rutherford, 2010; Lockwood, 2017; Marvin & Hodson, 2009; Meadowcroft, 2011; Verdeil, 2014) This has led to the combination of sociotechnical perspectives like MLP with the multilevel governance perspective to study transitions in cities and improve understanding of contextual effects. The introduction of the multilevel governance perspective to MLP aims to analyse wider political pressures, priorities and power relations, and how they play a role in shaping the transition agendas of cities. This means understanding how national or international level discourses and expectations; and the priorities of other key actors shape local transition strategies through processes of negotiation, and contestation. (Bulkeley & Betsill, 2005; Haarstad, 2016; Hodson & Marvin, 2009; Hodson, Geels & McMeekin, 2017; Rohracher & Späth, 2013) Introducing sociotechnical aspects to the multilevel governance perspective is key for understanding the disparity between aspirations and reality. It means acknowledging that a diversity of pathways are needed, both because the same policy will not unproblematically bring transitions in different contexts, and because different places have different social issues and requirements. (Huang, Castán Broto, Liu & Ma, 2018; Hodson, Geels & McMeekin, 2017; Marvin & Hodson, 2009)

2.3 Sociotechnical Imaginaries and Sociotechnical Change

Largely, these analyses are concerned with the multitude of heterogeneous actors that are important for achieving transitions, whether they are technologies, institutions, pieces of policy, or members of the public. They also emphasise that transitions are a product that emerge as a result of a complex interplay between many different actors and their choices. However, these perspectives have relatively little to say about the normative questions that arise when considering sociotechnical transitions. They trace interactions, but don't interrogate the values

and beliefs that shape the choices of individual and institutional actors, and can become embedded in infrastructures. Infrastructures that can then become obdurate, meaning that the structural effects of infrastructures may be felt for a long time. (Geels, 2011; Shove & Walker, 2010; Sovacool & Hess, 2017) This undermines conceptualisations of power in the multilevel and interactional approach to transitions, and is a long standing critique of these approaches. (Marvin & Hodson, 2009) The consideration of these questions is becoming more and more pressing, as particularly MLP, and SNM have become more prominent, and are increasingly of interest for designing future transitions, particularly through informing policy. It is easy to see how these frameworks can become performative, and in a detrimental way if they neglect or have the effect of masking the potential manufacture of inequality, as they are adopted as tools for understanding transitions, and for guiding action. (Geels, 2011; Shove & Walker, 2010; Sovacool & Hess, 2017)

One way of grappling with these normative questions is through the theoretical concept of sociotechnical imaginaries. Sociotechnical imaginaries are the collectively, and often institutionally, held and stabilised visions of futures that are made possible by the adoption or rejection of a certain scientific, technological or technoscientific innovation. These imagined futures are largely positive but can also concern the possible negative impacts of a particular innovation, and the resulting negative future. More than just painting a picture of possible futures, sociotechnical imaginaries also constitute normative judgements on what futures should be pursued. Jasanoff and Kim first formulated their concept of sociotechnical imaginaries in an effort to analyse why science and technology policies diverge across nation states, and sociotechnical imaginaries have continued to be a fruitful lens through which to look at policy making. (2009) From investigations of how nations and their technoscientific projects are co-produced, (Bowman, 2015; Hecht, 1998; Jasanoff & Kim, 2009; Kim, 2015) studies have shifted, along with Jasanoff and Kim's definition of the sociotechnical imaginary, to recognise that sociotechnical imaginaries are not limited to nation states (Hurlbut, 2015; Moon, 2015; Smith, 2009) *"but can be articulated and propagated by other organized groups, such as corporations, social movements, and professional societies."* (Jasanoff, 2015, pp. 6) While the term 'imaginary' paints the picture of a largely cognitive process, these imaginaries are, in fact, continuously performed and enacted. In addition, whether top- down or bottom-up, maintaining sociotechnical imaginaries requires constant rehearsal and stabilisation, a practice that draws on the past as much as the future, as groups use past decision making and collective experience regarding technology as a resource in present day futuring. (Felt, 2015; Hurlbut, 2015; Jasanoff, 2015) (Jasanoff, 2015) They

may initially emerge from one mind, and be in competition with multiple imaginaries circulating through society, (Jasanoff & Kim, 2009; Kim, 2015) but those that come to dominate have the power to shape 'agendas, research trajectories, projects and policies.' (Smith, 2009, pp. 462) This points to the importance of analysing sociotechnical imaginaries: that ultimately, they work to define what sociotechnical systems should be realised, how they should be realised, and for what reason. (Smith, 2009) The sociotechnical systems bourne of these imaginaries then represent realisations of certain moral judgements on what the world should look like and how humans should live in it. (Jasanoff & Kim, 2009; Jasanoff, 2015)

Instead of focusing on the procedural work that goes into achieving transitions, this work focuses on the values and grand visions that drive, and are embedded into technological decisions. Sociotechnical imaginaries direct us to critically reflect on what transitions represent: what they tell us about what futures are considered to be worth aiming for; what belief is placed in technologies to deliver these futures; and what they require in terms of human behaviours, requirements that are often obscured. (Walker & Cass, 2007) These are critical questions to consider both for the successful achievement of the right kind of transition, and for the achievement of a fair one. The concept of sociotechnical imaginaries has not been deployed extensively in the study of transitions, and there is quite some difference in the scale of the imaginaries that have been analysed, and the groups that have been the focus of analysis. Some work at the scale of a single research group, others focus on institutional imaginaries, while others make efforts to capture regional or even national level discourses. Case studies also vary according to the actors they centre around, and often analyse the co-existing or competing imaginaries of several different actors or groups of actors, whether these are groups of 'experts,' policy makers, other institutional actors, or members of the 'public.' Frequently, these discourses evolve around a particular renewable technology; however, others scrutinise sociotechnical imaginaries that arise around entire sustainable systems, whether it is a sustainable energy system or a carbon neutral city. Very rarely is only one sociotechnical imaginary articulated at the site of analysis, let alone a single sociotechnical pathway to an imagined future. Instead the vast majority of work conducted on sociotechnical imaginaries outlines multiple imaginaries and pathways to them, a multiplicity that can allow for cooperation, but, perhaps unsurprisingly, often leads to conflict.

2.3.1 Renewable Technologies, Sustainable Cities and Normative Values

One striking feature of the sociotechnical imaginaries that evolve concerning renewable technologies, and the principle of sustainability in general, is the variety of other, seemingly unrelated values that are tied to their realisation. In their analysis of 'expert imaginaries' concerning low-carbon housing in the UK, Cherry et al., (2017) found that two different kinds of low-carbon housing were imbued with very different values. The air-tight design of Passivhaus was imagined as a low-tech means to tackle climate change through reducing heating requirements, but more than that, it was to be a means to address wider social issues like the affordability of housing, and fuel poverty. In contrast, the imaginary that low-carbon housing could be a route to lower housing costs, greater security and improved health fell by the wayside when it came to 'smart homes.' This form of housing was instead solely seen as a means to integrate variable renewable energy systems into the grid. Ballo (2015) found the same concern for more effectively managing the grid system, when scrutinising expert imaginaries concerning the implementation of a future 'Smart Grid' in Norway. Internal imaginaries largely centred around the 'Smart Grid' as a mechanism for lowering 'peak demand' and for achieving various other gains for the energy companies themselves. Discourses that presented the 'Smart Grid' as a means to lower overall energy consumption, and achieve environmental goals were only really present in communications to the public. Jasanoff and Kim (2009) originally formulated sociotechnical imaginaries to analyse how technologies featured in imaginations and formations of the nation-state, and Ballo (2015) identified elements of this in the 'experts' discourses. Ballo found that imaginaries circulating within the 'techno-epistemic network' saw 'Smart Grids' as means by which Norway could establish itself as Europe's 'green battery' (pp. 14) by supplying renewable energy to the rest of Europe. In this regard, 'Smart Grids' were tied into imaginations of the future of Norway as a nation-state and a reformulation of its relationships to other countries in Europe. The importance of establishing a particular presence on the global stage is also apparent in the sociotechnical imaginaries surrounding sustainability and cityhood that were explored by Tozer and Klenk. (2018a) They conducted a discourse analysis of the sociotechnical imaginaries that are articulated in the urban carbon governance texts of 17 members of the Carbon Neutral Cities Alliance. The authors identified five storylines from their analysis of the text, which they saw as underlying and driving sociotechnical imaginaries of the role of the built environment in achieving carbon neutrality. Two of the underlying storylines in the overall sociotechnical

imaginaries centred around renewable, efficient technologies, and the carbon 'green economy' as the pathway to creating a city that is economically competitive, equitable and modern. Only via this pathway could a city earn a place of prestige on the global stage. Energy security and grid reliability were also important discourses at both national and regional level in the USA. (Levenda, et al., 2018) Domestic energy resources, including renewables; smart grid technologies; and energy efficiency measures were not only to deliver a future with increased security, and grid reliability, but were also to secure an environmentally benign and economically bright future for the USA as a nation, as well as for Portland and Phoenix. Moreover, for certain groups renewable technologies, specifically distributed generation also became imagined as a pathway to a more democratic energy system and a more equitable society. In Phoenix, access to Distributed generation of solar power (DG) was framed as a social justice issue, where ensuring the access of poor and Latinx neighbourhoods to DG, and the elimination of polluting power stations was seen as a route to address inequality by enabling access to the benefits of renewable energy, and eliminating harms that disproportionately affect marginalised communities. (Levenda et al., 2018; Richter et al., 2016) Social values of justice, equality, and democracy were also articulated in sociotechnical imaginaries that were analysed in Thailand. Sociotechnical imaginaries that saw sustainable energy in general, and decentralised sustainable energy specifically as a means to generate social and economic benefits arose in a counterpoint to dominant imaginaries that focused on centralised, and non-renewable energies to support economic growth. The principle of using decentralised energy to achieve social and economic growth in the limits of what nature can sustain was particularly seen as more compatible with rural life in Thailand. (Delina, 2018)

In each of these cases, engaging in an energy transition in a particular way was often presented as either a reformulation or enactment of the identity of the society engaging in the transition. The transformation of the energy system and the move towards sustainability was seen as a means of achieving a wholesale transformation of society. In Portland, renewable and smart grid technologies are to transform the city into one that is seen as both 'smart,' and a leader in sustainability. This is similar to the sociotechnical imaginary of the reformulation of Norway's identity as the green battery of Europe. (Ballo, 2015) Economic gains were also a strong focus of both the dominant national imaginaries of Thailand, the USA, and the regional imaginary of Portland in particular. The achievement of a particular vision of what it means to be an equal, and sustainable society was a much stronger element in the sociotechnical imaginaries in Phoenix, and alternative imaginaries in Thailand. (Dalina, 2018; Levenda et al., 2018) Each of these case

studies demonstrate how investing in renewable energy and sustainability, and excluding other forms of technology can be integrated into desirable visions of what a home, a city, or a country could be like. Not only is sustainability as a normative goal integrated into visions of a desirable form of cityhood, the technologies that were to supply these visions were also to transform society in a number of other ways that were not limited to environmental protection or secure supplies of energy. Sustainability also becomes linked to bright economic and social futures; particularly in Phoenix, renewable energy technologies were given the power to both disrupt and address inequalities by empowering lowering income communities, and reducing the detrimental environmental effects that disproportionately affected indigenous groups. However, these visions also emphasised the importance of the correct configurations of technologies for achieving normative goals. The utopian and dystopian visions that are common features of sociotechnical imaginaries were apparent in the concerns that if energy technologies were not distributed correctly, or embedded in the correct social infrastructure they could contribute to the further entrenchment of inequality. (Levenda et al., 2018; Richter et al., 2016) It is also noteworthy that imaginaries surrounding sustainability were not always concerned with how the lived experience of the city would be shaped; whether through actors gaining economic benefits through the sustainability transition; maintaining the reliability of energy supplies; or improving the living conditions of marginalised groups. These imaginaries were also concerned with how cities or countries would change in terms of how they were perceived by outside actors. In this respect, constructing the future of a nation or a city through sustainability is as much about receiving intangible goods like prestige, and recognition as a modern, technologically advanced, and even moral society; as it is about shaping the lived experience of being a member of that society.

2.3.2 Interpretative Flexibility in Sociotechnical Imaginaries

To this point, the discussion of the literature has focused on the various different values and desirable goals that have been co-evolved with various energy technologies and infrastructures, highlighting the wide variety of other normative goals that have become entangled with the idea of sustainability. A further important point needs to be raised, and that is that the same values are not articulated by all groups at the same time. Instead, the majority of the case studies emphasise the interpretative flexibility of technologies, and of sociotechnical imaginaries. Different groups can evolve very different sociotechnical imaginaries around the same technological artifact, or construct very different pathways for the achievement of what is ostensibly the same value. In a

number of case studies this has been put forward as a means to foster cooperation; however, it is more frequently a source of conflict.

The interpretative flexibility of the notion of carbon neutrality was highlighted in a study of the sociotechnical imaginaries articulated in the parliament of Finland, and by the city council of Helsinki. Cleantech was the central approach to carbon neutrality at both levels of governance; however, this notion of 'carbon neutrality' had the interpretative flexibility to accommodate a whole host of different technologies and policy options, which were co-produced along with sociotechnical imaginaries of carbon neutrality based on cleantech. This resulted in different policies being favoured at national and local levels, due to the fact that national parliament placed greater emphasis on providing predictability to industry and investors, while Helsinki City Council saw the flexibility to change policy paths as having greater importance. (Karhunmaa, 2019) Levenda et al., (2018) found similar interpretative flexibility in their case study, finding that the 'energy values' that were articulated at national level emerged in very different forms at regional level. At national level the development of numerous different energy technologies, including domestic energy resources, smart grid technologies, and energy efficiency, were linked to a multitude of different normative goals. National security through decreased reliance on foreign energy supplies, environmental and economic benefits, and increased grid reliability were all imaginaries that were articulated around these different energy technologies over time. The authors derived several 'energy values' from these imaginaries: reliability, and stability; and democracy and independence, that they argued were refracted through the different sociotechnical, historical, political and cultural contexts of Portland and Phoenix to produce divergent sociotechnical pathways. In Portland, sustainability, along with reliability, stability, and democracy is largely to be achieved through enabling demand side response with smart grid technologies, and energy efficiency. Democracy, and independence were then tied to community level development and governance of the distributed generation of solar (DG). In contrast, the discussion of reliability, and stability in Phoenix focused mostly on the regulation of DG, and the obligations that utilities should have to compensate those who engaged in generating their own energy. These obligations were then tied into ideas of democracy and independence, as citizens advocated for their right to generate electricity independently, and to have a greater role in political decision making. However, while DG was associated with democracy and independence in both cities, DG was much more strongly into ideas of environmental and social justice in Phoenix than it was in Portland. In Phoenix, solar advocates in Phoenix emphasised the potential

that DG had for addressing the inequality experienced by marginalised groups, which was not such a strong concern in Portland.

While both Karhunmaa (2019), and Levenda et al., (2018) highlighted the differences in the sociotechnical imaginaries held at different levels of government, or at different spatial scales, neither investigated how divergent imaginaries might influence the interactions between actors at these different levels. However, Levenda et al., (2018) did explore how sociotechnical imaginaries might influence the interactions between actors within the same spatial scale, and this is an important concern in a number of pieces of work. (Engels & Münch, 2015; Lovell, Bulkeley & Owens, 2009; Richter et al., 2016; Tozer & Klenk, 2018a; Tozer & Klenk, 2018b) There is some evidence that not only can multiple storylines or imaginaries coexist peacefully, and they may also be a resource for cooperation. (Lovell, Bulkeley & Owens, 2009; Tozer & Klenk, 2018a) In their analysis of the urban carbon governance texts of 17 members of the Carbon Neutral Cities Alliance, Tozer and Klenk (2018a) identified five storylines from their analysis of the text that they saw as underlying and driving sociotechnical imaginaries of the role of the built environment in achieving carbon neutrality. They found significant interpretive flexibility in imaginaries of 'carbon neutrality,' which accommodated a wide variety of sociotechnical pathways to carbon neutrality across the different cities, sociotechnical configurations that they described in another paper derived from the same empirical material. (Tozer and Klenk, 2018b) In this case, the authors argued that the interpretative flexibility of the concept of 'carbon neutrality' made it possible for an international network to rally around it, as they were able to commit to the same normative goal but in distinct ways. This demonstrates that coordinated action may be achieved through shared sociotechnical imaginaries even in instances of significant uncertainty, and sociotechnical imaginaries can be powerful resources for shared action even prior to the stabilisation to many aspects of the features of the technological artifact itself. (Engels & Münch, 2015)

While it has been argued that the interpretive flexibility of technologies and sociotechnical imaginaries can promote cooperation, it can also lead to contestation. Ballo (2015) reveals exactly these kinds of tensions in her analysis of the 'smart grid' sociotechnical imaginaries constructed by 'techno-epistemic networks.' She found that there was a great disparity between the imaginaries circulating amongst the 'techno-epistemic network,' and those that were being communicated to the consumers. This intensified the public's isolation from a discourse that was already almost exclusively taking place within networks of experts. Imaginaries within the

'techno-epistemic networks' that focused on managing the grid system, and achieving operational and economic gains for the energy companies themselves did not travel outside of these networks. Instead, the sociotechnical imaginaries that were communicated to the public centred on the idea that the consumer would be able to make economic savings, and contribute to environmental protection. Not only were neither of these imaginaries significant within the 'techno-epistemic network,' in some cases, the members were openly dismissive of them, with one interviewee saying that the consumer would only perhaps afford 'four or five extra lager beers a year.' (pp. 17) While this disparity hadn't caused conflict at the point of analysis, ultimately, this is seen as problematic, and the authors invoke the case of the Netherlands as a cautionary tale. Decision-making regarding the installation of smart meters in the Netherlands was made behind closed doors and encountered resistance, in part, because this created a perceived lack of democratic legitimacy, in addition to other concerns regarding consumer privacy. This makes a case for more open and honest communication with the public, and engaging a greater range of 'experts' and legitimate forms of knowledge in the decision-making sphere. (Ballo, 2015) Serious conflict did emerge in Phoenix, and Portland, where divergent sociotechnical imaginaries emerged from groups with opposing interests. In Portland, imaginaries that are communicated in Portland's wider city-level and policy discourses conflicted those held by utilities. Utilities emphasised the stability and reliability of the grid through the continued reliance on coal and gas, and the construction of smart grids to enable demand side responsiveness. This sociotechnical imaginary served the continued entrenchment of their interests, and power over energy futures. In contrast, wider city-level discourses constructed a pathway to the future that required large utilities to increase their share of renewables to 50%, and emphasised the growth of community energy solutions to build an independent, democratic and sustainable city from the ground up. Furthermore, the city was sued by two powerful institutional actors when the city council decided to ban the development of fossil fuel infrastructure in Portland, powerfully excluding fossil fuel development from Portland's energy future, and building resistance alongside sustainability into Portland's identity and cityhood. In Phoenix, there was also a conflict between the utilities and members of the public, centring around conflicting sociotechnical imaginaries of distributed solar power. For members of the public who engaged in producing solar energy, distributed solar power was seen as a way to reduce cost, and most notably, as a way to achieve a more democratic energy system, which would allow consumers greater independence and autonomy with regards to their energy choices. This imaginary was in conflict to that of the utility companies, who saw DG and specifically their legal obligations to purchase excess electricity as being oppositional to their

sociotechnical imaginaries of a sustainable, and reliable grid that was under centralised control and served their interests. Ultimately, the result was a change in legislature that favoured centralised, utility controlled solar power, in contrast to the emphasis on community governance in Portland. This was a change that was oppositional to visions held by citizens and advocacy groups that saw DG as a way to democratise the energy system, and improve the living conditions of disadvantaged groups. (Levenda et al., 2018; Richter et al., 2016) The variety of sociotechnical imaginaries that can evolve around a single technology, and the different sociotechnical configurations that are needed to realise these imaginaries demonstrates the point made by Tozer and Klenk. (2018a) That the term 'carbon neutral' can act as a black box, which can obscure a number of different normative goals, and sociotechnical pathways to those goals, all of which will have their own social effects. Even to the point that the principle of 'carbon neutrality' can even obscure mechanisms that will lock in fossil fuels in new ways. (Tozer & Klenk, 2018a; Tozer & Klenk; 2018b) Recognising the interpretive flexibility of technological artifacts, both in terms of the imaginaries that they become embedded in, or the way they are configured to achieve particular imaginaries is therefore important for achieving successful transitions. It is also important for achieving just ones as it becomes apparent how many important and contested values and goals have become deeply embedded in the pursuit of sustainability. (Karhunmaa, 2019; Tozer & Klenk, 2018a; Tozer & Klenk; 2018b)

2.3.3 Imagining Humans

The interpretive flexibility of technological artifacts and the sociotechnical imaginaries that are co-produced with them can be a critical point of conflict in transitions. However, the interpretive flexibility of the artifacts themselves, and the role they play in sociotechnical imaginaries is not the only point where contestation emerges. An important element of sociotechnical imaginaries is how different groups are embedded in them. This includes how they are imagined in terms of their characteristics; what roles and responsibilities that they hold in the imaginary; and what is imagined as being owed to these different groups. These imaginaries are important whether they are consciously constructed and articulated by the holder of the imaginary or not.

