

The processes and practices of sustainable cities

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

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Abstract

As concentrations of population and consumption, cities are fundamental to the sustainable transition that is urgently needed to resolve the ecological crisis we are facing. Cities have responded to this challenge with a large number committing to sustainable visions and/or initiatives such as the Global Covenant of Mayors (GCoM), C40 Cities Climate Leadership Group or ICLEI Local Governments for Sustainability network. Whilst there are pockets of best practice we are not seeing the speed or scale of change required in terms of resource use, carbon emissions or well-being. There is an implementation gap between cities' long-term sustainable visions and the short-term actions realised to achieve them; cities are struggling to achieve long-term goals in the face of short-term pressures.

To accelerate sustainable urban transitions a greater understanding of the regime-level processes that enable or constrain translation between long-term visions and short-term action is required. Transition research to date has neglected regime processes, especially non-technical institutional processes and cultural-cognitive habits and heuristics, as well as the role of power and agency. This thesis aims to critically explore the processes of regime-level change to gain insights into how urban transitions occur and under what circumstances they can be accelerated. To achieve this a novel analytical framework is proposed, with transition theory as the foundation, additionally drawing on institutional and quasi-evolutionary theory. This framework is tested using three leading sustainable cities case studies, London, New York and Copenhagen, including interviews with sustainable city network actors. Analysis using the framework generates important insights into how urban transitions might be steered and accelerated. In particular that normative institutional processes are an effective means for regime actors to coordinate power, affect resource allocation, and impact selection pressures and adaptive capacity. The findings suggests that unless the institutional and quasi-evolutionary processes that drive action are re-configured in line with sustainable city visions then progress will be limited.

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List of acronyms and abbreviations

DEP	Department for Environmental Protection
EPA	Environmental Protection Agency
EU	European Union
GLA	Greater London Authority
GHG	Green House Gas emissions
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
LCCA	London Climate Change Agency
LEZ	Low Emission Zone
LSDC	London Sustainable Development Commission
MLP	Multi-Level Perspective
MTA	Metropolitan Transport Authority
NGO	Non-Governmental Organisation
NYC	New York City
NYCAS	New York Community Air Quality Survey
TfL	Transport for London
ULEZ	Ultra-Low Emission Zone
US	United States
WHO	World Health Organisation

Chapter 1 Introduction

“There will be no sustainable world without sustainable cities” (Girardet, 1999, p.419)

1.1 Opening statement

The motivation for this thesis originates from my personal experience as a practitioner: initially supporting Peterborough’s goal to become a truly sustainable city, including establishing a UK network of sustainable city practitioners; and now working at C40 Cities Climate Leadership Group a global network of cities¹. This thesis is driven by years of ever increasing evidence of the ecological crisis we are facing, and yet continued trends towards unsustainability – by the onset of Anthropocene and the urban age and the destruction this is wreaking on our planet, on our climate and biodiversity. And it is inspired by working with a community of sustainable city actors, from Peterborough to Portland, and London to Lima, and by their genuine and strong commitment towards sustainable cities. I set out to ask why, despite this commitment, there is such a huge and growing gap between where we are (heading), and where we need to be. And to find insights into how to overcome this gap and accelerate sustainable urban transitions. My aim is to contribute to transition theory and to efforts on the ground - to the community of practice committed to, and tirelessly working towards, sustainable cities.

1.2 Sustainable development and urbanisation – two defining challenges of our time

In the 21st century we face an unprecedented ecological crisis; we are on the brink of catastrophic climate change and in the midst of a mass extinction (Steffen et al., 2018; Brondizio et al., 2019). And whilst human development has progressed enormously, we still have a long way to go before everyone has sufficient means to live a healthy, prosperous life (Raworth, 2012; Raworth, 2017). As the world is rapidly urbanising, cities are placed at the epicentre of this global challenge to transition to a sustainable society. Given they are sites of consumption and centres of population, cities are fundamental to addressing these urgent needs for sustainable development. However, urban growth is

¹ C40 Cities Leadership Group connects 94 of the world’s greatest cities to take bold climate action, leading the way towards a healthier and more sustainable future www.c40.org

difficult to manage, cities are challenging to govern, and their 'rapacious appetite' for resources continues to increase (McPhearson et al., 2016). Yet as engines of growth and sites of innovation cities also offer 'extraordinary potential' for radical change (Revi and Rosenzweig, 2013).

This transition from rural to urban is one of the biggest transformations in human history (McPhearson et al., 2016), and the decisions we make now, the cities we choose to (re)build, will shape our future (Harvey, 2003). Yet despite genuine, widespread commitment towards the vision of sustainable cities, progress is still woefully slow and the need to accelerate urban change is paramount. At this critical juncture what can we learn from existing city attempts at sustainable transitions? This thesis explores what insights can be drawn from leading sustainable city efforts – from Copenhagen's success in transforming urban travel; from New York's rapid elimination of dirty heating oil; and from London's world first Ultra Low Emission Zone – and further considers how these lessons could be transferred across all cities.

This thesis contributes to research efforts to better understand transitions, exploring the institutional and quasi-evolutionary processes which shape change within complex, socio-technical city systems. It does so in order to answer pivotal questions about whether (and if so how) we can steer and accelerate progress, contributing to on-the-ground efforts. Ultimately how well we learn to govern sustainable urban transitions will determine not only if we can avoid unsustainable cities in order to survive, but whether we can create sustainable, liveable cities that allow us to thrive.

1.3 Sustainable cities – controversies and complexities

It is clear that sustainable cities are critical to addressing sustainable development: 55% of us live in cities (United Nations, 2018); they consume 75% of global resources and account for 70% of global CO₂ emissions (IEA, 2008). Changes in how cities operate are fundamental to addressing current and future sustainable development challenges (Hodson and Marvin, 2012; Castán Broto and Bulkeley, 2013; Ernst et al., 2016). As rapid urbanisation continues, cities are not just shaped by their wider environment, but increasingly they are shaping global trends and overall development patterns (Rohracher and Späth, 2017).

It is less clear how to achieve sustainable cities. The persistent sustainability problems that society faces (e.g. climate change, biodiversity loss) and the challenge of achieving transformative sustainable change require a new approach (Loorbach, 2004; Voß et al., 2006; Grin et al., 2010; Markard et al., 2012). Such persistent problems are particularly

tricky given they are (1) a result of modern society and (2) beyond the capacity of our current, modernist systems to resolve (Grin et al., 2010). The 'new environmental problems' we are facing now are more complex than those of the 70's and 80's and there is a need for more 'substantive transitions' to solve them (Geels, 2010).

Furthermore the complexity of both sustainable development and cities precludes 'blueprint' thinking (Grin et al., 2010). Cities are complex socio-technical and socio-ecological systems; non-linear, emergent change is a property of such complex adaptive systems. This prevents both the ability to know all aspects of the system and the ability to predict or control change (Grin et al., 2010; Köhler et al., 2019). Instead a more reflexive approach is required. A change from command and control to a more learning and adaptive form of management is needed to tackle the 'wicked' problems of sustainable development and rapid urbanisation (Voß et al., 2006).

Even the starting point of simply defining sustainable cities is fraught with complications. Most definitions apply the generally accepted principles of sustainability to the city: the concept of inter- and intra-generational equity and the triple goal of environmental, social and economic sustainability (Brundtland, 1987; Bulkeley and Betsill, 2005). Girardet (1999, p.13) for example, gives the following definition: "A 'sustainable city' is organised so as to enable all its citizens to meet their own needs and to enhance their well-being without damaging the natural world or endangering the living conditions of other people, now or in the future."

However whilst there is broad consensus regarding the overarching principles of sustainable cities the details of this, i.e. defining the practical elements of sustainable cities, are 'hotly contested' (Bulkeley and Betsill, 2005; Smith and Stirling, 2010). Both sustainability and cities are hard to define, so combining these concepts is even more challenging (Camagni et al., 1998; Guy and Marvin, 1999; Muñoz-Erickson, 2014). Sustainability is an inherently ambiguous, complex concept and detailed end goals are not possible to fully define (Voß et al., 2006). And for cities, their complexity and scale means attempts to define them are 'doomed to failure' (Scott and Storper, 2014).

Given the variety of cities and the complexity of sustainability a single definition is not realistic or helpful; one size will not fit all (Guy and Marvin, 1999). Instead multiple definitions and pathways to sustainability are required. Within overarching principles each city will have to define the details for themselves (Newman and Jennings, 2008). Even where definitions are agreed they are not fixed or static; instead, as products of an ongoing discourse, they are dynamic and constantly evolving (Whitehead, 2003).

Navigating this complexity and uncertainty is a major challenge. Actors attempting to do so cannot have sufficient knowledge of all parts of urban socio-technical, socio-ecological systems to predict or control change with any degree of precision (Loorbach et al., 2015; Frantzeskaki et al., 2017) – especially when considering the global interconnectedness of cities and their impacts. Therefore despite sustainable urban transition's normative goal, it is unclear whether such transitions are, can be, or should be, vision-led (Voß et al., 2006; Geels and Schot, 2007; Kern, 2011). Instead change is a non-linear, emergent process. Therefore the focus of transition efforts should be on the processes of change, instead of a deterministic focus on the end outcome itself (Cook and Swyngedouw, 2012; Chatterton, 2013; Mendizabal et al., 2018).

It is important to note that despite this complexity and the resulting 'bounded' rationality of actors, actions are not taken without any sense of direction. Transitions may be, and often are, purposive (Berkhout et al., 2004; Smith et al., 2005; Mendizabal et al., 2018). So whilst we cannot command and control, we can at least steer – shaping the current processes of change in order to enable more sustainable outcomes to emerge (Grin et al., 2010; van den Bergh et al., 2011).

A large number of cities are attempting to enact such purposive transitions, committing to sustainable visions and/or initiatives such as the C40 Cities Climate Leadership group or ICLEI Local Governments for Sustainability network. However, whilst there are pockets of good practice, the wide-scale transformations and systemic changes that are required are not emerging (McCormick et al., 2013). This is confirmed by the literature which broadly acknowledges that progress is insufficient (Newman and Jennings, 2008; Bulkeley et al., 2010; Rauschmayer et al., 2015) and by global reporting e.g. the findings of the IPCC special report on the impacts of global warming of 1.5° C above pre-industrial levels (IPCC, 2018) and the IEA Global Energy & CO2 Status Report (IEA, 2018).

The fact that cities remain unsustainable despite commitments to the contrary is the rationale for this research. How can the implementation gap exist between cities' long-term sustainable visions and their existing attempts at transition be overcome?

1.4 Transition theory and the MLP – the research base and knowledge gaps

In response to the need for, and current lack of, transformative sustainable change an emerging field of research has developed on sustainable transitions (Markard et al., 2012). Sustainable transitions are defined as “a fundamental transformation towards more sustainable modes of production and consumption” (Markard et al., 2012, p.995) and as “a radical transformation towards a sustainable society as a response to a number

of persistent problems confronting contemporary modern societies” (Grin et al., 2010, p.1).

Transition theory is based on socio-technical systems thinking, and the challenge that such complex adaptive systems present in controlling transitions and determining outcomes. As already noted, it is unclear whether transitions can be vision-led. So to what extent can actors govern, manage and/or steer the process of change? Transition theory seeks to address this quandary through two central questions: (1) how does change occur; and, (2) can we steer it? (Grin et al., 2010).

This thesis therefore aims to better understand the *processes* of transition in order to gain insights into how to accelerate progress towards sustainable city *outcomes*. In particular the focus is on processes driving decisions and action of the incumbent city actors within what the Multi-Level Perspective (MLP) calls the meso or regime level (Geels, 2002; Smith et al., 2005; Geels and Schot, 2007; Geels, 2014). The MLP is a commonly used framework within transition theory which explores how transitions result from the interaction between three levels: the landscape, or macro, level at which broader political, cultural and social changes occur, shifting slowly over long time periods; the regime, or meso level, where dominant actors and practices, norms and regulations establish a set of ‘rules’ that structure, but do not determine, actions; the niche, or micro level, where (technological) experimentation occurs and successful innovations (and their supporting coalitions and systems) develop to the stage where they can break through into the regime, change at this level is fast paced (Rip and Kemp, 1998; Foxon, 2011; Geels, 2014; Hodson et al., 2017).

Taking transition theory and the MLP as the overall theoretical construct for understanding the implementation gap between long-term sustainable city visions and the current progress towards them, this thesis highlights a number of areas of weakness that require further elaboration. First, a much greater understanding of processes occurring at the regime level is needed (Geels, 2014). Transition research to date has emphasised technological innovation occurring at the niche level (Berkhout et al., 2004; Geels and Schot, 2007). Therefore, there is a neglect of processes occurring within the regime. Though recent research has begun to address this, looking at discursive destabilisation, ‘destructive’ policies, institutional processes and politics of the regime (Bosman et al., 2014; Kivimaa and Kern, 2016; Avelino et al., 2016; Barnes et al., 2018), there still remains further work to be done, particularly at the urban level (Bosman et al., 2014). This research joins these efforts to unlock the ‘black box’ of the regime, and more generally explore the potential for change from within the regime-level itself rather than viewing regime change only as a response to niche innovations.

Second, more insight into non-technical, wider institutional and socio-cultural processes is required. The emphasis on supply-side technological innovation at the niche level has led to a gap in work on non-technical innovation aspects of regimes (e.g. civic/social innovations) and user practices (acting as demand drivers) (Shove and Walker, 2010; Hargreaves et al., 2013; Geels, 2014). Greater understanding of the ‘everyday’ institutional processes (regulations and enforcement, values and standards, and habits and heuristics) would provide a much fuller picture of the regime.

Finally, more attention to power and agency is critical (Smith et al., 2005; Smith and Stirling, 2010; Foxon, 2011; Meadowcroft, 2011; Geels, 2014; Rauschmayer et al., 2015; Ehnert et al., 2018). The assumption of largely rational actor behaviour means the role of power and agency are neglected (Smith et al., 2005; Geels and Schot, 2007). Therefore the ability of (in this case regime) actors to adapt to and shape the system within which they are acting is often underplayed (Smith et al., 2005). Recent work has paid more attention to power and agency but there is still a need to understand contextual dynamics (Torrens et al., 2018), the concept of human agency (Schäpke and Rauschmayer, 2017), transformative capacity and spatio-institutional challenges (Wolfram, 2016).

By addressing these research gaps this thesis aims to gain a better understanding of regime-level processes, to provide greater insight into: first the processes at play within the regime itself; and second, if and how they might be (re-)configured to better align with sustainable urban transitions efforts.

1.5 Institutional and quasi-evolutionary theory – building a more comprehensive model of change

To address these weaknesses, and answer the research questions, this research builds on transition theory and the MLP as the foundation for understanding transitions, drawing on institutional and quasi-evolutionary² theory in order to construct a more holistic analytical framework. By adding these additional institutional and quasi-evolutionary lenses, the framework enables a fuller picture of sustainable urban transitions – in particular shedding light on everyday, non-technical processes and the role of power and agency within the regime itself.

² Quasi-evolutionary theory should not be confused with co-evolutionary work on transitions (see e.g. (Foxon, 2011)). The concept of co-evolution is used to conceptualise how technical and social aspects and sectors do not develop in isolation but are affected by and affect each other (Grin et al., 2010), whereas quasi-evolution conceptualises the selection pressures and adaptive capacities shaping development.

Quasi-evolutionary theory supports greater understanding of complex, dynamic systems and the processes of non-linear, emergent change. It conceptualises change as the outcome of interactions between selection pressures and adaptive capacity, where both processes continually co-evolve (Smith et al., 2005). This enables an understanding of the immediate selection environment and how it affects decisions and action, and hence sustainable city progress. The focus is not on determining or predicting the final outcome, but on better understanding the processes by which sustainable city decisions, actions and initiatives, survive or fail. If actors cannot control the end goal, then how can they at least shape the selection environment in favour of sustainable city visions, i.e. how can they (re-)configure quasi-evolutionary processes (selection pressures and adaptive capacity) to better align with sustainable city visions. Furthermore, the concepts of selection pressures and adaptive capacity foregrounds power and agency. They capture the duality of agency and structure, enabling greater insights into the potential and limitations of actor agency and the confines and support of structural power.

Institutional theory supports a more granular view of transition processes within, not just between, the levels of the MLP. This starts to unlock the 'black box' of the regime itself through enabling a much finer-grained analysis than the MLP alone. Furthermore applying an institutional lens elucidates understanding of the non-technical, everyday aspects of change, the formal regulations, normative values and unconscious cultural-cognitive beliefs processes that determine the 'rules' of the regime (Geels and Schot, 2007). This structural rule-set is particularly appropriate, and useful, for understanding the practices and politics of the dominant regime level. Institutional theory explicitly addresses cultural-cognitive behaviours and beliefs, helping address the neglect of the role of user practices within transitions (Shove and Walker, 2010; Hargreaves et al., 2013). Furthermore, institutional theory supports a better understanding of the role of power and politics through highlighting the role of structure. Such insights into how institutional processes support the dominant regime and inhibit 'radical' change are key to understanding how such inertia could be overcome to create reform of the system itself, i.e. truly transformational change.

By combining institutional and quasi-evolutionary theory with transition theory to construct a more holistic model of change, a deeper understanding of urban transitions is enabled (Markard et al., 2012; Köhler et al., 2019).

1.6 Sustainable urban transitions – leading city case studies

Within transition theory, empirical cases initially focused on sectoral transitions (e.g. energy or agriculture) (Geels, 2004; Geels, 2011), neglecting urban transitions. Such

sector studies do not provide insights into transitions in an urban context, or the role of city actors. Hence, additional work in this area is needed to gain greater understanding of the possibilities and limitations in governing urban transitions (Frantzeskaki et al., 2017). In 2012 only 6% of transition research considered cities (Markard et al., 2012). And whilst there have been an increasing number of case studies of urban transitions more recently, there is still a need for further research, in particular for comparative case studies (Wolfram and Frantzeskaki, 2016).

This thesis contributes towards empirical research through providing a comparative case study analysis of sustainable urban transitions. Through empirical exploration in urban settings (specifically three leading sustainable cities: London, New York and Copenhagen) this research aids in understanding to what extent transitions can be governed at the urban level, and how. Leading sustainable cities were selected as case studies because this research aims to explore the implementation gap between sustainable city visions and current progress, hence a vision is a prerequisite (see methodology chapter for a detailed explanation). Furthermore, situating the investigation within cities that show best practice has two advantages: (1) investigation of enablers as well as barriers; (2) investigation of barriers beyond those of individual and organisational execution capacity and performance to system barriers. Within each case study two current and prominent initiatives are explored (one progressing well and one more challenging initiative) which, due to different levels of success, offer a range of critical insights.

Taking a case study approach enables in-depth exploration of the complex phenomena of sustainable transitions, providing context specific insights into the challenges of urban transitions as they unfold in real-time and 'real-life' (Yin, 2013). Furthermore comparative case studies allow exploration of which patterns are specific to particular place-based contexts, and which might be general across geographies (Wolfram and Frantzeskaki, 2016). Combining case studies and framework analysis effectively enables critical exploration of 'how' and 'why' questions around sustainable urban transitions (Yin, 2013); how do current processes enable or constrain transitions, how and why do they vary, how could they be modified?

For the purposes of this research the city is conceptualised as the regime. This analytical boundary enables exploration of transition processes within the regime, rather than exploration of transitions as interactions between MLP levels. Thereby providing greater insight into regime change, adding to the body of work on (urban) sustainable transitions, and responding to the relative neglect of regime-level analysis (Berkhout et al., 2004; Geels and Schot, 2007; Hargreaves et al., 2013; Geels, 2014).

This thesis focuses on environmental sustainable development efforts, including but not limited to climate mitigation and adaptation actions. The sustainability focus reflects the need for holistic transformation in cities to address not just the climate crisis but sustainable development more broadly. It should also be noted that this thesis focuses on understanding the regime processes behind the implementation gap, and as a result does not dedicate research effort to evidencing the implementation gap itself.

This selected research method of looking at the urban regime across three leading sustainable cities enables an in-depth exploration of the barriers and enablers to sustainable urban transitions, helping to determine why the implementation gap exists between cities' long-term aspirations and their current progress – and importantly suggesting to what extent, and how, transitions might be steered in order to overcome this gap.

1.7 Research rationale and questions

Overall then, the rationale for this research is the implementation gap in achieving sustainable cities. Despite genuine commitments to sustainable city visions, progress is inadequate in the face of the ever increasing urgency of sustainability crises and rapid urbanisation.

The persistent problems we are facing require radical system change. The complex and dynamic nature of socio-technical systems means such change cannot be detailed, we cannot know the exact outcome. Traditional modernist command and control approaches are no longer adequate, and entirely vision-led, deterministic transitions are not possible. This calls for much greater attention to the processes of emergent change; a better understanding of processes is essential to enable more adept and successful steering of transitions towards the desired outcomes and visions. How can the direction of transitions be (at least partially) influenced, and, critically, how can transitions be accelerated?

This thesis responds to this need through shifting the focus of study from long-term visions to existing processes, aiming to better understand the current processes at play, and hence the dynamics of the system that the vision is (part of and) attempting to change.

This research builds on transition theory and the MLP by addressing research gaps in work on regime-level change, specifically non-technological, everyday processes, and the role of power and agency. In order to do this the research draws on institutional theory and quasi-evolutionary theory to build a more holistic model of change. Empirical

exploration of three leading sustainable cities case studies, using this model, enables in-depth exploration of the research questions:

1. What are the institutional and evolutionary processes that drive regime-level decision, actions, and their outputs and outcomes within sustainable cities?
2. How do these processes vary, and why? Do they enable or constrain progress towards the desired long-term outcome of sustainable cities?

Through investigation of these questions, this research aims to contribute to (transition) theory by addressing key research gaps, and in doing so contribute to practice on the ground by providing a better model, and understanding, of how to enact change. Drawing on the analytical framework helps identify what processes are at play and whether they enable or constrain process and therefore offers important insights as to how processes could be modified to better align with, and achieve, transitions to sustainable cities.

By building on transition theory and drawing on evolutionary and institutional perspectives this thesis contributes to addressing the research and policy gap of how to translate desired long-term *outcomes* into current *processes*, enabling a much greater understanding of the selection environment within the regime, and hence the possibility of (re)configuring this environment in favour of sustainable city transitions.

The novel framework supports mapping of the selection environment, and pays explicit attention to the processes of transition in complex, dynamic systems, and how these could be modified to accelerate and scale-up sustainable urban transitions. If transitions cannot be predicted or controlled, due to the complex, non-linear, emergent nature of change, then how can actors better understand the processes of change, and importantly how can they reconfigure these processes to create a more favourable selection environment from which sustainable transitions can emerge.

This thesis is structured as follows:

Chapter two discusses the literature around sustainable transitions and transition theory, highlighting the gaps in research and how this thesis attempts to address them. In addition this chapter introduces the analytical framework, setting out how the research and framework will contribute to the academic and practitioner knowledge base.

Chapter three sets out the research design, justifying a comparative case study approach and outlining selection of cases studies and initiatives, interview sampling and analysis of evidence.

Chapter four, five and six present the results from the three individual case study analyses, answering the first research question of what institutional and evolutionary processes drive regime-level change. The case study chapters also compare the two initiatives within each city, addressing the second research question of how and why processes vary, and whether they enable or constrain progress.

Chapter seven is a comparison of findings across the three case studies, critically discussing variations and similarities, and identifying cross-cutting themes and key lessons. This chapter offers insights from a cross-case perspective and presents overall findings in answer to the research questions.

Chapter eight brings together the overall conclusions and how they contribute to the academic and practitioner knowledge, and provides recommendations for further research.

Chapter 2 Literature review

The introduction set out the challenges of sustainable development and urbanisation, the current implementation gap between sustainable city visions and current progress, and the research aim to understand the processes enabling or inhibiting transitions to sustainable city outcomes. This chapter reviews the transition literature to establish what is known and highlight knowledge gaps, and set out how these will be addressed through the novel analytical framework. Section one covers the weaknesses and limitations in transition theory, and how the research focus addresses these. Section two introduces the analytical framework, setting out how the framework draws on institutional and quasi-evolutionary theory to construct a more holistic model of change. Section three concludes by summarising how this research and framework respond to the knowledge gaps.

2.1 Transition literature and the key research gaps

Transition research aims to understand how radical, structural change can occur in societal systems (Avelino and Rotmans, 2011; Köhler et al., 2019). Transitions are defined as “non-linear processes of social change in which a societal system is structurally transformed” (Avelino and Rotmans, 2009, p.543). This transformation aims at sustainability as a normative goal; transitions are ‘purposive’ (Smith et al., 2005; Wolfram and Frantzeskaki, 2016). Transition theory as an emerging field offers huge promise for understanding and resolving sustainable challenges but there are also weaknesses and gaps that still need addressing (Markard et al., 2012; Köhler et al., 2019).

This section looks at the key challenges and gaps as relevant to the aims of this thesis; to better understand the process of sustainable urban transitions in order to overcome the implementation gap. First, the challenge that sustainable transitions are too complex to be controlled, or vision-led, is considered. This results in the need for a greater understanding of the *processes* involved in transitioning to the desired long-term *outcome*, i.e. the sustainable city vision, is required. Second, focusing on the multi-level perspective within transition theory, the lack of research on the dynamics of the *regime* is highlighted. Third, the obsession with novel and technological solutions is noted along with the consequential need for greater attention to *everyday, non-technical aspects* of regimes (e.g. socio-cultural, financial, political). Finally, the neglect of *power and agency* is outlined, and the need to foreground their role in transitions. Overall then, in

responding to these key gaps in transition theory, this leads to a research focus on the regime-level processes, in particular, every day, non-technical processes, and the role of power and agency in sustainable urban transitions.

2.1.1 The complexity of urban transitions and the need for a process-oriented approach

The first challenge for transition theory is that sustainable transitions are too complex to be fully 'known', controlled, or vision-led. Accepting this then requires a move from a deterministic, command and control approach focused on the outcomes of change, to a more adaptive, manage and steer approach focused on the processes of change. Much greater attention needs to be paid to the *processes* of transition in order to understand how to achieve the desired long-term *outcome*, i.e. the sustainable city vision.

Society is increasingly complex with the ongoing specialisation and differentiation of functions, and development of ever-expanding networks and institutions (Loorbach, 2004). Voß et al. (2006) describe complexity as a 'principal feature' of sustainable development due to the 'systemic interconnections' that characterise sustainability issues. Cities are at the heart of these interconnected systems, as 'nodes' of global trade and centres of economic growth, with overlapping sectoral infrastructures and concentrations of population (Revi and Rosenzweig, 2013; McPhearson et al., 2016). Sustainable urban transitions have to contend with this complexity effectively in order to progress. Therefore there is a need to understand the complex systemic interactions between processes that are shaping and in turn shaped by cities (Frantzeskaki et al., 2016).