Imaginaries of the public often have an important role in the overall development of technological solutions and technological imaginaries. The characteristics that are given to the public shape both the role they are given in decision making, and the role they are to play in sociotechnical

imaginaries overall. Frequently, imaginaries of the public hold them to have some kind of deficit, whether this is a deficit in knowledge, interest, rationality, social responsibility, or engagement. (Ballo, 2015; Barnett, Burningham, Walker & Cass, 2012; Cherry et al., 2017; Skjølsvold & Lindkvist, 2015; Walker, Cass, Burningham & Barnett, 2010) These deficits are often seen as something that makes the public a threat to technological development and 'progress.' (Walker, 1995; Skjølsvold & Lindkvist, 2015) In a number of cases this has led to the construction of technological solutions that remove as many tasks from the hands of users as possible. This approach is apparent in discourses surrounding various renewable technologies, from solar PV systems, to low-carbon housing, where users are imagined as something that needs to be worked around technologically. (Abi-Ghanem & Haggett, 2018; Cherry et al., 2017; Wilhite, 2008) Alternatively, other mechanisms are investigated to address any perceived deficits, and frequently focus on managing public opposition rather than engagement and exchange. (Ballo, 2015; Barnett, Burningham, Walker & Cass, 2012; Skjølsvold & Lindkvist, 2015; Walker, Cass, Burningham & Barnett, 2010) Attempts to address supposed deficits in users have been most extensively investigated in sociotechnical imaginaries that have been co-produced with smart grid solutions. The discourses surrounding these technologies prescribe an important role for the public in achieving demand side responsiveness, which naturally comes with imaginaries of how to achieve the desired behaviours, and overcome any perceived barriers. In the case of smart grids, this normally means addressing knowledge deficits regarding their own consumption, which will then configure them to act as rational economic actors or 'resource men.' In this imaginary, the public will act in certain logical ways according to the appropriate signals, signals which are often economic and in the form of variable rate tariffs. (Ballo; 2014; Skjølsvold, 2014; Skjølsvold & Lindkvist, 2015) This is a model of behaviour that has been criticised extensively in the social science literature, and 'experts' often construct imaginaries of members of 'the public,' and their motivations in a narrow way that often doesn't match with the way this imagined public constructs itself. We can see this in the work conducted by the potential points of tension unearthed by Cherry et al., (2017) in their analysis of 'expert' and 'public' sociotechnical imaginaries of low carbon housing. The authors found that in some aspects, 'expert' imaginaries of the 'public' aligned with the concerns that were expressed by members of the public; for example, they identified aesthetics, and cost as areas of concern. However, while the 'experts' identified these concerns, they lacked the nuanced understanding necessary to meaningfully engage with these issues. In addition, there were a number of crucial issues that 'experts' failed to anticipate. Embedded in both visions of low carbon housing was a common imaginary of the

public as resistant to, or unable to achieve a lifestyle change, and therefore as something to be worked around through technological means. However these technological means became a potential point of conflict exactly because the members of the 'public' thought that both the smart home, and the Passivhaus would rob them of their autonomy. In the case of the smart house, participants disliked the idea of losing control over both their personal data and over the homes themselves. Whereas, in the case of the Passivhaus, some participants were concerned that losing the ability to alter their homes would reduce their ability to express their individuality. This can readily be recognised as a potential source of conflict in attempting to transition to low carbon homes: as 'experts' attempt to phase out the influence of their imagined 'public,' the real public simultaneously comes to resist this attempt to remove their control over their homes. (Cherry et al., 2017) The studies of Levenda et al., (2018) and Richter et al., (2016) that focused on the city of Phoenix, also identified similar conflicts in their case study. They emphasised that not only did conflict arise from the different imaginaries that evolved around particular technologies, but also from disagreements over what roles particular actors should play. Different groups held differing imaginaries of who should have ownership of infrastructure; and which actors, whether human or technological, count as legitimate producers of electricity. Members of the public who adopted DG invested in an imaginary of solar energy as a way to a less centralised, and more democratic energy system, an imaginary that centred around the belief that they were legitimate producers of electricity and as contributors to the grid, and had the democratic right to do so. They challenged the way that energy companies value the energy produced by them, arguing that its benefits should not be ignored because it doesn't fit into the traditional centralised control, and distribution mechanisms of the utilities. An argument that is particularly rooted in imaginaries of a future energy system where distributed generation is much more prevalent.

2.3.4 Power, Justice and Equality in Transitions

In the case studies explored here, numerous imaginaries were articulated around various technologies by several different groups. Technologies and people were to be configured in different ways in order to deliver a wide variety of futures, futures that focused on a multitude of goals from energy security and grid resilience, to economic prosperity and social justice. Therefore, it is clear that imaginaries that centre around the technologies and infrastructures involved in transitions, contain normative goals that go far beyond the principle of sustainability. In the hands of some groups, these technologies become imagined as the basis for the

achievement of a much wider shaping of society. A shaping that extends all the way to the redress of historical inequalities, which means both the reversal of the marginalisation and disenfranchisement of certain groups, and the destruction of entrenched power structures and interests. This contrasts, and conflicts with the imaginaries of other groups, where the same technologies are seen as tools for maintaining or even strengthening the status quo.

The conflict that arises from the multiple and often contested nature of these imaginaries reveals the relevance of analysing them to understanding questions of power, justice and equality in transitions. It reveals that instead of being a simple technical issue, transitions are instead a question of who has the power to participate in the framing of the problem, to pursue their idea of a desirable future, and to realise their goals. Furthermore, imaginaries that centre around technologies often mask certain expectations regarding the behaviour of citizens, or the need for particular forms of social organisation in order to achieve these normative goals. Not only does this mean that particular actors may not be able to realise the future that they desire, or even be able to contribute to the construction of an imaginary, they may also be prescribed a role in an imaginary that doesn't serve their interests, but nonetheless may take the form of a social obligation or even legal requirement. (Delina, 2018; Levenda et al., 2018; Richter et al., 2016)

The shaping of social life in course of the production of new sociotechnical systems, and over their lifetime will also go far beyond particular prescribed changes to behaviour, and any effects will likely be felt for years to come. The term 'energy transition' and the sense of contiguity and continuity that comes with it, belies the huge underlying social upheavals that often characterise a change in the infrastructures supplying energy. (Jasanoff & Kim, 2013; Laird, 2013) Achieving just transitions demands the acknowledgement that:

> *New energy futures will need to reconfigure the physical deep structures of civilization—grids and pipelines, seashores and pastoral landscapes, and suburbs and cities—that were shaped by the energy choices of the past. Equally, ... radical changes in the fuel supply are likely to transform social infrastructures, changing established patterns of life and work and allocating benefits and burdens differently from before. (Jasanoff & Kim, 2013, pp. 189)*

New energy systems built according to the participation or non-participation of particular groups according to their relative power can easily contribute to the reproduction, and justification of economic and power imbalances by distributing costs and benefits according to the interests of dominant groups. (Bridge et al., 2018) This is already apparent in our current obdurate energy

systems that are characterised by the fact that their negative effects and risks are felt by groups at a distance to those receiving their benefits. (Beck, 1992; Jasanoff & Kim, 2013; Levenda et al., 2018; Richter et al., 2016)

The case studies discussed here demonstrate the value of analysing sociotechnical imaginaries for understanding issues of inequality that may arise. In the case studies, several potential sources of injustice were discussed, including both the conscious and unconscious distribution of benefits, responsibilities and burdens throughout society; the over-reliance on technology and the neglect of the social infrastructures that are needed to achieve particular normative goals; and the reality that sociotechnical imaginaries are not only highly contested, but that not everyone is able to participate in their contestation at all. Analysing sociotechnical imaginaries, as well as the processes of their construction and their contestation therefore offers a means to identify any potential for the production of inequalities, challenge and change these aspects, as well as identifying opportunities for pursuing more equal futures. For these reasons, the concept of 'sociotechnical imaginaries' has the potential to act as a powerful analytical tool for us as we attempt to analyse the driving forces that shape Bristol's 'energy transition' and what the transition may ultimately look like. Therefore this study will utilise 'sociotechnical imaginaries,' as its primary sensitising concept. (Jasanoff & Kim, 2009; Jasanoff, 2015; Smith, 2009)

3. Sensitising Concepts and Research Questions

A number of these bodies of literature, and particularly the multi-level governance literature emphasised that cities and local governments have been given significant responsibility for achieving the low carbon transition. However, they also highlight that the material, political, economic and institutional context that local government actors are embedded in, intrinsically shapes their capacities to act. This has driven the focus of this thesis, and the choice of theoretical perspective in several ways. Firstly, the centrality given to local government and cities in directing transitions by both national and international governments means that their decision-making should be scrutinised. Secondly, if local governments are to play the role imagined for them the contextual factors that shape their capacity to do so should be understood so appropriate action might be taken to improve this capacity.

A number of the perspectives that have been deployed in other case studies that have been explored in the state of the art could be appropriate to analyse the decision-making of Bristol City Council. However, the choice was made to select sociotechnical imaginaries because of all the perspectives discussed here, it lends itself most strongly to the scrutiny of current plans in order to gain insight into what the future might look like. In contrast, the other perspectives tend to be more historical in nature like MLP or more suited for looking at the current moment like ANT, rather than trying to gauge how current decision making may shape the future. Obviously, no sociotechnical imaginary is deterministic and any future predictions are precarious. However, analysing current sociotechnical imaginaries, particularly with reference to historical lessons-learned has the potential to be very valuable when considering that there is a need low-carbon transitions to occur very rapidly, that they are aimed at wide-scale transformations that will have significant social effects and that they also target systems that have strong potential to become obdurate, which means any effects of these systems may be locked in for many years to come. Sociotechnical imaginaries offer an opportunity to unearth conflicting values, assumptions and the potential for producing inequality early on in transition processes and give the best chance for them to be addressed. The second theoretical perspective to be used here is the multi-level governance perspective, which emphasises that political power or the capacity to act is spread through multiple different spheres of authority. This is complementary to the choice of sociotechnical imaginaries because it emphasises that what is

considered possible and embedded in sociotechnical imaginaries, and then what will ultimately be brought into reality is not constructed by Bristol City Council in isolation of the political context in which it is embedded. This is important to recognise when considering how local governments are to play their mandated roles in realising the low-carbon transition, as their capacity is not just defined by the material features of the city and its infrastructures which will be foregrounded through the use of sociotechnical imaginaries. It is also defined by decisions made in other spheres of government, as well as other actors both within and outside of the city.

This research project will deploy these theoretical perspectives as sensitising concepts for its exploration of how Bristol City Council seeks to govern Bristol's low-carbon transitions. The research question to be investigated is:

How does Bristol City Council imagine Bristol as a 'sustainable' sociotechnical system and construct its own role as a governing body in pursuing this transition?

The theoretical lens of sociotechnical imaginaries will be used as a tool for understanding how sustainability is constructed as a goal by analysing how the future of Bristol as a sustainable city is imagined by the city council, an aim that is encapsulated in the first two sub-questions:

1. How are sociotechnical imaginaries concerning 'sustainability' constructed around different technologies and infrastructures?
2. How do sociotechnical imaginaries of Bristol as a future 'sustainable' city come to be imagined, with reference to imaginaries of sustainability?

A key aspect of this will be identifying the other values, narratives and normative goals that are articulated alongside the notion of 'sustainability.' An important part of analysing sociotechnical imaginaries, is not only investigating the values encapsulated in them, and visions as to how they will be achieved, but also the imaginaries of people that are necessarily embedded within them, but are often left unarticulated. Changing sociotechnical systems have important political effects, not only because their functioning relies on humans acting in certain ways, but also because they can propagate political effects. (Bijker, 1995; Jasanoff, 2004; Winner, 1986; Winner 1993) Discourses concerning 'just transitions' direct us to consider how sociotechnical transitions may reproduce certain power structures or propagate inequalities. Considering these different aspects of imaginaries and analysing how they are constructed with reference to each other, will ultimately provide insight into what sociotechnical imaginaries of Bristol as a future city are being constructed around the value of 'sustainability,' with particular reference to what this might mean for the people who live there. This aim is reflected in the third subquestion:

3. What role are Bristol's citizens to play in the imagined transition, and what implications might this have for social justice?

The analysis will then reflect on what this tells us about how Bristol City Council imagines its role as a governing body in delivering Bristol's transition, and will use insights from the multi-level governance perspective to understand how Bristol City Council is acting to bring about its imagined transition. This brings us to the final sub question:

4. How does Bristol construct its role as a governing body in bringing about this sociotechnical imaginary of a sustainable Bristol?

4. Materials and Methods

4.1 Documentary Analysis through Grounded Theory

Grounded theory, as developed by Kathy Charmaz, was used to analyse the documents gathered for this thesis. The constructivist approach of this theory emphasises that not only are the documents a product of the construction of reality by a group of actors, the analysis built here is also created in an interplay between the content of the document and the unique perspective of the researcher. The study analysed a number of documents produced by Bristol City Council, both independently and in tandem with other institutions. These included policy documents, and internal documents such as the summaries of council meetings and reports, as well as published documents like city plans and 'core strategies.' According to a constructivist standpoint on documents, while these documents can be interpreted as a reflection of discourses circulating in Bristol City Council, they are also a construction of reality that depends on the time they were produced, the different actors that contributed to their formulation, the purposes for which they are intended, and the audiences they are addressing. (Charmaz, 2015) Therefore, they cannot be taken to be a direct reflection of the dominant discourses at Bristol City Council. However, a number of the documents describe past actions, (Bristol City Council, 2015) as well as future intentions, or are intended to invoke some action according to what is written in the documents. Some documents acted as the basis for the creation of other documents, (Bristol City Council, 2015) others are intended to attract grant money from the central government or other institutions, (Bristol City Council, n.d.a; Bristol City Council, 2018a) while others are published with the aim to attract private investors, (Bristol City Council & Energy Service Bristol, 2018) or

to form the basis of coordinated action by a number of actors. (Bristol One City, 2019; Bristol One City, 2020a; Bristol One City, 2020b) This means that their content needs to be taken seriously and the documents investigated as agents that perform political work in their own right. (Shankar, Hakken & Østerlund, 2015)

The primary features of grounded theory are that theory is produced inductively from gathered data, not produced deductively according to a prior hypothesis; and that data collection and analysis are performed simultaneously. This process involved undertaking initial coding, focused coding, and the formation of conceptual categories. The coding and categorisation process was accompanied by the continuous creation of analytical memos which supported the process of analysis by encouraging theorisation from the beginning. Initial coding involved doing line-by line coding using gerunds, which was essential for breaking down assumptions and encouraging other interesting insights to emerge from the data. This was particularly important because embedded in my initial approach to the documents was the preconception that technology would be central to Bristol's low-carbon transition, and that the documents would reveal an emerging sociotechnical imaginary: an imagination of Bristol's future, with technology at its heart. While that did bear out in my conclusions, applying grounded theory provided a strong method from breaking down this assumption, providing the data needed to support it, as well as allowing the generation of an understanding of how technology featured in this imagined future. In addition, the inductive process of applying grounded theory generated a major shift in the focus of this project towards imaginaries of governance, and its co-production alongside those of a sustainable city. The shift in focus occurred over time as a result of coding the document in its entirety and building theoretical categories based on these codes, rather than searching the documents purely for data to support or disprove a pre-formed hypothesis. Completing the bulk of the literature review, which was done after the analysis, then unearthed other work that resonated with conclusions that the move towards sustainability was occurring a change in the nature of city governance. (Hodson & Marvin, 2009) In particular it introduced ideas of the multi-level governance perspective to the analysis; however, this theory was not a sensitising concept, neither were these dynamics assumed to exist or explicitly searched for in the documents. Instead they arose iteratively from the city council's own statements regarding the political context it was operating under, the challenges it faced and the actions it was taking, which were then placed under this theoretical umbrella, in part to make some connection to the wider literature on urban sustainability transitions.

According to the principles of grounded theory, data collection is concluded when theoretical saturation is reached, which means no new information is being gathered and added to the various conceptual categories. Practically, this meant expanding the corpus of documents analysed here to answer questions and gaps that appeared during the initial process of creating initial codes, memos and formulating conceptual categories. To this end, the analysis began with the white paper 'Our Resilient Future: a Framework for Climate and Energy Security' that describes the city council's previous and future strategies for Bristol; (Bristol City Council, 2015) and the 'City Leap Prospectus' a document intended to attract private investment in Bristol's low-carbon energy system. (Bristol City Council & Energy Service Bristol, 2018) These two documents formed the core of the first part of the analysis, which focused on sociotechnical imaginaries of a sustainable Bristol. Other documents were subsequently analysed to gain more data, particularly on important theoretical categories that remained under populated like those that focused on imaginaries of governance, and the political forces that Bristol City Council perceived it was subject to. These documents included other published documents from the city council, and documents it published collaboratively with other actors, as well as several attachments to reports or proposals to the central government. These documents were most important for enriching understandings of what discourse and wider political dynamics might contributed to the focus on particular energy technologies; (Bristol City Council, n.d.a; Bristol City Council, 2018a) and the evolving nature of the Bristol City Council's form of governance, and the why this was perhaps emerging (Bristol City Council, n.d.b; Bristol City Council, 2018a; Bristol City Council, 2019; Bristol City Council, Energy Service Bristol, & Bristol One City, n.d.; Bristol One City, 2019; Bristol One City, 2020a; Bristol One City, 2020b) Through this process, a satisfactory level of theoretical saturation to support the conclusions reached in this thesis, particularly when considered in the light of findings by the other authors whose work was explored in the state of the art. However, there are several categories that could have been pursued further through the use of interview data, which would have further strengthened the conclusions drawn here.

5 Empirical Analysis

5.1 Imagining Sustainability: what is Important and what is Possible?

The first section of the empirical analysis will explore how Bristol City Council constructs sustainability as a goal of governance, problematises existing sociotechnical systems that are embedded in and make up the city, and defines the features of new sustainable sociotechnical systems. Firstly, the analysis will address the city council's conceptualisation of sustainability, and explore how it is defined by narratives that give energy a central role in social and economic development. Then the discussion will foreground the central role that economic forms of valuation play in defining what a sustainable Bristol will look like, as measures that may damage the economy are discarded. Finally, the analysis will argue that the dominance of technology in Bristol's transition pathway demonstrates a belief that technology is able to resolve multiple values that have the potential to come into conflict. Bristol City Council's vision of a sustainable city can therefore be analysed as a sociotechnical imaginary.

5.1.1 Imagining Sustainability: The Goal of Sustainability

The first question to answer when attempting to understand governance of transitions is how sustainability is constructed as a goal, and what aspects of the city are problematised. When we turn to Bristol City Council's construction of sustainability it becomes apparent that 'sustainable' means two different things and tackles two different issues. Firstly, there is sustainability in terms of the amount of carbon that the city releases into the atmosphere. This form of sustainability can be readily seen throughout the document in the attribution of carbon emissions to different parts of social life, and is ultimately realised in the emissions targets that are at the core of the documents, targets which commit the city *"to being carbon neutral by 2050 and having net zero direct carbon emissions from energy use and transport,"* as the latest target. (Bristol City Council & Energy Service Bristol, 2018, p. 9) Then there is the second form of sustainability, which focuses on the energy system's ability to provide *"abundant and reliable energy,"* and is termed energy security. (Bristol City Council, 2015, p. 29) These two forms of sustainability are distinct but their conflation is significant in the respect that these two goals act in tandem to define visions of a sustainable Bristol.

A key narrative that emerges, and gives some insight into how the two different sustainability goals mediate each other, is the imagined role that energy plays in society. This narrative is central to the conceptualisation of, and the importance given to the principle of energy security, and appears to be a key influence in Bristol City Council's approach to achieving carbon neutrality. In the documents, energy is presented as *"crucial for social and economic development,"* (Bristol City Council, 2015, p. 29) something that is socially transformative, and, more than that, energy is seen as a tool for achieving a *"fairer city"*with fewer health problems, less poverty, and a more equitable economy. (Bristol City Council & Energy Service Bristol, 2018, p. 2) When we look at these assertions, and scrutinise the types of changes that are to be made on Bristol's path to carbon neutrality, it becomes apparent that Bristol City Council considers access to energy to not only be necessary for achieving its imaginary of the future, but to be a right for Bristol's citizens. This is a highly motivating factor for Bristol's transition in the document because energy is not only seen to be crucial for the city's development, it is also seen as under threat in the current energy systems, which *"are currently unsustainable and are increasingly vulnerable to shocks, stresses and strains which we need to identify, plan for and respond to."* (Bristol City Council, 2015, p. 29)

The threat to energy security is largely attributed to the necessity to use fossil fuels. These supplies *"are finite and fuels, like oil, are becoming increasingly more difficult to produce and this will affect their availability in the coming decades."* (Bristol City Council, 2015, p. 29) The finite nature of these fuels is seen as introducing vulnerability into Bristol's energy system, as is the fact that *"the UK imports the majority of the energy it currently consumes – from across the world";* supplies which are *"vulnerable to changes in other government's policies, conflict and other disruptions."* (Bristol City Council, 2015, p. 29) This is not only linked to an instability in energy supply, it is also expected to lead to an increase in energy prices. This introduces risk to Bristol's energy supply, and while it is framed in fairly narrow terms as *"placing more people at risk of not being able to afford to heat their homes and increasing manufacturing and business costs,"* the perceptions of risk are congruent with the characterisation of energy and its importance to the city. Ultimately, a risk to the energy system is a risk to the wellbeing of Bristol's businesses and citizens.

It is clear then, that Bristol's move towards a carbon-neutral energy system is also driven by a need to provide energy security. The intertwinement of these goals, and the underlying narrative concerning energy's role in modern development, can perhaps be seen in the form of Bristol's

transition in the respect that energy is to be continually accessible, and inexhaustible, or is at least to be experienced as such by the user. This is embedded into Bristol City Council's approach to carbon neutrality, which largely centres around energy efficiency and energy source replacement, and has far less to say about changing practices to reduce energy use. An energy system that is sustainable in the respect that it is carbon neutral, is simply an energy system that is not producing carbon emissions, which requires the elimination of fossil fuels. It is the second characterisation of a sustainable energy system, as one that provides energy security or, in other words, abundant supplies of energy, that then demands the replacement of fossil fuels with other energy sources.

For Bristol City Council, an unsustainable city is one that produces too much carbon, and has no guarantee of secure supplies of energy. This definition of what it means to be sustainable has prompted an underlying reimagination of different elements of the interconnected sociotechnical systems of Bristol, as they are re-understood as failing. Bristol's Energy system is most frequently invoked in the documents, and is characterised as being "*unsustainable and … increasingly vulnerable to shocks, stresses and strains"* (Bristol City Council & Energy Service Bristol, 2018, p. 29) This has resulted in the scrutiny of and distribution of fault throughout the energy system, as various elements have been identified and problematised as points of breakdown. In addition to the problematisation of particular practices, which are highlighted as we look at the type of interventions that Bristol City Council is to implement, there is also a strict attribution of carbon emissions to particular areas of life: *"a total of 6,602 GWh of energy was consumed by the City of Bristol in 2013. 27% of all energy was consumed in the transport sector, 32% in non-domestic, and 41% in the domestic sector,'* (Bristol City Council, 2015, p. 10) where non-domestic is defined as the commercial and industrial sectors. As these areas, and practices are problematised it becomes obvious that the two principles of sustainability in the document: being carbon neutral, and providing secure supplies of energy, can come into conflict. Energy is presented as integral to achieving a bright future for Bristol, and as a right for Bristol's citizens; however, its use is in conflict with Bristol's imagined low-carbon future. With these values comes an intrinsic tension: how can you continue to provide energy; this right, and source of potential, when the results of its production have become a threat to the imaginary it supposedly enables? In other words, how do we move *"towards a sustainable future where we can live well and do business without further damaging the climate we rely upon?"* (Bristol City Council, 2015, p. i) As evidenced by the previous quote, the problem to be solved is not simply one of reducing energy use, or even

greenhouse gas emissions. Ultimately, the goal is reducing greenhouse gas emissions, while still enabling the citizens and, notably, the businesses of Bristol to continue doing the things that energy is supposedly crucial for. In this problematization, the energy supply that is to be protected is not electrons travelling through wires, but the practices it symbolises. The council's task is to *"decarbonise the city,"* (Bristol City Council & Energy Service Bristol, 2018, p. 2) which is to say the task is to disentangle energy practices, energy as material stuff, and greenhouse gas emissions. In this respect, a sustainable city is one that is able to reduce its greenhouse gas emissions, despite maintaining the supply of energy deemed necessary to secure its social and economic future.

5.1.2 Imagining Sustainability: The Economy and Sustainability

Nowhere is the necessity for the disentanglement of energy consuming, or more accurately, carbon-emitting practices made more clear than in discussions of the economy. Energy use is seen as an indispensable enabler of economic growth, and so, naturally, as *"Bristol's economy and population are growing ... this is driving an increased demand for energy, and CO2 emissions."* (Bristol City Council, 2015, p. 18) This construction of a causal link between economic growth and carbon emissions is extremely significant because, and as will be elaborated here, it is clear from the documents that Bristol's economy is to be preserved above all else in the pursuit of Bristol's low-carbon future. This focus on the simultaneous realisation of sustainability and economic goals is embedded in the envisioning of Bristol's future that was discussed earlier: a vision of a *"a sustainable future where we can live well and do business without further damaging the climate we rely upon."* (Bristol City Council, 2015, p. i) That continuing to do business is specifically invoked, and separately to being able to live sustainably further demonstrates the strength of this value, and leads us to the conclusion that the only acceptable pathway to sustainability is to achieve a de-linkage between the economy and its carbon emissions.

This value is deeply embedded in Bristol's highly technological route to sustainability. The belief that economics should be the guiding principle of Bristol's transition is intrinsic to the 'The Economics of Low Carbon Cities: A Mini Stern Review for the City of Bristol,' or 'mini-Stern' analysis that forms the basis of the framework elucidated in 'Our Resilient Future.' In this report, *"interventions have been assessed on their scope for deployment, the associated investment needs, financial returns and carbon savings, and the implications for the economy and*

employment." (Bristol City Council, 2015, p. 22) This means that the interventions investigated as part of this report, are largely judged their suitability according to their cost effectiveness, which is defined as tonnes of CO_2 saved per £ spent. This means further narrowing the possible transition pathways due to an analysis which, from its inception, already limited the pathways to be explored, as a result of its *"focus primarily on the potential for the wider deployment of energy efficiency measures and small-scale renewables."* (Bristol City Council, 2015, p. 61) This is the clearest resource for decision making that is referenced in the framework outlined in 'Our Resilient Future;' however, it should be noted that the decision making process is relatively inaccessible to this document analysis. Significantly, only measures that are considered able to pay for themselves over a particular period of time are included in the framework, and; therefore, are considered to be appropriate for deployment. The dominance of this focus on carbon savings and economic elements demonstrates how foundational economic considerations are to this report, and the further documents derived from it. The focus on financial, and economic forms of assessment means that a choice has been made to build knowledge and shape Bristol's transition in the understanding that economic impact, and 'cost-effectiveness' are the primary concern. Effectiveness in reducing carbon emissions becomes synonymous with what is considered to be best value for money, and this is the bedrock upon which a new carbon neutral Bristol is to be built. This is noteworthy because it means the closing off of other pathways when they aren't judged to adequately serve both sustainability goals and economic values. More than being simple judgements of value, fulfilling these economic criteria is seen as a structural condition of Bristol's transition because it is the council's belief that for its programme to be stable, and self-sustaining, revenue needs to be generated, *"captured and reinvested in further interventions within the City of Bristol."* Only by achieving successive waves of changes based on the capturing of savings from early measures will it be possible to achieve the full extent of the imagined transition. (Bristol City Council, 2015, pp. 27)

It is clear from discussions of Bristol's sustainable future that there is a belief that it is both desirable and possible to promise a transition that will occur without any detrimental effect to the economy. This is made clear in the assertion that *"Bristol's targets for 2035 are achievable if a basket of measures are implemented and these could collectively be cost neutral to the Bristol economy,"* (Bristol City Council, 2015, p. iv) More than that, the protection of the city's economy is all but seen as an absolute requirement in order to make successive waves of change to the city.

Preserving the economy means that there is little problematisation of practices in the commercial or industrial spheres, even in comparison to household energy practices. Instead, a low-carbon transition while protecting Bristol's economy takes the form of ensuring the ready availability of energy through the exchange of fossil fuels for renewable sources, and only deploying 'cost-effective' technologies that will recoup their investment over a suitable time frame. Again, the belief is that practices that have been identified as problematic may continue unhindered if their energy efficiency is improved or their fuel source is exchanged. According to these values, a sustainable city becomes one that is able to reduce its greenhouse gas emissions, despite maintaining the supply of energy deemed necessary to secure its social and economic future. Furthermore, this future sustainable city should be realisable without any overall cost to the city's economy. (Bristol City Council, 2015; Bristol City Council & Energy Service Bristol, 2018)

5.1.3 Imagining Sustainability: Technology and Sustainability

To this point, the analysis has focused on how a sustainable Bristol is imagined in terms of what it must *do:* it must provide secure and abundant energy for Bristol's future development, without producing unacceptable levels of carbon or harming the city's economy. The next question is, what does a sustainable city look like that can do all of those things simultaneously? Bristol City Council's approach to urban sustainability is, perhaps unsurprisingly, dominated by technological and infrastructural solutions. Behaviour change is a secondary and often implicit accompaniment to these types of solutions, and is always to be driven by the introduction of new technologies or infrastructures. In the city council's imaginary, tackling "*the threat of climate change through the sustainable use and generation of energy*," (Bristol City Council, 2015, "description," para. 1) largely means using the right sources of energy at the highest possible efficiency, and this is highlighted by the fundamental goals outlined in 'Our Resilient Future.' Bristol City Council aims to *"replace energy from fossil fuel … with energy from renewable sources … [and] to make our homes, transport and businesses much more energy efficient, reducing the overall demand for energy so that we can supply it from renewable and low carbon energy."* (Bristol City Council, 2015, p. 34) That technologies come to the fore as opposed to behavioural change reflects a belief that technologies are able to decouple the behaviours that require energy use from their undesirable consequence, which is the emission of greenhouse gases. Energy efficiency measures are presented as *"the most cost effective way to reduce carbon emissions,"*

(Bristol City Council & Energy Service Bristol, 2018, p. 16) and do so by changing the relationship between the practice, and the amount of greenhouse gases it produces. The replacement of fossil fuel sources with renewables is seen as a means to all but remove direct greenhouse gas emissions from the equation, and by doing so, leave the practice intact. The belief that technologies are able to decouple problematic practices from their carbon emissions drives a conviction that technological measures are capable of de-linking the economy from its greenhouse gas emissions in its entirety. This belief is demonstrated in assessments of the carbon reductions that have already been made by the city, where the city council states that *"some of the reductions in CO2 emissions are likely to be a result of the recession; however Bristol has succeeded in significantly reducing the carbon emissions per pound of GVA [(general added value)]".* (Bristol City Council, 2015, p. 18) The economy and carbon emissions are connected in a causal relationship here, where the reduction in CO2 emissions is partly linked to an economic recession. Nevertheless, there is an understanding that the city has been able to decouple economic activity and greenhouse gas production by technological means: through energy efficiency measures and the replacement of fossil fuels through renewable energy installations. This assessment of the successes of past action is reflected in the similarities between the past action undertaken by the city council, and its future plans. (Bristol City Council, 2015)

The core approach to building a carbon-neutral Bristol is the integration of renewable energy sources into Bristol's electricity grid, which acts to serve the dual sustainability goals of Bristol's transition. These technologies serve sustainability in terms of moving Bristol towards carbon neutrality by replacing the fossil fuel sources that couple the city's energy production to carbon emissions, and also play a key role in improving Bristol's energy security. Generating energy locally from less carbon-intensive energy sources is seen as a way to insulate Bristol from the national and global energy system that Bristol is enmeshed in: *"Bristol's energy security is inextricably linked to the security of the UK energy system. However, we can make our energy system more resilient, and improve our energy security at a local level."* (Bristol City Council, 2015, p. 30) The belief that local renewable energy production can improve Bristol's energy security is also extended to Bristol's reliance on fossil fuel imports from abroad, and the global energy infrastructure. Bristol's independence from the global energy system increases alongside its independence from the national grid, because by doing so the city insulates itself from the reliance of the national grid on fossil fuel imports. This minimises the potential risk this poses to Bristol's energy security, due to the vulnerability of these supplies "*to changes in other*

government's policies, conflict and other disruptions," (Bristol City Council, 2015, p. 29) and the reality that *"fossil fuels are finite and fuels, like oil, are becoming increasingly more difficult to produce and this will affect their availability in the coming decades."* (Bristol City Council, 2015, p. 29)

Changing energy supply to the grid away from fossil fuels propagates further changes in the energy system in the documents, resulting from the need to reduce *"the overall demand for energy so that we can supply it from renewable and low carbon energy."* (Bristol City Council, 2015, p. 34) The necessity to limit energy demand is a core consideration that shapes expectations of what consumption levels need to look like, and this drives the integration of further technologies that are seen as the means to achieve these levels of consumption. While it is a method for reducing energy consumption in its own right, increasing energy efficiency is also an important example of the changes mandated by the introduction of renewable energies. It is an important element of Bristol's transition in the documents, not only because it is seen as a means to reduce overall energy use and; therefore, carbon emissions, but also as essential for the system to be able to supply the required amount of energy from renewable sources. (Bristol City Council, 2015; Bristol City Council & Energy Service Bristol, 2018) The imagined form of future energy production has also sparked a need to *"build significant demand-side response capacity on the local electricity network,"* in order to balance consumption and energy production. (Bristol City Council & Energy Service Bristol, 2018, p. 15) The response to this need, is the introduction of 'smart energy' technologies that are a core element of the approach of the council, which *"feels that it is imperative that the city moves to a smart energy system as quickly as is practicably and financially possible"* (Bristol City Council & Energy Service Bristol, 2018, p. 14) Firstly, a modal shift towards electric vehicles is considered attractive both because these cars are considered to be more energy efficient than fossil fuel powered cars, and because they can provide a *"balancing service"* that helps to mediate production and consumption of energy. (Bristol City Council & Energy Service Bristol, 2018, p. 15) However, the majority of the components of the smart energy system are aimed at changing the *"co-ordination of decentralised renewable energy production … and end user consumption through enabling technologies.* (Bristol City Council & Energy Service Bristol, 2018, p. 14) The *"enabling technologies"* (Bristol City Council & Energy Service Bristol, 2018, p. 14) that are referenced in this quote include " *smart meters linked to Time-of-Use tariffs (domestic and commercial).*" (Bristol City Council & Energy Service Bristol, 2018, p. 15) These technologies are to create a more favourable pattern of energy consumption by overcoming people's ignorance of their energy consumption, and applying economic incentives and disincenives to shape energy

consumption to suit the needs of the grid. Further smart technologies instead aim to remove other perceived barriers to individuals adopting the desired behaviours. For example, "*smart domestic appliances and controls*" allow energy consuming technologies like washing machines to be operated remotely in response to time-of-use tariffs and seem to be aimed at overcoming the barrier posed by lack of proximity to the appliance. (Bristol City Council & Energy Service Bristol, 2018, p. 15) Finally, ICT systems are to act to remove the question of human decision making as much as possible by automating the relevant practice, and activating appliances according to the conditions of the grid. (Bristol City Council & Energy Service Bristol, 2018)

The introduction of renewable energies is insufficient for reducing carbon emissions to the degree required, so a number of other energy consuming practices are targeted in the documents. The household is strongly identified as a point of failure in Bristol's energy system, as *"the domestic sector accounts for approximately 40% of the City of Bristol's CO2 emissions,"* and is a significant focus of the plans outlined in the documents. (Bristol City Council, 2015, p. 36) Recommended interventions span various different energy practices, including the use of cold appliances, household lighting, and heating. In each case, it is not the practice itself that is targeted, instead energy efficiency is to be achieved through the alteration of a material aspect of the practice:

> *Installing A++ rated cold appliances, installing ground and air source heat pumps and cavity wall insulation are some the most cost effective measures, external/internal and cavity wall insulation, low energy lighting, solar PV and mains gas, condensing combi-boilers have significant potential to reduce the City of Bristol's total energy consumption.* (Bristol City Council, 2015, p. 37)

In each case the problematic energy use is to be addressed through the provision of different, or more efficient technologies, and it is these technologies that lead to a reduction in energy consumption. *(*Bristol City Council, 2015; Bristol City Council & Energy Service Bristol, 2018)

This trend continues as we move to consider the decarbonisation of heating, with heating practices being identified as particularly problematic in the documents. Decarbonising heating is a key target in the documents because domestic and commercial heating *"represents 45% of final UK energy demand."* and these emissions have largely been targeted through the provision of loans for the improvement of building fabrics, through measures such as installing wall insulation. (Bristol City Council & Energy Service Bristol, 2018, p. 12) In addition to the

improvement of the energy efficiency of heating, the sustainability of heating is to be achieved through the replacement of fossil fuel sources with renewable energy sources. The technology to be used varies according to the context in which it is deployed; however, the most important infrastructure to be deployed is a city-wide heat network. In areas of high population density specifically those that site commercial buildings or council-owned social housing, individual, building-level heating systems are to be replaced with heat networks that generate centralised heat, which is then distributed throughout an area of the city connected by pipework. These systems can use *"combined Heat & Power plants, waste heat, geothermal and other zero carbon heat generation technologies to heat networks,"* and so have the potential to reduce carbon emissions both through increased energy efficiency, and through the replacement of fossil fuels. (Bristol City Council & Energy Service Bristol, 2018, p. 12)

Again, we see priority given to material changes for the reduction of carbon-emitting energy consumption. Heat networks and energy efficiency measures act as a means to decouple heating practices from their carbon emissions, both by replacing fossil fuel sources with renewables, and through reducing the amount of energy needed to heat the home to the same degree. Travel is another example of an energy behaviour that is problematised. In the documents, private car use and, specifically, fossil-fuel powered private car use is rendered problematic.

> *The transport sector is responsible for 27% of energy consumed, accounting for 22% of Bristol's CO2 emissions … 94% of fuel consumed in the sector is by vehicles other than buses. As a result there is significant opportunity to reduce emissions particularly from passenger cars.* (Bristol City Council, 2015, p. 42)t

64% of transport emissions have been attributed to car use, and in Bristol City Council's imaginary of the city, private transport is to be increasingly minimised. Private cars are instead to be replaced with low-carbon mass transport like trains or buses, and self-powered forms of travel such as walking or cycling. The only exception is the use of private electric cars, which are seen as a lower-carbon alternative, and, as will be discussed later, as an important component of Bristol's future energy system. Again, we can see that the issue of transport is to be addressed through the alteration of material and technological elements. A shift away from personal, fossil-fuel powered car use is to be achieved through the provision of alternative forms of transport in the form of buses or trains, or potentially through the introduction of autonomous or hydrogen-powered vehicles. (Bristol City Council, 2015; Bristol City Council & Energy Service Bristol, 2018) Central to Bristol City Council's approach to the issue of decarbonising transport

is the belief that by making changes in infrastructure, and supplying new technology, the council can prompt a modal shift away from fossil-fueled car use to alternative forms of transport. We can see this expectation embedded in the statements that *"implementation of the Metro-Bus system will bring about reductions in the City of Bristol's transport emissions",* (Bristol City Council, 2015, p. 41) and that *"improvements to the City of Bristol's mass transit system will reduce the City's emissions."* (Bristol City Council, 2015, p. 45) It is also apparent in the belief that it is possible to reduce private car use by *"locating development in a way that reduces the need to travel."* (Bristol City Council, 2015 p. 43) In each of these statements the individuals that are ultimately required to engage in these actions are left invisible and passive, and the myriad of factors that may contribute to the choice of individuals to use private cars are obscured. The council is also "*seeking a Government grant to install infrastructure for electric vehicles. The funding under the 'Plugged-In Places' initiative would pay for 50% of the cost of providing charging points for public car parks and private off road commuter parking."* (Bristol City Council & Energy Service Bristol, 2018, p. 12) The introduction of this infrastructure is to lead to increased uptake of electric vehicles, which are considered a low-carbon alternative to petrol and diesel vehicles. Similarly, the provision of walking and cycling infrastructures is to lead to a modal shift away from vehicle use all together, as a means to reduce carbon emissions. The focus on material means, whether technological or infrastructural, to achieve outcomes is congruent with the measures targeting household energy efficiency and heating practices.

5.1.5 Imagining Sustainability: The Pathway to Sustainability

To summarise, the centrality of technology and the transformation of infrastructure in Bristol City Council's imaginary of sustainability means it can credibly be analysed as a sociotechnical one. Bristol's sustainable future is to be realised through the use of various technologies: the integration of renewable energy technologies into the energy system, the replacement of fossil-fuel powered cars with sustainable forms of transport, the construction of heat networks and the replacement of energy-consuming technologies with more energy efficient ones. These technologies are to deliver a future city with secure supplies of energy that has successfully decoupled social and economic life from their carbon emissions. In this sociotechnical imaginary, it is technology that is given the power to maintain the abundant supplies of energy that are given a central role in narratives of social and economic development, while also achieving carbon neutrality and doing so without any detrimental effects on Bristol's economy.