Complexity underlies the persistent problems society is currently facing, including the challenge of sustainable cities, and the failure of traditional governance modes to deal with them (Voß et al., 2006; Grin et al., 2010; Geels, 2010a; Köhler et al., 2019). The move from dealing with systems to dealing with complex adaptive systems requires a more sophisticated approach (Grin et al., 2010). Furthermore, transitions, in and of themselves, are recognised by scholars as complex processes involving multiple dimensions, and occurring over multiple levels, scales and time (Geels, 2011; Köhler et al., 2019). This creates a significant challenge for transition research in tackling the 'irreducible complexity' of transitions whilst still meeting the need for theory that helps to structure and order such complex change (Vasileiadou and Safarzyńska, 2010; Köhler et al., 2019).

Given this complexity it is unclear whether transitions are, can or should be, vision-led (Voß et al., 2006; Geels and Schot, 2007; Kern, 2011). Historical analysis concludes that past transitions have not been driven or determined by visions (Voß et al., 2006; Geels, 2010). Despite this, current transition management work seeks to do just that (Rotmans et al., 2001; Loorbach, 2004; Köhler et al., 2019). Indeed, transition theory's normative goal of sustainability provides an inherent direction of travel. This presents what appears at first to be a contradiction between the impossibility of vision-determined transitions on the one hand, and the need for clear direction on the other. Digging deeper into the debate, a more nuanced middle-ground is emerging; whilst actors cannot command and control transitions, they can, and indeed should, attempt to purposively steer them (Berkhout et al., 2004; Smith et al., 2005; Grin et al., 2010; van den Bergh et al., 2011; Mendizabal et al., 2018).

This aim of purposive steering leads to the quandary of how to combine the long-term sustainable city vision with the short-term complexity of urban systems and sustainable urban transitions. The literature acknowledges a gap between visions of long-term outcomes and current system processes. For example, Seyfang and Haxeltine (2012) observe a disparity between short-term action and long-term goals in their analysis of the transition town movement; and Kemp et al. (2007) highlight the 'headache' policy makers have in setting short-term steps towards long-term goals, flagging the lack of theory on this. Other scholars also raise this issue but articulated from the reverse perspective: how can we understand the impact of today's policies on tomorrow's outcomes (Arts et al., 2006; Markard et al., 2012).

This begs the question of how long-term sustainable city visions are translated into the processes that steer outcomes. If the current city regime is not being changed as a result of, and in line with, long-term visions, then how will change from the status quo occur? This has led to a call for more process-oriented approaches (Geels, 2011; Cook and Swyngedouw, 2012; Chatterton, 2013).

The final consideration in adopting a process-oriented approach is that of systemic change. Grin et al. (2010) state that persistent problems are particularly tricky given they are (1) a result of modern society and (2) beyond the capacity of our current, modernist systems to resolve. Geels (2010a) adds that the 'new environmental problems' we are facing now are more complex than those of the 70s and 80s and refers to the need for 'substantive transitions.' More recently Köhler et al. (2019) emphasise that the 'grand challenges' of sustainable development remain unsolved. It is clear that addressing these challenges will require the need for deep structural change, for radical

transformation of the system itself – incremental change will not be sufficient (Grin et al., 2010; Rauschmayer et al., 2015; Markard et al., 2016).

Sustainable transitions are goal-oriented and seek to address these persistent sustainability challenges. In particular, transition management (a governance model within transition theory) specifically seeks to address such persistent, systemic problems. Whilst acknowledging that full control is not possible, transition management seeks to deliberately steer transitions by adapting and shaping societal systems through joint visioning, developing, doing and learning (Rotmans, 2005; Kemp et al., 2007), ultimately transforming the system.

Such radical system change implies the need for second-order learning (i.e. how to change the system itself), for systems awareness and transformative systems knowledge (Wolfram, 2016; Barnes et al., 2018). It also brings up questions of whether transitions can be achieved from within, what external forces might lead to change, and what constitutes endogenous vs exogenous change. Many authors refer to external shocks as key moments of destabilisation and windows of opportunity for transitional change (Turnheim and Geels, 2012; Kivimaa and Kern, 2016). However, some challenge the notion of ‘external’ altogether; in particular, regarding social practices, the existence of external ‘sources or forces of influence’ are questioned (Shove and Walker, 2010). Whilst others acknowledge, particularly from a more pragmatic, empirical view, that broader contexts need to be recognised (Røpke, 2009).

Voß et al. (2009) state that so far transition management in practice has been ‘layered’ over the current system without fundamental, systemic change. Furthermore, in a recent review of cities and systemic change (Wolfram and Frantzeskaki, 2016) conclude with the need to develop new approaches to transformation. Interestingly for this thesis, they also state that “cities are key for sustainability and the radical systemic changes required to enable equitable human development within planetary boundaries” (Wolfram and Frantzeskaki, 2016, p.144).

2.1.2 The Multi-Level Perspective and the need for a better understanding of the regime

Having outlined the first research challenge that transitions are too complex to be fully vision-determined, and instead require a process-oriented approach, this section now turns to the neglect of the regime within transition theory, and the Multi-Level Perspective in particular.

The MLP is the most common theory within transition literature (Wolfram and Frantzeskaki, 2016). It is a middle-range theory that offers a useful heuristic for asking questions about, and generating insights into the dynamics of transition change (Geels, 2011). The MLP draws on a range of theory in attempting to tackle the complexity outlined in the previous section:

“The analytical framework combines concepts from evolutionary economics (trajectories, regimes, niches, speciation, path dependence, routines), science and technology studies (sense making, social networks, innovation as a social process shaped by broader societal contexts), structuration theory and neo-institutional theory (rules and institutions as ‘deep structures’ on which knowledgeable actors draw in their actions, duality of structure, i.e. structures are both context and outcome of actions, ‘rules of the game’ that structure actions)”. (Geels, 2011, p.26)

Hence the MLP is able to conceptualise interacting processes at multiple dimensions and levels, and in doing so it goes beyond simple causality or single drivers of transitions (Geels, 2011). Whilst early MLP research proposed levels as a ‘nested hierarchy’, Geels (2011) later clarifies that the levels of the MLP refer to the different degrees of ‘structuration of local practices’ and hence stability (increasing in stability from niche, to regime, to landscape level).

In attempting to answer central questions of how (radical) change occurs, the primary unit of analysis is the regime (Geels, 2004; Geels, 2011). However, a criticism of transition theory and the MLP is the emphasis on innovation at the niche level as the prime driver of regime change (Berkhout et al., 2004; Geels and Schot, 2007). This dominant perspective of niche-led change results in a widespread view of the regime as a ‘barrier to be overcome’ (Geels and Schot, 2007; Geels, 2011; Fuenfschilling and Truffer, 2014). This is perhaps not surprising given the origins of MLP in the field of innovation studies (Smith and Stirling, 2010). Whilst this has provided a strong body of work on niche innovation (e.g. Strategic Niche Management) there is a relative gap in work at the regime level; a much greater understanding of regime processes is needed (Geels, 2014; Köhler et al., 2019).

The concept of the regime was originally used by Nelson and Winter (1982) and Dosi (1982) to describe a technological regime and associated problem-solving activities of engineers (Kemp et al., 1998). As previously mentioned, the MLP defines the regime as the meso level where dominant actors and institutions maintain a dynamic but relatively

stable status quo. This conceptualisation tends to result in shallow consideration of the regime as homogenous and monolithic (Smith et al., 2005).

More recent research has begun to explore the complex and dynamic nature of regimes. Geels (2004; 2014) conceptualises the regime as 'the deep structure' that creates stability and 'the locus of established practices and associated rules that enable and constrain incumbent actors in relation to existing systems'. Hodson et al. (2017) define the regime as 'the institutional structuring of tangible socio-technical systems; the intangible rules, shared cognitive routines, regulations and standards which structure but do not determine action'. Barnes et al. (2018) note the role of material infrastructures as part of the 'rules of the game'. And Turnheim et al. (2015) describe regimes as the result of 'prevailing regulatory, normative and behavioural practices', and emphasise that regimes involve both rules and active resistance.

This conceptualisation of the regime as generating stability and consensus through a coherent prevailing set of rules and practices risks obscuring the 'variety, disagreement on specific issues, debate, and internal conflict' (Rip and Kemp, 1998; Geels, 2011). Researchers need to make this homogeneity an explicit question not an implicit assumption (Geels, 2010).

Within the regime, rules are constantly being reproduced and changing (Kemp et al., 1998; Shove and Walker, 2010). However, Geels (2014) highlights active resistance to change from dominant regime actors as one of the major factors in resisting transitions. Therefore regime destabilisation is key to the processes of change, and transition analysis needs to better account for destabilisation of incumbent regimes (Geels, 2014; Turnheim et al., 2015). The destabilisation of incumbent regimes by 'weakening reproduction of core regime elements' is necessary to open up 'windows of opportunity' for niche innovations to break-through and generate regime change (Turnheim and Geels, 2012).

Building on this, and drawing inspiration from the Schumpeterian concept of 'creative destruction' Kivimäki and Kern (2016) propose an approach that includes creation of new and destabilisation of old policies. They emphasise the need for further work to better conceptualise the creation of niche-innovations and destabilisation of dominant regimes. Here again the assumption is that change comes from the niche, and stability and resistance from the regime. This view is widely supported within the literature which broadly views change as originating outside the regime. For example Geels (2011) states that most niche innovation occurs outside regimes; Elzen et al. (2012) refer to 'radical' innovation in particular as coming from outside the regime; and van de Poel (2000)

specifies the role of 'outside' actors in change. This research aims to challenge this notion of exogenous-led change, and critically explore whether, and if so to what extent, change is generated endogenously by the regime.

Wherever change is generated, the dialectic relationship between stability and change remains a core issue for transition research (Köhler et al., 2019). Stability and change are central to understanding fundamental questions of how change happens through innovation and transformation, and how change is prevented by deeply entrenched systems and a tendency towards stability and the resulting issues of lock-in and path dependence that this creates (Unruh, 2002; Köhler et al., 2019).

2.1.3 The socio-technical perspective and the need for a better understanding of the everyday, non-technological aspects of transition

Having outlined, first, the challenges of complexity and requirement for a process-oriented approach and, second, the gap in research on regime-level processes, this section now reviews the third gap concerning everyday, non-technical aspects of the regime.

Much transition analysis already draws on the sociology of technology (Geels, 2002; Grin et al., 2010; Markard et al., 2012), and transitions are often referred to as socio-technical transitions. The sociology of technology perspective holds that human agency, societal structures and organisations are required for technology to have functionality; in and of itself, technology 'does nothing' (Geels, 2002). Early work by Hughes (1987) talks of a 'seamless web' in which physical artefacts, organisations, scientific elements, natural resources and social practices combine. To add to this, Rip and Kemp (1998) refer to 'configurations that work', i.e. a 'seamless web' of elements that combines to deliver societal functions. The importance of this perspective for transitions is that it reflects that change cannot be brought about solely by technology.

As the notion of *socio*-technical systems and transitions developed so too did the regime definition, growing to encompass both social and technological dimensions. Despite this, socio-technical research tends to foreground the role of technology (Grin et al., 2010; Wolfram, 2016). This results in part from the emphasis on niche-level innovation, with a concurrent emphasis on technology (Hargreaves et al., 2013; Geels, 2014). And whilst this has resulted in a strong understanding of supply-side innovation, transition theory and the MLP provide a much weaker understanding of the 'dynamics of normality' (Shove, 2003; Shove, 2012). Transition theory remains focused on the aspects of

technological, not social, change (Shove and Walker, 2010), and ‘ignores’ demand-side drivers (Røpke, 2009).

Scholars following social practice theory are critical of the backgrounding of agency in transition theory, claiming that the central role of practitioners is ‘largely ignored’ (Shove and Walker, 2007; Pantzar and Shove, 2010; Shove and Walker, 2010; Hargreaves et al., 2013). Therefore, the consideration of the role of practices within transition theory and the MLP is proposed in order to gain insights into the social, demand-side dynamics of transitions in ‘everyday life’ (Shove and Walker, 2010). Practices are defined as the behaviours of actors, often highly ‘routinised’ and often unsustainable, e.g. cooking or showering (Reckwitz, 2002; Hargreaves et al., 2013; Durrant et al., 2018). Responding to this Geels (2010a; 2014) calls for further research into non-science and non-technical innovations, and for a broader analytical scope to include aspects relating to civil society, social movements and consumer behaviour.

Social practice theory focuses on the ‘doing’ of practices that ‘make up normal everyday life’ (Hargreaves et al., 2013). Theories of social practice bring a different analytical perspective to the same challenges that transition theory and the MLP aim to address, yet very few studies have incorporated these two perspectives to gain greater insight (Hargreaves et al., 2013). Furthermore, practice theory helps to illuminate the ‘perceptions and motives’ of people in ‘everyday-life’, and draw out the role of lifestyles, social innovations, discourses and practices (Wolfram and Frantzeskaki, 2016). As such, including practice theory approaches can offer insights into the more social, consumer aspects of change that the MLP might overlook (Hargreaves et al., 2013; Turnheim et al., 2015).

2.1.4 The need for a better understanding of power and agency

This section reviews the final weakness of transition theory and the MLP: the backgrounding of power and agency.

The central role of power and agency in transitions is widely acknowledged. Transitions are inherently contested and political processes, involving many types of agency (Köhler et al., 2019). Despite this, one of the major criticisms of transition theory and the MLP is the lack of attention to power and agency and the apolitical approach to a very political issue (Smith et al., 2005; Walker and Shove, 2007; Meadowcroft, 2009; Smith and Stirling, 2010; Foxon, 2011; Meadowcroft, 2011; Geels, 2014; Rauschmayer et al., 2015). The assumption of largely rational behaviour leads to a neglect of the role of power and agency (Smith et al., 2005; Geels and Schot, 2007). Highly political questions

around the 'winners and losers' of transitions are not adequately addressed, and greater attention to politics and issues of legitimisation is needed (Berkhout et al., 2004; Walker and Shove, 2007; Meadowcroft, 2009; Smith and Stirling, 2010). Furthermore, questions of internal regime dynamics and change require greater attention to power (Avelino and Rotmans, 2009).

Geels (2010; 2011), responding to these criticisms, states that as transitions are enacted by social groups, and the structuration of MLP levels is both the means and the result of human endeavour, then agency is integral to the concept. However, he does acknowledge that the role of certain types of agency has been underdeveloped (e.g. rational choice, power struggles, cultural-discursive activities), and furthermore suggests that drawing on other theories to better understand power, civil society and the cultural dimensions of transitions should be pursued (Geels, 2011).

Avelino and Rotmans (2009; 2011) attempt to better account for power within transitions. They define power as "the capacity of actors to mobilise resources to achieve a certain goal" (Avelino and Rotmans, 2009, p.550). This definition introduces the role of resources within the power dynamics of transitions. Resources are viewed broadly, including human, mental, monetary, artefactual and natural resources. The role of knowledge is key in terms of access to resources, and the strategies and skills to mobilise them. Power plays out across the MLP, regimes are seen as spaces of 'reinforcive power' (where institutions are reproduced); and niches as spaces of 'innovative power' (where new resources are developed), whilst the interaction between niche and regime creates a space of 'transformative power' (where institutions are renewed) (Avelino, 2011).

As well as the efforts of Avelino and Rotmans, there are various other approaches to conceptualise and account for power and agency within transitions. From a socio-technical systems perspective, power is conceptualised through institutional rules, with struggle and contestation between the niche and regime, highlighting the importance of hegemonic resistance from the regime (Geels and Schot, 2007; Geels, 2014). Governance scholars focus on agency, and see power played out through institutional reform (Grin et al., 2010). Whereas transition management is criticised for largely ignoring power; implicit assumptions mean that power is not explicitly or critically explored (Shove and Walker, 2007).

Central to the discussion of power and agency is structuration, and the structure-agency debate. At either extreme power is viewed as all individual agency or entirely structurally imposed (Avelino and Rotmans, 2011). However, most scholars acknowledge a mix of

both, with views ranging across a power-structure continuum. Giddens (1984) tries to resolve the dilemma of duality between structure and agency by incorporating both; actors have agency within a constraining, or enabling, structure. This balance of structure and agency is not always maintained within transition thinking, particularly with regard to the regime. Overly structured conceptualisation of the regime as ‘reinforcing institutions’, offering ‘hegemonic resistance’ and a ‘monolithic barrier’ to change (Smith et al., 2005; Geels and Schot, 2007; Avelino and Rotmans, 2011) downplay both the complex power dynamics within the regime, and the role of agency in shaping regime change.

However, the role of both individual and collective agency in transitions is acknowledged within transition literature, in particular networks and coalition-building (Kemp et al., 1998; Smith and Raven, 2012; Fuenfschilling and Truffer, 2014; Barnes et al., 2018). Furthermore, the importance of collective power resulting from such coalitions is frequently referenced (Kemp et al., 1998; Geels and Deuten, 2006; Smith and Raven, 2012). This suggests the agency of actors can shape the structural power around them, and indeed Barnes et al. (2018) note the ‘new governance arenas’ created by networks and that such collectives can create and shape institutional structures, enabling new, sustainable narratives and practices to emerge. Importantly coalitions are made up of public, private and civil society actors, thereby spreading agency and power more broadly (Bulkeley et al., 2010; Barnes et al., 2018).

Within the debates around power and agency the direction/directionality of power is critical: Do power constellations favour innovations and initiatives or not? Are they antagonistic or synergistic with sustainability transition goals (Avelino and Rotmans, 2009; Smith and Raven, 2012; Smink et al., 2015; Fuenfschilling and Truffer, 2016)? Many scholars take a contested view of power, referencing ‘struggles’ between the vested interests and ‘active resistance’ of incumbent actors and niche innovations that aim to ‘take over’ (Geels and Schot, 2007; Geels, 2014; Köhler et al., 2019). Contestation is viewed by some as inevitable (given the ambiguous and contested nature of sustainability) (Meadowcroft, 2007), and by others as necessary (given the need to transform existing synergistic regime consensus) (Avelino and Rotmans, 2011).

2.2 Building an analytical framework

The previous section set out four key research challenges and gaps that this thesis aims to respond to: (1) challenges of complexity and associated problems of steering transitions, and hence the need for a process-oriented approach; (2) gaps in understanding regime-level processes; (3) gaps related to the non-technical, everyday aspects of transitions; (4) gaps in exploring the role of power and agency. In order to address these challenges and gaps, and gain a better understanding of sustainable urban transitions, this research attempts to construct a more comprehensive analytical framework based on transition theory but drawing on insights from institutional theory and quasi-evolutionary theory. This approach is supported by research recommendations to utilise different theories to construct a more comprehensive model of change (Markard et al., 2012; Frantzeskaki et al., 2017).

Furthermore using a framework for analysis helps draw out lessons from the case study narratives, developing causal narrative and explanatory theories (Porter, 1991; Pedriana, 2005). In particular, there is a need for frameworks in analysing sustainable transitions in order to better understand the complexity and causes of transitional change (Köhler et al., 2019).

2.2.1 Institutional theory: regulatory, normative and cultural-cognitive processes

Institutional theory has been used by a number of scholars to gain deeper insights into transitions, MLP and regime change (Geels, 2004; Smith et al., 2005; Geels and Schot, 2007; Geels et al., 2016; Avelino and Wittmayer, 2016; Ehnert et al., 2018). The role of institutions in the 'dominant selection environment' of the regime is central (Smith and Raven, 2012). Institutional elements (financial, political, regulatory...) coordinate and structure regime activities, are constructed by and structure the agency of actors, and provide the rules and stability of the regime that acts as the 'grammar' and 'glue' of the system (Geels, 2004; Barnes et al., 2018). Despite this central role, the importance of institutional change and/or reconfiguration in transitions has largely been overlooked (Barnes et al., 2018). However, more recently efforts to explore the role of institutions in shaping regime change have been undertaken (Barnes et al., 2018).

Fuenfschilling and Truffer (2014) see institutionalisation and structuration as one and the same. The levels of the MLP show increasing degrees of structuration from weak at the niche level, to strong within the regime, and very strong at the landscape level. Institutionalisation is required for less stable, fluid niche configurations to gain greater

scale and uptake. However, institutions are well-aligned with the incumbent regime, and both actively resist change from niche innovations and passively stifle it through institutional inertia (Geels, 2014; Fuenfschilling and Truffer, 2014; Barnes et al., 2018). As previously mentioned, this research challenges the concept of the regime as a monolithic barrier to change. Therefore, this thesis aims to provide a finer grained analysis of the institutional processes within the regime that both constrain *and enable* change, thereby providing deeper insight into regime change and responding to the call from scholars for a greater understanding of the role of institutions in transitions (Fuenfschilling and Truffer, 2014; Fuenfschilling and Truffer, 2016). Furthermore, drawing on institutional theory supports forward-looking analysis and policy-making, providing insights into how transitions can be accelerated (Foxon et al., 2013; Turnheim et al., 2015; Köhler et al., 2019).

How institutional theory supports in addressing research gaps

This research draws on institutional theory to address several of the research gaps identified in Section 2.1: neglect of regime-level processes; neglect of non-technical, every day aspects of transitions; and neglect of the role of power and agency.

First, this research uses institutional theory to analyse transitions across three institutional pillars, enabling a deeper analysis into regime level processes along a continuum from formal, imposed regulations, to values-based norms, to cultural-cognitive habits and heuristics. This deeper analysis helps to unlock the 'black box' of the regime by focusing on the institutional 'rules of the game' that make up regime-level processes (Geels and Schot, 2007). Drawing on institutional theory supports more granular analysis, going beyond aggregate explanations of alignments between the niche, regime, and landscape, to explanations of chains of events, and of particular events or local projects by zooming in on specific actors and (local) contexts (Geels and Schot, 2007). Thus institutional theory can be used to build a more 'local' understanding of change within the regime, complementing the MLP 'global' analysis of alignments between MLP levels (Geels et al., 2016).

Second, by bringing to the fore the wider range of processes at play, institutional theory supports addressing the research gaps around non-technical, everyday regime-level processes. This institutional framing prompts analysis beyond technological innovation to explore regulatory political and financial processes, normative values and standards, and cultural-cognitive behaviours and beliefs. In particular this approach responds to the criticisms of transition theory in 'ignoring' demand-side practices and behaviours (Shove and Walker, 2010; Hargreaves et al., 2013). Through the cultural-cognitive

institutional pillar, the unconscious habits and heuristics that make up everyday practices and underlying ways of thinking are explicitly included. Incorporating this institutional pillar is particularly important: first, to support the analytical process as drawing out cultural-cognitive elements is difficult, given their unconscious nature; and second, to support analytical findings – such cultural-cognitive processes are ingrained in all aspects of society and hence all aspects of transitions, and therefore are critical to understanding transitional change.

Third, institutional theory can support enhanced understanding of power (Ehnert et al., 2018). Highlighting the rules of the game enables analysis of who sets the rules and who is included or excluded from play. This institutional rule set provides a framework for a more nuanced analysis by bringing in multi-actor arenas and the politics of transitions (Geels and Schot, 2007). Furthermore it supports exploration of shifting power relations, looking at how networked power and agency are spread across different actors (Avelino and Wittmayer, 2016). In particular, institutional theory aids effective analysis of structural power, and how this might constrain or enable change. This mirrors the quasi-evolutionary concept of selection pressure in supporting the analysis of structural power, and is complemented by the quasi-evolutionary concept of adaptive capacity in the analysis of agency to shape change. Hence by using both institutional and quasi-evolutionary theory a more comprehensive picture of the role of power and agency across the structure-agency spectrum is gained. Furthermore, this analysis of the structural power of institutions enables greater insight into the problem of inertia, lock-in and path dependency, for example, through exploring the role of institutional path dependency in constraining particular transition pathways from playing out and particular actors from play (Castán Broto, 2016).

For the purposes of this analysis, this thesis adopts Scott's (1995) synthesis of institutional theory into three pillars: regulative, normative and cultural-cognitive processes. Regulatory processes consist of rule-setting, monitoring, and sanctioning activities (for example regulations and laws). They signal clear demands: how things *must* be done. These are hard and fast rules compared to the 'softer' normative processes which establish standards and values. Regulatory processes are formal and explicit compared to the unconscious, internalised cultural-cognitive processes. Normative processes include both values and norms, they define both the goals and the appropriate ways to achieve them (for example standards, accreditation). They set out the vision, values and standards of the sustainable city actor network – i.e. what *should* be done, and how those things *should* be done. Normative processes can be shaped by developing new knowledge, skills and evidence that redefines what best practice is.

Normative values affect power coordination and resource allocation within the municipality and wider city network, impacting organisational structure and staffing capacity, and network and alliance formations. Cultural-cognitive processes are the shared conceptions that make up the nature of social reality, they act as a frame from which to create meaning (for example beliefs and customs). They shape ways of thinking and being, both in terms of thought processes and heuristics, but also practical habits and routines. These are the unconscious, unwritten rules that set out how things are and how things are done (there is no conscious thought process about how they *must* or *should* be done).

2.2.2 Quasi-evolutionary theory – a process-oriented approach to conceptualising complexity, and the role of power and agency

Transition theory has long drawn on evolutionary theory to help analysis: to understand technological innovation (Nelson and Winter, 1982; Dosi, 1982); in developing the MLP as an analytical framework (Geels and Schot, 2007); for governance perspectives (Grin et al., 2010); and in better accounting for actor choice (Foxon, 2011). With regard to sustainable transitions and radical transformational change of complex urban systems, evolutionary perspectives are useful viewpoints from which to conceptualise how change emerges from complexity. Complex systems are constantly evolving: they comprise diverse components interacting in a non-linear way, without simple cause and effect relationships; no one component part can contain, 'know' or control the whole system; they are path dependent, past impacts upon present and future (Grin et al., 2010). Complex Adaptive Systems (CAS) in particular are co-evolutionary, emergent and self-organisational (Grin et al., 2010).

Co-evolution is an underlying concept central to transition theory, and common across the various schools of thought within it (Grin et al., 2010; Köhler et al., 2019). The concept of co-evolution describes how interaction between and within system components influences the dynamics, and evolution, of the system. Technical and social aspects co-evolve and sub-systems of e.g. energy and water co-evolve (Grin et al., 2010). Furthermore, transitions are inherently co-evolutionary due to the multiple elements within socio-technical systems (politics, practices, technologies, infrastructures, etc). Transitions emerge from the multitude of interactions between all these elements, developing in an interdependent, non-linear way (Köhler et al., 2019).