This reflects a belief that technology has the power to change the relationship between energy consuming practices and their carbon emissions, and by doing so serve the goals of carbon-neutrality, energy security, social development and economic development simultaneously.

5.2 Reimagining Bristol: Citizens and the City

The previous section focused on the dominant values that shaped imaginaries of what it means for a city to be sustainable, and the beliefs that gave technology a central role in delivering a sustainable city according to these values. The largely technological sustainability measures that were given a place in an imagined sustainable Bristol were largely selected based on the belief that they were able to deliver a form of sustainability that was not economically or socially harmful, or that limited the role that energy is imagined to play in Bristol's future development. Further analysis constructs a sociotechnical imaginary that paints a transformation of the city that goes far beyond its transformation into a sustainable one according to these values. Instead, sociotechnical imaginaries of sustainability have been co-produced with, and are inseparable from imaginaries of what Bristol should look like as a future city according to a much wider array of values. This part of the analysis will be broken down into three parts, each of which will address a different form of transformation that appears in the documents. The first two sections focus on two visions of Bristol that appear in the sociotechnical imaginary, both of which outline numerous benefits that may be derived from Bristol's transformation via this particular technological sustainability pathway. They are differentiated according to the actor or actors that are to derive these benefits: the city as an actor as it is perceived on the global stage, or Bristol's citizens that benefit from the transformation of Bristol as a lived experience. This distinction is made to highlight that the move towards sustainability is entangled with a wide array of other values and goals, some of which concern improving the lived experience of Bristol's citizens, and some of which do not. This is important to acknowledge and analyse because issues for social justice may arise if the chosen sustainability pathway fails to deliver on both sets of goals simultaneously. Considerations of social justice also inform the third part, which moves away from constructing the sociotechnical imaginaries of a transformed Bristol that emerge around various technologies. Instead, this section will delve into the social aspects of the so-called 'sociotechnical' system, and unearth the imaginaries of citizens and their behaviours that underlie the sociotechnical imaginaries elaborated in the first two sections. It

will be argued that these behaviours are not only integral to the realisation of these sociotechnical imaginaries of a sustainable city, they also dictate whether Bristol's citizens are able to derive any of the imagined benefits from this transformation. This constitutes a transformation of social life that extends beyond what is explicitly imagined and pursued, and this will have important implications for social justice.

5.2.1 Reimagining Bristol: Visions of a Global City

Two future cities are apparent in the sociotechnical imaginary that is emerging in these documents. One vision is of a transformed Bristol as an experience that is to be lived by its citizens and actors within the city. The other vision, which will be elaborated here, the city of Bristol as it appears and is understood by other actors on the global stage. Dividing the sociotechnical imaginary of a future Bristol in this way is useful because it highlights that governing Bristol's sustainability transition is performed in the pursuit of two distinct sets of goals. One set of benefits is to be derived by the citizens of Bristol and other actors in the city, the other set targets the city of Bristol as an actor and beneficiary in and of itself. Therefore, it cannot be assumed that a sustainability pathway that fulfills goals that concern the city as an actor will translate to benefits for the citizens that live in it.

When we turn to the first set of benefits to be derived by the city through the move towards sustainability, economic values again come to the fore. In this case, a sustainability transition through technology is a path to greater economic strength for the city of Bristol. There is a belief that the technological and infrastructural changes outlined in the documents create *"considerable potential for the City of Bristol to reduce its energy use and carbon emissions whilst benefiting the local economy."* (Bristol City Council, 2015, p. 27) In this framing, the pursuit of sustainability has become a core component of achieving Bristol's economic goals:

> *We are currently the only Core City outside of London to make a net positive contribution to the UK Exchequer – a testament to our strong local economy. The development of a low carbon, resilient and sustainable city is a cornerstone of our approach to remaining competitive in the global economy.* (Bristol City Council & Energy Service Bristol, 2018, p. 4)

In this statement, the pride invested in Bristol's economic standing is clear, and the idea that sustainability could in fact be a 'cornerstone' to economic competitiveness in modern times is a powerful narrative for resolving two values that could easily be seen as oppositional. Here the

narrative link between economic activity and greenhouse gas emissions that was discussed earlier in the analysis is broken. Instead, sustainability becomes a vehicle for ensuring economic competitiveness. The benefits to be delivered to Bristol's economy come in several forms, one of which relies on the reframing of Bristol's energy bills as being GVA that *"leaves the local economy every year through payment of the energy bill."* (Bristol City Council, 2015, p. v) Suddenly, money is leaking out alongside carbon emissions, and instead of being a threat to Bristol's economy due to the economy's reliance on energy, a low carbon transition is a way of preventing the loss of economic value through a faulty energy system. Through this framing, renewable energy technologies, and other measures become a means of retaining economic value in Bristol's energy system. Furthermore, there is a belief that *"investment in reductions in energy bills and carbon footprints will also have wider economic benefits, providing additional jobs and money for the City of Bristol. ... Implementation of all the cost effective and cost neutral measures would lead to the generation of 10,000 jobs over the next ten years."* (Bristol City Council, 2015, p. 27) In this scenario, the physical realisation of Bristol's transition is to lead to job creation and wealth. This is grounded in a particular understanding of the role that sustainability already plays in Bristol's economy, and the opportunities it has already afforded. The city council argues that, already, *"the Sustainability, [sic] low carbon environmental goods and services, and environmental technology sectors make up an increasing component of Bristol's economy, contributing jobs and wealth, and this can be developed."* (Bristol City Council, 2015, p. iv) Sustainability is discursively positioned as something that is already a positive force in Bristol's economy; therefore, there is no doubt that it will continue to be so, as Bristol's energy transition is pursued.

> *The economic returns on investment could be very significant indeed. Many of the measures make sound commercial sense and would pay for themselves in a relatively short period of time, they would generate significant levels of employment and economic growth in the process, and if done well there may be a wider range of indirect benefits (not least from being a first mover in this field). The business case for large investments in the low carbon economy is very strong indeed.* (Bristol City Council, 2015, p. 31)

The belief placed in the economic potential of Bristol's energy transition is well illustrated by this quote, which frames the transition as a sensible business venture, and predicts benefits for the city's economy in the form of growth and jobs. In this respect, technology and infrastructural change is not only imbued with the power to change the relationship between energy generation and carbon emissions, their introduction allows the simultaneous recapturing of economic value, and even provides the mechanism by which further economic benefit can be

derived. In this sociotechnical imaginary carbon emissions essentially become a resource that can be transformed into economic value through the introduction of the right technologies.

The entanglement of sustainability with economic strength has also brought the pursuit of sustainability into contact with narratives concerning global competitiveness, as is apparent from the statement that *"the development of a low carbon, resilient and sustainable city is a cornerstone of our approach to remaining competitive in the global economy."* (Bristol City Council & Energy Service Bristol, 2018, p. 4) However, the idea of global position as a goal to be served by the city council is a much more nuanced one. Sustainability has in many ways become a field of global competition in and of itself, and while it is not allowed to come into conflict with economic competitiveness, this is a field in which Bristol is able to construct and enact other forms of global standing. For example, there are frequent references to Bristol as a city that is both innovative, and has significant expertise in sustainability related sectors, which has led to particular forms of global recognition:

> *Bristol has long led the way in the fields of energy, sustainability, digital and future start-up companies. It has the lowest carbon footprint of any of the UK's Core Cities, was the UK's first European Green Capital in 2015, has possibly the largest environmental network of its kind in Bristol Green Capital Partnership, won the 2018 GLOMO Smart City Award, was voted the number one smart city in the UK in 2017.* (Bristol City Council & Energy Service Bristol, 2018, p. 4)

It is clear from this quote that it is important to the city council to construct an identity for Bristol as a centre of expertise, and as a city that has been successful in becoming sustainable. Continuing to pursue a low-carbon future is a means to enact and strengthen Bristol's identity and perception as a global expert, centre of innovation, and leader in the field of sustainability, and to achieve recognition as such on the global stage. However, there is also a strong sense that the pursuit of sustainability is a construction and enactment of a particular identity of Bristol, not just as a centre of knowledge, but also as a model of strong community, cityhood, and governance. This is exemplified by references to the unity of the city itself, which emphasise that *"the people, businesses, organisations and politicians of Bristol are concerned about climate change,*" and are allied in their concern. (Bristol City Council, 2015, p. i) Political unity is also explicitly referenced in the City Leap prospectus, which states that *"Bristol City councillors unanimously adopted ambitious targets to reduce CO_2 emissions and energy use."* (Bristol City Council, 2015, p. i) And that there is agreement across all parties that Bristol's energy infrastructure

should be the focus of their efforts: *"Our Mayor and political leadership, across all parties, is committed to continued delivery and want to achieve a step change in the delivery of low carbon and smart energy infrastructure."* (Bristol City Council & Energy Service Bristol, 2018, p. 5) The picture painted of the shared concern, drive, and vision of Bristol's citizens, political actors, businesses, and organisations, presents this unity as a key strength of Bristol. Furthermore, the cohesiveness of the city as a community is considered to be an important reason for Bristol's position as a global leader:

> *We are now moving forwards with innovative pilot schemes that will help build the city's future smart energy system. This level of delivery, coupled with the city's thriving community energy scene and a wealth of socially responsible organisations, is just one of the reasons why Bristol is internationally recognised as a leading energy city in the UK.* (Bristol City Council & Energy Service Bristol, 2018, p. 2)

Here, Bristol is constructed as a leading energy city that is recognised as such both nationally and internationally. Its global position is not just attributed to its delivery of infrastructure, and innovativeness, it is also presented as being rooted in a community that is engaged and socially responsible. Therefore, there is a belief that it is not just Bristol's economic strength, or the concentration of relevant expertise in the city that makes it strong, it is also its style of governance, and the nature of Bristol as a cohesive, socially conscious community. In this respect, becoming a leader in the field of sustainability also becomes a way of demonstrating Bristol's leadership according to these values. The drive to establish Bristol as a leader according to this set of values is undoubtedly tied to economic reasoning, as is evidenced by the fact that the city's strengths are most strongly espoused in a document that is essentially an advertisement for investors. This indicates a belief that establishing the city as a leader in this way will attract benefits like investment, and grant funding. However, it is clear that achieving global recognition and influence as a leader in sustainability is seen as having its own value:

> *For those outside Bristol, the programme outlined below is replicable nationally and internationally. The City Leap Programme provides an urban living laboratory mechanism to demonstrate how to strategically manage such a wide ranging, diverse programme of works, as well as demonstrating the framing and catalytic role of local and central government.* (Bristol City Council & Energy Service Bristol, 2018, p. 2)

This reflects a drive to produce a model of urban sustainability and successful governance of urban transitions that will be adopted by other national and international actors, and possibly deployed on a grand scale.

It has been established that sustainability has become a means to enact and construct Bristol's identity as a global leader, and to establish Bristol city council as a model for good governance. In the city council's imaginary being a global model of sustainable cityhood means being a model of expertise, innovativeness, good governance, and socially conscious society. This begs the question, how are these qualities to be made recognisable on the global stage, in order to establish Bristol's leadership according to these values? To be a model of expertise is to *"have the largest cluster of environmental technology and service businesses in the core cities and … two leading universities with excellent research and teaching capabilities in climate, energy and sustainability issues."* (Bristol City Council, 2015, p. iii) To be innovative is to engage in *"innovative pilot schemes that will help build the city's future smart energy system."* (Bristol City Council & Energy Service Bristol, 2018, p. 2) To govern well is to be united in the desire to *"achieve a step change in the delivery of low carbon and smart energy infrastructure,"* by successfully managing and delivering a rapid transformation to Bristol's energy system. (Bristol City Council & Energy Service Bristol, 2018, p. 5) And to be socially conscious is to participate in *"community energy initiatives"* that will contribute to the city's sustainability. (Bristol City Council, 2015, p. 2) So ultimately, for Bristol City Council being a global leader in sustainability is having a citywide unity of vision and of action that is concentrated on the transformation of the city through technological means. This suggests that the council's judgement concerning what sustainability measures can be legitimately pursued are those that will be perceived as such in the international arena. Therefore, Bristol City Council's sociotechnical imaginary of a sustainable Bristol is instead a sociotechnical imaginary of a city that is internationally recognised as a global leader, not only in terms of its sustainability, but also its economic strength, expertise, and the social responsibility of its citizens. In this respect it is possible to see how sociotechnical imaginaries of sustainability are co-produced with imaginaries of good cityhood, and good governance.

5.2.2 Reimagining Bristol: Visions of Better Lives

The second vision of Bristol is of a city that has been transformed as a lived experience for its citizens. This transformation can largely be seen in descriptions of the so-called "*co-benefits,"* that are to emerge naturally through the sustainability pathway to be pursued by the city council and are generally to be realised through the introduction of a particular technology. (Bristol City Council, 2015, p. 28) The first benefit to be derived by Bristol's citizens stems from the core

value that a sustainable city must have secure and abundant supplies of energy. Energy security for Bristol's citizens is not just defined as an abundance of energy, but also as having energy that is available at a price point that is considered fair by the city council. We can see this value embedded in the fact that citizens are predominantly to derive benefit from Bristol's transition by retaining some of the value that leaves their hands through payment of their energy bills. This is to be achieved by making energy efficiency upgrades to their homes, being connected to heat networks or by becoming producers of electricity. For example, it is believed that *"solar PV, despite the initial investment, will result in ... long-term benefits for households and businesses through reducing energy bills,"* (Bristol City Council, 2015, p. 41) while domestic low carbon refurbishment is to have the effect of *"reducing heating costs for thousands of families."* (Bristol City Council, 2015, p. 36) The narrative that low-carbon measures can lead to economic savings gains particular significance when it is embedded in the city council's imaginary of the global future. The city council anticipates a future where the cost of energy is to increase. Therefore, engaging in the low-carbon measures recommended in the documents will act as a kind of future proofing for the city's citizens and businesses:

> *The City of Bristol's energy bill is currently £870 million per year and under the business-as-usual trends this will remain at approximately the same level in 2025, as reductions in energy use are offset by rising energy prices. However, investments now will help to significantly reduce the City's energy bill.* (Bristol City Council, 2015, p. 27)

In this quote, there is an expectation that without further efforts, energy use will decrease but energy bills will remain steady in the face of increased energy prices. This will place *"more people at risk of not being able to afford to heat their homes,"* which is a fairly narrow assessment of the problems that may be caused, but does show a concern for the situation of citizens in the face of rising energy prices. (Bristol City Council, 2015, p. 29) It is through engaging in technological or infrastructural changes in the way mandated by the city council that Bristol's citizens are to be protected from these risks, as these changes will *"provide an effective buffer and reduce the impact of energy prices fluctuations, thus making the city more resilient."* (Bristol City Council, 2015, p. 27)

The belief that low-carbon technologies can lead to economic savings has further implications, in the respect that these technologies are also seen as a means to reduce energy poverty. This is a major social goal that emerges in the documents, and measures like energy efficiency upgrades to homes are to "*generate other benefits – more efficient homes will be cheaper to heat,*

helping people out of fuel poverty, and helping to create healthier homes and healthier citizens." (Bristol City Council, 2015, p. 34) In 'Our Resilient Future' the reduction of energy poverty is treated as a more general outcome of the group of measures outlined in the document, whereas in the 'City Leap Prospectus' it is more localised to particular measures. In particular, *"heat networks can … be integrated into wider city urban growth and regeneration plans, helping to address fuel poverty,"* (Bristol City Council & Energy Service Bristol, 2018, p. 12) and this issue can be further addressed through *"a best practice city-based energy efficiency programme for low income households, with the objective of ensuring that all treated properties reach Band C Energy Performance Certificates."* (Bristol City Council & Energy Service Bristol, 2018, p. 16) Part of the reason that fuel poverty emerges as a particular social issue is that it is linked poor health outcomes, and making domestic low carbon upgrades is seen as a means of "*increasing the comfort of housing and improving residents' health - particularly to [sic] most socially disadvantaged and therefore vulnerable to climate change"* (Bristol City Council, 2015, p. 36) Health is the most frequently mentioned, and arguably the most important co-benefit that emerges in the document, and is connected to a number of the measures to be pursued by Bristol City Council. Improving health is also the normative goal that emerges most clearly as one that has had a real influence on the interventions outlined in the document.

The role of health values in shaping the sustainability pathway chosen by the city council is most readily apparent in the case of sustainable travel, particularly in the ambition to achieve a shift to self-powered forms of travel such as walking or cycling. The potential health benefits of these changes include "*improvements in health and a decrease in the demand placed on health services through lower pollution, a reduction in obesity and an increase in physical fitness."* (Bristol City Council, 2015, p. 43) A reduction in carbon emissions and air pollution would largely be achieved by a simple shift away from fossil-fuel powered cars; however, only self-powered travel will result in greater personal fitness and a reduction in obesity. Therefore, it appears that encouraging a move towards walking or cycling, alongside other technological options is desirable because of the belief that it could have greater potential benefits for citizens' physical health. This treatment of travel measures in Bristol's low carbon transition also represents a prioritisation of values concerning citizens' health over cost-effectiveness, which is the dominant value that drove the selection of particular measures. Improvements to vehicles and travel infrastructure are not considered to give good returns on investment in comparison to household, commercial and industrial interventions, particularly over short time-scales.

Nevertheless, they are seen as desirable because *"transport intervention investments often have other benefits which provide a compelling case for their implementation, for example reducing congestion, improving air quality, [and] increasing productivity."* (Bristol City Council, 2015, p. 25) Therefore, it is clear that other social values have influenced the place of travel measures in the council's imaginary of the city's transition pathway.

Decreasing fuel poverty, and improving health are the co-benefits that are discussed in the most detail in the documents; however, several others are referenced, including improving comfort in the home, increasing the longevity and appearance of housing stock, reducing the operating costs of buildings, and reducing congestion. (Bristol City Council, 2015) These co-benefits are highly diverse but several co-benefits are often to be realised by a single intervention. For example, health benefits are far from the only expectation placed on changes to Bristol's travel infrastructure, as demonstrated by this quote concerning the implementation of a metro-bus system:

> *Whilst the implementation of the Metro-Bus system will bring about reductions in the City of Bristol's transport emissions, it is also part of the West of England's plan to: support sustainable economic growth, promote accessibility, contribute to better safety, security and health, improve quality of life and create a healthy natural environment.* (Bristol City Council, 2015, p. 42)

Here we can see that a wide range of social goals rest on what is in effect a single technological, and infrastructural change, from health, to economic growth, to improved quality of life. This is by no means to say that this is the only measure that is to be deployed in the pursuit of these goals; nevertheless, it further demonstrates the power given to technology in imaginaries of Bristol's future. Technologies are at the centre of the vast majority of the potential benefits outlined in their document, and are tied to social transformation in a much greater sense than the realisation of individual co-benefits. Instead, it is clear that their deployment and the pursuit of sustainability via a technological pathway is to lead to a complete transformation of the social life of Bristol's citizens:

> *Delivering the activities outlined in the Prospectus will lead to significant additional benefits for Bristol's residents and businesses, including reducing fuel poverty, the creation of jobs, warmer and cosier homes for residents, improvements to residents' physical and mental wellbeing, better digital connectivity, significant business opportunities, inclusive growth and low carbon energy security and resilience. In essence, a future city fit for its residents, businesses and visitors in the*

> *21st Century, a city that will continue to successfully compete at a global level and be a net fiscal contributor to the UK.* (Bristol City Council & Energy Service Bristol, 2018, p. 5)

Technological and material change are put forward as the solution for what are complex social problems, which they are able to resolve to a transformative degree.