Foxon (2011) promotes evolutionary thinking as a way to strengthen transition theory. He argues that although a co-evolutionary approach has been adopted, the use of sociological concepts (alignment between elements) over evolutionary ones (variation,

retention, selection) is overly structural and does not adequately account for actor choice (e.g. individual user choice, business strategy development) or economic factors (e.g. investment and relative prices). Foxon builds on the definition given by Murmann that “two evolving populations coevolve if and only if they both have a significant causal impact on each other's ability to persist” (Murmann, 2003, p.22). Causal influences arise through changes in selection criteria or replicative capacity, and hence a co-evolutionary frame can explain both the ‘dynamic interactions’ and ‘mutual stability’ between systems (Foxon, 2011). Co-evolutionary theory supports greater understanding of the complexity of transitions; however, greater depth and detail are required. There is the need for “a much finer analysis at both empirical and theoretical level, and to move from statements that everything is co-evolving with everything else to the identification of what is coevolving with what, how intense is this process and whether indeed there is a bi-direction of causality” (Malerba, 2006, p.18).

Although it is often a source of controversy Foxon (2011) defends the use of evolutionary terminology in non-biological contexts. He references the approach of ‘generalised Darwinism’ whereby any population can be described as evolving so long as the three processes of variation, retention and selection occur. It is important to note that, unlike biological evolution, in this context variation and selection are not (necessarily) blind. Actors both anticipate and attempt to steer development (Rip, 1992; Schot, 1992), although Foxon points out that there need not be a specific end-goal.

Rip (1992; 1995) and Schot (1992; 1998) first developed a quasi-evolutionary approach to take into account these, at least partially, directed efforts of niche actors in not only anticipating selection pressures but also in trying to shape them (e.g. through R&D programmes or demonstration projects). More recently Smith et al. (2005) have used the quasi-evolutionary model to analyse transitions. They see transitional change as a function of two processes: shifting selection pressures, and coordination of resources to adapt (to these selection pressures). They use ‘quasi-evolutionary’ to describe how these two processes can be linked based on the earlier work by Rip and Schot showing that actors who are adapting to selection pressures can at the same time influence the selection pressures impacting on them (Rip, 1992; Schot, 1992)) Smith et al. (2005) note that selection pressures can be directed (e.g. anti-nuclear), general (e.g. environmental awareness) or not directed (e.g. an aging demographic), and, importantly, that they need to be articulated in order to have an impact on the regime.

Within the MLP the regime has been conceptualised as the selection environment where innovations developed in a niche survive or fail (Smith et al., 2010). This evolutionary perspective helps understand the contested and competitive regime environment by

conceptualising structural power and agency. Shove and Walker (2010) see structuration as a mechanism for retention; ‘enduring and relatively stable practices’ in systems only exist because they are ‘consistently and faithfully reproduced’. This thesis builds on this and combines it with Smith et al.’s (2005) quasi-evolutionary definition of power and agency as (the articulation of) selection pressures and (the access to and coordination of resources for) adaptive capacity, resulting in a conceptualisation of structuration as: *agency* – the adaptive capacity to respond to and shape structure; and *power* – as selection pressure that enables and constrains through structure. This quasi-evolutionary approach captures the idea of structuration and Giddens’ (1984) duality of processes as actors are both shaped by and shape the rules at the same time.

This thesis draws on evolutionary perspectives to help understand the complexity of sustainable urban transitions to conceptualise how change emerges from complexity, acknowledging the co-evolution of multiple process at play within transitions, and specifically drawing upon quasi-evolutionary theory to understand the processes driving and shaping change.

How quasi-evolutionary theory addresses the research gaps

This research draws on quasi-evolutionary theory to address several of the research challenges and gaps outlined previously in Section one, namely, challenges of complexity and associated problems of steering transitions; and research gaps around the role of power and agency.

First, this analysis uses quasi-evolutionary theory to address problems of complexity by providing a process oriented approach (Geels and Schot, 2010), specifically the quasi-evolutionary processes of selection pressure and adaptive capacity (Smith et al., 2005). Drawing on evolutionary theory supports analysis of the non-linear, emergent change inherent in complex adaptive systems. The addition of ‘quasi’ acknowledges the purposive efforts of actors; their ‘partial sight’ in attempting to steer how the regime evolves. Thus quasi-evolutionary theory helps analyse actor efforts at responding to and shaping selection pressure to better align with sustainable city visions.

Second, conceptualising the regime as a duality of selection pressure and adaptive capacity helps elucidate the role of power and agency: selection pressures highlight power, especially structural power within the system; and adaptive capacity highlights the agency of actors to adapt to and shape the selection pressures around them. This quasi-evolutionary lens elucidates how actor decisions and action are both shaped by, and shape, the regime.

Conceiving the regime as a selection environment in this way helps to ‘unlock’ how the current regime processes shape transitional change as it emerges from complex urban systems. Whilst actors cannot predict with accuracy how transitions will evolve into long-term outcomes, they can understand the current selection environment and how selection pressures and adaptive capacity might enable or inhibit change. How well is the selection environment aligned with the sustainable city vision? Has the vision been translated into a modified configuration of selection pressures and adaptive capacity that creates a favourable selection environment? What agency do city actors have to adapt to and shape the selection environment of the regime, i.e. regime-level selection and adaptive processes?

The proposition of this thesis is that sustainable city visions need to be translated into current regime-level processes in order for transitions to succeed, especially at the speed and scale required. In other words, if the current system processes are not altered then the outcome will largely remain unchanged. The conception of the regime as a selection environment enables an approach to steering transitions via (re-)configuration of selection pressures and adaptive capacity to (better) align with sustainable city visions. If city actors cannot control, deterministic vision-led change due to system complexity, then to what extent might they be able to modify the selection environment of the regime in order to steer or shape sustainable transitions?

This analysis draws specifically on the work of Smith et al. (2005) in using quasi-evolutionary theory to explore transitions. Transitional change is conceived as a function of two processes: shifting selection pressures that act upon regime actors to shape, but not determine, action; and the adaptive capacity of actors to respond to and shape selection pressures. Selection pressures can be directed, general or undirected. Adaptive capacity is a combination of the *availability* and *coordination* of resources to adapt to these selection pressures (Berkhout et al., 2004), and shapes the particular form and direction of regime change over the long term.

2.2.3 Analytical framework

Having summarised the relevant literature and set out the rationale for drawing on institutional theory and quasi-evolutionary theory, this section now describes how the framework is constructed to augment transition theory and build a more comprehensive model of change.

Figure 2.1 below shows the construction of the analytical framework based on:

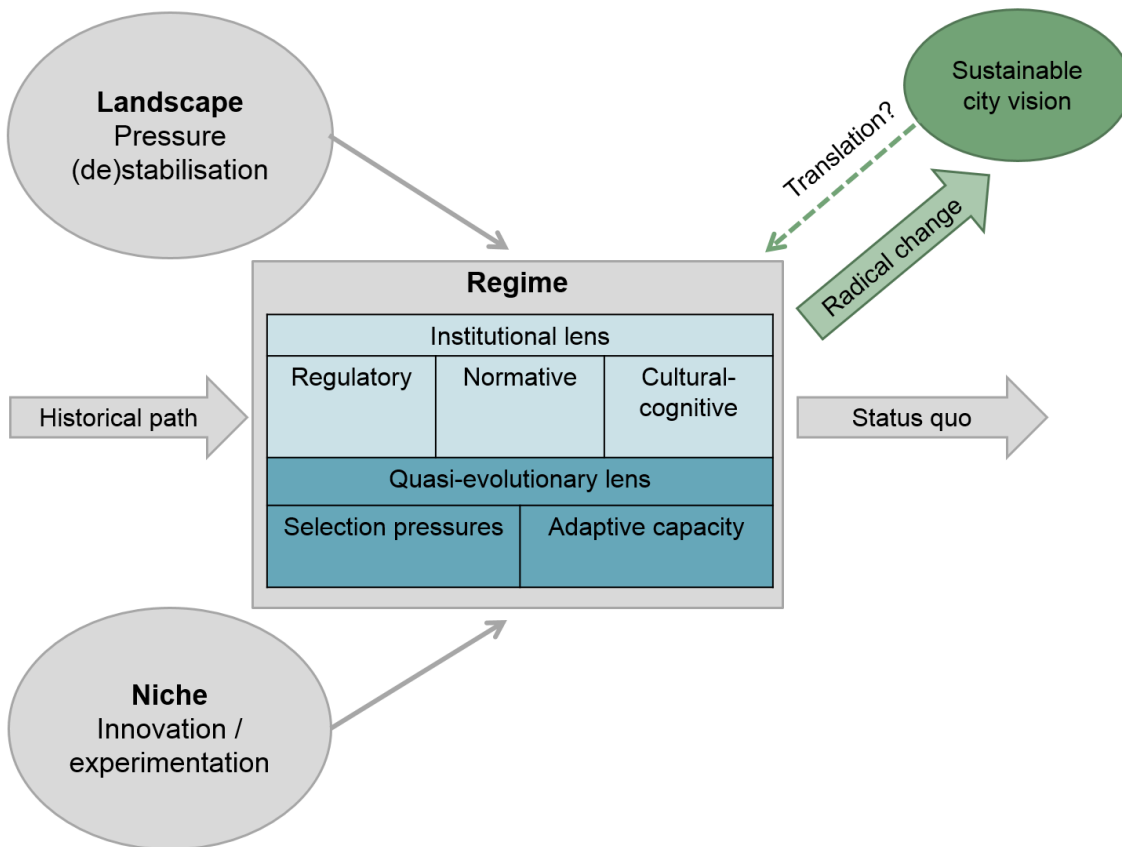
Transition theory and the MLP as the foundation (in grey) - the transition theory foundation provides the landscape, regime and niche levels of the MLP. The thin arrows indicate landscape pressure acting to (de)stabilise the regime and niche innovations competing with, or supporting, the regime. The large arrows denote system inertia, showing the continuation of the historical path and preservation/persistence of the status quo via the dynamic stability of the regime.

Sustainable city visions and implementation gap (in green) - the sustainable city vision is shown in green. The large green arrow denotes the requirement for radical change, transformation of the system itself, in order to achieve this. The thin, dashed green arrow symbolises the research proposition that the implementation gap is due to sustainable visions not being translated into regime processes.

Institutional theory (light blue) – the light blue boxes show how institutional theory is used to gain depth of understanding of processes across the spectrum from formal regulatory factors to unconscious, deep-rooted cultural-cognitive factors

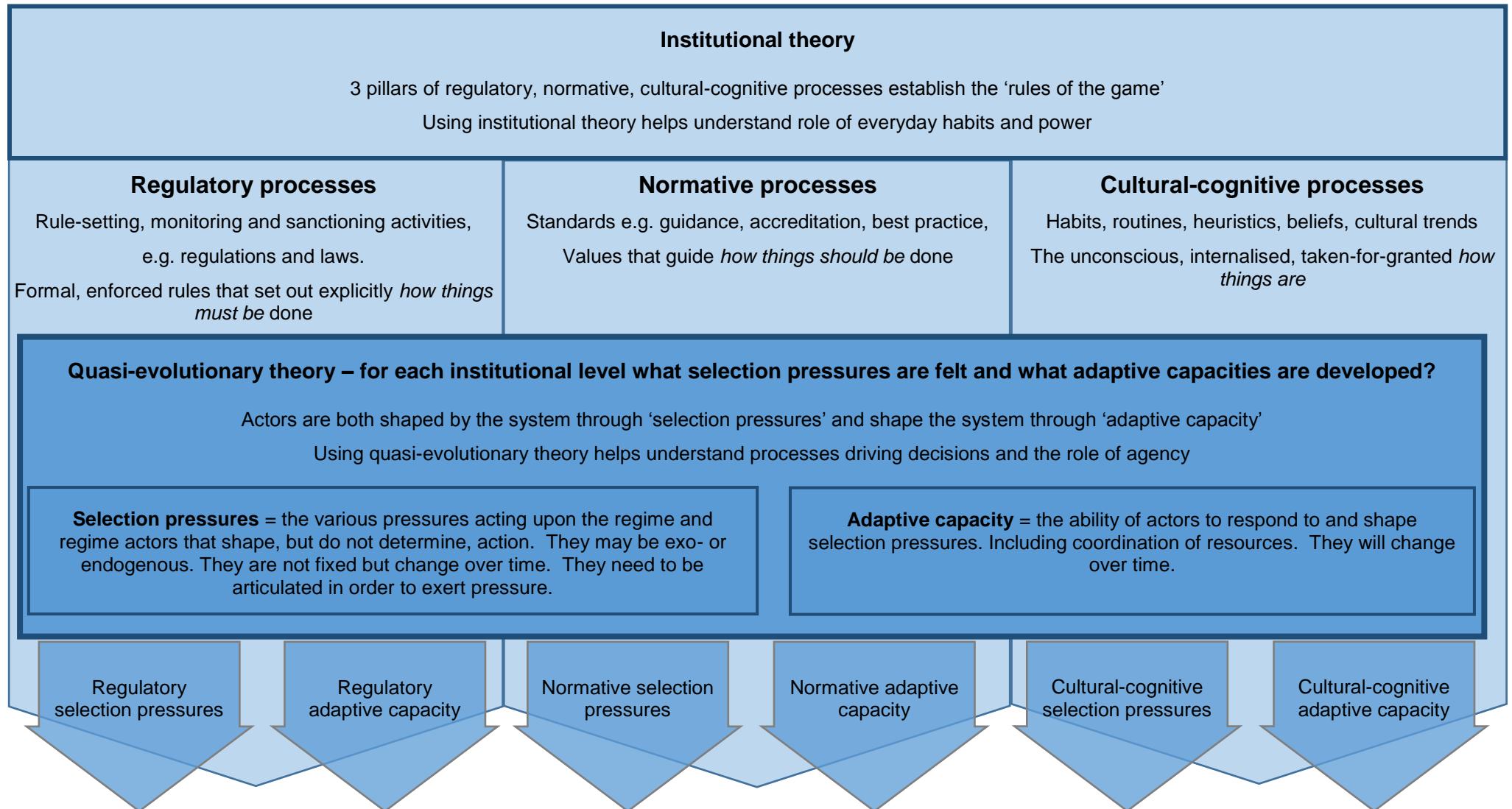
Quasi-evolutionary theory (dark blue) – the dark blue boxes denote how each institutional pillar is further analysed by the two quasi-evolutionary processes of selection pressure and adaptive capacity.

Figure 2.1: Diagram showing the construction of the analytical framework



In summary, the analytical framework takes transition theory as the overall theoretical construct to explore and explain sustainable city transitions. The framework then draws on additional conceptual 'lenses' to address weaknesses in transition theory and unlock the 'black box' of the regime. First, using an institutional theory lens to understand regime level processes across the three institutional pillars (regulatory, normative and cultural-cognitive). This provides a greater depth of analysis of processes within the regime, and addresses research gaps by incorporating non-technical, everyday aspects, and structural power. Second, using a quasi-evolutionary theory lens to conceptually view each institutional level through the two quasi-evolutionary processes of selection pressures and adaptive capacities. This provides a process-oriented approach necessary for dealing with complexity, and addresses research gaps by foregrounding power and agency. This results in the final analytical framework, where the regime is analysed first by institutional pillar, and then for each pillar by selection pressures and adaptive capacity. Figure 2.2, zooms in on the blue box in Figure 2.1, to set out a more detailed schematic of the analytical framework.

Figure 2.2: Summary of the analytical framework



2.3 Research contribution

The focus of this thesis on the regime contributes to overcoming the relative neglect of regime-level processes. As the incumbent and dominant domain, it is critical that the regime is not seen as simply the backdrop to niche-led change, but as the centre stage for transitions. This exploration of internal regime processes challenges the, often implicit, conceptualisation of the regime as a monolithic barrier by unlocking the 'black box' of the regime using the novel framework to illuminate the complex and myriad processes at play that both constrain and enable transitions. This research looks at how change occurs in the regime, providing a better understanding of the processes of regime change in relation to the vision: what are the regime-level processes; and how do they vary and enable or constrain transitions towards sustainable city visions? This will help to better situate attempts at vision-steered transitions within the complex, dominant regime environment of interacting, co-evolving processes. Furthermore, it will shed light on how regime processes might be modified to better align with, and support, sustainable city visions.

The thesis will provide a fuller picture of the everyday processes of regime, vs novel, largely technical innovations. By drawing on institutional theory, and paying attention to social practices, this research aims to provide greater insight into the socio-cultural and broader institutional mechanisms of change: political and financial regulatory processes (e.g. lobbying and taxes); normative values and standards (e.g. visions); and cultural-cognitive habits and heuristics (e.g. consumer behaviours and ways of thinking). This analysis will support insights into the role of all these processes in current attempts by leading cities to drive change.

Power and agency continue to require greater attention and transition research is still viewed as having 'fallen short' in this endeavour (Scoones et al., 2015; Avelino et al., 2016). Much of the work to date focuses on power struggles between niche and regime, this research explores the role of power and agency within the regime. Particularly the internal dynamics of active resistance and the vested interests of regime actors. Furthermore, the direction of power is explored, providing a greater understanding of the highly political and contested environment of the regime, and posing questions of whether power is synergistic or antagonistic, and how these dynamics vary over time, continually shaping a more or less favourable alignment of regime processes. Finally, the balance of agency vs structure in the regime is investigated, offering greater insight into how much power city actors have to mobilise resources and shape their selection environment.

Chapter 3 Methodology

The introduction set out the 'why and what' of the thesis, and introduced the research questions. The literature review chapter set out the current theory and the research gaps which this research aims to address, and introduced the novel framework. This methodology chapter now details how this thesis attempts to best answer the research questions, addressing the research aim and contributing towards the current body of knowledge in the process.

To recap, the relevant research gaps identified by the literature review that this thesis aims to address are: first, the challenge of complexity and hence the need for a process-oriented approach; second, gaps in understanding regime-level processes; third, the neglect of non-technical, everyday aspects of transitions; and fourth the need to foreground the role of power and agency. This results in a research focus on regime-level processes, paying particular attention to every day, non-technical processes, and the role of power and agency in sustainable urban transitions.

To address these gaps, this thesis builds a more comprehensive analytical framework based on transition theory but drawing on institutional theory and quasi-evolutionary theory. Using this framework gives a better understanding of: the processes driving change within the regime; and whether they enable or constrain progress. The results from this analysis provides insights into how regime processes might be (re-)configured to better align with sustainable urban transitions efforts.

Overall then, this thesis contributes to research efforts to better understand transitions, by exploring the institutional and quasi-evolutionary processes which shape change within complex, socio-technical city systems. It does so in order to gain insights into whether (and if so how) we can steer and accelerate the transition to sustainable cities.

The detailed methodology set out in this chapter is structured as follows: section one sets out the research approach; section two summarises the research rationale and questions; section three outlines the empirical contribution; section four presents the research design; section five sets out case study and sample selection; section six describes data collection and analysis, including quality; section seven outlines the limitations; and finally section eight summarises the ethical review.

3.1 Research approach

The research has been driven from experience in the field and the need for practical solutions. This has influenced the approach taken, from the overarching ontological perspective through to the nuts and bolts of the methodology. Specifically this research takes a pragmatic approach, conducting the inquiry with the firm aim of contributing useful policy-relevant knowledge that can help provide solutions in the real world (Feilzer, 2010). From a pragmatic perspective the research rejects the extremes of a positivist single truth and a relativist entirely subjective reality. Instead this work 'accepts, philosophically, that there are singular and multiple realities that are open to empirical inquiry and orients itself toward solving practical problems' (Feilzer, 2010).

This pragmatic philosophy fits well with the mix of qualitative methods used (Feilzer, 2010). Sustainable development, cities and sustainable transitions are multi-dimensional problems and require a multi-dimensional approach to solving them. Furthermore, analysis of the city system requires an interdisciplinary approach across the various sectors within the overall urban system, and transition research is a transdisciplinary science, and requires science and societal collaboration in understanding and implementing transitions, as well as engaged methods of research (Wolfram and Frantzeskaki, 2016; Köhler et al., 2019). Therefore this thesis draws on a range of qualitative methods to undertake an in-depth exploration of three sustainable city case studies. Responding to this call for collaborative and engaged research, this research is situated very deliberately in a real-world context and engages with current efforts and practitioners to understand the challenges and solutions for transitions. The case studies focus on contemporary initiatives within cities, and the exploration engages with a range of sustainable city actors involved.

This approach is supported by, and reflects, the positionality of the researcher as an academic and a practitioner: academic experience as a PhD researcher; and practitioner experience over 15 years including at the local level involved in Peterborough's efforts to become the UK's Environment Capitol, the national level establishing an informal practitioner network among UK sustainable cities, and the international level working for C40 Cities Leadership Group³.

³ The position with C40 (currently a full-time role as Director of Knowledge and Learning, previously during PhD fieldwork a part-time role as a research manager) offered a good opportunity to support this thesis through access to sustainable city actor networks and potential interviewees. Whilst C40 were supportive of this thesis the research was solely affiliated with the University of Leeds and independent from C40 (indeed the research was conceived and a place and funding secured prior to any involvement with C40).

Positionality is relevant both to the research itself and in relation to research participants (Rowe, 2014). Positionality impacts and shapes the research; for this thesis the researchers' personal experience gave rise to and informs the research but also potential limits it. Past and present experience as a practitioner introduces bias in how the research is framed and undertaken. This influences the research, motivating the choice of a pragmatic, impact oriented approach, and a methodological approach situated in, informed by and aimed at the 'real-world'. This has advantages in terms of generating applied research and solutions, and disadvantages in terms of restricting the research framing – the overall paradigm, as well as framing of issues, researcher heuristics and preconceptions about what will and won't work.

In relation to participants the position adopted was as an independent doctoral researcher at the University of Leeds. The experience as a practitioner was acknowledged but not presented as part of the research role, merely as informing it. This positioning intentionally emphasised the research role to provide participants with assurance of independence and academic due diligence. In terms of the relatedness and power dynamics with participants, the position as a PhD researcher both gave confidence regarding research expertise and integrity, but also a flat power relationship as the PhD researcher position represents expertise but without hierarchical authority. Any risk of academic positionality and research expertise inhibiting participant responses was managed by introducing the interview aim as learning from participants, asking for *their* story of the initiatives as they had experienced it, rather than *the* story of the initiative (Warren, 2001). This created a safe space where interviewees could share experiences without feeling like it was a 'test' or that certain answers were expected or favoured. An appreciative enquiry approach further encouraged and enabled participants to share by building on their observations rather than 'probing' into them (Grieten et al., 2018).

The role as an academic researcher was largely an outsider position; this was advantageous as it encouraged participants to provide explanations (rather than assuming any degree of existing local knowledge) and giving a degree of impartiality. This outsider perspective was (counter-)balanced by the practitioner experience, which gave an insider perspective, and provided a degree of relatedness for participants (in this instance sharing a common professional background and experience). This insider position had both advantages, enabling deeper conversations and a sense of collaboration, and disadvantages, potentially inhibiting and/or influencing responses due to (perceived) conflicts of interest relating to the researchers' practitioner role. In particular, the link between the practitioner role at C40 and some interviewees association with the C40 network had both positive and negative positional influence.

Positive in providing trust but negative in causing participants to be mindful of their wider relationship with C40, limiting or influencing their response. This was mitigated to the extent possible by the independent research position adopted, and by if necessary reemphasising during interviews the independent, impartial nature of the research. Broad socio-demographic similarities (age, socio-economic and educational status) across the three case study cities, the sustainable city actors and the researcher resulted in a relatively close 'position' with participants. Again this provides both advantages in terms of good power dynamics and relatedness, and disadvantages in terms of shared viewpoints and heuristics increasing the risk of shared presumptions and potentially limiting certain avenues of exploration and analysis (Rowe, 2014).

3.2 Research rationale and questions

This section sets out the underlying motivation behind the thesis and the gaps in literature that informed and defined the research questions.

This research is motivated by: first, the underlying ecological and urban crisis (as outlined in preceding chapters); and second, the researcher's experience as a practitioner of genuine commitment to sustainable city visions but a persistent lack of progress at the speed or scale required - this experience is backed-up by the literature (see e.g. McCormick et al., 2013; IPCC, 2018; Rauschmayer et al., 2015). The aim is to better understand the implementation gap between cities' long-term sustainable visions and their current progress towards it, with the ultimate end-goal of helping to overcome this gap. With the research motivators and aim in mind a literature review was undertaken. Following a broad review of the research on sustainable cities, transition theory was selected as the most relevant body of work to support the thesis aim of understanding cities' (lack of) progress towards sustainability. This selection was based on, and is justified by, the fact that the aims of transition theory and definition of transitions map very closely with this thesis' research aim to explore how to overcome the implementation gap in realising sustainable city visions. Achieving sustainable cities' will require radical change; and transitions are defined as fundamental and/or radical transformations towards sustainable society (Smith et al., 2010; Markard et al., 2012). Furthermore, transition theory aims to understand if and how transitions can be steered, and in doing so aims to address the persistent problems of modern society; specifically the challenge of sustainable development, and more recently the challenge of urban sustainability (Grin et al., 2010; Wolfram and Frantzeskaki, 2016; Köhler et al., 2019). Moreover, transition theory has an impact oriented approach, with much of the work within the field rooted firmly in real-world contexts and aiming at on-the-ground change;

for example Transition Managements (Rotmans et al., 2001; Kemp et al., 2007), urban experiments and 'city laboratories' (Castán Broto and Bulkeley, 2013; Sengers et al., 2019), and co-production (Neuens et al., 2013).

A deeper literature review was then undertaken within transition theory in order to identify the current state of knowledge, what is already known, and identify what the main, relevant research gaps were. This identified four main gaps which informed the research questions. These are detailed below.

First, the complexity of transitions precludes an entirely vision-determined, outcome oriented approach, and requires instead a process-oriented approach which is vision-steered and purposive. This led to the research focus on *processes*. Furthermore quasi-evolutionary theory is drawn upon to provide a theoretical framing capable of handling the complexity of, and conceptualising how transitions emerge from this 'chaos'. This led to the specific focus on *quasi-evolutionary processes*.

Second, the current body of work focuses on niche-innovation and neglects processes within the regime itself. This results in an, often implicit, assumption or conceptualisation of the regime as a monolithic barrier to change. This research rejects this view and aims to explore the processes within the regime itself, both constraining and enabling change. This led to the research question on *regime-level* processes.

Third, this focus on niche-innovation emphasises novel and technological aspects of transitions and neglects non-technological, everyday processes of change. This prompted the incorporation of institutional theory in order to gain greater insight into the broader aspects of transition, beyond technological innovation, specifically regulations, normative values and cultural-cognitive habits and heuristics. This led to the research focus on quasi-evolutionary *and institutional* processes.

Fourth, and finally, transition theory is widely acknowledged to 'fall short' in addressing the role of power and agency (Scoones et al., 2015; Avelino et al., 2016). Here the structuration and structure-agency debate is central to the analysis of power dynamics within transitions. This thesis takes Giddens' (1984) approach of a duality of structure and agency and draws on both quasi-evolutionary and institutional theory to better address power and agency. This reaffirmed the focus on *quasi-evolutionary and institutional processes*, as well as the *regime-level* focus as the dominant power within the MLP (Geels, 2014).