In this respect, the second vision of Bristol that is being constructed through the documents is directly tied to the use of particular low-carbon technologies. In the imaginary, technologies are to enable Bristol City Council to realise a number of social goals, including reduced energy poverty, improved health, and a better overall quality of life for Bristol's citizens. These social outcomes are to emerge as a result of Bristol's transition and this sociotechnical imaginary is an important motivation for pursuing this sustainability pathway. In contrast to economic values, which were clearly stated as foundationational to the selection of measures, the role social considerations played in the selection of measures is more murky. Only in the case of travel interventions are the choices made by Bristol City Council definitively tied to a social goal and are still considered to be viable despite their comparatively poor return on investment. This is because "*transport intervention investments often have other benefits which provide a compelling case for their implementation, for example reducing congestion, improving air quality, [and] increasing productivity.*" (Bristol City Council, 2015, p. 25) Instead, the influence of social goals and values in decision making appears in a more general sense, and is predominantly orientated towards future interventions, rather than the ones that have already been made. This is clear from the council's acknowledgement that

> *Whilst the Mini-Stern Review for Bristol quantifies energy savings, carbon reduction, pay-back periods, and job creation associated with a range of carbon reduction measures, there is a need to consider social equity and broader sustainability issues, such as reducing fuel poverty and improving health.*" (Bristol City Council, 2015, p. 27)

So to this point, it is predominantly, but not exclusively the economic forms of valuation in the Mini-Stern Review that have shaped the sustainability measures in the documents. However, there is some evidence that social goals have influenced decision making and sociotechnical imaginaries of a socially transformed Bristol are key motivation for pursuing a low carbon transition. Furthermore, there is an intention that social values will continue to be a factor in decision making as future *"interventions must be designed in such a way that reduces emissions and maximizes these wider co-benefits."* (Bristol City Council, 2015, p. 28)

The transformation of the social lives of Bristol's citizens is the final component of the sociotechnical imaginary that has been built around low-carbon technologies. Low-carbon technologies are the pathway to a sustainable Bristol where greenhouse gases have been disentangled from the energy practices that have been problematised, as Bristol as a sociotechnical system has been re-understood as unsustainable. By performing this disentanglement, technologies are able to achieve the council's sustainability goals without sacrificing the other core values that are the foundational to its approach to sustainability. Through technology it is possible to reduce greenhouse gases without any detrimental effect on Bristol's economy or limiting the supplies of energy that are believed to be central to Bristol's development. While these values are foundational to the document, a multitude of other values become embedded into Bristol City Council's imagined pathway to sustainability, as imaginaries of a highly technological transition pathway is co-produced with sociotechnical imaginaries of Bristol as a desirable future city. In sociotechnical imaginaries of a future Bristol, sustainability becomes a vehicle by which Bristol City Council can establish itself and the city as leaders on the Global stage according to a variety of measures. The ability to do so is highly contingent on pursuing a form of sustainability that will attract recognition on the global stage, which means producing expertise that is seen as relevant, selecting measures that are deemed legitimate, and successfully using Bristol's sustainability transition to increase the city's economic strength. Furthermore, the technologies that are to bring about Bristol's sustainable future are also to deliver a socially transformed Bristol, with more jobs, reduced congestion, greater security, and better health and well being for all. These social goals are both believed to be deliverable by the pathway constructed in the documents, and are intended to play an ongoing role in shaping Bristol's transition pathway. The reciprocity that exists between sociotechnical imaginaries of sustainability, and imaginaries of a future Bristol demonstrates that the form of Bristol's transition pathway is shaped by imaginaries of a future Bristol, even as it acts as the foundation for these sociotechnical imaginaries of the future city. Therefore, Bristol City Council's sociotechnical imaginaries of sustainability and of Bristol as a future city can be considered to be co-produced, united by the belief that the same low-carbon technologies are able to realise the multitude of goals articulated in both imaginaries, simultaneously.

5.2.3 Reimagining Bristol: Changing the City, Changing Lives

The emerging sociotechnical imaginary of a transformed Bristol places technologies at the heart of this transformation, while the social aspects of the so-called 'sociotechnical' system are largely left implicit. In this section, it is these social aspects that will be foregrounded, both to highlight the contingencies that contribute to whether Bristol City Council's imaginary will be realised, and to identify some elements that may contribute to the production of inequality. The exploration of social contingencies will focus on the underlying role that Bristol's citizens must play in order for the city council's imaginary to be realised, a role that is frequently masked by assumptions regarding the capabilities of technologies. It will be argued that these behaviours are not only integral to the realisation of these sociotechnical imaginaries of a sustainable city, they also dictate whether Bristol's citizens are able to derive any of the imagined benefits from this transformation. This means that Bristol's imagined transition can propagate inequalities, as different groups and individuals will have different capacities to fulfill the role mandated for them.

Firstly, and perhaps obviously, achieving sustainability or any of the other co-benefits articulated in the council's imaginary, are dependent on citizens adopting the various technological and infrastructural measures that are placed at the centre of the sociotechnical imaginary. One of the most significant expectations emerges from the necessity to construct Bristol's new energy system. This future energy system is largely to be powered by renewable sources, which includes a limited provision of more centralised renewable energy sources like council-owned large wind turbines and solar parks, as well as the potential development of hydropower and marine energy. (Bristol City Council, 2015; Bristol City Council & Energy Service Bristol, 2018) However, the shift towards renewable energy sources emerges as particularly significant, because *"Bristol is a dense urban area and the options for the deployment of large scale renewable installations are limited."* (Bristol City Council, 2015, p. 12) This limitation means that, instead, it is predominantly the potential for the development of smaller scale solar installations on commercial and domestic roof space that is to be exploited. A capacity of 46MWe is identified for commercial roof space, and a combined capacity of 96MWe for private and social housing, and this has prompted the *"installation and facilitation of solar PV on private domestic housing, and corporate roofs across the city."* (Bristol City Council, 2015, p. 19) In this

scenario, roof tops are reconfigured as potential sites for energy production, and both corporate actors, community groups, and citizens are reimagined as the producers of renewable energy for their communities.

The decentralisation of Bristol's energy supply represents massive redistribution of responsibility for energy production to its citizens, as exemplified by the statement that *"Bristol City Council (BCC) will work with community energy groups to maximise the contribution that community energy can make in achieving the targets outlined in this framework … to maximize the delivery of low carbon and renewable energy in the City at a community level."* (Bristol City Council, 2015, p. 47) In this quote, community energy groups are given a key role in achieving the council's sustainability goals, and, ultimately, these actors are to take on responsibility for energy production for the city overall. This characterisation holds true as we look at all of the different energy practices that are problematised in the document, and the behaviour changes that are required. In each instance, whether it is the choice of transport, using the dishwasher, choosing an energy supplier, or any of a number of practices that relate to energy consumption in both the home and commercial spaces, it is no longer a purely individual concern. Instead these choices have become integral to the sustainability, and the integrity of its Bristol as a sustainable sociotechnical system as a whole. In this respect, the realisation of Bristol as a sustainable sociotechnical system means an acceptance of this responsibility by a diverse range of actors and an enactment of this responsibility in these everyday practices and choices. *(*Bristol City Council, 2015; Bristol City Council & Energy Service Bristol, 2018)

Realising the essential role that citizens must play for Bristol as a sustainable sociotechnical also places them at the centre of any benefits that this system is to deliver. In other words, as Bristol's citizens become responsible for the realisation of the city of Bristol as a sustainable sociotechnical system they also become responsible for unlocking the various benefits painted for them in the imaginary. At an individual level, citizens may only access a number of these benefits by investing in particular low-carbon technologies; for example, they gain lower energy bills only by investing in solar panels, or energy efficiency upgrades to their homes. Furthermore, the majority of the benefits painted in the sociotechnical imaginary, like energy security, improved air quality and the generation of new jobs can only be achieved by collective action. It is up to Bristol's citizens to take their individual energy security, and that of the city into their own hands by generating energy locally, accepting smart metres, and altering their

patterns of energy use. By adopting these technologies, making energy efficiency upgrades to their homes and by changing their appliances they may also reduce their energy bills and those of their neighbours. They can improve their own health, and those of others by reducing fossil-fuelled car use and the associated air pollution; and by connecting to heat networks, which rely on distributed heating. (Bristol City Council, 2015; Bristol City Council & Energy Service Bristol, 2018)

This is noteworthy for several reasons. Firstly, it highlights that each aspect of Bristol City Council's sociotechnical imaginary, including the social benefits, are dependent on Bristol's citizens acting in certain ways and doing so en masse. It also shows where problems of inequality might emerge, as not everyone has an equal capacity to invest in new technologies, make changes to the fabric of their home, or alter the temporality of their energy practices. This not only means that not everyone is equally able to access the benefits painted in the imaginary. Moreover, there are even instances where additional burdens may be placed on those who failed to play their prescribed role. The most clear example of this emerges when considering that smart metres aim to alter patterns of energy consumption by using variable rate tariffs, which means that people may ultimately receive penalties for having inflexible energy practices. This concern only in two places in the documents, in the acknowledgement that *"there is some evidence that historically actions similar to those set out in this Framework have proportionately low take up from equalities communities such as black and minority ethnic (BME) communities, older people, etc."* (Bristol City Council, 2015, pp. 69) The concern here is that by failing to engage with the measures outlined in the documents, certain groups will fail to derive benefits, and inequalities will be propagated. However, there is no further discussion of the ways that this could be addressed and this is something that will need to be considered very carefully going forward, and upon the formulation of further measures. (Bristol City Council, 2015; Bristol City Council & Energy Service Bristol, 2018)

The fact that different groups will not be able to engage in these technologies equally means that not everyone will be able to receive the imagined benefits of Bristol's transition. Moreover, the case studies discussed in the state of the art demonstrate that any outcomes are highly dependent on the multiple elements in a sociotechnical network, and the wider social context in which they are embedded. (Ballo, 2015; Levenda et al., 2018; Richter et al., 2016) Therefore, despite how it is presented in the documents, there is no guarantee that engaging with

low-carbon technologies in the ways mandated by the city council will deliver the promised benefits. Savings on energy bills may not flow directly from the installation of solar panels, or making energy efficiency upgrades, or connecting to heat networks. Instead, the derivation financial savings will be highly contingent on other actors that are part of the new networks that are formed around these technologies. For example, we can see from the 'City Leap' prospectus that these technologies are to be the basis of *"replicable, investable business cases across the full range of energy-related technologies at city-scale for the benefit of residents, businesses, the council and Programme partners."* (Bristol City Council & Energy Service Bristol, 2019, p. 10) This means that there is an expectation that citizens allow both new technologies, and those who invest in and manage these technologies to be integrated into their networks. These human or institutional actors will have important effects on whether citizens are able to gain any imagined benefits, as they seek to derive their own benefits from these networks. This has the potential to be a significant social change, and represents an important source of uncertainty for Bristol's citizens, as these networks, and the possible terms of the relationships within them are largely undiscussed, and undefined by the city council.

5.2.4 Reimagining Bristol: the Co-production of Sustainability and the City

In the previous sections it was demonstrated that a sociotechnical imaginary was being constructed where low-carbon technologies are the pathway to a sustainable Bristol where greenhouse gases have been disentangled from problematic energy practices, reducing carbon emissions without sacrificing the other key values that are central to its approach to sustainability: maintaining energy supplies that are to be central to Bristol's development, and preserving Bristol's economy. In this section, the analysis moved away from elucidating the sociotechnical imaginary of sustainability that Bristol City Council has been built around low-carbon technologies. Instead, the analysis turned to the council's emerging sociotechnical imaginary of Bristol as a future city, arguing that sociotechnical imaginaries of good cityhood are being co-produced along with sociotechnical imaginaries of urban sustainability. In sociotechnical imaginaries of a future Bristol, sustainability becomes a vehicle by which Bristol City Council can demonstrate the city's leadership by a variety of measures, including expertise, economic strength and social integrity. However, demonstrating these qualities through a sustainability transition means pursuing a sustainability pathway that resonates with discourses concerning the 'right' form of sustainability that are held at international levels. This means

that the pathway to Bristol's low-carbon future is likely to be shaped by Bristol City Council's visions of Bristol as a global leader, as much as sociotechnical imaginaries of the future city are shaped by the belief that the technologies within this pathway are able to deliver a particular kind of imagined future. This same co-production is apparent when we consider the social transformation that is also a core component of sociotechnical imaginaries of a future Bristol. Here, low-carbon technologies are also to transform the lives of Bristol's citizens, bringing them greater security, reduced energy bills, and better health and quality of life overall. Again, these goals are seen both as deliverable by the pathway constructed in the documents, and as forces that will play an ongoing role in shaping Bristol's transition pathway. In this respect, sociotechnical imaginaries of a sustainable city are so entangled as to be inseparable from sociotechnical imaginaries of a good one. This sociotechnical imaginary features a city and a governing body that has reduced its carbon emissions, established itself as a global leader and transformed the lives of its citizens through low-carbon technologies. However, the analysis then demonstrated that proper functioning of this sociotechnical system and realisation of this imaginary relies on a number of social factors. Focusing on the implicit expectations concerning Bristol's citizens, it was demonstrated that citizens and their spaces had been reimagined as core components of the functioning of Bristol's energy system. This meant that by becoming renewable energy producers and electric car drivers; or by buying energy efficient appliances or making energy efficiency upgrades to their home, citizens are assuming their responsibility for Bristol's functioning as a sustainable sociotechnical system. Additionally, only by doing so will they be able to receive the benefits painted for them in the city council's sociotechnical imaginary, and only through their collective action may these benefits be generated for their fellow citizens. This is an important contingency to the realisation of any of the components of Bristol City Council's imaginary for the city, which is masked by their attribution to the capabilities of technologies. In addition, it highlights that inequalities may be generated according to the relative abilities of different groups to adopt the role mandated for them in the documents, as a failure to do so will not only prevent them from accessing the benefits to be delivered in the sociotechnical imaginary, it may also lead to an unfair distribution of burdens across the city. This is particularly pertinent when considering that Bristol's sustainability transition means transforming and building new relationships between different human actors, as well as between humans and technologies. This means that along with adopting new technologies, Bristol's citizens are also expected to accept the integration of new human and institutional actors into their networks. All of these actors will have their own interests to

pursue, which will shape the degree of benefit that citizens are able to derive. (Bristol City Council, 2015; Bristol City Council & Energy Service Bristol, 2018)

5.3 Governing Bristol's Transition: Governing in a Multi-level World

The analysis of Bristol City Council's emerging sociotechnical imaginary of a sustainable Bristol has been useful for several reasons. Firstly, it has unearthed the multitude of values and goals that are entangled with sustainability, including economic strength, global competitiveness, and social development. It has shown how the central place of technology in this sociotechnical imaginary stems from a belief that technologies are able to serve all of these values simultaneously. Secondly, it has challenged this belief by demonstrating how the achievement of these goals is highly contingent on social factors, which largely centre around Bristol's citizens engaging in certain behaviours, an expectation that is largely implicit. Together these insights are valuable for identifying vulnerabilities in the imagined transition pathway, both in the sense of identifying points for overall failure, or for the production of inequality. Identifying these issues in future orientated visions that shape decision making is advantageous because it creates opportunities for intervention, and is a key strength of using sociotechnical imaginaries as a theoretical perspective. This section will explore how Bristol City Council's sociotechnical imaginary of a transformed and sustainable Bristol also provides the first insights into how Bristol City Council is governing, or intends to govern, Bristol and its transition, not just by providing information on what actions the city council is taking, but also how it constructs its role as a governing body. The next part of the analysis will build on these insights using the multi-level governance perspective, which emphasises that governance and the capacity to govern is subject to forces beyond a single sphere of authority. Sensitised by this concept, the discussion will turn to what can be discerned concerning the wider political contexts that Bristol City Council is embedded in, and how this may have played a role in shaping the city council's sociotechnical imaginary of a sustainable Bristol. It will be argued that Bristol City Council's sociotechnical imaginary of sustainability is subject to the influence of a wide variety of other governmental and non-governmental actors at regional, national and international levels. This influence can be seen through the adoption of frameworks produced by other actors, and the need to attract funding from other governmental and non-governmental institutions. However, the influence of other actors is most readily apparent in the city council's choice to involve multiple actors in the formation of the sociotechnical imaginary discussed in the earlier

part of this thesis. It will be demonstrated that Bristol City Council's approach to vision formation has become increasingly collaborative in response to its limited capacity for direct action: a capacity that is defined by a lack of adequate financial resources and limited jurisdiction over the infrastructure it seeks to act upon. This lack of capacity has driven a need to coordinate action by other actors according to the sociotechnical imaginaries of the city council, and the process of collaborative envisioning has become a central mechanism for achieving this goal. Coordinated action often takes the form of partnerships with the council, and the formation and imagined role of these coalitions in Bristol's transition will be explored. A key aspect of this exploration will be how the city council discursively constructs itself as an attractive partner, particularly in 'the City Leap' prospectus. Analysing this construction will enrich our understanding of Bristol City Council's form of governance, as it will provide insight into how the city council characterises its own capacities and how it intends to deploy them in pursuit of its aims. Finally, the thesis will enter into a discussion of the ways that urban sustainability can be seen as being co-produced with imaginaries of governance. It will be argued that the council's sociotechnical imaginary of a sustainable Bristol is shaped by how it imagines its role as a governing body, as its chosen pathway to sustainability is defined by what the council believes it must deliver to the city, and its beliefs concerning the ability of particular low-carbon technologies to serve these values. The highly technological nature of its chosen pathway, and the council's limited capacity to implement this pathway then drives the move to more collaborative forms of governance, which in turn introduce the potential for further reshaping of sociotechnical imaginaries of Bristol's sustainability pathway. However, the most significant co-production of a sustainable Bristol and governance is apparent in the council's ambition to leverage its responsibility for the low carbon transition to gain greater autonomy and political power.

5.3.1 Governing Bristol's Transition: Building Shared Visions

Bristol's sociotechnical imaginary of a transformed and sustainable Bristol provides the first insights into how Bristol City Council is governing Bristol's transition, in the respect that it not only provides information on what actions the city council is taking, but also how it constructs is role as a governing body:

> *In 2030, Bristol is carbon neutral and climate resilient. We have collectively achieved a fair and inclusive transition; capturing the opportunities of new jobs and investment, improved health,*

> *wellbeing and education, and a better environment for local people. We have helped lead the way to a safer global climate.* (Bristol One City, 2020a, p. 4)

This sociotechnical imaginary of Bristol is a reflection of how the council imagines its role as a governing body in terms of its responsibility to other actors, in terms of what it should deliver to the city and its citizens, but also the role it sees for itself in the national or international arena. The multi-level governance has sensitised this analysis to the influence of other actors in the formation of Bristol City Council's sociotechnical imaginaries. However, as is highlighted by the multi-level governance perspective, these sociotechnical imaginaries have not emerged in isolation. Instead the sociotechnical imaginary being constructed in the documents are influenced by the values, goals and visions of other powerful governmental and non-governmental actors, operating at regional, national and international levels. The influence of these actors is readily apparent from the participation of Bristol City Council in national, and international organisations and pledges, "*including the 'Covenant of Mayors' and the 'Compact of Mayors,'*" (Bristol City Council, 2015, p. 44) and the adoption of frameworks developed by other governmental actors. (Bristol City Council, 2015; Bristol One City, 2018; Bristol One City, 2020a; Bristol One City, 2020b) The potential influence of discourses held at other political levels can also be seen when we consider that the city council must fund its transition through some mechanism. Bristol City Council aims to qualify for certain forms of central or European government funding, as well as funding from non-governmental actors and has done so in the past:

> *The council has been successful in applying for various grant funding opportunities to support project delivery, including an EIB ELENA grant, EU Horizon 2020 funding (REPLICATE) and, specifically in regards to heat networks, the highest grant awarded by the Department of Business, Energy and Industrial Strategy (BEIS) to any Local Authority for the development of heat networks.* (Bristol City Council & Energy Service Bristol, 2018, p. 13)

It is apparent from this quote that the council has pursued several different forms of funding from outside sources, each of which will have some institutional vision of their own that they are seeking to enact through the provision of funding. This is important for the shape of Bristol's transition in the respect that these funding institutions may influence which forms of transition are considered financially viable by the council, as they may only be able to attract funding for certain measures:

> *UK Government's Business, Energy & Industrial Strategy department (BEIS) has identified heat networks within the Clean Growth Strategy as key to delivering on its Paris climate commitments*

> *and has made available both feasibility and capital grant funding to support heat networks... BEIS also recently announced details of the Heat Network Investment Project (HNIP) capital grant fund. This grant funding could enable further expansion of the Bristol heat network whilst still maintaining a net positive financial return to the council.* (Bristol City Council, n.d.a, p. 15)

In this quote BEIS grant funding is to enable Bristol City Council to expand its heat networks, and to obtain financial returns while doing so. In this respect, the belief placed in heat networks by the BEIS at least has the effect of strengthening the place of heat networks in imaginaries of a sustainable Bristol, by increasing belief in the financial viability of these networks and the opportunities that they offer for the council. The ability to attract central government funding is presented as an important facilitator for the adoption of several low-carbon technologies, including solar PV and electric vehicles. (Bristol City Council, 2015; Bristol City Council & Energy Service Bristol, 2018) There is an expectation that central government funding will continue to be an important enabler of action, and will continue to shape the kinds of sustainability measures that are selected by the city council:

> *We are also aware that the Government is seeking to support innovative energy-related projects at the city level through, for example, the Industrial Strategy Challenge Fund. This may present an additional opportunity for us to increase the pace and expand the scope of our ambition further than is possible without Central Government support through leveraging additional private sector investment.* (Bristol City Council & Energy Service Bristol, 2018, p. 8)

Here, the central government funding is given great value, not just for realising individual projects but also for leveraging additional funding for Bristol's transition. This hints at the potential importance of engaging in a form of transition that will obtain central government support.