Overall this leads to the two research questions (set out in full in the introduction chapter and summarised here): first, what are the quasi-evolutionary and institutional processes

operating within the regime; and second, why and how do they vary and do they enable or constrain progress?

In order to answer these research questions this thesis undertakes a deep investigation into sustainable urban transitions involving comparative case studies in London, New York and Copenhagen drawing on a range of collection methods and sources.

3.3 Empirical contribution

This section outlines the empirical contribution of this thesis, specifically: the need for contemporary, comparative case studies; the importance of a local, place-based appreciation of transitions; the need for more cross-sector research; and leading cities as particularly good opportunities for case study contribution to transition theory.

Early transition research focused on case studies of historical transitions (e.g. Geels, 2005a; Geels, 2005b; Geels, 2006), with a lack of more current empirical research (Grin et al., 2010). More recently there is a growing number of contemporary case studies, including urban cases (Bulkeley et al., 2010; Hodson and Marvin, 2010; Wolfram and Frantzeskaki, 2016; Frantzeskaki et al., 2017). However, whilst there is an increasing number of urban case studies there is a gap in comparative case studies (Wolfram and Frantzeskaki, 2016). There is therefore the need to build up evidence and learning from across sustainable transition case studies (McCormick et al., 2013; Wolfram and Frantzeskaki, 2016).

Transition research efforts have often been directed at national, rather than local scale, leading to a gap in understanding of local level processes (Barnes et al., 2018). Furthermore, the importance of geography and local context is increasingly being highlighted by transition scholars (Hansen and Coenen, 2015). The role of local landscapes, physical infrastructures, socio-cultural contexts in shaping (urban) transitions is seen as central (Hodson and Marvin, 2012; Castán Broto and Bulkeley, 2013; Wolfram and Frantzeskaki, 2016). In addition, the impact of initiative-specific context, though less widely acknowledged, is also highlighted by some scholars (Fuenfschilling and Binz, 2018). Therefore, further exploration of the local, place-based and initiative-specific dynamics of transitions is required.

In addition to this, transition theory has been applied at the sub-system, or sector, level as the unit of analysis (e.g. energy, water) (Grin et al., 2010). Whilst tackling change at sub-system level is a practical approach it does inherently reinforce sector silos. Hence further work on transitions across multiple sectors, and how these sectors interact, is needed (Geels, 2011; Barnes et al., 2018). Sustainable cities pose a particular challenge

as integrated management across systems is required (Bulkeley et al., 2010). Therefore, from a sustainable cities perspective, there is a gap in transition work on whole-system approaches where the unit of analysis is geographical (in this instance the city) not sub-systems based.

Finally, as cities are critical for sustainable development so building a body of empirical research on the transition journeys of cities is a hugely important task. Bulkeley and Betsill (2005) refer to the range of scales of governance acting on cities, the role of power and capabilities and the entrenched policy communities relating to cities. Furthermore Barnes et al (2018) note that cities are at the confluence of globalisation, sustainability, and urbanisation. These aspects make for good case studies; hence the three case studies from leading sustainable cities in this thesis offer a valuable empirical contribution to transition theory.

This thesis contributes to the body of empirical work on transitions, specifically providing comparative case studies of attempts at sustainable urban transition. By analysing comparative city cases, and different initiatives within each case, this research offers greater insight into similarities and differences between urban place-based transitions and purpose-specific initiatives. Furthermore, selecting urban case studies across multiple sectors enables exploration of how interactions between sectors affects transitions and how to achieve holistic change at the intersection of different sectors.

3.4 Research design

This section details how the research, including data collection and analysis, has been designed to best answer the research questions generated by the gaps identified in the literature review.

A case study method was selected as a suitable approach for in-depth exploration of complex and context-specific phenomena. Case studies enable exploration of phenomena within their context, providing insights into how transitions unfold in real-time and 'real-life' research (Yin, 2013). They are widely used in the transition field, as an appropriate method for process-oriented analysis (Geels and Schot, 2010). Because many transitions are based on historic analysis, this research was designed to study current cases, and responds to recommendations in the literature to build contemporary empirical evidence (Wolfram and Frantzeskaki, 2016; Barnes et al., 2018; Köhler et al., 2019). Furthermore contemporary city cases enable engagement with transitions in situ and in action (Smith and Stirling, 2007; Köhler et al., 2019).

The choice of a comparative case study approach was because it generates more robust results by drawing on several cases, as well as generating deeper insights enabled through comparison between the different contexts, thereby increasing the reliability and validity of findings (Yin, 2013). Comparative case studies allow exploration of which patterns are specific to particular place-based contexts, and which might be general across geographies (Wolfram and Frantzeskaki, 2016). Furthermore, as noted previously, this approach addresses the gap in comparative case studies identified by transition scholars (Geels, 2011; Wolfram and Frantzeskaki, 2016).

In using case studies, an important aspect of research design is defining the boundaries of analysis (Yin, 2013). This provides clear limits and scope for the research. For the case studies, each city constitutes a case, and within each case the place-based sustainability city actor network is the unit of analysis. The analytical focus at the network level is a deliberate distinction from the unit of data collection, the individual, reflecting the research focus on the processes driving system change, not individual motivations and behaviours – noting here that the latter is an important part of the former (Shove and Walker, 2010). The unit of analysis, the place-based sustainable actors (also referred to as the sustainable city actor network), is defined as the actors who are involved with sustainable city visions and associated initiatives, i.e. stakeholders with a role in the city vision and/or initiative.

Furthermore, the MLP creates a second requirement to clearly define the boundaries of analysis. This is because the MLP can be applied at different scales of analysis depending on the focus of research. The MLP does not ‘prescribe how broad or narrow the empirical topic should be delineated’ (Geels, 2011), hence it is important for the researcher to do so clearly. The analytical boundary for the regime could be applied at different empirical levels (Berkhout et al., 2004), for example cities could be considered as the regime, or they could be considered as niches where urban innovations are developed (Wolfram and Frantzeskaki, 2016). For the purposes of this research the city is defined as the regime. This analytical boundary enables exploration of transition processes within the regime, rather than exploration of transitions as interactions between MLP levels. This provides greater insight into change within the regime, responding to the relative neglect of transition work at this level (Hargreaves et al., 2013; Geels, 2014).

This thesis focuses on city cases (rather than sectoral cases) not only because of the overall aim to better understand, and enable, sustainable urban transitions but also for several methodological reasons: such studies enable holistic understanding of transitions across multiple sectors, contrary to the historical prevalence of sector-specific

transition analysis; and they enable place-based analysis and exploration of context-specific dynamics of transitions (Torrens et al., 2018).

Within each case study two initiatives are explored. This generates multiple embedded case studies, as per Yin's definition (Yin, 2013). This multiple-case design, with embedded (multiple) sub-cases/units of analysis, is shown visually in Figure 3.1 and Figure 3.2. The decision to investigate specific initiatives within the overall sustainable city vision was firstly based on practical considerations; to enable a deep dive into case study phenomenon the scope of the research was limited to two specific initiatives. Secondly, selecting two initiatives within each case created the opportunity for comparison within each city case, generating insights into how processes vary within as well as between cities. Furthermore selection of initiatives showing differing levels of progress (one progressing well and one more challenging) enabled a greater range of critical insights. The selection of initiatives that were progressing well was prompted by feedback on the research design from city practitioners, who wanted to understand what worked as well as what was more challenging; the enablers, as well as barriers to change (this feedback was gained via a practitioner workshop outlined further at the end of this section). This research adopts the initiative definition given by Barnes et al.:

“locally-based initiatives that aim to drive transformative change towards environmental sustainability of existing societal systems (i.e. through the renewal or replacement of infrastructures and technologies, rules and norms, routines and practices, and so on)” (Barnes et al., 2018, p.70)

Figure 3.1: Visual representation of the multiple-case design with embedded (multiple) sub-cases/units of analysis.

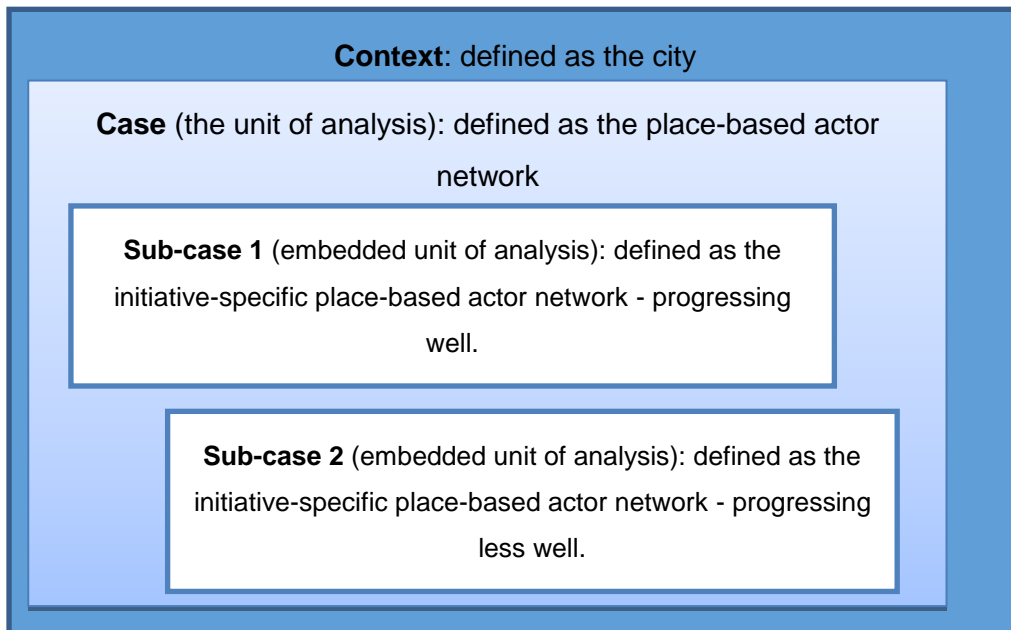
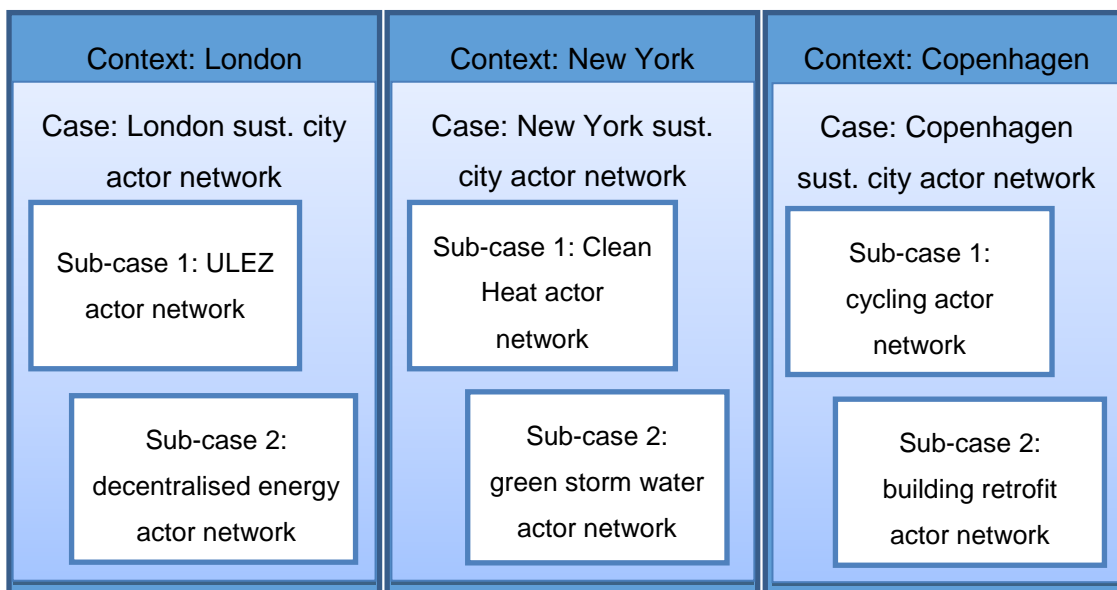


Figure 3.2: Visual representation of the three case studies and their embedded sub-cases.



This design focusing on city cases analytically defined as the regime, and incorporating place- and initiative-specific sub-cases, responds to calls from transition scholars to understand place and project specific aspects of transitions, and in particular of regimes (Fuenfschilling and Binz, 2018). Furthermore, comparing across different cities and initiatives provides much greater evidence and insights into variation of processes and

potential causes for this, particularly relating to place- and initiative-specific context, responding in particular to the second research question: how processes vary and why?

This focused design raises the challenge of balancing greater insight into locally specific transitions against the ability to draw more universal learnings and transfer insights more broadly (Wolfram and Frantzeskaki, 2016). This challenge is addressed through the analytical framework because it is based on regime processes which are universal to all contexts, and therefore maintains general application and transferability of insights, and at the same time enables identification of the processes specific to the particular place and initiative studied (discussed further in the limitations section in the concluding chapter).

Turning to what relevant data to collect, the research design identified case study evidence consisting of documentary, interview and observational data. The main bulk of the evidence was from interviews with place-based actors. Interview data offers richer, more in-depth evidence than many alternative sources (e.g. surveys or questionnaires), and interviews were selected with the complexity of transitions in mind (Brinkmann and Kvale, 2015). Interviews can reveal how participants think about and view the world more generally, as well the case study and/or initiative more specifically. This can elicit information beyond the direct answers to the research questions as framed by this thesis' research approach and this researcher's positionality and bias. Interview data was supplemented with documentary and observational evidence for a number of reasons. Documentary evidence helped provide contextual information at the start of case study field work, informing initiative and interview selection and supporting the interview processes. Observational data was collected to provide actual evidence to supplement, and verify, reported evidence (via interviews and documents). Both documentary and observational evidence were used to triangulate and corroborate interview findings, in order to increase the robustness of the overall case study data and resulting findings (Yin, 2013). Documentary data collection focused on key sustainable city documents that set out the vision and provided any additional information about why the city was committing to this vision, and how they were intending to achieve it. Observational data focused on discussions and decision-making moments, key meetings and discussions. This observational data proved hard to obtain as such discussions and decisions often occurred behind closed doors. In addition the complex nature of transitions as a myriad of many interconnected processes made it hard to identify specific opportunities, or where such opportunities were identified to 'catch' them at the right time (interviewees often mentioned discussions or meetings that had happened in the past).

Considering next data analysis, the research design used the framework as the main tool for analysis. As described in the previous chapter a novel analytical framework was developed in order to address some of the gaps in transition theory and build a more holistic model of change through drawing on institutional and quasi-evolutionary theory. This was used for analysis of case study data enabling both an in-depth exploration of each single case, and critical comparative exploration across the cases. By combining case studies and framework analysis the research design effectively enables critical exploration of 'how' and 'why' questions around sustainable urban transitions (Yin, 2013). Furthermore this design, which incorporates comparison across a number of cases and uses an analytical framework to build a general theory of change, responds to calls from transition scholars to balance in-depth 'particularity' of cases with general insights (Köhler et al., 2019). As noted previously the framework enables attention to the context specific place- and initiative-based aspects of each case but also provides a universal framework and set of processes to be able to build a general theory of transition that can be applied more widely.

Finally the research design processes included an element of co-design. A workshop with nine practitioners from a number of UK cities was undertaken before data collection to co-develop and validate research design. Participants were from five cities (Bristol, Leeds, Leicester, Middlesbrough, Peterborough) and represented a range of roles (charity CEO/manager, local authority sustainability, energy, transport roles manager/head). The feedback from the workshop encouraged a focus on enablers as well as barriers, to ensure appreciation for what is working well so that this can be scaled and built on. This was incorporated into the research questions and research design. In terms of validation there was broad support for the research aims and approach, and participants confirmed the utility of the research questions and resulting anticipated findings.

3.5 Case study and sample selection

This section outlines case study, sub-case initiative and sample selection for interview, documentary and observational evidence. Looking first at case study selection, this research focuses on cities that are committed to a long-term sustainable vision and demonstrate best practice. The aim is to investigate issues of implementation of a vision, and therefore an existing vision is a pre-requisite. Furthermore, situating the investigation within cities that show best practice allows two advantages: (1) investigation of enablers as well as barriers (2) investigation of barriers beyond those of individual and organisational execution capacity and performance, i.e. system barriers.

The case studies were selected from the C40 Cities Climate Leadership Group of 94 global cities. One aspect of this selection was based on the nature of the network as a cities leadership group, which meets the research requirements for leading cities. C40 Cities demonstrate leadership in sustainability, committing to the Paris Agreement aspiration to keep global warming to below 1.5 degrees Celsius, and developing plans to achieve this ahead of most other actors. Whilst the organisation is focused on climate change many, if not most, of its member cities take a broader view of sustainable development (including London, New York and Copenhagen). The second aspect of selection from the C40 network was practical, resulting from an ESRC funded company internship at C40 that led to ongoing work. Whilst the research was independent of the work at C40, the support provided, especially in terms of identifying and recruiting interviewees, significantly aided research efforts – both a reason for, and benefit of, selecting C40 cities.

From within the C40 network, cases were selected against the criteria of: commitment towards a long-term sustainable vision; best practice; and willingness and ability to participate in the research. All the selected cities have strong sustainable city visions: London's early work as one of the first cities to have a climate plan and now a comprehensive environment strategy with the aim to become "the world's greenest city" (Greater London Authority, 2018b, p.7); New York's GreenNYC and now OneNYC plans outlining the aspiration to be "the most sustainable big city in the world" (City of New York, 2015, p.6); and Copenhagen's ambition to be carbon neutral by 2025 (Copenhagen, 2012). The selected cities have demonstrated particular leadership and best practice in terms of C40 chair roles (London and New York), steering committee membership (London, New York and Copenhagen) or 'innovator city' status (Copenhagen). In addition, practicalities, e.g. conducting research interviews in English, were taken into consideration in the selection of cases.

Within each case study, initiatives were selected from key informant interviews supported by documentary evidence. Key informants were asked for examples of initiatives progressing well not so well, and initiatives were then selected based on the frequency referenced, and the level of ambition and impact (from a sustainability perspective). It should be noted that key informants' opinions regarding the progress of initiatives were subjective, though this was mitigated by drawing on documentary evidence to verify interviewees' views. Additionally, it should be noted that the judgement of progress was relative to other city initiatives, and does not represent evaluation against absolute criteria.

Interview participants were selected in two stages; key informant interviewees followed by initiative interviewees. Key informant interviewees were selected by identifying central roles within the sustainable city actor network (e.g. lead for sustainability within local government, or civic or private sector sustainability groups). Selection was supported by C40 staff with local knowledge and with documentary evidence. Initiative interviewees were then recruited via a combination of snowballing, opportunistic and sampling methods. Snowballing was the main approach used, whereby key informant interviewees were asked to recommend potential initiative interviewees, and all initiative interviewees were asked to recommend further potential interviewees (Black, 1999). However, the overall interview sample was partially controlled for a number of factors: representation across public, private and civic sectors; and the overarching criteria of place-based actor network. In practice this meant largely following interviewee recommendations but balancing recruitment efforts to ensure sectoral representation and filtering out recommendations that fell outside the unit of analysis (e.g. recommendations to interview actors from other cities). Snowballing introduces bias in terms of interview selection, but this is in many ways reflective of the regime and the unit of analysis as a place-based network of actors. Most potential participants approached were willing to undertake interviews but some declined to participate so there was a very practical aspect to sampling in terms of who accepted. However, there was no clear pattern to which participants accepted and which declined so no particular bias was introduced as a result.

A challenge with interview selection was identifying regime actors, as distinct from niche actors. Given the complexity involved (in transitions, cities and initiatives) it is difficult to determine in advance, and delineate afterwards, whether actors are regime or niche actors. This reflects the ambiguity of MLP boundaries and, as noted previously, the fact that the MLP levels can be defined differently depending on the focus of the analysis (Berkhout et al., 2004; Geels, 2011). This ambiguity results in the general challenge of delineating and maintaining the analytical boundary between niche and regime, which in real-life is rarely 'clear cut' (Smith, 2007). Furthermore, the difficulty in identifying regime actors reflects the cross-level role that many actors play (Elzen et al., 2012; Smink et al., 2015; Wittmayer et al., 2017), and the ambiguous definitions of regime- or niche-actors (Avelino and Wittmayer, 2016); from one analytical perspective an actor may be defined as a regime actor, whilst from another they may be a niche actor. This blurred boundary between regime and niche levels is explored further in Section 8.4 of the conclusion chapter. There is a predominant assumption that government and large corporation actors are regime, whilst smaller, especially civic sector, organisations are niche. This

is due to assumptions about power; regime, government and large corporations as more powerful, niche and smaller, civic organisations as less powerful (Avelino, 2011; Avelino and Wittmayer, 2016). This thinking has been largely reinforced by empirical analysis to date (Avelino and Wittmayer, 2016). As previously stated this research challenges these common assumptions around the dominance and homogeneity of the regime, and attempts to take a more nuanced view to reflect the range of regime-level actors and the variety of ways in which they shape, and are shaped by, the regime. A limitation of the research was that all of the actors interviewed were related to sustainable city initiatives. It would have been ideal to interview a wider range of regime actors to ensure representative views, not only from actors with a normative sustainability perspective. However a wider sample representative of the whole regime would be practically and analytically challenging to handle. In addition it should be noted that interviewees spanned a wide range of roles (e.g. legal officers and engineers), offering a reasonable regime perspective beyond the views of actors very centrally, and directly involved in the sustainable city initiative (e.g. sustainability managers and officers).

For each initiative 8-10 interviews were undertaken to ensure a sufficient sample whilst keeping data collection practically manageable. Some interviewees spoke about both initiatives where they had experience to do so. Table 3.1, Table 3.2 and Table 3.3 list the interviews for each case study by: number; interview type (key informant or initiative); interviewee role (note generic roles are given to maintain confidentiality); and sector (public, private, civic).

Table 3.1: London case study interviewees

Interviewee number	Interview type	Role	Sector
L1	Key informant	Political	Public
L2	Key informant	Policy	Public
L3	Key informant	Policy	Public
L4	Air quality / ULEZ	Campaigner	Civic
L5	Decentralised energy	Engineer / implementation	Public
L6	Air quality / ULEZ	Campaigner	Civic
L7	Decentralised energy	Director	Civic
L8	Decentralised energy / Licence Lite	Technical specialist	Public
L9	Decentralised energy	Senior Manager	Private / Civic / Public
L10	Air quality / ULEZ	Strategy	Public
L11	Air quality / ULEZ	Air Quality Officer	Public
L12	Air quality / Decentralised energy	Senior Manager / Economic	Public
L13	Decentralised energy	Strategy	Public
L14	Decentralised energy	Director	Private
L15	Air quality / ULEZ	Academic	Public
L16	Air quality / ULEZ	Strategy /planner	Public
L17	Air quality / ULEZ	Policy	Private
L18	Decentralised energy	Senior Manager	Private
L19	Air Quality / ULEZ	Transport Planner	Public
L20	Air quality / ULEZ	Senior Manager	Public

Table 3.2: New York case study interviewees

Number	Interview type	Role	Sector
N1	Key informant	Policy	Public
N2	Key informant	Director / architect	Civic
N3	Key informant	Policy	Public
N4	Key informant	Officer	Public
N5	Buildings retrofit	Senior manager	Private
N6	Clean Heat	Policy	Public
N7	GHG inventory	Officer	Public
N8	Clean Heat	Policy	Public
N9	Water management	Senior Manager	Public
N10	Both initiatives	Legal	Public
N11	Clean Heat	Senior Manager	Public
N12	Buildings retrofit	Officer	Public
N13	Green storm water management	Officer	Public
N14	Green storm water management	Innovation	Public/Private
N15	Green storm water management	Policy	Public
N16	Both initiatives	Senior Manager	Public
N17	Both initiatives	Research / resilience	Civic
N18	Clean Heat	Policy	Public
N19	Green storm water management	Consultancy	Private
N20	Clean Heat	Project delivery	Private
N21	Clean Heat	Policy	Private
N22	Clean Heat	Public Health	Public

N23	Green storm water management	Senior Manager	Public
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Table 3.3: Copenhagen case study interviewees

Interviewee number	Interview type	Role or organisation type	Sector
C1	Key informant	Policy	Public / Civic
C2	Key informant	Climate change	Public
C3	Key informant	Climate change	Public
C4	Retrofit	Manager	Public
C5	Cycling	Political	Public / Civic
C6	Retrofit	Operations	Private
C7	Cycling	Cycling officer	Public / Private
C8	Retrofit	Manager	Private
C9	Cycling	Cycling officer	Public
C10	Cycling	Planner	Public
C11	Cycling / Retrofit	Architect	Public / Private
C12	Cycling	Environment	Public
C13	Cycling	Academic	Public
C14	Retrofit	Policy / Housing association	Civic
C15	Retrofit	Architect	Private
C16	Cycling	Academic	Public
C17	Cycling	Planning	Public
C18	Retrofit	Architect	Private
C19	Retrofit	Policy / construction association	Civic
C20	Retrofit	Policy	Public / Civic

Documentary evidence was collected mainly from online sources, and predominantly from the public sector. Data collection focused on the main documents setting out the sustainable city vision, e.g. Copenhagen's Carbon Neutral 2025 plan. Additional documentary evidence relevant to the specific initiatives was collected during the interview process with participants providing or signposting to relevant material, e.g. New York's Green Infrastructure plan. Documentary evidence was used to inform case study research, as well as to triangulate and corroborate interview findings. Table 3.4 lists the documentary evidence by title, type, year of publication and author.

Table 3.4: List of documentary evidence by case study.

Document title	Type	Year	Author
London			
Could do better - a report card on progress with Mayoral carbon reduction targets	Report	2014	London Assembly
Cutting carbon in London 2015 update	Presentation slides	2015	London Assembly
Delivering London's energy future - the mayor's climate change mitigation and energy strategy	Report	2011	GLA
Greater London Authority Carbon Disclosure Project Cities	Report	2013	CDP, C40 Cities, AECOM
Greater London Authority website	Website	2016 (accessed)	GLA
Levelling the playing field: Unlocking heat infrastructure investment	Report	2016	The Association for Decentralised Energy
London Environment Strategy	Report	2018	GLA
Sadiq Khan for London - a Manifesto for all Londoners	Report	2016	Labour Party
The Mayor's climate change mitigation and energy annual report	Report	2014	GLA

New York			
1.5°C Aligning New York City with the Paris Climate Agreement	Report	2017	City of New York
Mayor de Blasio announces historic step to report local progress on global sustainable development goals	Press release	2018	City of New York
Mayor, Comptroller, Trustees Announce First-In-The-Nation Goal to Divest From Fossil Fuels	Press release	2018	City of New York
NYC Clean Fleet	Report	2015	City of New York
NYC Clean Heat website	Website	2016 (accessed)	City of New York
NYC climate justice agenda - strengthening the Mayor's OneNYC Plan	Report	2016	New York City Environmental Justice Alliance
NYC green infrastructure plan - a sustainable strategy for clean waterways	Report	2010	City of New York
NYC Retrofit Accelerator website	Website	2016 (accessed)	City of New York
One city - built to last	Report	2014	City of New York
One New York - the plan for a strong and just city	Report	2015	City of New York
OneNYC 2016 progress report	Report	2016	City of New York
PlaNYC - a greener, grater New York	Report	2007	City of New York

Copenhagen			
Co-Create Copenhagen	Report	2015	City of Copenhagen
Copenhagen city of cyclists: Facts and figures 2017	Report	2017	City of Copenhagen
Copenhagen climate adaptation plan	Report	2011	City of Copenhagen
Copenhagen climate projects annual report 2014	Report	2014	City of Copenhagen
Copenhagen climate projects annual report 2015	Report	2015	City of Copenhagen
Copenhagen climate projects annual report 2016	Report	2016	City of Copenhagen
CPH 2025 Climate Plan - a green, smart and carbon neutral city	Report	2012	City of Copenhagen
Cykelpolitik 78	Report	1978	Danish Cyclists Federation
Cykelstier og cykelveje (Bicycle paths and cycle paths)	Report	1981	Niels Jensen
Good, Better, Best - the City of Copenhagen bicycle strategy 2011-2025	Report	2011	City of Copenhagen
Green Building Alliance Roadmap	Website	2016	Norsk Elendom
Kobenhavns kommune (City of Copenhagen) website	Website	2017 (accessed)	City of Copenhagen
Trafikdifferentiering - en vej til trafiksikkerhed (Traffic differentiation - a route to road safety)	Book	1971	City of Copenhagen

Observational evidence was part of the original design in order to supplement reported behaviours through interviews with actual behaviours from observation. However opportunities for observations were limited to a small number of public events. This gives some insight into how open/closed actor networks are. The events observed were: for London, an air quality event related to ULEZ initiative facilitated by the Institute for Public Policy Research (IPPR) and hosted by the GLA; for New York a retrofit accelerator event related to the Clean Heat initiative hosted by the city to update and engage stakeholder; for Copenhagen a healthy and liveable cities masterclass related to the cycling initiative and delivered by Gehl architects (experts in the field), as well as a presentation at a C40 City workshop by Copenhagen city cycling staff. This observational evidence is not sufficient to fully corroborate interview reported behaviour with observed actual behaviour. However, it did provide a form of useful triangulation, but given the limited sample this cannot be assigned a high level of confidence. Furthermore, the events supported a better understanding of city context. This lack of observational experience is counter-balanced by previous and ongoing practitioner experience as part of working with city staff through the C40 Cities Network.

Table 3.5: List of events observed

Event	Organiser/presenter	Date	City
Lethal and illegal – London’s air pollution crisis	IPPR and GLA	18/7/16	London
Second biennial NYC Retrofit Accelerator symposium	City of New York	17/11/16	New York
Healthy and liveable cities masterclass	Gehl Architects	20-21/6/17	Copenhagen
Presentation on bicycle account	City of Copenhagen	19/09/18	Copenhagen

3.6 Data collection and analysis techniques

This section sets out the methodological protocol for data collection and analysis of case study evidence, primarily interview data supported by documentary and observational evidence for triangulating results.

Interviews were semi-structured in order to balance flexibility for participants to express their views and experiences, with gaining the data required in a reliable, comparable manner (van Doren et al., 2020). An Interview guide was used to manage the interview.

This covered: the background and role of the participant; the participants' view of whether the city has a sustainable city vision, and commitment to it; the participants' account of the 'story' of the initiative as they have experienced it (Warren, 2001). Questions were open-ended and drew on an appreciative inquiry approach to provide interviewees with a positive environment in which to talk about what was working well, ensuring that interview data covered the enablers as well as barriers to progress (Cooperrider and Whitney, 2005; Nevens et al., 2013; Grieten et al., 2018). As noted above the place-based sustainable city actor network is the unit of analysis for the case studies, so questions were focused at the system or organisational level, and not at the level of the unit of data collection, the individual. Interviewees were informed in advance of the purpose of the research, what their interview data would be used for, and how data protection and confidentiality would be ensured (see participant information sheet in Appendix B). Interviews were mostly conducted in workplaces, usually private offices but occasionally interviews were undertaken in open and/or public spaces. Interviews lasted for around an hour and were recorded, with the interviewees' permission. Some notes were taken during the interview to aid in follow-up questioning, but this was minimal so as to remain focused on listening and to maintain good rapport with participants. Only a few participants expressed concerns about sensitive data, all of which were noted and checked to ensure confidentiality processes were sufficient.

Documentary evidence was collected to support the interview data. Key documents relating to the sustainable city initiative were gathered and reviewed during the case study selection process to verify the criteria relating to level of ambition of, and commitment to, sustainable city vision. Additional documents were collected and a review was undertaken at the start of the case study data collection in order to: provide initial contextual insights and understanding of the case study cities; support the selection of key informant interviewees; and finally to inform the selection of more and less successful initiatives. During interviews further documentary evidence was gathered relating to the specific initiatives, often referenced by interviewees.

Observational evidence was collected at events, detailed notes were taken during events and presentations and handouts gathered where available.

Moving on from data collection, the process for data analysis is now set out. The analysis focused on interview data to identify processes, look for patterns and check for (in)consistency and outlying data. Triangulation of data from documentary and observational evidence was used to support this.

All interviews were transcribed using dictation software and listening to and 're-speaking' the interviews. This process of 're-speaking' provided another valuable, level of immersion in the analysis. High-level notes were taken during the transcription process to capture initial thoughts and aid later analysis. As analysis focused on the content of what was said and not the manner in which it was said transcriptions captured this, whilst details around behaviour and speech pattern were not included. Furthermore transcription captured what was said faithfully and without interpretation/editing. The risk of handling data in this way is that it becomes ossified, and challenging for someone else to handle, creating a potential limitation of further use of data. However, this approach is defended to reduce bias resulting from inherent researcher subjectivity in any interpretation or editing undertaken.

Once interviews had been transcribed initial analysis was undertaken to code the content. Coding was done using Nvivo software to support in identifying the prevalent themes within the data (Bazeley, 2007). Codes were based on the analytical framework, coding the interviews to identify firstly institutional processes across the three pillars (regulative, normative and cultural-cognitive), and secondly quasi-evolutionary processes (selection pressure and adaptive capacity), resulting in six overall codes:

1. Regulatory selection pressure
2. Regulatory adaptive capacity
3. Normative selection pressures
4. Normative adaptive capacity
5. Cultural-cognitive selection pressure
6. Cultural-cognitive adaptive capacity

Within each of the six framework codes a draft set of sub-codes was developed based on significant and common themes emerging from the interviews and documentary evidence. The analysis critically interrogated case study data to attempt to go beyond a description of events to an understanding of cause and effect (Fairclough, 2013). This proved a challenging period of analysis for trying to reconcile themes emerging from the interviews, as expressed by sustainable city actors, with the analytical framework, an entirely academic framing and language. Initial efforts to combine the framework codes and interview data sub-codes resulted in a cumbersome and contrived set of codes. Further work then rationalised this to a reduced number of sub-codes through a productive process of reviewing, revising and combining sub-codes. As analysis progressed sub-codes proved a useful way of identifying the institutional and quasi-evolutionary processes driving change in each city, helping to define and detail how these processes manifest in real world transitions, and providing a framework to handle

the complex myriad of processes in a manageable way. This iterative process of rationalising codes was useful to test the framework and the definitions of institutional and quasi-evolutionary processes to enable accurate and consistent coding. Through this coding process the framework supported deeper analysis; the use of institutional and quasi-evolutionary 'lenses' enabled analysis to go further than common themes and the superficial narratives, e.g. vision is commonly picked up as critical, but professional cultures and ways of thinking are often overlooked (Shove and Walker, 2010; Hargreaves et al., 2013).

One very telling aspect of coding was the need to supplement the six framework codes due to frequent references to context specific or historical path dependencies made by interviewees. In response a separate code was created for historical and contextual factors. The decision was made not to include these factors within the six framework codes in order to separate out those aspects which were more about context than processes. However there are limitations of coding all history and contextual references together (elaborated upon further in the limitations section), and following on from this, one of the research recommendations from the thesis is to delve into this 'code' to explore it further.

Having developed a set of codes and sub-codes, all the interview transcripts were coded. As above the sub-codes identified the main institutional and quasi-evolutionary processes driving decisions – answering the first half of the first research question.

Analysis then explored the configurations of institutional and quasi-evolutionary processes by looking at prevalence of the six framework codes overall, by case study, and by initiative. Further exploration critically compared how configurations vary between case studies, and between initiatives; both investigating variation between initiatives within a case, and across cases, paying particular attention to the differences between initiatives progressing well and those progressing less well. Nvivo was used to determine the frequency of each code and this was exported into Excel to allow analysis within and between cases and sub-cases, and graphical representation (shown in various figures in the case study chapters and comparison chapter).

Throughout data collection and analysis care was taken to control for quality of data and results. For data collection the interview guides ensured that the semi-structure of the interview was consistently followed. At an early stage in each case study initial interview data was reviewed to ensure sufficient and quality data was being collected. As previously stated, triangulation of interview data with documentary and observational evidence verified findings, further supporting data quality. During analysis a rigorous

and iterative process of coding was undertaken to enhance quality of findings. Initial codes were tested with a sample of interviews from each case study; this aided further refinement of codes, identifying and eliminating any issues of inconsistent coding, and ensuring that final codes reflected all case studies and initiatives.

3.7 Limitations

Whilst the methodology above has been designed to best answer the research questions, there remain a number of limitations.

The focus on sustainability actors results in a potential sustainability bias in case study evidence that is not representative of the wider regime. As discussed above practical resource constraints prevented wider interview sampling to understand views across the whole city regime. However, this sampling limitation was somewhat mitigated by recruitment focused on the initiative and not sustainability per se, which led to a wider range of interviewees beyond those directly involved in sustainability (e.g. motor trade association representatives). Furthermore, in defence of this research design, the focus on sustainable city actors enables insights into the processes that are affecting their efforts. Given the research aim is to overcome the implementation gap between long-term sustainable city visions and current progress it is reasonable to assume that sustainable city actor efforts are central to this, and hence the bias towards the barriers and enablers they are facing is (somewhat) justified.

Another limitation of this research is that it does not analyse historical and contextual factors. Instead these factors are grouped as one homogenous aspect of each case study and treated as context rather than process. The coding of these factors as one homogenous group obscures insights into path dependency and the impact of material, physical infrastructures (e.g. the existence, or not, of pipework required for decentralised heating impacts the success of decentralised energy initiatives). Reconceptualising context specific and historical path dependencies as processes would help avoid this limitation of backgrounding contextual factors (indeed this is one of the recommendations for future research in the concluding chapter). Such a reconceptualisation of historical and contextual factors as part of the 'rules of the game' and coding them by institutional and quasi-evolutionary processes would enable them to be fully included in framework analysis - thereby, enabling the same level of exploration and gaining the same depth of insight as for all other processes analysed. In particular, deeper exploration of historical and contextual processes might shed more light on where actors have most and least agency. For example, some elements of each case study's context are practically unchangeable, e.g. geography and climate. These might be better conceptualised as

natural resources that are available, or unavailable, in order to best consider the impact they have upon transitions. This approach follows the work of Avelino and Rotmans (2009) on the role of resources in transitions (outlined previously in the literature review chapter). Actors have agency over how they use such natural resources, but not the agency to create or change them. For the relatively more mutable aspects of history and context, such as physical infrastructures and culture, these can be changed albeit gradually.

Finally, as noted in the research design section, the analytical boundaries for both the case studies and the MLP need to be carefully drawn and defined. The boundaries depend on the specifics of the research and intended analysis. These analysis-specific and subjective boundaries represent both a strength and limitation of the research. If boundaries are purely analytical then a potential weakness of the framework is the subjective nature of analysis. For example what is considered regime and what is considered niche (or indeed landscape-level) is challenging to determine. Furthermore the boundaries associated with institutional and quasi-evolutionary theory are also blurred and present challenges. For example regarding institutional processes, economic processes were hard to categorise. For this analysis they were treated primarily as a regulatory processes, but they could be considered more as cultural-cognitive (e.g. the growth paradigm as an overarching way of thinking), or as normative (e.g. values around money and status). Regarding quasi-evolutionary processes, delineating between selection pressures and adaptive capacities is subjective as they flow from, and lead into, each other so seamlessly. A further complication is that this subjectivity is introduced by the case study data and interviewees, as well as the researcher; one person's enabling agency is another's confining structure depending on perspective and personality. This subjectivity poses challenges for consistent analysis, and limitations for comparison of results from different research. In addition it serves as a reminder that analytical boundaries are useful but not 'real' (Smith, 2007; Barnes et al., 2018).

3.8 Ethics

This research followed the University of Leeds' ethical approval process. Ethical approval was granted on 27th May 2016. See Appendix A for the ethical review form and approval letter. The main ethical considerations for this thesis were: data protection and participant consent; conflict of interest due to the researcher role at C40 Cities; and confidentiality, due to the potentially sensitive nature of interview data.

All due processes were followed regarding data protection and ensuring participant consent to participate. As previously noted, participants were informed in advance of the purpose of the research, what their interview data would be used for, and how data protection and confidentiality would be ensured (see participant information sheet in Appendix B). Written consent was secured from all participants through a consent form, which was sent in advance with the participant information sheet, and all interviewees were given the chance to ask any questions at the start of the interview before signing the form. In addition participants were informed from the outset that they could withdraw from the research at any time up to analysis and publication and did not have to give a reason. No participants asked to withdraw from the research.

The principal ethical considerations for this research were around potential conflict of interest and confidentiality. Regarding potential conflict of interest, some of the interviewees in the case study cities were contacts through C40 cities, therefore it was important to ensure that all participants were aware the research was independent research through the University of Leeds and that there was no obligation to take part, or if they did take part no obligation to provide 'favourable' answers. This was done during the recruitment process by providing clear written information and then confirming verbally during the consent processes (see participant information sheet in Appendix B).

Regarding confidentiality, a number of measures were taken to ensure this. The name, specific job title, recordings and transcripts were only accessible to and used by the immediate research team. In referring to participant data in any published material only the city and a generic job role were given, and only excerpts, ideas and findings from the recordings and transcripts were be used. Wherever any potentially identifiable details remain these were anonymised. Participants were made explicitly aware of this confidentiality process as part of the consent process.

Chapter 4 London case study

This is the first of three case study chapters which offer results and insights from using the analytical framework developed in chapter two. The distinctive features of this case study are: first, the importance of cultural-cognitive and regulatory selection pressures that act as drivers to get an issue onto the agenda in the first place; second the ability to respond to this mandate through normative adaptive capacity shaping and directing change, and how this influences the coordination of power and resources; and third the context and configuration of processes, in particular competing selection pressures and adaptive capacities that are misaligned with the sustainable city vision and act as barriers to progress.

These findings unearthed by the analytical framework respond to the knowledge gaps that this research aims to address: first, the importance of processes in achieving longer-term outcomes (i.e. sustainable city visions) is clearly demonstrated; second, the importance of regime-level processes is shown; third, the significant role of social, non-technical processes is highlighted; finally, the role of power is illustrated through selection pressure and adaptive capacity. Furthermore, these findings help answer the research questions, identifying the processes at play and exploring how they vary between the two initiatives and whether they enable or constrain progress.

This chapter is structured as follows: the first section introduces the case study; the second section sets out the institutional and quasi-evolutionary processes by institutional pillar (regulatory, normative, cultural-cognitive), and for each pillar by quasi-evolutionary processes (selection pressure and adaptive capacity); the third section explores how these processes vary and why, and whether they enable or constrain progress; and finally concluding thoughts are offered.

4.1 Introduction

This section provides an overview of the London case study, briefly introducing the city, the sustainable development backdrop and sustainable city vision. It then summarises the wider history and context and the two initiatives; the Ultra-Low Emission Zone (ULEZ) and the decentralised energy initiative.

London overview

London has a population of approximately 8.8 million (Greater London), 13.4% of UK population, Greater London region covers 1,572km². Greater London is governed by the

Mayor of London and the London assembly, with responsibility for strategic governance across the Greater London region. The Greater London Authority (GLA) covers 32 boroughs and City of London. The GLA was formed in 2000, though long before that a Greater London council was established in 1963. Ken Livingstone was the first mayor of London for two terms from 2000-2008, initially as an independent candidate then as a Labour candidate. Boris Johnson was mayor for two terms from 2008-2016, for the conservative party. Sadiq Khan is the current mayor since mid-2016, and is a member of the Labour party.

The GLA has a number of powers and functions relevant to sustainable city endeavours (Greater London Authority, 2018b):

- Strategic planning, including the environment, housing and production of the London Plan
- Planning approval, including the power to refuse or permit planning applications in line with the strategy within the London Plan
- Transport powers and policy, delivered by Transport for London (TfL)
- Economic development, delivered directly by the GLA

The London boroughs manage the remaining local government functions, though often working closely with the GLA. For example the GLA sets an overall strategy for waste management but the boroughs are responsible for delivering waste management services.

At the time of the data collection, May – Aug 2016, Sadiq Khan had just taken over as mayor. Given Mayor Khan had only been in post for a few weeks at this time most of the interview discussions reflected the previous mayor, Boris Johnson's, time in office. In addition there were also quite a few comments related to Ken Livingstone's time as mayor. The documentary material within the case study is taken from online resources reflecting Boris Johnson's mayorship as they had not yet been updated by the new administration during data collection.

London and sustainable development

London now has an integrated environment strategy, however at the time of the data collection (May-Aug 2016) there was no single overarching strategy. Instead there were several policies and strategies covering air quality, water, waste, climate change, green space and biodiversity, and noise.

London did, and does, have a Sustainable Development Commission (LSDC). The LSDC was established in 2002 by Ken Livingstone, and tasked with advising the Mayor

on how to make London a ‘sustainable world city.’ In addition Livingstone created the London Climate Change Agency (LCCA) and pioneered arguably world leading work on climate in the early 2000’s (Castán Broto and Bulkeley, 2013; Hodson and Marvin, 2007). The LCCA is seen as one of the main vehicles for delivering the Mayor’s energy strategy, which targets cuts in carbon outputs of 60% by 2025.

Sustainable City Vision

As above, at the time of the interviews London did not have a single overarching sustainable development strategy document, nor a single document setting out the sustainable city vision. The sustainable strategy and visions were across the various strategies, therefore it was less clear what the overarching sustainable city vision was for London. This was probably both a cause and effect of having a number of strategy documents instead of one, overarching strategy.

At the time of the research there was not consistent priority or use of terminology; environment, sustainability and climate change are all used at various points throughout strategy documents and the GLA website. The strategies for air quality, water, waste and climate change, are set out under the ‘Environment’ section of the GLA website (Greater London Authority, 2016). There is a sustainable development element within the environment section but no strategy document. The London Plan, one of the most important documents for setting out the vision for London’s development, refers to the Mayor’s vision for the ‘sustainable development’ of London.

The Mayor’s vision reflects the triple bottom line of economy, environment and society:

“Over the years to 2036 – and beyond, London should: excel among global cities – expanding opportunities for all its people and enterprises, achieving the highest environmental standards and quality of life and leading the world in its approach to tackling the urban challenges of the 21st century, particularly that of climate change” (Greater London Authority, 2016).

This vision is supported by six objectives around: economic and population growth; an internationally competitive and successful city; diverse, strong, secure and accessible neighbourhoods; a city that delights (quality of life); an environmental world leader; and access to jobs, opportunities and facilities. The plan states that *“these embody the concept of sustainable development” (Greater London Authority, 2016).*

The current Mayor, Sadiq Khan, launched the London environment strategy on the 31 May 2018, as London’s first integrated environment strategy (Greater London Authority,

2018b). This plan sets out the goal *“to act now to tackle the most urgent environmental challenges facing our city, as well as safeguard London’s environment over the longer term. We need to ensure that London is greener, cleaner and ready for the future”* (Greater London Authority, 2018a).

Case study initiatives: ULEZ and decentralised energy

As per the methodology outlined in chapter three, two initiatives with differing levels of success were explored in order to achieve the ambition of a city-wide, cross-sector research approach but still enable depth of research. These are set out below.

Air quality was identified as a significant issue for London, it had been a cross-party issue in the recent elections and was a major part of the successful candidate, Sadiq Khan’s, manifesto. Interviewees referenced the ambitious targets that had been set, and felt good progress had been made – though noting substantive challenges remain. This case study focuses on the Ultra-Low Emission Zone initiative (ULEZ) initiative within wider air quality efforts, having been identified by key informants as an example of good progress. The ULEZ covers central London and introduces new, tighter exhaust emission standards, for most vehicles – those that don’t meet the standards have to pay a daily charge. The ULEZ was originally set to come into force in 2020 by the Johnson administration, and has now been implemented ahead of schedule by the Khan administration. The ULEZ aims to contribute towards a healthier, more sustainable London. This issue of transport-related air pollution is predominantly an urban issue and therefore particularly interesting for an exploration of city actor networks and urban drivers and decision-making processes.

Decentralised energy was identified as progressing relatively poorly, with specific references to district heating and (frameworks for) local power generation. The aim of the decentralised energy initiative is to contribute to climate targets, but also provide ‘energy for all’ enabling access to affordable, sustainable, secure energy.

Nine interviews were undertaken for both air quality and decentralised energy. Air quality interviewees included a range of campaigner, strategic, technical, academic and transport roles from the public (7), civic (1) and private (1) sector. Decentralised energy interviewees included a range of technical, strategic and policy roles from the public (6), private (2) and civic (1) sector. For details see the full table of interviewees in Table 3.1 in the methodology chapter.

4.1.1 History and context

This section describes the history and context of the case study, and covers the story of ULEZ and decentralised energy that emerges from the case study data.

Important context for both initiatives is the governance structure and the powers vested in the GLA, in particular strategic planning and transport powers. These provide strong regulatory adaptive capacity. Sustainable city actors can use these to respond to, and shape, selection pressures. In addition the adversarial, contested nature of national and local politics impacts upon both initiatives, in particular party politics and the change from labour to conservative to labour mayors.

The overarching economic growth paradigm is an important contextual backdrop for both initiatives. This is a global paradigm but plays out strongly in London where there is a powerful business voice and a keen sense that maintaining London as competitive city is important. This reinforces profit-oriented, market-driven behaviour, e.g. developers incentivised to maximise profits and dis-incentivised to invest in long-term, new (risky) technology.

Ultra Low Emission Zone and air quality

In London there has been a history of air pollution, notably the great smog of 1950. More recently there has been the issue of congestion which became a huge problem for businesses and commuters in the 1980s and 1990s. These both created cultural-cognitive concerns around air pollution and congestion, creating the political mandate and/or pressure to act. The implementation of the congestion charge was a bold move by the GLA and then Mayor Ken Livingstone. The success of the scheme has left a legacy of both 'hard' and 'soft' infrastructure that provides a favourable context for the ULEZ (e.g. the charging technology and the professional capacity for and credibility in such schemes).

EU legislation, and in particular the translation of this into UK law and accompanying threat of fines, acted as the initial regulatory selection pressure driving action. This was further strengthened by the Client Earth legal action against the national government, creating more pressure for action. As an early response to the issue the GLA invested in research, working with independent, world leading institutions such as Kings College London (Greater London Authority, 2019). This generated evidence to show a clear problem with air quality.

The final stages of the original Low Emission Zone (LEZ) expansion was reviewed by Mayor Johnson and TfL and found to be too expensive. It was not considered the most

cost-effective way to impact air quality in London and the final expansion was therefore delayed. Here it should be noted that this was cost to motorists and businesses, not just the GLA. Interviewees referenced the influence of motorist stakeholder groups lobbying against the LEZ (Interviewees L1, L15, L17, L20) and the concern around affordability for the 'white van man' - seen as a 'bellwethers' for political popularity with working-class voters and as a proxy for local traders and small businesses (The Economist, 2015).

There was significant activity from the NGO sector lobbying for air quality improvements. Here civic sector actors used results from the Kings College London research funded by the GLA to generate awareness of air pollution as an issue. The role of the media was particularly pivotal in supporting this, and for London this is very specifically through the Evening Standard which plays a huge role in shaping the local conversation. Both the NGO and media action further strengthened cultural-cognitive concerns around air quality and created strong political pressure to act.

Interviewees reported that the original idea of an ultra-low emission zone, in place of expanding the existing low emission zone, came from the Mayor himself. This was then rapidly announced publicly as the first of its kind; a world leading ultra-low emission zone. TfL were then tasked with developing a plan to implement the ULEZ as a priority. This prioritisation was linked to the strong, inherent mayoral buy-in as the originator of the idea and the quickly generated publicity and associated scrutiny. The TfL strategic team spent time exploring options, 'optioneering,' with a process of iterative back and forth between TfL and mayor's office, developing and selecting options based on balance of impact, feasibility, and (political) acceptability. A key aspect of the feasibility of the scheme is the extensive transport powers of the GLA, enabling them to introduce and enforce the ULEZ – specifically the power to charge polluting vehicles.

There was extensive consultation, as a statutory requirement and following a statutory process. This was reported as a productive, constructive process, creating reasonable alignment within a highly contested environment.

The current mayor, Sadiq Khan, introduced the ULEZ on 8 April 2019, ahead of the 2020 launch set by Boris Johnson. This early implementation was supported by continued visibility, awareness and concern around the issue of air quality; in the last mayoral elections air quality was a cross-party issue and the current mayor Khan had air quality as one of his main manifesto pledges.

Decentralised Energy

The aim of the decentralised energy initiative is to contribute to climate targets (60% reduction by 2025), and also provide 'energy for all' enabling access to affordable, sustainable, secure energy. The climate vision and targets act as normative and regulatory selection pressures creating the primary driver behind the pressure for low carbon energy, and the decentralised energy initiative.

Considerable planning was undertaken by the GLA, supported by the set-up of a new energy team, on how to meet the climate target. This led to a sub-target for 25% decentralised, renewable energy by 2025, which was then translated into planning requirements through GLA planning powers. These planning requirements created regulatory selection pressure for decentralised energy.