These dynamics are no doubt significant; however, it is the processes of production of the documents analysed here that give the greatest insight into the political forces and actors that have played a role in shaping Bristol City Council's chosen sustainability pathway. Each of the documents analysed here and the sociotechnical imaginary emerging in them is a product of a coalition of actors that was consciously constructed by Bristol City Council. The role played by these coalitions in the vision-building practice of realising these documents varies. The earliest document, 'Our Resilient Future: a Framework for Climate and Energy Security' is stated as being greatly influenced by The Systems Thinking for Efficient Energy Planning (STEEP)

project, in addition to the foundational Mini-Stern analysis. This EU-funded FP7 research project engaged in *"research into the use of group model-building workshops with stakeholders to reach a shared understanding of complex energy systems,'* (Bristol City Council, 2015, p. 2) which was then to be used to generate an energy master plan for districts of three different European cities. The framework in 'Our Resilient Future' was developed using the methodology developed in the STEEP analysis; namely, through engaging in stakeholder consultation and joint modelling, as well as drawing on the *"experience of officers and senior managers from across BCC, ... and UoB project teams, and a range of other stakeholders."* (Bristol City Council, 2015, p. 2) This is a process that is slated to continue, as the city council seeks to transform systems that it considers separate from the energy system, for example, the council intends to *"work with partners and stakeholders across the city to develop our understanding of the transport system and further develop a single integrated transport plan for the City of Bristol."* (Bristol City Council, 2015, p. 51) The vision built in this document, and the process of its creation is collaborative in the sense that is based on the selection and engagement of stakeholders to form new social networks as a basis for the process of shared meaning-making.

The 'City Leap' prospectus is also presented as being at least partly derived from 'Our Resilient Future,' and; therefore, stemming from the same processes in the respect that *"the Prospectus came from the city, not just the council,"* which emphasises the same collaborative vision-making process. (Energy Service Bristol, 2019, p. 22) However, in the case of the 'City Leap' there is less of a sense that the collaborative construction of vision is to be an ongoing process. In the documents there is some openness to alternative ideas and routes to a sustainable Bristol, as demonstrated by the fact that *"Bristol City Council is also keen to work with partners with innovative energy-related business models and ideas that are not directly linked to the areas of potential activity listed."* (Bristol City Council & Energy Service Bristol, 2018, p. 29) Yet, ultimately, the city council reserves the right to *"not to consider Expressions of Interest for any reason whatsoever,'* and to *"not to enter into any partnership or arrangement for any reason whatsoever."* (Bristol City Council & Energy Service Bristol, 2018, p. 31) Therefore, there are limits to the openness of the vision creation process, and Bristol City Council attempts to maintain a position of power in order to realise its particular vision. This highlights the boundaries that are drawn by Bristol City Council around who is a legitimate contributor to imaginaries of Bristol's future.

The importance given to this collaborative process intensifies as we scrutinise the circumstances of production of the most recent document included in this analysis, the 'One City Climate Strategy.' (Bristol One City, 2020a) This document is the successor to 'Our Resilient Future,' and builds on the more general 'One City Strategy,' the first iteration of which was published in 2019, and the second in January 2020. (Bristol One City, 2019; Bristol One City, 2020b) The 'One City Climate Strategy' has quite different circumstances of production to 'Our Resilient Future,' in the respect that instead of being directly responsible for the development of the climate strategy through a process of consultation, the council has instigated the creation of another body to generate this document, which includes actors from a variety of different institutions. While this represents a significant change, Bristol City Council still invokes a sense of ownership over the document, stating that it would *"play a leading role in creating a One City Climate Strategy for Bristol,"* and considered its development to be a core component of its response to climate change, and to the climate emergency it announced in November 2018. (Bristol City Council, n.d.b) This is borne out through the key role that the city council plays in the governance of the One City approach. It is a member of the City Leaders Group which supervised, and will continue to oversee the development of the One City Plan for Bristol's development. (Bristol One City, 2019) Furthermore, a senior representative of Bristol City Council was one of the three members of the selection committee that chose the members of the One City Environmental Sustainability Board that was responsible for publishing the climate strategy. The city council also has a representative on the environmental sustainability board. (Bristol City Council, 2019) So, while Bristol City Council retains a leadership role in some regards, the increased emphasis placed on collaborative vision creation is clear and is emphasised by the insistence that the One City Climate Strategy *"is not … owned by any one organisation, such Bristol City Council."* (Bristol One City, 2020a, p. 3) It is clear that other actors have been increasingly engaged in collaborative vision formation by Bristol City Council and have played a role in shaping the sociotechnical imaginary elaborated here. The contribution that the different stakeholders have made to the sociotechnical imaginaries being constructed within them is opaque to this analysis, as these stakeholders are not discussed in great detail. However, what we can gain from the documents is an insight into why building future visions collaboratively with stakeholders has in fact become a core feature of Bristol City Council's governance.

The key to understanding some of the contextual factors that have made collaborative envisioning a central aspect of Bristol City Council's style of governance, lies in the criteria for identifying relevant stakeholders for the STEEP analysis. The STEEP analysis formed the basis for stakeholder consultation in 'Our Resilient Future,' and the basis for the selection of stakeholders is described as follows:

> *Stakeholders that are considered to be 'relevant' will be those who fit into one of the following three categories: parties whose interests and activities affect, or will be affected by, the content of the energy plan; parties who can provide information, resources and expertise that are required for effective policy making in this sector; parties whose involvement is necessary for the successful implementation of the energy plan.* (STEEP, 2015b, para. 2)

It is clear that this description leaves more questions than it answers. For example, the first category, those *"whose interests and activities affect, or will be affected by, the content of the energy plan"* (STEEP, 2015b, para. 2) could arguably be just about anyone, and there is little meaningful insight that can be gained from this categorisation without further research into the decision making behind what groups are placed into this category and why. However, what can be gleaned from these categorisations, and other discussions of stakeholder engagement is that collaborative vision making is seen as crucial for two main reasons: to enable the creation of better visions, and to drive action.

Stakeholders both within, and outside of the council are believed to have expertise that can contribute to better vision creation, which has a link to the nature of the particular sustainability pathway that is being pursued by the council:

> *It is necessary to take a holistic and integrated approach to energy planning. In recognition of this and of the fact that energy planning is a continuous iterative process, BCC will consider how it can best work with partners and stakeholders to further develop an integrated energy plan for [sic] City of Bristol. This will ensure that the energy system is planned as a single integrated system that maximizes carbon reduction potential.* (Bristol City Council, 2015, p. 50)

Bristol's energy system is one of the major targets for change in the documents, and it is clear from this quote that there is a belief that the need to change this system requires the engagement of stakeholders. This is seen as the avenue to *"ensure that the energy system is planned as a single integrated system that maximizes carbon reduction potential,"* and the expertise of other actors is required to develop an effective plan. (Bristol City Council, 2015, p. 50) The need to engage stakeholders in order to benefit from their expertise is also linked to ideas of innovation,

and the idea that the council's plans should remain open to new ideas as they are developed. There is an expectation of *"substantial innovation in the energy sector, particularly in relation to the future smart energy system, [and] the City Leap Programme could easily be expanded to include other activities, reflecting innovative business models or ideas proposed by potential partners."* (Bristol City Council & Energy Service Bristol, 2018, p.10) In both of these cases it is clear that the engagement of stakeholders is valuable for the expertise they are able to supply, which enables the city council to formulate better visions.

The engagement of stakeholders in the vision-creation process is motivated by another important belief: that Bristol City Council will have a greater chance of success if it involves stakeholders that have some influence over Bristol's energy system, whether they are *"parties whose interests and activities affect … the content of the energy plan,"* or groups that are considered *"necessary for the successful implementation of the energy plan."* (STEEP, 2015b, para. 2) And it is clear that collaborative vision formation is not just performed to generate better visions, it is actually a resource for generating coordinated action through the creation of a sense of ownership over Bristol's future. This is reflected in discussions of stakeholder engagement in 'Our Resilient Future,' that in pursuing Bristol's transition *"stakeholder engagement is required in order to obtain wider 'buy in' and better influence City wide decisions to tackle CO2 emissions and improve energy security."* (Bristol City Council, 2015, p. 3) In this respect, collaborative vision creation moves beyond the act of creating a vision itself, and becomes a tool for achieving action, and the realisation of that vision:

> *A key principle underpinning our approach is Bristol City Council's philosophy, supported by its Corporate Strategy and set out in the council's 'Our Resilient Future: A Framework for Climate and Energy Security,' … the aim of this philosophy is to encourage and facilitate a partnership approach to the engagement and deployment of the full range of energy-related technologies (including supply, generation, efficiency and smart) across the city, involving as many citizens and organisations as possible.* (Bristol City Council & Energy Service Bristol, 2018, p. 5)

This philosophy is the vision for Bristol's low-carbon transition that is laid out in 'Our Resilient Future,' and as well as inspiring action through the collaborative processes of its creation, it is to be used as a further resource for prompting coordinated action by a variety of actors including actors in the commercial sector, NGOs and academia.

5.3.2 Governing Bristol's Transition: Coordinating Action

The need to govern in coalitions with other actors is linked discursively to two major contextual factors that result from the council's embedding in a multi-level system that consists of multiple overlapping spheres of authority and power. The first, which would be categorised as a 'type I' interaction, stems from the financial conditions that have been imposed on the city council by the policies of the central government. There is a belief that decisions made at central government level have severely limited Bristol City Council's capacity to drive Bristol's transition independently. This belief is readily apparent in the statement that "*grant funding … has not been successful in delivering energy efficiency measures at the scale required to meet its carbon reduction targets.*" (Bristol City Council & Energy Service Bristol, 2018, p. 2) and that because of *"the current challenging funding environment there is need to further explore and implement sustainable business/community energy models to secure the delivery of this programme."* (Bristol City Council, 2015, p. 47) There is a perception that this trend will continue, and this reality *"coupled with shrinking public budgets, mean that we need to find new, innovative and inclusive ways of delivering and funding the city-scale low-carbon infrastructure that will be required to deliver on our ambition.* (Bristol City Council, Energy Service Bristol, & Bristol One City, n.d., p. 8) These economic limitations set the conditions for the council's approach to delivering the energy infrastructures that are integral to Bristol's low-carbon future, as *"this transformation will require significant levels of investment; levels that the council simply cannot deliver alone."* (Bristol City Council, Energy Service Bristol, & Bristol One City, n.d., p. 1) Bristol City Council's financial limitations means that it must engage other partners, because *"whilst the council may wish to, and reserves the right to, invest in some or all of these projects, it is likely that the large majority of the investment will be made by its partners."* (Bristol City Council & Energy Service Bristol, 2018, p. 5) It is clear that the availability of financial resources shapes the capacity of Bristol City Council to act. This capacity to act is further hampered by a second contextual factor, which is the council's limit power to directly influence the relevant infrastructure because it often comes under the authority of other institutional or human actors:

> *The responsibility for changing our energy system and reducing carbon emissions lies not only with BCC, but with many of Bristol's businesses, social enterprises, public bodies and communities. Furthermore, there may be opportunities where BCC does not have appropriate*

> *jurisdiction to take a lead role and BCC will collaborate, empower and enable these organisations.* (Bristol City Council, 2015, p. 46)

The idea of jurisdiction is a key one here, because it reflects the limited ability that Bristol City Council has to enact its imagined changes directly, and the need to motivate action by those with the appropriate authority.

In the documents, coalitions are formed for a number of different reasons to serve various purposes, in addition to the construction of shared visions. The first area that coalitions of actors for coordinated action become important is in the council's formation of coalitions with other actors for the purposes of knowledge production, as they allow the council to access other knowledge resources and expertise. Ultimately, the formation of these coalitions is performed to produce knowledge that will be used as a resource for the transformation that Bristol is to undergo. This can mean generating knowledge that makes problematic practices visible, and allows the designing of new measures to address them. It can also mean generating the knowledge or technological artifacts that are needed to realise the elements of Bristol's transition imaginary that appear to be relatively stabilized. For example, the use of energy efficiency measures, renewables, and smart technologies, which have persisted across the corpus of documents analysed here. (Bristol City Council, 2015; Bristol City Council & Energy Service Bristol, 2018; Bristol One City, 2019; Bristol One City 2020a; Bristol One City 2020b) The generation of knowledge is also seen as essential for giving legitimacy to and learning from current measures, as well as being a powerful tool for motivating action by other actors.

The generation of knowledge to make problematic practices both visible and actionable is readily apparent in the city council's commitment to *"collaborate with partners in all sectors to identify more interventions and source more accurate Bristol specific data,"* (Bristol City Council, 2015, p. 66) because *"only by understanding the extent to which consumption in Bristol results in emissions elsewhere can we start to identify how action within the city can contribute to reducing these emissions." (*Bristol City Council, 2015, p. 66) The purpose of this collaboration for knowledge production was to expand on the Mini-Stern and the measures outlined in 'Our Resilient Future' by capturing indirect emissions, and developing further interventions in the various sectors. (Bristol City Council, 2015) The expansion to include indirect emissions is a clear evolution of imaginaries of what sustainability is. Therefore, this new knowledge has been used as a basis for altering sociotechnical imaginaries of Bristol's transition, and forms the basis of a vision of

sustainability that includes indirect emissions, as it is articulated in the later 'One City Climate Strategy.' (Bristol, One City, 2020a) This need to produce more knowledge as a resource for developing better visions, and facilitating further actions is ongoing, as is evidenced by the statement in the 'One City Climate Strategy' that *"we need more information and evidence to develop our city delivery plans to ensure that we invest in the most effective actions to achieve carbon neutrality and climate resilience."* (Bristol, One City, 2020a, p. 25) This knowledge will be generated through *"work with partners both in the city and beyond to use the best global expertise to help meet our goals."* (Bristol, One City, 2020a, p. 25) This shows the importance of coalitions for the creation of new knowledge, but also emphasises that this knowledge is to be generated according to the needs perceived by the city council, and what knowledge is required to further its aims.

In addition to generating knowledge that makes currently invisible practices or processes visible, in order to allow the new measures to be generated. Further coalitions emerge to support the realisation of measures like solar power and energy efficiency measures, which are already somewhat stabilised in imaginaries of Bristol's transition. The formation of knowledge coalitions to support the realisation of these more stable elements has been central to the council's involvement in research and development: the council *"has an extensive track record of taking research and development projects through the pipeline from innovation to delivery,"* and has delivered *"a range of collaborative research and development projects ... such as REPLICATE, SoLa Bristol, and 3EHouses, providing an understanding of the potential for new approaches to be adopted."* (Bristol One City, 2020a, p. 17) These research projects all focus on the technological means to deliver a sustainability transition, and; therefore, generate knowledge that serves an imaginary of Bristol's transition where technology plays a dominant role. (Bristol City Council & Energy Service Bristol, 2018, p. 8) For example, the SoLa Project was conducted in partnership with Western Power Distribution. The project *"investigated the potential for battery storage to be used in conjunction with Solar PV generation within 26 homes, five schools and an office block,"* and the potential of a variable tariff to *"incentivise customers to use the battery to reduce electricity consumption at peak times."* (Bristol City Council & Energy Service Bristol, 2018, p. 8) The other projects named here also focused predominantly on the deployment of energy efficiency measures, smart technologies, and other ICT-based technologies for reducing energy consumption, and were conducted in coalitions with other actors. (Bristol City Council & Energy Service Bristol, 2018) The collaborative research projects discussed here show the

importance given to the involvement in these coalitions as a means to develop and realise the vision that is held by the city council. These research projects are not just important for informing, and building visions, frequently they are pursued in order to realise a vision that already exists, as they generate the knowledge and technologies that will support these processes.

These coalitions are important for generating or accessing knowledge resources that Bristol City Council feels it needs to support the realisation of its vision for the city. Directing knowledge production in this way means establishing itself as an attractive partner for knowledge coalitions, and the city council presents itself as having significant strengths as a partner for knowledge production. This belief in the council's institutional strength, and the value that the city council is able to add to the research and development process is apparent in the statement that "*Bristol City Council has an extensive track record of taking research and development projects through the pipeline from innovation to delivery.*" (Bristol City Council & Energy Service Bristol, 2018, p. 8) Here, the city council is the active party and leader that forms coalitions for knowledge production and takes projects from the research phase all the way to deployment. This is clearly advocacy for forming coalitions for knowledge production with Bristol City Council, and fits with the purpose of the City Leap Prospectus, which is to attract investment partners. (Bristol City Council & Energy Service Bristol, 2018) Establishing its institutional experience and expertise, and; therefore, its attractiveness as a partner for knowledge production, is not the only way the council seeks to direct knowledge production in line with the council's vision of Bristol's transition. In the following discussion of smart technologies, access to particular forms of funding emerges as another way that the city council can add value and shape knowledge production:

> *Technology has huge potential to increase the efficient and more intelligent use of energy resources, thus decreasing overall demand and GHG emissions. … BCC will identify opportunities and pursue funding (e.g. Smart Cities and Communities (SCC1) under Horizon 2020) that enables BCC and partners to explore, pilot and implement schemes that use smart technologies to reduce energy demand and carbon emissions.* (Bristol City Council, 2015, p. 53)

The council aims to form a coalition for generating knowledge by supplying funding to direct research efforts towards smart technologies, in order to realise the role that smart technology is imagined to play in Bristol's transition. This demonstrates the significant emphasis placed on

shaping knowledge production in line with the council's vision, and highlights the different tools the council uses to engage the groups, and encourage the production of knowledge that it deems relevant.

Ultimately, the existence of these knowledge coalitions, and the knowledge created by them is largely intended as a resource for action. This means that the knowledge produced by these coalitions is to be used as leverage for forming further coalitions, and instigating coordinated action. In one case, the knowledge generated through knowledge coalitions is to be used to compel the formation of a coalition for action in the form of the marine energy industry. In order to achieve this Bristol city council will *"provide a joint, clear and consistent vision for the Bristol Channel"* to potential industrial partners, and ensure that there is *"pre-commissioned research to reduce uncertainty."* (Bristol City Council, 2015, p. 55) Here, Bristol City Council works to form coalitions around the council's vision for marine energy, and uses knowledge as a means to lower perceptions of risk. This is intended to prompt the coordinated action that will bring the marine energy industry into being, and so Bristol City Council sees *"ideas develop through pilots to larger scale demonstrations and then on to become mainstream services."* (Bristol City Council & Energy Service Bristol, 2018, p. 8)

The use of knowledge as a tool to encourage coordinated action in the form of the foundation of the marine energy industry is significant, as it brings to the forefront Bristol City Council's approach to realising the desired changes to the city's infrastructure. It is clear from the outset that coordinated action is central to the approach, as the council believes it *"will require … substantial contribution from all sectors, and a scale of action, investment and collaboration beyond what we have seen to date,"* (Bristol City Council, 2015, p. 18) and this means enrolling the relevant actors into playing the role envisaged for them. The funding for these technological and infrastructural changes is to be partially generated through central government or European funding sources including grants, and community efforts. However, there is a significant role to be played by community energy groups and private investors, the latter of which form the foundation of the city council's approach to realising its sociotechnical imaginary.

As outlined in the previous sections, community energy groups are given a key role in the realisation of Bristol's sustainable energy system through their contributions to its renewable energy power source. This requires the same building of shared visions, and coordination of

action, according to the council's expectation of the role to be played by community energy. The city council believes that successfully realising the role of community energy in Bristol's energy system will require:

> *transparency, openness and collaboration with community groups in order to understand the problems, develop a shared approach, leverage additional investment, and share skills and knowledge in order to maximize the delivery of low carbon and renewable energy in the City at a community level.* (Bristol City Council, 2015, p. 47)

Collaborating with community groups is presented as significant for both developing common understandings of problems, shared visions, and ultimately achieving Bristol's transition. It is when looking at community energy that it becomes most obvious that building coalitions of actors means building networks of diverse groups, as Bristol City Council seeks to expand the influence and extent of community energy groups, in order to increase the contribution these groups can make to the provision of greener forms of energy. In particular, this means making the case for community energy to actors like investors who are to play a role in strengthening these initiatives:

> *Bristol City Council (BCC) will seek to enable greater uptake of community led energy initiatives, making sure that the benefits of community energy are better understood and market community energy to developers and investors as part of our Corporate programmes.* (Bristol City Council, 2015, p. 48)

The city council attempts to form new coalitions for action by connecting investors with community energy groups, which enables these groups to play the role envisaged for them by the council in realising its energy goals. Private investors are central to the realisation of Bristol City Council's approach to realising its imaginary in an environment where public money has proved insufficient for stimulating Bristol's transition. The approach taken by Bristol City Council was to develop and release the 'City Leap' prospectus, which is "*a soft market testing exercise*" (Bristol City Council & Energy Service Bristol, 2018, p. 0) that is intended to test the ability of the market to *"deliver up to £1bn of low carbon and smart energy infrastructure investment in Bristol's energy system over the next ten years.*" (Bristol City Council & Energy Service Bristol, 2018, p. 5). Bristol City Council's sociotechnical imaginary is to be achieved through *"the building of replicable, investable business cases across the full range of energy-related technologies at city-scale for the benefit of residents, businesses, the council and Programme partners."* (Bristol City Council & Energy Service Bristol, 2018, p. 10) In this vision Bristol's sustainable future is to be built on revenue generating businesses that will both benefit the actors that invest in sustainability, and

a host of other human and institutional actors. In some cases, the imagined recipient of the revenue to be generated is the council itself; for example, the use of council land for renewable energy installations means the council is able to *"derive benefit from lower fuel bills and potentially enter into power purchase agreements to sell the electricity through Bristol Energy to local households and businesses."* (Bristol City Council & Energy Service Bristol, 2018, p. 19) While investing in heat networks is seen as an opportunity to generate revenue for the council because "*as well as providing an upfront connection fee, these new connections will provide long term revenue to BCC through heat sales.*" (Bristol City Council, 2018a, p. 9) The foundation of a council-run energy company, which is highly unusual in the context of the UK, also reflects the city council's changing priorities in the face of the financial challenges it is currently facing. However, generally it is private actors who invest in sustainability measures that are to receive these economic benefits.