Further scoping was undertaken by GLA including heat mapping to identify areas of supply and demand, and an assessment of current infrastructure capacity. This supported the development of a strategy to create a network of local district heating grids across London, with the aim to join these up to create city-wide grid as part of longer-term strategy. The planning requirement for all new developments to be 'connection ready' is important for this longer-term goal. It also led to the Licence Lite scheme aiming to create the legal and financial framework to enable the generation and sale of power locally. The Licence Lite work proved a long and complex process, and having taken much longer to develop than expected, other options are now available so the scheme will now be competing for market share. In addition there was political frustration that Licence Lite was not delivered within the mayoral term in order to gain a political win.

However, constraints from existing infrastructure (e.g. lack of pipework), market set up (e.g. centralised procurement frameworks), current business models (e.g. 'build and sell' approach to development), and professional culture and capacity (e.g. professional siloes/roles as developers not energy suppliers) resulted in slow and patchy progress, and mixed results. The general wider national context of a centralised power generation and supply system mean that the infrastructure for decentralised energy does not exist, neither the 'hard' and 'soft' aspects. In terms of the 'hard' aspects the context of London as a busy, chaotic built environment makes it particularly difficult to put in new city-wide physical infrastructure for district heating. In terms of the 'soft' aspects, the legal and financial infrastructure relating to energy is also geared towards a centralised energy system and this context makes it hard to introduce local power generation and supply.

For decentralised energy, particularly district heating schemes, there were challenges associated with the current market set up and business models, in particular from high

upfront expenditure and uncertain future demand and associated income. Developers are unwilling to make the initial investment required without guaranteed demand, and hence payback. The 2008 recession further impacted viability: existing schemes suffered as development, and associated energy demand decreased dramatically; and the case for future schemes was weakened by increased uncertainty over future demand. Where district heating was implemented there were some challenges from poorly executed schemes that created issues around trust, credibility and risk. This prompted efforts, through normative adaptive capacity, to develop standards and quality assurance processes important in ensuring successful heating schemes.

Generally interviewees talked of a process of learning and cultural change amongst the stakeholders involved in decentralised energy projects. Stakeholders were becoming more informed, more familiar with the technologies available, better able to commission and design schemes, and to develop and defend the business case for them – and stakeholder roles were evolving e.g. from the perception that decentralised heat is something for energy engineers to the idea that it is an opportunity for developers (Interviewee L5,8,7,9,14). Multiple stakeholders (clients, consultants, associations, government, developers, installers, financiers, etc.) were all learning how decentralised energy works. Increased investment in decentralised energy supported this process, in particular funding for feasibility studies, as well as organisations investing in staff skills and capacity.

4.2 Results: What are the regime-level processes, how do they vary and do they enable or constrain progress?

This section sets out the findings from the London case study data with regards to the research questions: what are the institutional and quasi-evolutionary processes that drive regime-level decision, actions and their outcomes within sustainable cities; how do they vary and why, and do they enable or constrain progress?

For air quality, and the ULEZ initiative in particular, the evidence shows that regulatory and cultural-cognitive selection pressures create a strong driver for action (importantly both types of selection pressures are enforced; regulatory by fines and cultural-cognitive by voting). Existing normative adaptive capacity is then bolstered by these regulatory and cultural-cognitive drivers which provide legitimacy and a mandate for action. Additionally existing formal powers around transportation create adaptive capacity. This is further supported by a favourable context, largely due to a history of concern and successful action on air quality, and a successful precedent for vehicle charging set by the congestion charge.

For decentralised energy the driver for action is created through normative adaptive capacity, creating a vision, and importantly translating this into ‘hard’ targets that act as regulatory selection pressure. However this regulatory selection pressure is not as strongly enforced as for the ULEZ; they are self-set targets and there are no concrete sanctions if they are not met. Furthermore, there is an absence of cultural-cognitive selection pressure acting as a driver for action. Nevertheless, the normative vision and regulatory pressure leads to allocation of resources, increasing normative adaptive capacity, and in turn shaping selection pressures: normative selection pressures around standards and best practice; as well as cultural-cognitive selection pressures around professional ways of thinking. This is all against an unfavourable context, largely due to decentralised energy being a ‘new’ approach for the London, and UK, context.

The first sub-section addresses the first research question regarding what processes are at play, and the second sub-section explores the second research question regarding variation, and whether processes enable or constrain progress.

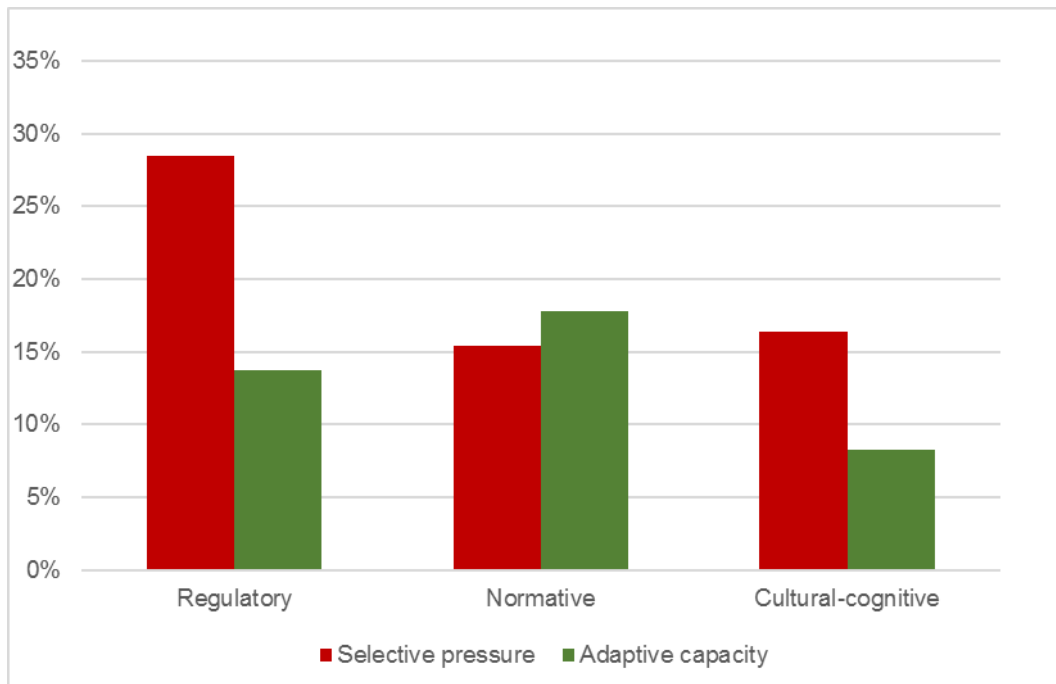
4.2.1 What are the institutional and quasi-evolutionary processes that drive regime-level decision, actions, outputs and outcomes?

Table 4.1 summarises the case study results, and the following sections provide details organised by the three institutional pillars (regulatory, normative, then cultural-cognitive), and then for each institutional pillar by the two quasi-evolutionary processes (selection pressure and adaptive capacity). Figure 4.1 presents the relative frequency of the processes occurring by institutional and quasi-evolutionary process.

Table 4.1: Summary of the London case study findings by institutional pillar and selection pressure/adaptive capacity, showing the main processes identified.

Regulatory		Normative		Cultural-cognitive	
Selection pressures	Adaptive capacity	Selection pressures	Adaptive capacity	Selection pressures	Adaptive capacity
<ul style="list-style-type: none"> • Regulation and planning requirements (e.g. requirements for % of on-site, renewable energy generation for new developments) • Political and policy pressures (e.g. unstable national policy environment) • Market and economic pressures (e.g. ensuring the business case stacks up) 	<ul style="list-style-type: none"> • Strong powers (e.g. strategic planning powers) • Lobbying and campaigning (e.g. Clean Air London campaign) • Planning capacity (e.g. to turn visions into 'hard' targets) • Work around and/or fit with selection pressures (e.g. financial support/incentives) 	<ul style="list-style-type: none"> • Visions (e.g. an environmental world leading city) • Standards, guidance, best practice (e.g. WHO air pollution standards) • Accountability (e.g. operational responsibilities) 	<ul style="list-style-type: none"> • Develop and communicate compelling visions (e.g. ULEZ as a world first) • Develop standards (e.g. new Heat trust standards for decentralised energy) • Networks and associations (e.g. taxi unions) • Stakeholder engagement (e.g. Statutory consultation process) 	<ul style="list-style-type: none"> • Articulated concerns around problems, alignment around solutions (e.g. health concerns associated with air pollution) • Visibility (e.g. Volkswagen scandal creating high visibility of air pollution from vehicles) • Ways of thinking (e.g. car culture, e.g. developers not seeing themselves as energy/heat providers) 	<ul style="list-style-type: none"> • Data & communication (e.g. commissioning and publishing research) • Work around and/or better fit with selection pressures (e.g. decentralised energy solution to climate problem)

Figure 4.1: The relative frequency (y-axis) of London case study processes occurring in each institutional pillar and by selective pressure or adaptive capacity.



4.2.1.1 The regulatory pillar

Regulatory processes are the formal and explicit legislation and ‘hard’ targets – the enforced rules, *how things must be done*. As outlined in the literature review chapter, regulatory processes consist of rule-setting, monitoring, and sanctioning activities (for example regulations and laws). They signal clear demands: they are the ‘hard and fast’ rules compared to the ‘softer’ normative processes; they are formal and explicit compared to the unconscious, internalised cultural-cognitive processes (Scott, 1995).

Regulatory processes account for just over 40% of the processes cited during the interviews. Within this around two thirds are selection pressures and one third is adaptive capacity.

The main regulatory selection pressures from the London case study are: regulation and planning requirements; political and policy pressures; and market and economic pressures. The main regulatory adaptive capacities from the London case study are: strong powers; lobbying and campaigning; planning capacity; and efforts to work around and/or better fit with selection pressures.

Of these main regulatory processes two in particular influence overall progress and are distinctive features of this case study: first, regulatory selection pressures act as strong drivers for progress (e.g. air quality legislation and threat of fines); and second, that

misaligned selection pressures act as a barrier to progress (e.g. market and economic pressures dis-incentivising investment in decentralised energy).

Regulatory selection pressures

This section details the main regulatory selection pressures from the London case study: regulation and planning requirements; political and policy pressures; and market and economic pressures.

Regulations, both international and local, were frequently cited as a strong selection pressure for the ULEZ. EU regulations and fines were initial regulatory selection pressures. Importantly EU legislation was translated into UK law and the UK government used the localism act to pass on the liability for the fines to local authorities. This threat of fines in particular was a strong driver of action:

“you'd never have been able to persuade the [previous] administration... with their focus on jobs and growth... but they devoted a huge amount on air quality because there was the threat of EU fines so that was the main driver” (interview L3)

Planning requirements generated the main regulatory selection pressure for decentralised energy. These originate from the climate vision, which was then effectively translated into hard targets; 60% reduction in emissions by 2050, and more specifically generation of 25% of London's energy from renewable, decentralised sources by 2025. These hard targets were then turned into local planning requirements. The capacity, and/or willingness, to enforce the planning requirements is also important. Applicants for planning permission have to show they have endeavoured to meet requirements as far as possible:

“lots of the climate change action plan were areas where the mayor could coax, encourage, provide funding for, but with planning it was ‘you must’, and where ever there was an option for you must that’s when things started to happen, rather than we would like you to” (interview L7)

However it should be noted that meeting requirements ‘as far as possible’ is subjective and often a negotiation between developers and planning staff: *“when it comes to planning it’s a giant negotiation as to what is achievable and different people have different priorities” (interview L13).*

Political factors were the next group of frequently cited regulatory selection pressures. Winning over the voters was seen as a fundamental, with many references to public

pressure and voter preferences: *“they’ve got to win elections these guys, they can’t do anything if they can’t win an election” (interview L1).*

Short-term political cycles were often mentioned as a big problem for long-term planning. It is hard for elected officials to take long-term decisions when they are ‘judged’ by the electorate on short-term promises and results. It is important to note that the interviews were undertaken immediately after a mayoral election and the Brexit referendum (May 2016 and June 2016) so this may well have influenced responses. Interviewees also referenced the impact of differing ideologies and priorities of Mayors:

“different politicians will come with different views on what is important for their city and certainly the previous mayor... didn’t put air quality very high on his to-do agenda and as a consequence we didn’t come up with anything which would look like a robust policy... that can and probably has changed with the new administration” (interview L15)

Conversely, political cycles were also cited as an opportunity for voter pressure to drive change: *“it’s a fascinating time at the moment, when you got a new mayor and there’s an opportunity for these things to be on the agenda” (interview L10).* For example traffic was the number one issue in the 2000 electoral campaign, and this was one of the primary factors that led to the congestion charge. More recently air quality was a priority issue for all main candidates in the 2016 mayoral elections, and again the evidence shows the impact this has on progress of air quality initiatives. Here the interdependence between cultural-cognitive and regulatory selection pressures is apparent, for example concern around traffic and air pollution strengthens regulatory political selection pressures.

The lack of a stable policy environment was frequently cited as a barrier to progress of both initiatives. Wider international and national policy uncertainty weakens regulatory selection pressures, or eradicates them entirely. For decentralised energy a highly changeable national policy environment ‘killed’ energy efficiency retrofit work: *“we saw two big changes at national level and... then a third change after the general election... it basically killed it” (interview L1).*

For the ULEZ, the recent Brexit referendum result led to a number of comments about how this would impact on air quality work given current regulatory pressures come from EU legislation: *“some members say to us this was all driven by compliance with the EU laws and now we’re leaving the EU we don’t have to do any of it any more” (interview 17).*

Market and economic factors were the final group of frequently cited regulatory selection pressures. Economic viability was referred to for both the ULEZ and decentralised energy as one of the main barriers to action. For air quality, decisions around the scale, timing and strictness of restrictions for the ULEZ (and before that the LEZ) were heavily impacted by cost. This cost, not just to the GLA, but also to individuals and businesses was a critical criteria:

“first of all it’s presented to senior managers and the mayor’s office, they need to be aware of what the economic costs of compliance are, because it’s a political decision whether you are willing to have economic costs of compliance” (interview L16)

For decentralised energy the viability of schemes was ultimately evaluated on cost, the business case has to stack up: *“you’ve got to make the business case, there’s no specific budget there for improving things you have to go out and get the funding, or justify investment” (interview 13).*

The upfront cost of infrastructure is a huge barrier, especially combined with the uncertainty of future return on investment stemming from the fact that there is no guarantee of future demand for decentralised energy. This prompted several interviewees to suggest that large-scale infrastructure should be a public investment:

“the physical challenges of putting in (the infrastructure), the economic investment needed to make it happen is very difficult, it’s not impossible, but it does need a much more overarching and strategic approach with some public infrastructure funding to make it happen” (interview L18)

Furthermore the predominant ‘build and sell’ business model for physical developments incentivises minimisation of upfront capital expenditure and a disregard for operational expenditure (and performance): *“the developers want to build a building, sell the building and leave” (interview L7).* The alternative business model where developers were also the owner/operator changed priorities and approach. Under these circumstances there was a greater balance between capital and operational considerations: *“some developers are ‘build to operate’ so they cared about the energy system” (interview L1).*

Regardless of the business model, the ability to develop an overall financial case and gain buy-in from financial decision makers (e.g. private Chief Financial Officers or public budget committees) was critical for decentralised energy projects.

Within the GLA the need for a strong financial case was referenced for both initiatives. The Performance and Management Board were cited by GLA staff as an important

decision-maker, with cost, and financial risk, as one of the priority considerations (i.e. selection pressures).

Regulatory adaptive capacities

This section details the main regulatory adaptive capacities from the London case study: strong powers; lobbying and campaigning; planning capacity; and efforts to work around and/or better fit with selection pressures.

The strong powers of the GLA are really important for regulatory adaptive capacities. For the ULEZ the transportation powers were deployed and for decentralised energy the planning powers were used: *“so one of the big things that the Mayor of London has power on is planning” (interview L7).*

Important here was the support for this use of powers; suggesting that you need both the regulatory adaptive capacity and supporting selection pressures to succeed (supporting pressures were across all institutional pillars). Both mayoral support and wider stakeholder support from businesses, media and citizens was mentioned. Once actioned the adaptive capacity to operationalise powers is effectively and immediately ‘turned into’ a selection pressure:

“all planning authorities have powers to do it (ambitious energy policy) but we wouldn’t be here doing it if it wasn’t here in London, if it wasn’t for the mayor and his targets and his policies” (interview L5)

The second area of adaptive capacity which was frequently cited is around lobbying and campaigning. In relation to the ULEZ, the Clean Air London campaign was often referenced. Here the use of data and evidence was particularly effective, with the number of premature deaths annually from air pollution as a pivotal figure (9,400 as per Walton et al. (2015)).

In contrast the motorist lobby were referenced as effectively campaigning against bringing in tighter vehicle restrictions, both in the ULEZ and the LEZ before that. Here, strength in numbers of associations and unions (in particular the taxi unions), and the weight of the economic growth argument were effective:

“then we had a massive battle on our hands with the motor manufacturing industry... the other part of it was what you do about the taxi fleet, we had loads of discussions with the taxi industry” (interview L20)

Campaigners both for and against the ULEZ used networks and connections as an effective adaptive capacity to influence the mayor and TfL decision makers. This

supports the literature around the importance of networks in transitions (Kemp et al., 1998; Kivimaa and Kern, 2016). In addition there were many examples given of high adaptive capacity to effectively participate in consultations and influence decisions through this channel.

An interesting example of such lobbying adaptive capacity was the use of litigation to force action. Whilst this action was aimed at the national government it was referenced frequently by interviewees, both GLA staff and non-government interviewees, as impacting the strength of the regulatory selection pressures. This litigation increased the pressure to meet regulations, and in turn the likelihood of negative consequences for not doing so, e.g. fines: *“it helped that the pressure was being applied to the government from Client Earth because there wasn't necessarily an appetite for going down that road at the mayor's office” (interview L20).*

The third area of adaptive capacity is around planning capacity to turn visions and goals into 'hard' targets. For example for decentralised energy there was a high level of capacity to develop a comprehensive heat map for London identifying areas for development of decentralised energy and underpinning targets:

“we established what seems to be now our common methodology around starting with heat mapping... we got decentralised energy better defined within the policy documentation and that of course provides the guidance for decision-making” (interview L5)

This example suggests that adaptive capacity was increased through establishing a methodology that others can deploy.

For the ULEZ this planning capacity was not required to generate hard targets as regulation was already in place. However the significant research and 'optioneering' capacity of TfL was still highly beneficial. A huge amount of work was undertaken to identify and analyse policy options. This led to a much better ability to respond to (often unexpected and urgent) requests, and increase the capacity to influence the options politicians were selecting from:

“there's a general optioneering... what we try to do is make sure that anything that gets to that point, that there is a possibility it might be chosen, that it will be selected from the best options and the ones that we are all sure that will be beneficial” (interview L10)

The organisation structure and resources are critical to this process. The fact of there being a strategic team in TfL dedicated to this, and importantly separate from

implementation and the pressures of running London transport, creates the capacity for strategic planning and mitigates against the risk of immediate operational pressures distracting energy and attention from strategic planning. Finally, it is clear from the interviews that data is crucial in supporting this planning capacity.

The last group of regulatory adaptive capacity processes was around efforts to work around or better fit with selection pressures. It is evident that in addition to utilising adaptive capacity to change and shape selection pressures, it is also used to work around or better fit with them. For example the London Lite project aimed to set up a framework to enable local energy suppliers to more easily sell energy to the grid and overcome the selection pressures of a centralised grid that favours larger suppliers. Another example is the use of financial incentives and support to help overcome market selection pressures, such as financial support for taxi drivers to upgrade their vehicles. There were also more ad hoc, individual examples, such as an experienced staff member with legal and financial expertise who ‘found a way to make it work’:

“you had to wrap up a parcel of funding programmes each one coming with its own kind of constraints about what you could do with it, so the officers had to be very canny about how they can knit all that money together” (interview L14)

4.2.1.2 The normative pillar

Normative processes are the vision and values of *what should be done*, and *how it should be done*, set out in e.g. standards, professional best practice and guidance. As outlined in the literature review chapter, normative processes are the values and norms, and define both the goals and the appropriate ways to achieve them. Normative visions provide the ‘direction of travel’ for transition efforts. Normative values affect power coordination and resource allocation. Normative standards can shape normative processes through developing new knowledge, skills and evidence and (re)defining best practice (Scott, 1995).

Normative processes account for around a third of the processes cited during the interviews. Within this just over 45% are selection pressures and just under 55% is adaptive capacity.

The main groups of normative selection pressures from the London case study are: visions; standards, guidance, best practice; and accountability. The main groupings of normative adaptive capacity processes are: developing and communicating compelling visions; developing standards, guidance and best practice; networks and associations; and stakeholder engagement.

The normative adaptive capacity to shape and direct change, and how this influences the coordination of power and resources is a distinctive feature of this case study. The main normative adaptive capacities listed above have a significant impact on overall progress, in particular: developing and communicating compelling visions; and networks and associations.

Normative selection pressures

This section details the main normative selection pressures from the London case study: visions; standards, guidance, best practice; and accountability.

Starting with normative selection pressures around visions, the evidence shows that an effective selection pressure for decentralised energy was the climate vision. This was frequently cited as the driver behind this initiative:

“if there wasn’t a climate change issue and Kyoto [and targets].... that’s my Bible, that’s what I’m directed towards all the time... cities won’t come together unless there’s strategy and policy” (interview L5)

In contrast, although air quality is one of the suite of strategies that make up the overall sustainability vision in London, there were not many references to vision as a driver for the ULEZ. The visions cited during interviews were often associated with a particular mayor. This strengthened the selection pressure from such visions during the mayor’s term, but risks weakened pressure afterwards due to lack of ownership from the new/next mayor. For example Ken Livingstone had a clear climate vision and pushed this agenda hard whilst in office, creating a strong selection pressure. This has arguably been weakened since the end of his term. However, some selection pressure has still been maintained due to embedding the vision through hard targets and planning requirements which remained beyond the mayoral term. The vision of the ULEZ is attributed directly to Boris Johnson, and there was a very strong pressure from the Mayor’s office to get this implemented during his time in office. Again here the pressure was maintained despite a change in mayor, as air quality is a currently a cross-party issue for London and was one of the main manifesto pledges of the new mayor, Sadiq Khan:

“in London, the recent mayoral elections, because the five main candidates every one of them put improving air quality is one of their five major election items, and that was unheard of because in the previous election no one talked about air pollution” (interview L15)

The next prominent group of normative selection pressures were standards, guidance, best practice. For air quality and the ULEZ, standards were a very important normative

selection pressure. The existence of established, accepted, clear, measurable standards underpinned the regulatory selection pressures. For pollution levels the World Health Organisation provide legitimate, recognised standards. For vehicle emissions the Euro standards are critical. The latter demonstrate the importance of standards by virtue of the consequences from their failure to reduce emissions. Interviewees reference this in relation to the reduced impact of policies based on the Euro standards. For example London's LEZ restrictions worked to change the type of vehicle circulating within the LEZ but did not reduce overall emissions as forecast because the Euro standards were not effective in reducing pollution.

For decentralised energy the absence of established standards was an issue, creating risks around quality and credibility. More than just quantified air quality or vehicle standards, the wider professional norms and values were important here. The lack of best practice guidance and established professional norms impacted capacity, even to begin to understand the issue, and to ask the right questions. This results in a lack of normative selection pressures (standards, guidance, etc) in relation to the (decentralised) energy (sub-)sector hindering progress and jeopardising the quality of results. This impacts trust and credibility, and perceived risk, in relation to adopting 'new' decentralised energy technologies or approaches for developers, consumers and the GLA. In particular, the performance of 'new' technology and approaches in its early days is critical to trust. Problems with some early decentralised energy schemes were cited by several interviewees as damaging trust and confidence.

The final group of important normative selection pressures is around accountability. This manifests in several ways. For example in terms of accountability at TfL for keeping London moving, the main job is to keep transport running; they *"get shouted at when things go wrong"* (interview L1). This is backed up by a reference that *"the only thing that ever get fired for is operational failures... so I think they are so risk averse, so operationally focused, they don't like doing anything different or unusual"* (interview L7). Finally, environmental accountability might simply be outside of scope:

"we have done almost no really significant work to think about the demand of the city as big of London on the natural world and the resources it consumes... partly because none of those things are our responsibility as policymakers, we tend not to think about them" (interview L12).

Another interesting example is potentially the accountability linked to public statements made in particular by local government. One interviewee referenced the fierce debate over precise wording of press releases due to the substantive impact the exact wording had on policy implementation. This suggests that public statements enact selection

pressure through accountability. The role of the media extends beyond the vehicle for making the statement, to the mouthpiece for then holding government to account for delivering on their word: *“it still comes to that crunch point when you’re agreeing small words in a press release, that could actually to some extent change what the policy might be as well” (interview L20).*

Normative adaptive capacities

This section details the main normative adaptive capacity processes: developing and communicating compelling visions; developing standards, guidance and best practice; networks and associations; and stakeholder engagement.

Starting with the capacity to develop visions, it can be seen that there is a good level of adaptive capacity to develop and support visions. For the ULEZ for example this was promoted heavily as the ‘first of its kind’ and world leading, creating a strong vision. Though an interesting comment by one interviewee suggested that this was simply rebranding the delayed LEZ – if this is the case then this suggests that adaptive capacity around visions can be both a positive force to generate new visions for change as well as a potential negative force to avoid accountability for former visions:

“it’s quite difficult if you are an administration continuing an old person’s [mayor’s] scheme, and you just delayed a certain part of it, you don’t really want to sell it like that, you want to sell it as something new, that’s where the ‘ultra’ [in ultra-low emission zone] came from” (interview 20)

The next main group of normative adaptive capacity was around developing standards. There was ample data from the interviews demonstrating the capacity to develop standards and guidance for new technologies and approaches for decentralised energy. For example the Heat trust standards have been developed to provide customers with the same protection for heat as exists for electricity and gas (Heat trust, 2019). As referenced in the previous section on normative selection pressures, these standards are foundational for enabling progress, and ensuring its quality. At the time of the interviews the newly developed Heat trust standards were being used to help ensure effectively implemented and operated decentralised energy schemes:

“Heat trust was designed... to ensure that customers... have similar standards that you would expect if you were an electricity customer or gas standard, heat is obviously unregulated so it is trying to make sure that the customers have that level of protection” (interview L19)

Again as with the selection pressure, the evidence shows that more than just quantifiable standards for decentralised energy are at play. Interview data suggests that the ability of actors to develop professional capacity generally was important:

“as clients they are becoming more informed, so they are less risk averse to the different design solutions, they’re becoming more familiar with the technologies, with the opportunities... they are asking more direct questions and they are helping to refine better solutions as well” (interview L14)

Here decisions to invest in capacity and learning support this process: *“some of the big utility companies in London now have community energy divisions, they are actually increasing the number of staff they have looking at community energy and district heating” (interview L14).*

As well as organisational investment, funding programmes can impact sectoral capacity. For example funding for feasibility studies for decentralised energy supported boroughs to move beyond simply setting out planning requirements to taking on a coordination role. This helped to develop capacity, and through demonstrating viability helped increase the credibility of proposed schemes. This is particularly important with new technology and approaches where this upfront investment to scope projects is unlikely to be privately funded due to high uncertainty and risk.

The third important group of normative adaptive capacity referenced by interviewees is the existence and/or establishment of networks and associations. As previously referenced the motor association and taxi unions had increased influence through strength in numbers. This density gives legitimacy and clout. Another example relates to the formation of a new network in order to support decentralised energy through accelerated, collective learning and development: *“[Energy for London] set up a network of like-minded individuals to work together to create, to accelerate the development for what they want to do in this climate change energy sustainability agenda” (interview L7).* This supports the literature looking at how network (re)formation is an important processes within transitions (Barnes et al., 2018).

Finally interviewees frequently cited stakeholder engagement as an important group of normative adaptive capacity processes. Consultation and stakeholder engagement was referenced in relation to the ULEZ as a productive adaptive capacity. Interestingly for the ULEZ a statutory consultation process was legally required, helping ensure sufficient time and resource is dedicated to comprehensive consultation. The productive dialogue with a wide range of stakeholders throughout the consultation was in large part enabled by a consensus around the problem of pollution and its impact on health. In addition the good level of evidence provided by GLA throughout the consultation and the range of

options openly shared and discussed with stakeholders supported a very constructive conversation. Whilst there was no statutory consultation for decentralised energy the ability to engage stakeholders was still cited as important: *“I find we have to work more and more with people... it’s about getting all the stakeholders involved aligned and bought into it” (interview L5).*

4.2.1.3 The cultural-cognitive pillar

Cultural-cognitive processes are the beliefs, habits and heuristics of *how things are* and *how things are done*. As outlined in the literature review chapter, cultural-cognitive processes are the shared conceptions that make up the nature of social reality, they act as a frame from which to create meaning (for example beliefs and customs). They are the unconscious, unwritten rules that shape ways of thinking and being, both in terms of thought processes and heuristics, but also practical habits and routines (Scott, 1995).

Cultural-cognitive processes account for around one quarter of the processes cited during the interviews. Within this around two thirds are selection pressures and one third is adaptive capacity.

The main groups of cultural-cognitive selection pressures are: articulated concerns around problems and alignment around solutions; visibility of an issue; and ways of thinking. The main groups of cultural-cognitive adaptive capacity are: data and communication; and efforts to work around and/or better fit with selection pressures.

Of these main cultural-cognitive processes two in particular influence overall progress and are distinctive features of this case study: first, selection pressures that act as drivers for progress (e.g. concerns around air pollution and health); and second, misaligned and/or competing selection pressures that act as a barrier to progress (e.g. traditional ways of thinking that present a barrier to the adoption of decentralised heat).

Cultural-cognitive selection pressures

This section details the main groups of cultural-cognitive selection pressures: articulated concerns around problems and alignment around solutions; visibility of an issue; and ways of thinking.

Starting with cultural-cognitive concerns, from the interviews data a strong set of cultural-cognitive selection pressures involve the common, collective sense of what the big problems are that need tackling and what the most desirable solutions to them are. For air quality and the ULEZ initiative there were very strong pressures around the health risks from air pollution. The immediate, tangible nature of the risk and the personal impact underpin this: *“the new mayor is being a lot more actively involved [in air quality] as a personal story he says that he’s developed adult asthma” (interview L4).*

Importantly these concerns need to be articulated in order to exert pressure (Smith et al., 2005). Within the air quality debate and the ULEZ initiative in London the evidence shows a myriad of ways in which concerns are being voiced; via questions at public meetings, responses to polls and letters to politicians. The role of the media was often cited as a major influence:

“when different departments were going out to consultation... air quality started appearing at the top... and also the media coverage has helped, it’s you know it’s in the Evening Standard all the time” (interview L11)

Whether the media, and the Evening Standard in particular, supported or opposed policies has a huge impact on whether they are more widely deemed acceptable or not. A relevant feature here is that the Evening Standard is very much a London newspaper, not a national paper, and perhaps this explains why it was cited more frequently than other media in influencing city-wide opinion.

In contrast for decentralised energy interviewees referenced a lack of awareness and concern. This is perhaps not surprising given energy is much less ‘visible’ than air quality.

This leads onto the second group of cultural-cognitive selection pressures around visibility. For air quality the issue is highly ‘visible’ given the evidence of immediate, tangible impact and media attention, and importantly the personal experiences of air pollution. Whereas for decentralised energy the issues were less visible to the public, media and politicians. For most Londoners there was no immediate or impending, tangible impact from decentralised energy. Such invisible, intangible challenges are harder to mobilise support for (Geels, 2011).

Several interviewees referenced events in relation to visibility. For example the 2012 Olympics led to heightened attention, discussion and debate around air quality. More directly the Volkswagen scandal created greater awareness and concern around air quality, and in particular diesel vehicles:

“with all the Volkswagen stuff now having come out, the mayor wants it [ULEZ] quick as well, it’s almost become very well accepted, not only that air quality is a priority for the mayor, the public are very aware about the problem” (interview L20)

A strong underlying selection pressure that impacted the ULEZ initiative is ‘car culture.’ The strength of internalised beliefs around cars manifest itself in the fact that it is not even on the agenda to talk about less cars, or driving less:

“these are MPs that are obviously interested in environmental issues... [even so] not one of them in talking pollution talked about the need to reduce the number of vehicles on the road” (interview L4)

The final group of cultural-cognitive selection pressures is around professional disciplines and associated ways of thinking. For decentralised energy, housing and heating are seen as separate systems. Developers do not see themselves as heat providers so there is general resistance to local heating solutions, though interviewees acknowledged this was gradually changing.

There were a number of references to City Hall and TfL culture, for example in relation to what is seen as serious transport: *“the stature comes from running the tube, running the buses, it doesn’t come from, didn’t come from then, messing around with cyclists... there was just a straightforward attitude of that’s for the little boys to play around with” (interview L2).*

Interestingly there were references to how professional and/or organisational culture and ways of thinking change over time through the influence of factors such as leadership and a change in organisational remit. There were also a number of comments around mayoral or leadership culture and the impact of this. The ideology of approach and style of leadership of mayors was cited as having a big impact on organisational culture and approach, certainly within City Hall but potentially more broadly as well:

“there’s a change of culture now at TfL that we must invest, we must aim our money to spend on improving air quality, whereas before at the start of the ULEZ process it just wasn’t seen as a priority, and that goes back to leadership from the mayor’s office as well, obviously the two administrations have got a quite different approach” (interview L20)

More generally in terms of ways of thinking there were references to working in silos. Several interviewees referenced the problems this can lead to in terms of one-dimensional policies, most likely the legacy of the modernist approach and resulting entrenched sector-specific institutional set up (Grin et al., 2010). This creates problems in terms of one-dimensional targets and policies. For example past national climate policy promoting diesel leading to serious side-effects on air quality.

In relation to cultural-cognitive ways of thinking there was acknowledgement of selection pressure around convenient habits and routines; *“the behaviour change angle is so difficult, is got to be easier and it’s got to be quick people to do things in order for them to do it” (interview L3).* These habitual processes were more generally occurring than the heuristic processes associated more specifically with professional ways of thinking.

Cultural-cognitive adaptive capacities

This section details the main groups of cultural-cognitive adaptive capacity: data and communication; and efforts to work around and/or better fit with selection pressures.

Starting with data and communication a range of actions taken by a range of actors in relation particularly to air quality were successful in increasing visibility and hence concern.

Here the importance of using data to highlight an issue is clear. For example the extensive efforts to monitor and model air quality undertaken and funded by the GLA was very effective in shaping cultural-cognitive selection pressures. Of note is the partnership with external organisations, for example Kings College London, that lent legitimacy to results:

“we commissioned loads of research with Kings [College London] and then they came up with this figure that is now lauded around every week on 9,400 people dying prematurely every year in London, and that really catapulted it into a different level in terms of how we can engage with the public on the issue” (interview L20)

However it is important to note that data per se is not enough, it needs to be communicated to have impact. Several interviewees referenced the decision by Mayor Khan to publish a report on poor air quality that Boris Johnson’s administration did not publish, as well as the decision to provide air pollution data on bus stops and at tube stations.

Another example of communicating data effectively was through providing residents with air quality sensors so they could monitor the levels of pollution they were exposed to on a daily basis. Here the immediate, personal nature of the data was particularly effective in generating cultural-cognitive awareness and concern:

“it became real to them, they carried a little monitor around, they tracked the routes, so it got them thinking about and asking questions, and delving into it to what’s been done, and also they are now a really good supportive group” (interview L11)

Although much more in evidence for air quality there were still some instances of using and communicating data to shape cultural-cognitive pressures for decentralised energy. For example one interviewee referenced the importance of a 2008 white paper on electricity in evidencing the lack of local generation schemes, increasing the awareness and perception of this as a problem, and hence leading to pressure to act: *“the electricity*

White Paper recognised there wasn't enough local generation schemes, it recognised this barrier and made provision for [a solution]" (interview L5).

The role of events was noted in the previous section regarding selection pressures, but interviewees also referenced events in relation to adaptive capacity. Events create more visibility and pressure, and actors demonstrated the capacity to use this to gain greater awareness: *"I was getting traction with the media fairly regularly and the Olympics is coming up" (interview L6).*

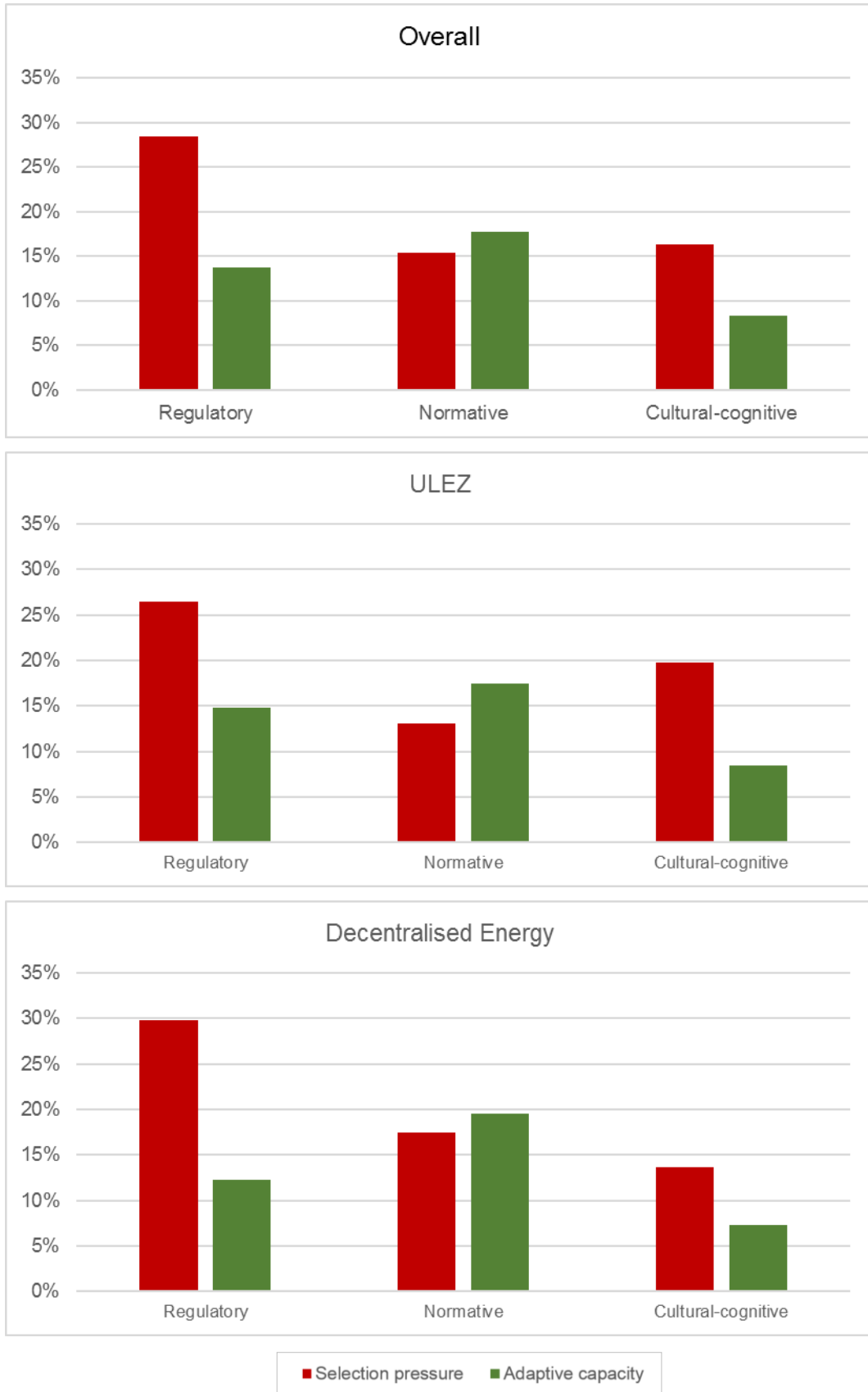
The second group of cultural-cognitive adaptive capacities are efforts to work around and/or better align with selection pressures, as distinct from attempts to shape selection pressures. This is inherent in the overall approach for decentralised energy, the whole premise of the solution is to resolve the environmental impact of energy without the consumer being impacted; the selective environment is unchallenged, the solution is adapted to fit with existing pressures. The same is true for air quality in relation to the Euro standards, vehicles would become more efficient gradually over time in such a way that the consumer is not impacted either through price or any change in the product. This demonstrates the lure of the 'technical fix' which poses no risk of falling foul of selection pressures.

4.2.2 How do the institutional and quasi-evolutionary processes vary and why, do they enable or constrain progress?

The previous sub-section set out the results from the analytical framework in identifying what institutional and quasi-evolutionary processes are involved (responding to the first research question). This sub-section looks at how these processes vary and why, and whether they enable or constrain progress (responding to the second research question).

Looking at how processes vary Figure 4.2 presents the relative frequency, both overall and by initiative, across all three institutional pillars and both quasi-evolutionary selection pressure and adaptive capacity.

Figure 4.2: The relative frequency (y-axis) of institutional and quasi-evolutionary processes in the London case study, overall and for each initiative.



The graphs in Figure 4.2 show a broadly similar pattern in terms of prevalence of processes occurring across regulatory, normative and cultural-cognitive pillars. Across the two initiatives regulatory processes are the most prevalent, then normative, with cultural-cognitive as least prevalent. In addition for both initiatives selection pressures are more prevalent within the regulatory and cultural-cognitive pillars, whilst adaptive capacity is relatively more frequent for the normative pillar. However there are some differences between the two initiatives. For air quality cultural-cognitive processes are more prevalent, mainly due to a relatively higher frequency of cultural-cognitive selection pressures. For decentralised energy though the overall prevalence of regulatory processes is similar the relative frequency of selection pressures is higher and of adaptive capacity is lower. In addition decentralised energy has a slightly higher proportion of normative processes. Although air quality has a higher proportion of adaptive capacity to selection pressure within normative processes than decentralised energy.

Overall then, considering the relative frequency of the processes for the two initiatives they show a broadly similar pattern. However from the case study data it can be seen that there is greater variation in the *alignment and strength* of these processes with each initiative. The extent to which the processes are (mis)aligned with the sustainable city vision, and the strength or weaknesses of these processes. For example, cultural-cognitive concerns around air quality and health act as a strong selection pressure aligned with the ULEZ initiative, whereas strongly embedded cultural-cognitive selection pressure around car culture is misaligned with the ULEZ initiative. For decentralised energy the normative climate change vision is aligned with the initiative but is a weaker selection pressure. This suggests that the difference between the air quality initiative progressing well and the more challenging decentralised energy lies in the overall configuration of processes; are processes aligned and enabling progress or mis-aligned and inhibiting progress, are processes exerting a stronger or weaker impact on progress.

Table 4.2 summarises the variance between the two initiatives in terms of the main processes at play and their alignment and strength.

Table 4.2: Summary of the variance between the two London initiatives in terms of the main processes at play and their alignment and strength.

Regulatory		Normative		Cultural-cognitive	
Selection pressures	Adaptive capacity	Selection pressures	Adaptive capacity	Selection pressures	Adaptive capacity
ULEZ (more successful initiative)					
<ul style="list-style-type: none"> Aligned EU air quality legislation, externally imposed, strongly enforced through fines and legal action, well-coordinated across scales of government Aligned political pressure, supported by competitive mayoral environment and linked to cultural-cognitive voter concerns 	<ul style="list-style-type: none"> Aligned, strong transport powers to introduce restrictions, i.e. the ULEZ, supported by resources and capacity through existing TfL teams Aligned campaigning capacity, e.g. clean air London, misaligned capacity e.g. motor lobby and taxi unions 	<ul style="list-style-type: none"> Aligned, strong vision championed by 'current' mayors (current mayor during development, current mayor during implementation) Aligned existing standards, guidance and best practice from congestion charge 	<ul style="list-style-type: none"> Existing adaptive capacity strengthened, building on existing capacity from congestion charge (hard and soft infrastructure) Aligned stakeholder engagement, supported by compulsory consultation process, successful in getting motor lobby on side 	<ul style="list-style-type: none"> Aligned, strong concerns about the risk air pollution poses to health, consensus and density of opinion generates dominant selection pressure, linked to history of concern and visibility of problem Misaligned, competing car-culture 	<ul style="list-style-type: none"> Aligned research capacity, generating aligned data/evidence that creates further capacity Aligned communication of air quality concerns, especially role of media
<ul style="list-style-type: none"> Aligned, favourable history and context: congestion charge legacy of physical monitoring infrastructure, cultural-cognitive confidence/belief in solution, and normative skills and experience congestion charge; and air quality history of awareness and concern around pollution and health impacts 					

Regulatory		Normative		Cultural-cognitive	
Selection pressures	Adaptive capacity	Selection pressures	Adaptive capacity	Selection pressures	Adaptive capacity
Decentralised energy (more challenging initiative)					
<ul style="list-style-type: none"> • Aligned climate targets, weaker self-imposed enforcement by public censure • Aligned planning requirements, weaker enforcement through negotiation, lack of coordination across government scales • Misaligned legal and financial 'set-up' for centralised energy • Misaligned, strongly competing 'build to sell' business model 	<ul style="list-style-type: none"> • Aligned planning capacity to create targets, supported by allocation of resources (e.g. increased staff capacity through creation of a team) • Aligned planning powers to introduce requirements • Misaligned lack of powers on energy • Misaligned, strong bargaining power of developers 	<ul style="list-style-type: none"> • Aligned climate vision developed by previous mayor • Misaligned accountability, supported by cultural-cognitive lack of confidence/belief in decentralised energy solution 	<ul style="list-style-type: none"> • Developing standards and skills (e.g. Heat trust) 	<ul style="list-style-type: none"> • Misaligned ways of thinking – centralised energy, building development and energy as separate • Misaligned lack of trust and high (perceived) risk, lack of confidence/belief in decentralised energy 	<ul style="list-style-type: none"> • Funding supporting feasibility studies, building belief and changing professional culture/ways of thinking
<ul style="list-style-type: none"> • Misaligned, unfavourable history and context - hard and soft infrastructure geared towards centralised energy system, posing an 'active' barrier to decentralised system 					

The rest of this section expands upon the tabled summary of variation in processes, exploring why this variation occurs. Possible explanations are differences in: the processes acting as the driver for action; the adaptive capacity to respond to these drivers; the history and context of each initiative; the role of power and resources; and the overall configuration of processes.

The processes acting as the driver for action

For the two initiatives the processes acting as the driver for action are different. For air quality the initial selection pressures are: cultural cognitive concerns about the risk air pollution poses to health; and regulatory processes, namely EU legislation. For decentralised energy the initial selection pressure is from the normative climate vision, which is then translated into regulatory selection pressure in the form of 'hard' targets and then planning requirements.

The findings from the case study suggest that this normative approach is weaker than the cultural-cognitive and regulatory drivers. The initial normative driver associated with the climate vision lacks the immediate, tangible, personal impact – and hence urgency and relevancy – compared to the cultural-cognitive concerns around air pollution and health (Barnes et al., 2018; Geels, 2011). Here it is clear and immediate what the impact is, and importantly who will be impacted. This indicates that the presence of a clear, strong cultural-cognitive process acting as a driver is the foundation of, and/or an enabler to, accelerated, meaningful progress. You can attempt to compensate for this (in this instance through normative visions around climate and decentralised energy), and have some success, but it will be a weaker set of selection pressures.

Looking at the regulatory processes that are acting as drivers, the selection pressures for air quality are legally binding regulations imposed by an external organisation, the EU, over which the GLA has very little (arguably no) influence. This hints at an interesting possibility that the EU is better able to create long-term, impactful regulations as it is insulated from the short-termism, and more volatile politics of local or national democracy. By contrast, for decentralised energy the regulatory selection pressures are self-imposed planning requirements, they are both negotiable and within the realm of local influence.

For both regulatory drivers the evidence suggests that enforcement is critical, this echoes the literature on processes of 'policing' to maintain institutions (Fuenfschilling and Truffer, 2016). Here again, for the ULEZ and air quality generally, the threat of EU fines was a very strong selection pressure. The legal action being taken by Client Earth against the government also served to reinforce the strength of regulatory selection pressures for air

quality. Whereas for decentralised energy with regards to the 'hard' targets there is no concrete sanction should targets be missed. Instead the consequence is more around public perception and censure, felt through reporting on progress to public committees and the threat of an 'attack' by the media that might damage political standing. For the planning requirements, there is enforcement of a sort; planning staff when negotiating and approving (or not) applications are able to more or less strongly enforce the decentralised energy requirements. Again this is not as concrete, or as strong, as the threat of fines. In addition it relies on the capacity and willingness of planning staff and this perhaps accounts for some of the variation in progress across London boroughs (though other factors are also at play, e.g. existing energy infrastructure). This indicates that where there are externally imposed and enforced regulatory selection pressures supporting the sustainable vision, this acts as a powerful enabler of progress. Again cities can introduce local rules but these may be weaker due to their self-imposed and policed nature.

The adaptive capacity to respond to drivers

Turning from the variation in initial selection pressures to the variation in adaptive capacity to respond the evidence shows that for the ULEZ there was a good degree of existing capacity, whereas for decentralised energy new capacity had to be generated. For example for the ULEZ the groundwork to establish the best practice, standards and guidance to support the scheme was already in place via the congestion charge. Whereas for decentralised energy this was being developed from scratch. One potential factor behind this variation is the stage of the initiative, is it a new scheme or well developed. For example with decentralised energy the fact that this was a 'new' technology, at least locally for London and the UK, meant that the existing processes were not well aligned. Cultural-cognitive ways of thinking that conceive of development and energy generation as separate functions acted as a selection pressure against developers including decentralised energy generation in their developments. In addition there was not an established level of trust in the technology, as a 'new' technology it was perceived as riskier and less certain than traditional approaches (Kemp et al., 1998).

For the ULEZ initiative regulatory adaptive capacity in the form of strong transport powers supported progress, specifically the capacity to introduce and enforce restrictions, with a clear 'sanction' i.e. charges for polluting vehicles. Whilst for decentralised energy the GLA has good planning powers, and these were a strong adaptive capacity enabling progress, these powers were less strongly enforced through a more 'negotiable' process and less clear sanction.

For both initiatives there was good normative visioning capacity and regulatory planning and target setting capacity. These created selection pressures in the form of hard targets that stimulated action. However for the ULEZ this was less important given the presence of other, stronger selection pressures. Here the difference between initiatives is not so much in the adaptive capacity itself but the relative importance of this capacity in driving progress given the presence, or absence, of strong regulatory and cultural-cognitive selection pressures.

For the ULEZ initiative there was strong adaptive capacity to reinforce selection pressure: regulatory capacity in the form of effective campaigning; normative capacity via stakeholder engagement; and cultural-cognitive capacity for communications. For decentralised energy there was campaigning, stakeholder engagement and communications but to a lesser degree. The lack of visibility of the problem, and the subsequent relatively lower priority meant less pressure to act and hence less resources and capacity focused on doing so.

The history and context of each initiative

This variance in visibility links very closely with the context of the initiative. With air quality there is a long history of cultural-cognitive concern, for example as a selection pressure and adaptive capacity deployed to research the issue, generating evidence which reinforces pressure from concerns. In addition the existing congestion charge supported processes in favour of the ULEZ, e.g. the cultural-cognitive belief within the GLA that this sort of charging scheme was possible, the normative adaptive capacity in terms of skills and experience of staff to implement it, as well as the existing physical infrastructure from the congestion charge that made operationalising the ULEZ much easier. Whereas for decentralised energy not only is there an absence of the hard infrastructure necessary for local energy, but in addition the current infrastructure acts as a barrier to progress because it was developed for centralised energy generation and supply. For example, considering decentralised heat, not only is there an absence of a local physical network required to support local heat supply but digging up the roads to create a district heating network is extremely challenging and costly. Similarly for decentralised energy there is a lack of softer, institutional infrastructure because of historically generating and supplying energy through a centralised market. Therefore local energy generators find it hard to access the market due to the legal and financial set up. Again the evidence suggests not only a 'passive' absence of infrastructure, but 'active' barriers from misaligned infrastructure. Perhaps more fundamental still are the even 'softer' infrastructural gaps around confidence and belief in decentralised energy

as a viable solution. This highlights the challenges of developing adaptive capacity, and the time and resources required to change institutional processes.

In addition, this indicates the importance of historicity and context not just for existing adaptive capacities, but more generally across all processes. This case study evidence corresponds with transition concepts of pathway dependence and lock-in (Köhler et al., 2019; Unruh, 2002), as well as practice theory's emphasis on specific context and historicity (Reckwitz, 2002). Existing processes are in large part a function of this existing infrastructure, both 'soft' institutional infrastructure and 'hard' physical infrastructure. Indeed it is interesting to note how the physical 'hard' infrastructure mirrors the 'softer' institutional infrastructure in enabling or inhibiting progress. The history and context of the geographical place and social space relating to an initiative heavily influences the institutional and quasi-evolutionary processes at play, and therefore what is possible, and what is perceived as possible.

The role of power and resources

A second general observation across all processes at play, is around the role of power and resources. The strength of processes is directly impacted by the coordination of power and allocation of resources. Considering power, there are several ways this manifests. The first is formal powers that actors have, for example for the ULEZ initiative the power to legislate is imposed through EU and UK law enacting a strong regulatory selection pressure. In addition the GLA has transportation powers that enable it to introduce a charge on polluting vehicles, providing a strong regulatory adaptive capacity. By contrast decentralised energy has self-set hard targets which generate a regulatory selection pressure that is less concrete, and more vulnerable to change. Here too the GLA have powers to leverage in the form of the planning requirements, and this is noted as a strong adaptive capacity. However they have less 'energy' powers overall, with less powers than utilities for installing and fixing underground infrastructure for example.