The need to coordinate the investment of other actors in line with Bristol City Council's sociotechnical imaginary in order to realise the technology and infrastructure in it, places new requirements on the sustainability measures. In particular, as the achievement of sustainability through *"replicable, investable business cases"* has come to primacy, the requirements placed on the ability of these measures to generate revenue have grown. (Bristol City Council & Energy Service Bristol, 2018, p. 10) Previously, the requirements placed on sustainability measures was that they should generate enough revenue to be reinvested into further sustainability measures. Now it has become clear that it is seen as necessary for sustainability measures to become the foundation of new forms of economic life, in the form of new businesses and revenue streams. (Bristol City Council, 2015; Bristol City Council & Energy Service Bristol, 2018) This is likely to place further limitations on the types of sustainability measures that are selected and what is considered a plausible transition pathway. In this way, the sociotechnical imaginary that drove Bristol City Council to adopt this collaborative style of governance may in turn be reshaped by the interests of those actors who become engaged in these collaborations. (Bristol City Council & Energy Service Bristol, 2018, p. 15)

The process outlined in the prospectus is one where the council holds the power to dictate whether potential investors are allowed to invest in Bristol's energy infrastructure according to their degree of alignment with the council's vision for Bristol. (Bristol City Council & Energy Service Bristol, 2018) The involvement of partners is expressed as a means to *"achieve the*

council's objectives," (Bristol City Council & Energy Service Bristol, 2018, p. 15) and, alternatively, as a way to achieve *"shared goals."* (Bristol City Council & Energy Service Bristol, 2018, p. 1) And while in the second quote, the emphasis is on mutual aims in both cases there are to be a set of unified goals and an ability to collaborate around the council's vision. And, as aforementioned, the council reserves the right to *"not to enter into any partnership or arrangement for any reason whatsoever."* (Bristol City Council & Energy Service Bristol, 2018, p. 31) It is only possible to exercise power to exclude particular actors from partnerships if you are in fact considered a desirable partner. The advocacy of the value added by Bristol City Council, and, for that matter, the attractiveness of Bristol as a site for investment, again emerges as a key means by which it seeks to enroll actors into partnerships to act according to the council's vision. In the 'City Leap Prospectus' the council outlines what it refers to as *"achievements, assets and enablers."* (Bristol City Council & Energy Service Bristol, 2018, p. 6) These categories are intended to provide insight into the value that could be added by through partnerships with the council, or the council's *"ability to deliver, and enablers that prospective partners could leverage."* (Bristol City Council & Energy Service Bristol, 2018, p. 6) The council's 'achievements,' or its successes as a manager of different energy projects, are used to advocate for itself as an expert that has valuable experience to bring to partnerships. This is not the only kind of immaterial value added that the council outlines, and in fact, the coalitions of actors that the council has already formed are seen as important leverage for forming new ones.

> *The city also has extensive reach through global networks such as Enercities, Rockefeller 100 Resilient Cities, Eurocities, the Global Parliament of Mayors, the UK Foreign and Commonwealth/Department for International Trade network overseas, as well as city-to-city partnerships in Europe, US and Asia. We propose to use this network to share learning and to promote the work of our partners in the City Leap Programme who may wish to allocate resource [sic] to this area because of the value it could generate for them.* (Bristol City Council & Energy Service Bristol, 2018, p. 20)

In this quote, the value added by the city council is the promotion of partners in networks outside of the city's boundaries, and the promise that this will enable further value generation for its partners. The advocacy for the value added by partnering with the city council continues as Bristol City Council identifies itself as a gateway to cheap finance. *"Bristol City Council has access to sources of relatively low cost finance for delivery of public infrastructure. Capital funding from these sources may, therefore, be available to support particular aspects of the City Leap Programme,"* and this is presented as a compelling reason for partnering with the council. The conditions

attached to this form of finance can also have the effect of directing investment towards public infrastructure, as desired by the council. (Bristol City Council & Energy Service Bristol, 2018, p. 8) Bristol City Council also positions itself as a useful partner as an owner of a number of infrastructural assets, including renewable energy generation capacity, the ownership of land, highways, and social housing. (Bristol City Council, 2018a) In this respect, Bristol City Council establishes its relevance to these coalitions by presenting itself as a gatekeeper to useful resources, including coalitions of actors, finance, and relevant land or infrastructure. Finally, Bristol City Council also acts to can also act as an important advocate or detractor for potential investors:

> *It is also recognised that market and regulatory structures can obstruct innovative approaches to engaging citizens and the process for approving certain infrastructure investment decisions. Bristol City Council intends to engage with regulators, such as Ofgem, to identify opportunities to use City Leap to test new ways to save costs and deliver benefits to citizens through the transformation of the local energy system.* (Bristol City Council & Energy Service Bristol, 2018, p. 10)

This can be interpreted as a means by which the city council seeks to change the conditions of the market, both through altering the framework conditions that it operates under, and encouraging the engagement of other actors by changing their perceptions of the market conditions.

Further analysis reveals that attempting to influence regulatory frameworks is not the only way that Bristol City Council has acted in an effort to alter market conditions. While market mechanisms are seen as key for Bristol's transformation, this is not to be a 'free' market. Instead, it is imperative to shape the market correctly in order to achieve the city council's goals. The council, through the successful realisation of its City Leap programme will *"provide the finance, create the demand and engage the supply chain, all of which are required to deliver an energy efficiency programme at scale."* (Bristol City Council & Energy Service Bristol, 2018, p. 16) In this scenario, the energy efficiency market is essentially to be built from the ground up by Bristol City Council, by engaging all the necessary actors to create the market, from manufacturers to consumers and enrolling these actors into the council's vision. Different interventions are made by the council to support the creation of the marine energy industry. The council *"has supported the development and maintenance of professional skills within this sector ... and has a dedicated marine energy officer to develop this sector further, in line with the economic potential."*

(Bristol City Council & Energy Service Bristol, 2018, p. 22) This is another way in which the city council seeks to shape the conditions of the market that is to deliver the measures for Bristol's transition. In this case it is attempting to build and maintain a workforce with the skills and expertise to bring the marine industry into being. The actions of the city council in each of these examples can be seen as an attempt to shape how investors perceive the conditions of the market, and each of these two examples of how the city council attempts to shape the market involves the creation of a significant network of actors, all of whom must act in certain ways mandated by Bristol City Council in order to realise its vision of more energy efficient spaces, or a marine energy industry. This emphasises that nothing short of significant coordinated action according to the belief that the different sustainability measures that are central to Bristol City Council's sociotechnical imaginary represent important and legitimate business cases will bring about the council's vision.

5.3.3 Governing Bristol's Transition: Changing Urban Governance

It is clear that Bristol City Council believes it must govern increasingly through the coordination of the action of other actors, and collaborative vision formation has become an increasingly important tool for governance, as it is seen as a powerful means to coordinate action. The significance of this change cannot be underestimated, and in the most recent documents the commitment to collaborative vision formation for coordinated action has precipitated a shift to an entirely new form of governance by the city council:

> *we are truly realising the aim of moving our understanding that modern city leadership requires a move from local government (a disproportionate focus on the machinations of the city council) to city governance (a recognition Bristol is a collective act and is the product of the decisions made by the whole spectrum of city actors)* (Bristol One City, 2020b, p. 5)

This is referred to as its 'One City Approach' to governance, which is based around the coordination of thematic boards one of which is the One City Environmental Sustainability Board. These boards are made up of representatives including a member of the city council, and other actors "*from the public and private sectors, unions, civil society and politics - each taking responsibility for one of the six strands in the One City Plan,"* . (Bristol One City, 2020b, p. 5) The vision developed through this process is then to be used as a tool to align the actions of various actors across the city, and, in the words of the co-chair of the Environmental Sustainability Board, *"it will be for each member - including those representing Bristol City Council - to take these views back to their own organisations and their decision-making structures."* (Cousins, 2019) This does

not replace the normal governance processes of the council; however, it represents a significant co-production of sociotechnical imaginaries of urban sustainability and urban governance. Bristol City Council's sociotechnical imaginary of sustainability is constitutive of its view of its own role as a governing body, as the future it constructs for the city is in fact a construction of what the city council believes it is responsible for delivering to the city and its citizens. These goals and a belief in the capability of technology to deliver all of them simultaneously has produced a transition pathway that requires significant investment, and influence over existing infrastructures and technologies. This need, coupled with the council's limited capacity to act independently to make these changes has contributed to a style of governance that centres around coordinating the action of a wide array of other actors. These actors are then involved in collaborative vision formation to motivate them to act in the way mandated for them in the city council's imaginary; for example, by generating knowledge or investing in infrastructure. The involvement of actors in each of these processes may then in turn alter sociotechnical imaginaries of a sustainable Bristol. Coalitions for knowledge creation may generate knowledge that will stabilise elements of the imaginary, or knowledge that will destabilise and change it. The same potential emerges from belief that it is necessary to achieve Bristol City Council's sociotechnical imaginary through the coordinated action of investors. This belief has contributed to the conviction that Bristol as a sustainable sociotechnical system must be achieved through the creation of legitimate business cases that will generate revenue for these investors. The need to generate revenue is an important constraint on what sustainability pathways are considered viable, and may contribute to an ongoing reshaping of Bristol City Council's sociotechnical imaginary. This constitutes a co-production of urban sustainability and urban governance, and in the documents, the co-production of urban governance and urban sustainability goes much further.

The need to engage in collaborations is frequently linked to the council's perception of both the material and social complexity of Bristol's energy system, and of the limitations in its ability to directly affect all of these different elements:

> *Our energy system is complex, and our energy use and the resultant CO2 emissions we generate, are constantly influenced and affected by the decisions of many people, communities, organisations and industries in Bristol and beyond.* (Bristol City Council, 2015, p. 1)

This quote highlights the scope and complexity of the energy system as it is perceived by city council, not just in the respect that the conditions of the energy system are produced by the

decisions of countless actors within Bristol, but are also defined by those beyond the city boundaries. The recognition of the non-local character of energy systems has prompted the city council to *"work with neighbouring authorities in the West of England,"* and engage with both national and international actors with the ambition to prompt coordinated action. (Bristol City Council, 2015, p. 1) Bristol's decarbonisation is seen as depending on the conditions of the electricity grid of the wider UK, and *"if the decarbonisation of the national grid progresses more slowly than planned, Bristol could see a rise in emissions beyond 2025."* (Bristol City Council, 2015, p. 31). This is not just seen as a product of the physical obduracies of the infrastructure, it is clear that the policy context of the UK and Europe is considered as key to Bristol's transition as the material elements of the wider energy system:

> *The European and National framework for energy policy, regulation and incentives is a major determining factor in meeting emissions reduction targets. As such, BCC will continue to work with [sic] UK government to advocate the continuing decarbonisation of the national energy system, and enhance the uptake of energy efficiency, sustainable transport, low carbon and renewable energy measures at the local level.* (Bristol City Council, 2015, p. 29)

Not only is the reliance of Bristol's transition on the national and European policy context highlighted here, so is the city council's intention to act to influence policy at the national level. The city council seeks to alter UK policy to reflect its vision for a low carbon future, which is one of enhancing the uptake of certain energy technologies at a local level. The principle of 'advocacy' is therefore the attempt to prompt coordinated action by national and international actors according to the vision adopted by Bristol City Council. This demonstrates that vision formation at all levels is not a one way process, and that for the city council, governing Bristol's transition is a process of influencing and being influenced by other actors. What is deemed possible is highly influenced by the visions held by the central government that are embedded in policy at that level. However, these forces are not deterministic and there is a changing imaginary of the relationship between the city council, and the central government emerging in these documents. In the earliest document, 'Our Resilient Future' there was a *"recognition that local governments share the responsibility and are uniquely placed to lead in combatting [sic] climate change,"* and a commitment to *"demonstrating effective decentralised action."* (Bristol City Council, 2015, p. 5) Over time this has evolved to be a true advocacy for the devolution of power from the central government:

> *Given the UK's centralised system of governance we are often bound by Government direction and related legislation, as well as relying on many central grants, the reduction of which has*

> *caused many of our current financial challenges. … We will continue to seek more devolution of national powers and funding to a local level and make the case for fairer funding, whilst collaborating where it is beneficial to the city.* (Bristol City Council, 2018b, p. 13)

There is a desire to gain greater autonomy from the central government, and gain greater power to direct decision-making, and action at the local level. The changing role imagined for local government is again, at least partially attributable to the character given to Bristol's transition, and the need to change the material elements of the city. *"The council advocates that devolving infrastructure decisions to the local level, enabling local solutions to be developed, will deliver effective management and realisation of synergies and trade-offs across a range of objectives."* (Bristol City Council & Energy Service Bristol, 2018, p. 10) In this respect, the same conditions that have prompted a move towards forming extensive collaborations for vision formation collective and action, have in this case contributed to the belief that there should be a devolution of power to local government.

Discussions of the relationship between local government and national government have largely characterised national government as a hindrance to the work that needs to be done by the local government. In contrast, Bristol City Council's desire to strengthen its international partnerships is driven by the belief that they will enable the city to further its strategic aims through collaborations with international actors. Climate change is identified as one of the primary reasons for pursuing global partnerships, interestingly, along with advocating for city sovereignty:

> *We value our international collaborations and work with organisations across the city to raise Bristol's profile abroad. Within our international strategy we prioritise engagement with global cities and organisations that have strong links to Bristol partners; that bring opportunities of funding or investment to the city; that are twin cities; and with whom we can partner on collaborative innovation projects on varied issues like transport and energy. We partner with global networks to increase our understanding of challenges like climate change, and to jointly advocate on issues like governance and city sovereignty.* (Bristol City Council, 2018b, p. 13)

The drive to become increasingly independent from the national government also appears to have some links to the council's desire to establish itself as a global leader in its own right, and to gain recognition by other actors on the international stage. A value which is also embedded in its sociotechnical imaginaries of a sustainable Bristol. This is apparent in Bristol City Council participation in a number of international collaborations for vision creation. The

significance of the city council engaging in these groups is demonstrated by the statement that "*as a signatory of international initiatives, including the 'Covenant of Mayors' and the 'Compact of Mayors', the scope and detail of Bristol City Council's energy and greenhouse gas emission reporting will need to expand."* (Bristol City Council, 2018a, p. 10) As well as the fact that Bristol's 'One City Strategy,' and the 'One City Climate Strategy' are based around the UN's Sustainable Development goals. (Bristol One City, 2019; Bristol One City, 2020a) Not only is Bristol a participant in these international collaborations, there is the commitment that the city council will align its actions with visions articulated by these international coalitions.

From this commitment, it is clear that the city council has enrolled into values, and visions held within these groups, and seeks success according to these standards at an international level. However, we again see that influence is not to be one way, in the respect that the city council seeks to expand its influence beyond the boundaries of the city. Bristol City Council sees its efforts as a kind of urban experiment, the results of which can be readily exported to other sites:

> *For those outside Bristol, the programme ... is replicable nationally and internationally. The City Leap Programme provides an urban living laboratory mechanism to demonstrate how to strategically manage such a wide ranging, diverse programme of works, as well as demonstrating the framing and catalytic role of local and central government.* (Bristol City Council & Energy Service Bristol, 2018, p. 5)

By succeeding in the field of sustainability, a value that is held both nationally and globally, the city council will not only demonstrate the strength of its transition pathway, but will also achieve recognition as an example of good governance. Success means that the city council's influence, in the form of their vision for both sustainability and governance may be expanded beyond the city, and even worldwide. This can be seen as a mechanism for achieving coordinated action according to visions held at the level of Bristol City Council, on a global scale.

This demonstrates that a changing imaginary, and reality of urban governance is being co-produced with sociotechnical imaginaries of a sustainable Bristol. Bristol City Council must govern more collaboratively in tandem with other institutional actors in the city due to the nature of its sociotechnical imaginary of Bristol's transition, and its limited capacity to act directly. However, the city council's role in achieving the overall low-carbon transition is also seen as something that can be used to justify and demand increased resources, power and

independence from central government, to improve its capacity to fulfill this role. Furthermore, this particular sociotechnical imaginary of sustainability is to be a pathway to building greater international influence for Bristol City Council, and for expanding its sociotechnical imaginary beyond the borders of the city to coordinate change on a national and international scale.

5.3.4 Governing Bristol's Transition: The Co-production of Urban Sustainability and Urban Governance

Earlier parts of the analysis elaborated a sociotechnical imaginary of a city that had been socially, economically and politically transformed through a highly technological sustainability transition, arguing that sociotechnical imaginaries of a sustainable Bristol and Bristol as a good and successful city were being co-produced. This section then showed how the concept that Bristol should be sustainable, and that it should become so through infrastructural and technological means has also played a role in shaping the city council's approach to governance, arguing that Bristol's sociotechnical imaginaries of a sustainable Bristol were being co-produced with its form of urban governance. The processes of production of the corpus of documents analysed here demonstrate a growing focus on collaborative vision formation, which accompanies an increasing need for the city council to govern through the alignment of goals and coordinated action. This is strongly linked to the perception of the limited reach and resources of the council, which means it must coordinate action by a large number of other actors in order to generate the knowledge and the wide-scale infrastructural changes that are required for the realisation of its imaginary. While collaborative vision formation is one of the council's core approaches for initiating coordinated action according to its vision, it is not the only one. The council also seeks to govern by forming coalitions for action and must use a variety of capacities, including expertise, political influence and ownership of key infrastructure to discursively construct itself as a desirable partner for their formation. These capacities will also be leveraged by the council to establish a position of influence within these coalitions. The council also takes various actions in an attempt to change the conditions of the market that is to bring about its desired transition. The council intends to generate supply chains, engage regulators, conduct research to reduce investment risk, and has supported the development of relevant skills in the workforce all with the aim of making market conditions appear more favourable to investors. In this way, it is possible to see how imaginaries of a sustainability pathway that focuses on infrastructure and technologies has played a role in influencing the

production of a form of government that is increasingly based in collaborative vision formation and action, a shift that has culminated in a form of governance that is considered to be completely novel by the city council: it's 'One City' approach to governance.

This collaborative form of governance then opens Bristol City Council's sociotechnical imaginary up to further change, and in this way urban sustainability and urban government are being co-produced. This is not the only co-production that is occurring: the move towards sustainability, and the focus on changing infrastructure at a local level is being used to advocate for the devolution of power from the central government to the city government. Conversely, as the city council seeks greater independence from national governance, it pursues greater alignment with other international actions. Bristol City Council aims to establish itself as an influential global actor in its own right, and Bristol's sustainability transition is both a driver and a mechanism for achieving this goal. By achieving a vision of sustainability that is recognisable by the values embedded in international frameworks, the city is able to establish itself as a model for sustainability, governance, and a global leader. More than that, it is to generate a model of urban governance and a framework for achieving a sustainable city that will be adopted by other international actors. Therefore, generating a sustainability pathway according to a certain set of values becomes a mechanism for increasing political power on the national and international stage. This represents a co-production of urban sustainability and urban governance.

6 Conclusions

This case study of Bristol City Council and its governance of Bristol's low-carbon transition constructed a sociotechnical imaginary of a sustainable city that is to be transformed in its entirety through the use of low-carbon technologies. Low-carbon technologies like renewable energy sources, heat networks, electric cars and energy efficient appliances form the core of a sociotechnical imaginary of a city as a sustainable sociotechnical system, where sustainability refers to both the level of carbon emissions emitted by the system and the degree of energy security that the city enjoys. The value that a sustainable city is also one with a secure energy supply was born of the narrative that *"secure supplies of energy is crucial for social and economic development."* (Bristol City Council, 2015, p. 29) Therefore, the challenge is not to decarbonise Bristol, it is to decarbonise the city without impacting practices that are considered central to social and economic life. In other words, Bristol's transition is to deliver *"a sustainable future where we can live well and do business without further damaging the climate we rely upon."* (Bristol City Council, 2015, p. i) The sustainability measures in the document are selected based on this understanding of sustainability, and, importantly, based on the value that they must be cost-neutral to Bristol's economy. Therefore, the selection of the highly technological measures in the council sociotechnical imaginary of sustainability represents a belief that technology has the ability to change the relationship between energy consuming practices and their carbon emissions, and by doing so serve the goals of carbon-neutrality, energy security, social development and economic strength simultaneously. The measures to be used to attain Bristol's sustainable future change the relationship between practices and their carbon emissions through two main mechanisms, which often work in tandem. Firstly, they may reduce the carbon penalty associated with a practice by improving its energy efficiency. Secondly, they can act to apparently decouple a practice from its carbon emissions entirely, by replacing a fossil fuel source with a renewable source of energy. They also target three main areas: travel practices, heating practices and the supply of energy to the grid. In each case it is largely the material components of these practices that is problematised and is to be addressed through changes to the infrastructures and technologies associated with these practices. In the case of travel, it is the private fossil-fueled car that is deemed problematic and a modal shift away from the private fossil-fuel cars is to be achieved through the provision of low-carbon public transport, improved walking and cycling infrastructure, and infrastructures to support the

adoption of electric cars. The carbon emissions of heating practices are instead to be addressed through energy efficiency upgrades to homes, and the introduction of heat networks which may be supplied by renewable energy sources. However, the most extensive changes and the most explicit requirement for behaviour change comes from the goal of decarbonising the grid. The decarbonisation of the electricity supply is to be achieved through the integration of renewable sources like solar panels and wind turbines, which propagates a number of other changes. These renewable sources introduce variable rates of energy production which are to be accommodated by the introduction of other technologies like electric cars, which can provide balancing services to the grid. However, the major means of managing this variability comes from the *"co-ordination of decentralised renewable energy production … and end user consumption through enabling technologies.* (Bristol City Council & Energy Service Bristol, 2018, p. 14) In other words, Bristol's citizens and businesses must alter the temporality of their energy practices according to the patterns of energy production of Bristol's new energy system. This behaviour change is to be driven by other technologies, denoted 'smart' technologies via a number of different mechanisms. Firstly, smart meters with variable energy rate tariffs are designed to make consumers aware of their patterns of energy consumption, and then apply a financial incentive to change these patterns. Other technologies act to remove further perceived barriers to the desired behaviours by allowing the remote activation of technologies, or by introducing automation that eliminates human decision making as much as possible. In addition, introducing more energy efficient technologies and making energy efficiency upgrades to buildings are to be introduced as the central means to make *"homes, transport and businesses much more energy efficient, reducing the overall demand for energy so that we can supply it from renewable and low carbon energy.* (Bristol City Council, 2015, p. 34) It is possible to see that the pursuit of each of these goals: the decarbonisation of heating, travel and the electricity grid, relies on the alteration or introduction of a technological or material element. This is true even in the cases where explicit behaviour change is required, which demonstrates the strength of the belief that technology is able to disentangle practices from their carbon emissions.

The individual technologies within the sociotechnical imaginary of sustainability, are not just central to this imaginary, they are the basis of a reimagination of the city of Bristol as a whole. The sociotechnical imaginary of a future Bristol was divided into two visions, to highlight that the different benefits to be derived as a consequence of Bristol's transition were actually to be derived by two different types of actors. The first vision featured the city as an identity that can

be perceived by other global actors, where the city was the actor to benefit from Bristol's transition. The second vision featured Bristol as it is experienced by its citizens, who were to be the recipients of the benefits in this vision. In the first vision, the highly technological transition pathway in the city council's imaginary becomes a vehicle for building Bristol's economic strength by recapturing value that *"leaves the local economy every year through payment of the energy bill,"* (Bristol City Council, 2015, p. v) and by forming the basis for a 'green' economy. Here the low-carbon transition is constructed as a key mechanism for ensuring Bristol's economic competitiveness, instead of a potential threat to Bristol's economy. Increasing economic competitiveness is an important value that is highly entangled with principles of international competitiveness, and sustainability has also become a field in which to compete on the global stage. Bristol's sustainability transition becomes a means by which Bristol City Council can demonstrate the city's leadership according to a variety of measures, including expertise, economic strength and the integrity of Bristol as a community. This resonates with the findings of other case studies that also found that urban sustainability transitions have become embedded in narratives where they are central to 'green' economic growth and global competitiveness. (Tozer & Klenk, 2018a) However, demonstrating these qualities through a sustainability transition means pursuing a sustainability pathway that resonates with discourses concerning the 'right' form of sustainability that are held at international levels. This means that the pathway to Bristol's low-carbon future is likely to be shaped by Bristol City Council's visions of Bristol as a global leader, as much as sociotechnical imaginaries of the future city are shaped by the belief that the technologies within this pathway are able to deliver a particular kind of imagined future. This same co-production is apparent when we consider the social transformation that is central to the second vision of Bristol: the city as the lived experience of its citizens. Here, low-carbon technologies are also to transform the lives of Bristol's citizens, as renewable energy sources, energy efficiency measures, electric vehicles and heat networks deliver a host of social benefits. Benefits which include greater energy security, reduced energy bills, improved job prospects, reduced inequality and a better health and quality of life overall. Findings which are, again, reflective of those in other case studies of sociotechnical imaginaries of urban transitions. (Levenda et al., 2018; Richter et al., 2016) Once more, these goals are seen both as deliverable by the pathway constructed in the documents, and as forces that will play an ongoing role in shaping Bristol's transition pathway. In this respect, it is clear that sociotechnical imaginaries of Bristol as a sustainable sociotechnical system and imaginaries of what Bristol should look like as a city in its entirety,

are so entangled as to be inseparable, and imaginaries of sustainability are being co-produced with imaginaries of the city as a whole. Ultimately, Bristol City Council's sociotechnical imaginary is one of a city that has reduced its carbon emissions, and ensured its supplies of energy without any detrimental effects on its social life or economy. A city that has established itself as a global leader by a variety of measures, as sustainability becomes a shorthand for a variety of strengths, including economic strength, expertise, and the social integrity of its citizens. And finally, a future city where citizens are wealthier, healthier and more equal. A future that is to be realised almost exclusively through the use of low-carbon technologies.

The belief that the alteration, exchange or introduction of low-carbon technologies will lead directly to the decarbonisation of problematic practices is at odds with literature that argues that technologies are highly embedded into practices and cultures, as well as social norms and values, which means that achieving low-carbon transitions is not simply a matter of exchanging 'bad' technologies for 'good' ones. Instead, a significant amount of social work is required to achieve 'transitions in practice' in order to address unsustainable practices. (Dodson, 2014; Shove, Walker & Brown, 2014; Walker & Cass, 2007) Furthermore, it ignores the wider social contingencies that may affect the achievement of Bristol City Council's sustainability, and particularly its social goals. As demonstrated by Levenda et al., (2018) and Richter et al., (2016) in their case studies of the deployment of distributed solar power in Phoenix, the successful implementation of a technology does not necessarily lead to the desired social outcome. Instead these technologies are embedded into sociotechnical systems with powerful actors and their interests, which have the potential to define whether benefits may be derived by Bristol's citizens or not. In these two case studies, citizens' sociotechnical imaginaries featured a more democratic energy system, which would enable citizens to financially benefit from producing energy, and perhaps even redress historical inequalities. This was defeated by the utilities who acted to protect their interests, and lobbied regulators to cut feed-in tariffs for solar power producers in the community.

The failure to discuss these contingencies reveals significant potential for both the overall failure of Bristol City Council's transition pathway, and its potential to generate inequality. The production of social goods are seen to follow more or less naturally from the introduction of technology. In reality, the sociotechnical imaginary comes with a significant allocation of responsibility to Bristol's citizens to accept specific roles in the new sociotechnical system. The

realisation of Bristol City Council's sociotechnical imaginary relies on Bristol's citizens becoming energy producers to fulfil the renewable energy targets of the city council, altering the fabric of their homes, changing the temporality of their energy practices and adopting technologies like more energy efficient household appliances, electric cars or smart meters. Only by integrating themselves into this new sociotechnical system in these particular mandated ways, both as a collective and as individuals, will Bristol's citizens be able generate and derive most of the benefits to be found in the new sociotechnical system. This means that choices regarding spaces, technological artifacts, and practices are being reframed as choices that affect the wellbeing of the city at large, and points where the citizens of Bristol are meant to enact their responsibility for the functioning of Bristol's as a sustainable sociotechnical system and the well-being of their fellow citizens. Recognising the role of the social in the supposedly technical is important both for the success of this transition, and in the interests of social justice. People are not equally able to take up the responsibilities that are being distributed throughout Bristol, whether by investing in the technological or infrastructural changes required of them, or by having the flexibility to adapt their practices in the way mandated by the documents. This poses a problem both in the respect that it threatens the achievement of sustainability and because it means that individuals are not equally able to unlock the potential benefits, like energy bill savings, from adopting these technologies. More than that, it is possible to see how those who don't have the flexibility to change their practises may even be punished for doing so; for example, by attracting higher electricity tariffs if they are not able to change their consumption patterns. Furthermore, the acceptance of new technologies or infrastructures means being integrated in new ways into sociotechnical systems that are intended to support the generation of profit by the investors who are to bring them about. These actors and their interests will undoubtedly shape whether citizens are able to derive benefits, and to what degree. It also highlights that the entanglement of so many other values, goals and interests in the same pieces of infrastructure comes with the risk that the failure to serve one value may be masked or deemed worthwhile because some other goal is satisfied; for example, economic strength over carbon reduction or social justice. There is therefore a risk that this system change might propagate inequalities, rather than delivering on the opportunities for wide-scale positive social change. These dynamics highlight the ways that sociotechnical imaginaries of sustainability may be co-produced with the city and social life in ways that are left unimagined in the documents. It also shows the utility of scrutinising the urban governance of transitions through the lens of sociotechnical imaginaries because, unlike

the majority of other approaches to transitions, it is not biased towards historical analysis of past transitions. Instead, constructing sociotechnical imaginaries from past or current actions and discourses that also look towards the future can give some insight into what forms of transition are to be pursued and why these choices are being made. This is useful because sociotechnical imaginaries can be constructively critiqued with reference to the lessons learned from more historical case studies, and as has been demonstrated here, through this process it is possible to identify and interrogate values, assumptions and biases that may cause transitions to fail, or lead to an unfair distribution of burdens and benefits. Early identification of these potential issues gives the greatest opportunity to make better plans, which is particularly significant when considering transitions because there is a need for them to progress quickly under conditions of high uncertainty. Furthermore, transition pathways that focus on technological and infrastructural change require a large amount of capital investment, which contributes to system lock-in that will be difficult to disrupt. (Geels, 2005a; Hughes, 1983) This is important because while any social effects of these systems emerge in complex entanglements of the 'technological,' 'natural' and 'social', in an equally complicated interplay with the wider world, these sociotechnical systems nevertheless produce social effects. (Bijker, 1995; Jasanoff, 2004; Winner, 1986; Winner 1993) The tendency of these systems to obduracy then means that any social effects that they contribute to have the potential to persist for decades to come. Therefore, it is essential to disrupt potential for detrimental effects as much and as early as possible.

Sociotechnical imaginaries have a further utility in the respect that they are always somewhat reflective of the actors that are creating them. Therefore, Bristol City Council's sociotechnical imaginary of a sustainable and transformed Bristol offered an entry point into understanding how the council seeks to govern the transition. These sociotechnical imaginaries of a future Bristol are products of how council imagines its role as a governing body, and are a painting of what the city council believes it is responsible for delivering to the city and its citizens. The city council is to build a city that is sustainable, economically strong and a leader on the global stage, as well as unlocking economic savings, job opportunities, health benefits; and a better overall quality of life for its citizens. The application of the multi-level governance perspective offered further insights into Bristol City Council's mode of governance as it highlighted other influences that emerge as a result of the council being embedded in a context that is subject to a number of overlapping spheres of authority. The city council is embedded in political networks

with other national and international actors, whether governmental or non-governmental, each of which have their own interests, values and visions of the future. The analysis discussed how the potential influence of these other actors is made apparent in the documents, highlighting the number of international frameworks and agreements that Bristol City Council engages in, and its need to attract outside funding as key means through which a number of other actors may shape the imaginaries of Bristol City Council. However, the influence of other actors on the development of the city council's sociotechnical imaginaries was most strongly introduced as a result of a style of governance that has become increasingly focused on collaborative envisioning and coordinated action. A form of governance that has been co-produced with sociotechnical imaginaries of a sustainable Bristol.

The corpus of documents analysed here and the sociotechnical imaginaries in them were produced through processes that were increasingly collaborative, and this was driven by a need for the city council to govern through the alignment of goals and coordinated action. A change that was presented as ultimately culminating in an entirely new form of governance by the city council: a 'one city' approach to governance. This form of governance was shaped by the sociotechnical imaginary that the city council wants to realise, as it requires significant investment and the wide-scale changes in infrastructure. The council lacks the financial resources and jurisdiction to make these changes directly, which means it must coordinate action by a large number of other actors including investors, knowledge producers, individuals and community energy groups in order to realise its imaginary. Collaborative vision formation is a core means of achieving this coordinated action by generating a shared sense of ownership, and in this respect it is possible to see how urban sustainability and urban governance may be co-produced. The demands of a Bristol City Council's sociotechnical imaginary and its limited resources and authority the imagined changes directly, drives a form of governance that at its very core opens up this sociotechnical imaginary to change. This can occur during the processes of collaborative vision formation that are to drive coordinated action, or emerge as a result of information produced by coalitions for knowledge production, or may occur as a result of the integration of investors and their interests into coalitions for infrastructural change. This is an extremely useful insight as it emphasises that Bristol City Council cannot act with complete autonomy, and this is important to acknowledge if local government is expected to play a central role in the low-carbon transition. It highlights that not only must synergies be built between local and central government to improve the capacities of local government to act, but

with the multiple actors that must also be brought in line with these plans. Further work that scrutinises the interactions between Bristol City Council and these governmental and non-governmental actors can produce richer information about potential hindrances and enabling factors than is possible from the scrutiny of a single actor. This finding reflects arguments made by a number of the theoretical perspectives discussed in the state of the art, including the multi-level governance and multilevel perspectives, which emphasise the importance of networks of other actors for determining transition outcomes. Both sociotechnical imaginaries, and the products of these sociotechnical imaginaries emerge through processes of collaboration and contestation, which are key points for leveraging successful change. (Bulkeley & Betsill, 2005; Dale et al., 2019; Emelianoff, 2014; Ehnert et al., 2018; Haarstad, 2016; Huang, Castán Broto, Liu & Ma, 2018; Hodson, Geels & McMeekin, 2017; Jaglin, 2014; Kern & Bulkeley, 2009; Marvin & Hodson, 2009; Verdeil, 2014)

We can see hints of these dynamics when considering the way that the council discursively constructs itself as a desirable potential partner for coalitions for action with other actors. The council makes reference to a variety of its own capacities as well as attractive features of the city to make partnerships attractive to investors. The council characterised the city as economically strong, a centre for sustainability related businesses and centres of expertise, as well as a thriving, vibrant and socially conscious community, features that make Bristol an attractive prospect for investors. The council then presents itself as an institution with significant expertise and experience in undertaking energy projects, and one that can alter market conditions to make them more favourable to investors, as well as a means of accessing sources of cheap finance, building political influence and gaining access to key infrastructure. This construction of the city and the city council is performed to make it a desirable partner and to engage partners on its terms. By doing so Bristol City Council seeks to exercise power over the transition to be realised, which is apparent in the statement that the council reserves the right *"not to consider Expressions of Interest for any reason whatsoever,'* and to *"not to enter into any partnership or arrangement for any reason whatsoever."* (Bristol City Council & Energy Service Bristol, 2018, p. 31) This construction is important because it highlights the capacities that Bristol and Bristol City Council have to leverage in order to bring about its sociotechnical imaginary of a sustainable Bristol through the investment of other actors. Whether this form of governance successfully engages other actors to bring about its imagined transition, and the role that these different capacities played in realising this transition could be a fruitful subject

for analysis, and gathering lessons learned for other transitions. This is particularly true when considering that the same capacities of cities is highly contextual; therefore, even if Bristol City Council's transition is successful, it will likely not be successful if it is replicated exactly in other sites. This information may then be used to help design transition pathways for other contexts. (Coenen, Benneworth & Truffer, 2012; Marvin & Hodson, 2009; Raven, Schot & Berkhout, 2012) This is particularly significant as the final co-production of sociotechnical imaginaries of urban sustainability and urban governance is a City Council which has greater autonomy from central government and an increased on the global stage. In this imaginary of urban governance, Bristol City Council's model of an urban sustainability transition can be used to demand greater independence from the UK government due to its focus on local infrastructures. Furthermore, it is imagined that its successful realisation will gain Bristol City Council international and establish the council and its low-carbon transition as models that should be emulated nationally and even world-wide. If this is to be pursued, the contingencies inherent in the transition pathway should be well understood, so it may be adapted successfully to different contexts.

In summary, this case study has demonstrated that two co-productions are occurring in Bristol City Council's sociotechnical imaginaries, and realities of Bristol's transition. Sociotechnical imaginaries of a sustainable Bristol, characterised as a city that is low carbon, energy secure, and enjoying continued social and economic development, are being co-produced with a sociotechnical imaginary of the city in its entirety. This sociotechnical imaginary features a city that provides a great quality of life for its citizens, has a strong green economy, and is considered a global leader. This co-production demonstrates that Bristol City Council's sociotechnical imaginary of a sustainable Bristol is indistinguishable from its sociotechnical imaginary of what it means to be a good and successful city. Wide-scale alteration or replacement of existing infrastructure and technologies with low-carbon alternatives provides the link between these sociotechnical imaginaries, and forms the basis of Bristol City Council's sociotechnical imaginary of Bristol's future. A focus that obscures a significant requirement for social work and; therefore, the potential for the production of inequality. A further co-production is apparent as Bristol City Council's style of governance is shaped by the requirements of its sociotechnical transition and its limited capacity to act directly to bring about this transition. The result is a reality and an imaginary of governance that centres around collaborative envisioning and coordinated action with a multitude of actors across Bristol,

brought about by the city council successfully leveraging its own capacities and those of the city. By doing so, the city council will be able to successfully bring about its sociotechnical imaginary of Bristol's transition, and achieve greater sovereignty and international influence for itself as a governing body.

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8 Appendices

8. 1 Abstract in English

Cities have been of growing importance in sustainability transitions due to the large proportion of the population living in urban centres. Therefore, cities and the actors in them have attracted increasing scrutiny in literature that seeks to understand how transitions may be successfully governed and in the interest of social justice. This thesis aimed to contribute to this body of literature using the lens of sociotechnical imaginaries, and the multi-level governance perspective to understand how Bristol City Council is attempting to bring about a low-carbon transition for the city of Bristol (UK). By analysing texts published by the city council, the thesis elaborates an emerging sociotechnical imaginary of a transition that will deliver sustainability, abundant energy, social transformation, economic strength, and a city that is a global leader, all through the introduction of a few key technologies. These goals reflect the role that Bristol City Council imagines for itself as a governing body, and the multi-level analysis shows that this sociotechnical imaginary is being co-produced with a form of city governance that is increasingly collaborative. Together, these perspectives highlight some of the social, political and economic contingencies that shape Bristol City Council's visions for a sustainable Bristol, define its capacity to deliver its sociotechnical imaginary, and that have important implications for a just low-carbon transition for the city.

8.2 Abstract in German

Aufgrund des hohen Anteils der Bevölkerung, der in städtischen Zentren lebt, gewinnen Städte in der Gestaltung ökologischer Nachhaltigkeit zunehmend an Bedeutung. Daher haben Städte und deren Akteure auch in der Literatur zur erfolgreichen Governance entsprechender Übergangsprozesse, nicht zuletzt unter dem Gesichtspunkt von deren Gestaltung im Interesse sozialer Gerechtigkeit, gesteigerte Aufmerksamkeit auf sich gezogen. Die vorliegende Arbeit will einen Beitrag zu dieser Literatur leisten, indem das Konzept der sociotechnical imaginaries und die Perspektive der multi-level governance auf die Initiative des Stadtrats von Bristol (Großbritannien) für eine kohlenstoffarme Energiepolitik angewandt werden. Basierend auf einer Analyse von Publikationen des Stadtrats legt die Arbeit das aufkommende sociotechnical imaginary eines Wandels dar, der Nachhaltigkeit, Energie im Überfluss, soziale Transformation, ökonomische Stärke und eine Stadt in Weltführerschaft bringen wird – alles durch die Einführung einiger weniger Schlüsseltechnologien. Diese Ziele spiegeln die Rolle wider, die der Stadtrat von Bristol für sich als Regierungsorgan vorstellt, und die Mehrebenenanalyse zeigt, dass dieses sociotechnical imaginary mit einer Form der Stadtverwaltung ko-produziert wird, die zunehmend kooperativ ist. Zusammengenommen verdeutlichen diese Perspektiven einige der sozialen, politischen und wirtschaftlichen Kontingenzen, die die Visionen des Stadtrats von Bristol für ein nachhaltiges Bristol prägen, die sein Vermögen zur Verwirklichung des vorgebrachten sociotechnical imaginary abstecken, und die wichtige Implikationen für einen sozial gerechten Übergang hin zu einer kohlenstoffarmen Stadt haben.