As well as formal powers, there is less formal power at play. This corroborates, and is corroborated by, existing work showing the role of informal governance and informal institutional rules (Barnes et al., 2018; Kern, 2011). For example the case study highlights the power of the media in shaping cultural-cognitive concerns. Here the evidence shows the influence of the Evening Standard in particular in strengthening cultural-cognitive selection pressures in support of the ULEZ initiative. Another example is the power of the taxi unions in lobbying for delayed introduction of ULEZ restrictions. With regards to decentralised energy, there is not such obvious power at play and this maybe because it is a less contentious issue than air quality and health (or at least it was

during the time of the interviews). The main push for the initiative came from the mayor in relation to the climate vision, reflecting both the formal and informal powers associated with that position. The main pushback against decentralised energy came from developers reluctant to invest upfront. In this instance power could be at play as local authorities are often keen for development to occur and so the developers have strong bargaining power to argue against inclusion of decentralised energy within a development.

Linked to this is the power associated with, or derived from, the legitimacy of (coalitions of) actors and ideas involved (Smith et al., 2005; Wolfram and Frantzeskaki, 2016). For the London case study this is influenced by the different actors who are articulating the selection pressure. In the case of air quality this is the general population and media, supported by independent academics such as Kings College London. These actors give a high level of legitimacy, strengthening the cultural-cognitive selection pressure. For decentralised energy and the climate vision, this is being championed by climate organisations and City Hall – neither, arguably, representing the voice of the people, or with the influence of the media, or the independent, expert status of academics. However, as above the backing of the Mayor does have legitimacy. This indicates that legitimacy is an important form of power, supporting the view of Smith et al. (2005) who conceptualise legitimacy as an important resource for transitions, and Rauschmayer et al. (2015) who flag the role of democratic legitimacy in transitions. Considering the ideas involved, for the ULEZ initiative there was almost universal agreement that good air quality was important due to the associated health impacts, this lent a great deal of legitimacy, and strength, to the cultural-cognitive concerns acting as selection pressures. This links with the notion put forward by Geels (2011) that conformity to broader public opinion (in this case the importance of good air quality and health) is part of the ‘struggle’ for legitimacy.

Furthermore, whether the initiative is within a highly contested environment or not appears to have an impact. In the more contested environment around the ULEZ initiative, the selection environment was ‘fiercer’ and selection pressures were greater through the very act of being in opposition. Thus greater adaptive capacities were deployed to fight for competing views, priorities and ideals. This played out across all institutional pillars, e.g. regulatory political factors and lobbying, normative visions and networks, and cultural-cognitive concerns. The ULEZ elicited greater mayoral focus on visioning: resources from across TfL for planning; media focus from the Evening Standard; lobbying by Clean Air London; etc. Whereas decentralised energy was less contested, it was a less political, public issue (at least during the time of the case study),

and this impacted the level of lobbying, media coverage, and mayoral attention. This indicates that highly contested environments impact the strength of the institutional and quasi-evolutionary processes involved.

Turning from power to resources, the evidence suggests that allocation of resources impacts on the strength of processes across the two initiatives. The provision of adequate resources, typically staff capacity (time, skills, expertise) and budget/funding, as well as less tangible resources such as data or communication channels, affects the strength of processes involved. In addition power is an important resource, for example the decision to allocate planning powers to setting requirements for decentralised energy, or using transportation powers to impose ULEZ charges.

The interplay between adaptive capacity and selection pressure, and between power and resources is important. The case study data shows how selection pressure and the allocation of resources, which impacts adaptive capacity and agency, in turn this adaptive capacity influences the coordination of power, which leads full circle to impact selection pressure. For example for all cities the political context and high visibility of the mayoral role leads naturally to a competitive, contested environment which exerts political selection pressure. Hence it is important for the mayor to have a strong vision to politically distinguish him- or herself. This prompts the use of mayoral power to allocate resources creating greater adaptive capacity to develop and strengthen a vision (e.g. resource for teams of skilled staff provides capacity for visioning, target-setting and research). This generates (or strengthens) selection pressure (e.g. regulatory 'hard' targets and cultural-cognitive concerns). This in turn reinforces this vision and supports the further allocation of resources. This potentially creates a self-reinforcing cycle - increases in power and resources aligned with the sustainable city vision increase adaptive capacity to shape selection pressures and lead to further power coordination and resource allocation in line with the vision. The evidence suggests how a self-reinforcing cycle might alter the overall regime environment over time. This insight builds on Berkhout et al.'s (2004) definition of adaptive capacity as the availability and coordination of resources to adapt to selection pressures, but brings in the interplay with selection pressures and power, thus incorporating the other side of the coin as well. The evidence suggesting a self-reinforcing cycle show how this can potentially alter the overall regime environment over time. This supports the assertion of Smith et al. (2005) that this availability and coordination of resources shapes the 'form and direction' of transitions.

The overall configuration of processes

Furthermore, the configuration of processes at different scales of governance and over time is important. In terms of governance, there is a cohesion across international, national and local levels of governance for air quality: EU air quality regulations have been translated into UK law, and the risk of EU fines has been passed onto local authorities. Whereas for energy there is a disparity between local regulations around decentralised energy and national policy and infrastructure around national generation and supply.

In terms of configurations over time evidence from the case study was largely in relation to political cycles and cultural trends. For both initiatives the priority of the current mayor has a big impact (acknowledging that such priorities are not developed in isolation but are highly influenced by other processes at play, e.g. cultural-cognitive concerns). For London, the Mayor has the power to set the vision – as previously stated this influences the vision and accompanying coordination of power and allocation of resources. This shows how mayoral priorities impact and shape the selection environment: normative selection pressures in the form of visions; adaptive capacities in the form of resource allocation (especially in terms of normative capacity to communicate the vision, but also more generally). A significant observation here is that cultural-cognitive and regulatory processes appear to be harder for sustainable city actors to influence, possibly because they are less vulnerable to local influence.

In addition, configurations over time at the national and international governance level impact processes and initiatives. Changes in energy policy nationally weakened regulatory selection pressures for the decentralised energy initiative. Whereas stable policy on air quality provided stronger regulatory selection pressure for the ULEZ initiative. However, here it should be noted that Brexit was a source of potential future uncertainty.

This leads on to an overall observation that the configuration of processes in relation to the sustainable city vision, and specific initiatives within it, is fundamental. Processes are not operating in isolation, there are multiple processes affecting each initiative and they affect each other both positively and negatively. As Kohler et al. (2019, p. 2) state 'transitions are not linear processes, but entail multiple, interdependent developments', transitions are multi-dimensional and co-evolving. For example for the ULEZ, political factors acting as regulatory selection pressures are strongly linked to cultural-cognitive selection pressures in the form of concern about air quality and health as these affect citizen concerns and hence voter preferences. In the case of London strong cultural-

cognitive selection pressures (health concerns) strengthen strong regulatory selection pressures (political factors). For decentralised energy by contrast, there are no strong cultural-cognitive selection pressures driving action and as a result the regulatory and normative selection pressures are weaker.

In terms of configuration, it is important to note the role of power and rival visions (and their associated initiatives and processes) competing against sustainable city initiatives through opposing selection pressures and adaptive capacities. For both initiatives competing processes were present: an example for decentralised energy is regulatory selection processes generated by the “build to sell” business model (arguably underpinned by competing normative vision and cultural-cognitive beliefs in economic growth); and an example for the ULEZ is cultural-cognitive selection pressure in the form of strong pro-car culture. Interview evidence suggests that where such competing processes exist they can create a strong barrier, especially if they are hard to influence such as deeply engrained cultural-cognitive heuristic selection pressures (e.g. for decentralised energy professional ways of thinking) or externally imposed regulatory pressures (e.g. for decentralised energy the competing centralised legal and financial set up). This finding points to the impact of the *alignment* of processes within the overall configuration.

This overall configuration of processes, and the impact it has on the progress of the two initiatives, can be conceived of as the selection environment in which transition initiatives need to compete to survive. This builds on several transition scholars who employ the analogy of the selection environment to conceptualise the structures that make up regimes and which transition management is seeking to alter in order to support change (Barnes et al., 2018; Kemp et al., 2007; Kivimaa and Kern, 2016).

Do these institutional and quasi-evolutionary processes constrain or enable progress?

The findings from the analysis suggest that the institutional and quasi-evolutionary processes themselves are agnostic, they can both constrain or enable progress. It is the outcome towards which processes are directed that determines whether processes contribute or inhibit the achievement of sustainable city visions. As the evidence shows, these outcomes are not necessarily explicit normative visions, but instead unconscious cultural-cognitive habits or externally imposed regulatory political and market forces. In addition there are a plurality of desired outcomes and whilst they might not have been designed to oppose each other there is often conflict, for example increased better air

quality, vs the freedom of the car and economic development. This leads to a contested environment with competing outcomes.

The emergence of an overall constraining or enabling configuration of processes in such a contested environment is determined by both the alignment, or misalignment, of processes with outcomes and the strength of these (mis)aligned processes. In other words, the configuration of processes determines the overall direction of travel. Furthermore, the case study evidence suggests that the alignment and strength of processes is constantly changing and evolving, as are the outcomes towards which they are directed.

4.2.3 Overall findings in terms of research aims and questions

Having set out the results from the London case study, what do these findings tell us? How do they address the research gaps and answer the research questions?

The findings from the case study address the weakness and gaps identified in the literature review. First, the importance of processes in shaping outcomes is clearly demonstrated. Second, the importance of regime-level processes is shown, challenging the notion of the regime as a monolithic barrier to change. Third, the significant role of social, non-technical processes is highlighted by the prevalence and impact of all institutional processes but particularly cultural-cognitive processes; and finally, the role of power is illustrated through coordination of power and resources, and the competing processes and visions at play, and the role of agency is illustrated through the capacity of actors to undertake this coordination power, and the adaptive capacity of actors to shape the processes acting upon them (particularly normative adaptive capacity).

In terms of the first research question regarding what processes are at play, the London case study highlights the importance of initial regulatory and cultural-cognitive drivers for action. These pressures create a political mandate and/or pressure to act, in turn generating the space for power and agency to be deployed by sustainable city actors. Normative processes are the ones that actors have most agency to purposively steer and shape change. Considering the second research question, how these processes vary and whether they enable or constrain progress, the evidence suggests that the normative agency of actors to steer progress is underpinned and/or 'bounded' by the wider configuration of processes, in particular the harder to influence cultural-cognitive and regulatory selection pressures. Additionally the history and context influences what is possible, and what is perceived as possible. Furthermore the coordination of power and allocation of resources impacts, and is impacted by, the processes at play and the

strength of these processes. This final configuration of processes is where the variation between the initiatives lies. It is clear that processes both enable and constrain progress, and the overall configuration determines the balance of enabling and constraining processes and the space for change. The overall alignment with the vision and the presence or absence of competing processes determines the lower and upper 'boundary' for change.

These case study findings are now added to by the next two chapters presenting the New York and Copenhagen cases, testing whether results from the other cities corroborate London's findings.

Chapter 5 New York case study

This is the second of three case study chapters which offer results and insights from using the analytical framework developed in chapter two. The distinctive features of this case study are: first, the very high normative adaptive capacity, created by purposeful resource allocation which itself was directed and underpinned by visionary and committed leadership; second, this high capacity enabled actors to shape selection pressures in favour of sustainable city initiatives, effectively translating normative adaptive capacity into cultural-cognitive and regulatory selection pressures; and third, although the normative pillar provided the means for change, the underlying drivers were cultural-cognitive and regulatory selective pressures.

These findings support those from the London case study, providing a second set of case study evidence that addresses the knowledge gap and answers the research questions. In addressing the research gaps the New York case further demonstrates that: first, that processes are what drive change towards long-term outcomes; second, that within the regime there are a multiplicity of processes at play; third, that non-technical, socio-cultural processes have a major impact on transition progress; and finally, the role of power and agency are highlighted through selection pressures exerting structural power and adaptive capacity providing agency. Using the novel framework, the analysis provides answers to the research questions by identifying the institutional and quasi-evolutionary processes at play, and enabling greater insights into exactly what mechanisms are enabling or constraining transitions.

This chapter first introduces the case study; the second section sets out the processes observed by institutional pillar (regulatory, normative, cultural-cognitive) and then for each pillar by quasi-evolutionary process (selection pressures and adaptive capacity); the third section compares between the two initiatives to investigate how these processes vary, and why, and whether they enable or constrain progress; the final section sums up the case study results and their implications for the overall research findings.

5.1 Introduction

This section provides an overview of the New York case study, briefly introducing the city, together with the sustainable development context and sustainable city vision. It then summarises the wider history and context of the two initiatives; Clean Heat and green storm water management.

New York overview

New York was formed in 1898 when five boroughs merged to create the City of New York. New York has a population of around 8.5 million, making it the largest US city. The city is very dense with over 27,000 people per square mile.

New York is governed by a mayor-council system, under a more centralised system than that of most other US cities. The city government is responsible for public education, prisons, public safety, recreational facilities, sanitation, water supply and welfare services. However the Metropolitan Transport Authority (MTA) is run by New York State, and much legislation and regulation is at state or federal level.

Data collection was undertaken between August and November 2016. Interviewees largely referred to activity during the current and previous mayoral administrations, reflecting the sample of participants serving under both mayors. Michael Bloomberg was Mayor of New York from January 2002 until December 2013, an unusually long three-term tenure⁴. Bill De Blasio took over in January 2014 and is the current Mayor of New York. The majority of the interviews were undertaken before the national US elections. New York has very stable party politics, it has been democrat for the past 91 years, with a strong majority in the last elections in 2016 of 80%.

New York and sustainable development

The initial driver for the sustainability agenda in New York was population growth. After a declining population for several decades, the city's population recovered and began to grow again. Analysis at the start of the Bloomberg administration forecast one million extra inhabitants by 2030, catalysing an investigation into how to plan for a thriving city whilst managing this growth. This led to the conclusion that sustainable development was critical and ultimately led to the establishment of the Office for Long-Term Planning and Sustainability (now the Mayor's Office for Sustainability) early in Bloomberg's tenure. This was followed with the launch of PlaNYC in 2007, which had sustainability as a core element, positioning New York as an aspiring global leader. In addition at this time Bloomberg was chair of C40 Climate Cities Leadership Group⁵.

In 2012 Hurricane Sandy devastated large parts of New York and resulted in much greater awareness and cultural cognitive selection pressure to manage future climate

⁴ All elected officials were limited to a two consecutive-term limit until Mayor Bloomberg pushed for an amendment to allow for a third term in the 2009 elections, this was based on the need for strong business leadership after the financial crash in 2008.

⁵ C40 Cities Leadership Group connects 94 of the world's greatest cities to take bold climate action, leading the way towards a healthier and more sustainable future www.c40.org

risks. From this resilience was prioritised alongside climate mitigation and wider sustainability issues.

In 2013 Mayor De Blasio launched OneNYC, his plan for New York. OneNYC built on PlaNYC but De Blasio reframed the priority from sustainability to equity. However, sustainability is still an important element, it is one of four visions within the plan with the aspiration for New York to be “the most sustainable big city in the world” (City of New York, 2015).

Current activity shows ongoing commitment: New York is one of a handful of pilot cities to develop 1.5 degree compliant climate action plans (City of New York, 2017); in early 2018 De Blasio announced New York City would divest from all fossil fuel investments and launched a law suit against fossil fuel companies (City of New York, 2018b); and at the end of 2018 New York was the first city in the world to report sustainability progress to the UN (City of New York, 2018a). The national backdrop was less positive, for example in the US federal government pulled out of the Paris Agreement on climate change.

Sustainable City Vision

New York has set out its city strategy in one document; OneNYC (2015) – the plan for a strong and just city. As per the previous PlaNYC (2007), the strategy continues to focus on economic growth, sustainability and resilience, but adds a new focus on equity. The OneNYC strategy sets out four visions:

1. New York City will continue to be the world’s most dynamic urban economy, where families, businesses, and neighbourhoods thrive
2. New York City will have an inclusive, equitable economy that offers well-paying jobs and opportunity for all New Yorkers to live with dignity and security
3. New York City will be the most sustainable big city in the world and a global leader in the fight against climate change
4. Our neighbourhoods, economy, and public services will be ready to withstand and emerge stronger from the impacts of climate change and other 21st century threats

Vision three is the key section where the City of New York articulates its sustainable city vision. This vision is split into six goals, shown in Figure 5.1.

Figure 5.1: OneNYC goals for vision three for a sustainable city (City of New York, 2015).



Case study initiatives: Clean Heat and green storm water management

As per the methodology outlined in chapter three, two initiatives were explored in order to achieve the ambition of a city-wide, cross-sector research approach but still enable depth of research. Additionally initiatives with differing level of success were selected, enabling a range of critical insights. These were identified through key informant interviews to select one initiative that is progressing well and another that is more challenging:

Clean Heat was cited as an initiative that was delivered over a relatively short time span between 2007 and 2015 and that successfully reduced air pollution and GHG emissions (City of New York, 2016). It is an energy transformation initiative that aimed to eliminate the dirty heating oil (number six heating oil) that was being used in the city in order to tackle both air pollution and carbon emissions. Clean Heat was a central initiative within New York's vision to have the cleanest air quality of any big city in US, and part of the 80x50 carbon target (80% reduction in carbon emissions by 2050). The programme has now been finished, though it is being rolled into the Retrofit Accelerator initiative to provide support to large building owners (>50,000sqft) to improve the energy efficiency of their stock (City of New York, 2019).

Management of inland storm water flooding through green infrastructure (hereafter 'green storm water management') was identified as progressing relatively poorly. There was not a specific initiative to point to here but there is an overarching green infrastructure plan for New York, in which storm water management features. The aim of the initiative was both to manage water quality and quantity using a mix of both grey and green infrastructure. The focus on inland storm water management was due to the lack of progress in comparison with coastal flooding that had received a strong push after Hurricane Sandy.

Twelve interviews were undertaken for Clean Heat and nine for green storm water management (though three interviews covered both initiatives). Clean Heat interviewees included a range of policy, senior, officer, legal and health roles from across the public (8), civic (1) and private (3) sectors. Green storm water interviewees included a range of technical, strategic and policy roles from the public (6), private (2) and civic (1) sector. For details see the full table of interviewees in Table 3.2 in the methodology chapter.

5.1.1 History and context

This section describes the history and context of the case study, and covers the story of the Clean Heat initiative and green storm water management that emerges from the case study data.

Important general context for both initiatives is the strong sense of organisational culture associated with the Bloomberg administration. Interviewees referred to data-driven decision making, strong leadership and a willingness to take political risks, as well as a partnership approach and strong stakeholder engagement. These are of course subjective views of interviewees who served during the Bloomberg administration, but the frequency and strength of such references was marked.

In addition the strong civic culture was also referenced by several interviewees, and emerges as an important general context for both initiatives. In particular, there has been a long and thriving environmental justice movement in New York.

Clean Heat – air quality and cleaner heating fuel, and buildings energy efficiency

In New York there is a history of air quality issues. From the late 1950s and to late 1960s there was mandatory building level waste incineration to deal with a solid waste crisis, with around 17,000 incinerators burning waste with very little controls. This was later banned due to the air pollution it caused. In the 60s there were some killer smogs, over 100 people died and it was seen as a major health crisis. Again this led to reforms and improved air quality control.

Heating oil is only used in the north-east of the US, in older cities. Furthermore, New York was one of the only cities in the US still using the dirtiest grade heating oil. This meant it was a dumping ground for low grade, number six oil. In addition number four and number two heating oil are used in New York. Number six heating oil was described as the bottom of the barrel, lowest grade refinery waste, number two is the cleanest heating oil, and number four is a blend of number six and number two oil. New York, especially Manhattan, has high-rise, very dense, old building stock, with old heating systems powered by heating oil.

In 2007 PlaNYC set out the vision for the city to have the cleanest air of any big US city. The underlying drivers for this was the data from the EPA that showed the extent of the air pollution problem, and campaigning efforts by environmental justice groups. This underlying cultural-cognitive concern around pollution and health led to regulatory political pressure to act. External funding led to data collection through the New York Community Air Quality Survey (NYCAS) showed a huge problem with heating oil. Importantly pollution was spatially mapped, showing heating oil was a problem in affluent neighbourhoods, particularly the Upper East Side due to the age of the buildings. At this time number six heating oil had already been phased out of most buildings in New York. It was only being used in 6-10,000 older buildings (roughly 1% of total building stock).

New York has strong powers in relation to buildings, in particular the Department for Environmental Protection (DEP) authorises permits for heating systems. Permits are re-issued every three years and so the city was able to set targets to phase number six oil out very quickly over a three year period, from 2012 – 2015.

At the same time as using regulatory selection pressures to phase out number six, efforts were being made to make the transition as effective and easy as possible. City actors were working with the state government to standardise and regulate number two oil,

which was traditionally of varying quality. This was successful, resulting in improved quality number two oil (specifically extremely low sulphur content <15ppm), and automatically improved the blended number four oil, making both much cleaner.

In addition, efforts were made to enable natural gas as an alternative fuel. Natural gas was much cheaper than historically due to fracking, and as a result was a viable alternative. This competition from natural gas meant that the heating oil industry felt pressure to clean up their act, acting as a strong regulatory selection pressure to encourage them to cooperate. However, there was a lack of natural gas infrastructure and the city government worked with the local utility, Con Edison, to improve supply. Historically gas prices had fluctuated so there were some residual concerns over security of supply and it was expensive and difficult to put in the pipework to create a new gas infrastructure.

A commercial organisation was brought in to help 'sell' the initiative, educating building owners about the new regulations, raising awareness about air quality and providing support for boiler upgrades. Wherever possible building owners were encouraged to jump from number six oil straight to number two or natural gas for both greater efficiency and health gains. There was also financial support; the city of New York worked with financial organisations to commit over \$100M for building owners (only a small proportion of this was recorded as being accessed, though more may have been loaned given there was no official monitoring in place).

There was good stakeholder engagement throughout the process, both within city government and with wider stakeholders. A very transparent and open approach was taken, including the use of models to show the options for phase out and relative impacts in relation to cost. This was highly effective in enabling collaborative, holistic decision-making, resulting in greater buy-in and support.

Though mostly a relatively smooth process, there was reference to a last minute crisis, with the phase out nearly being delayed. The team behind the initiative presented the case again to the mayor, importantly using data to show the health impact, and the mayor stuck with it.

Overall the phased approach to cleaning up heating oil, the clear regulation and support provided led to a highly successful initiative. Number six heating oil was successfully phased out without a single permit needed to be with-held, and resulted in air pollution and GHG emissions reductions: elimination of the dirtiest heating oil within the city leading to a 65% reduction in PM2.5 emissions from buildings previously using low grade oil (2011 baseline); contributing to overall reductions in concentrations of sulphur (SO_x)

levels by 23% and PM2.5 by 23% between 2008 and 2016; and lowering GHG emissions by an estimated 800,000 metric tons (through improved efficiency and switching to lower carbon fuels) (City of New York, 2016). Phase out of number four is set for 2030, but the city is aiming to get ahead of the regulation through a similar programme of education and support.

Green storm water management

New York has a long history of taking a green infrastructure approach to water management, notably the city's natural drinking water supply. This dates back to the original catchment area that the city has continued to manage naturally rather than via more traditional grey infrastructure solutions. Certainly among US cities this is unique and it creates challenges in terms of the national regulatory set up which is designed for more traditional water supply approaches, though it has proven a significantly more cost-effective.

In terms of managing water run-off and flooding New York is a fairly typical city. Two extreme weather events that results in heavy flooding emerged from the data as important context for the initiative. Hurricane Sandy, which occurred in 2012, was the most frequently mentioned, but prior to this in 2007 there was a heavy rainfall event that flooded many parts of New York including the subway. This interruption to the subway was critical as it led to a significant city-wide impact. The 2007 event generated awareness of the risks from inland flooding and this cultural-cognitive selection pressure was a driver for more action in this area. Hurricane Sandy generated huge cultural-cognitive awareness and concern around storm surges and the risk of coastal flooding. It also increased awareness of the need for resilience and climate adaptation measures.

As part of the PlaNYC processes, the Mayor's Office of Sustainability reviewed options regarding green infrastructure and launched the 'NYC Green Infrastructure plan; a sustainable strategy for clean waterways' (2010). The review and planning process identified the potential to save significant money through using a mix of grey and green infrastructure to manage floodwater, estimated savings were US\$1.5 billion (City of New York, 2010). Extensive analysis and modelling was undertaken, as well as stakeholder engagement using the convening power of the Mayor's Office of Sustainability to bring together different departments within the City of New York.

In developing the plan New York was able to work with other cities who were leading on green storm water management, and establishing proof of concept and best practice (helping change cultural-cognitive conceivability/credibility, and normative standards

around storm water management). In particular the city developed a strategic agreement with Copenhagen to develop green storm water solutions collaboratively.

Initially there was a lack of buy-in from the DEP to the green infrastructure plan, and within it the proposals for green storm water management, and the plan sat on the shelf. The DEP had a history and professional culture of the traditional grey infrastructure approach to storm water management. Staff roles and skills reflected this, as well as departmental budgets and normative values whereby large grey infrastructure solutions with big budgets were most respected. The plan was re-visited when there was a change in leadership at the DEP and also when one of the main staff involved in developing the plan transferred from the Mayor's Office of Sustainability to senior role within the DEP. At this point there was DEP, Mayoral and Office of Management and Budget buy-in and a new unit was created to implement the plan.

The role of the EPA as the regulator for water quality was central. There was already a history of negotiating with the EPA around water quality regulations in relation to drinking water supply, with mixed results. In terms of green storm water management the EPA demanded proof, modelling and projections were not acceptable evidence. This led to three pilots, carried out over three years with extensive data collection, resulting in consent from the EPA to a 20 year scheme, with five year implementation plans and associated monitoring and reporting. EPA regulations acted as the initial regulatory selection pressure but with mixed alignment; driving action through regulatory requirements, but also inhibiting it through restrictions around green storm water management.

5.2 Results: What are the regime-level processes, how do they vary and do they enable or constrain progress?

This section sets out the results from the New York case study data with regards to the research questions: what are the institutional and quasi-evolutionary processes that drive regime-level decision, actions and their outcomes within sustainable cities; how do they vary and why, and do they enable or constrain progress?

For both initiatives there is a very strong normative adaptive capacity. This is by some margin the most prevalent set of processes. This adaptive capacity was driven by a purposeful process of organisational change management, directed and underpinned by visionary and committed leadership. Through this change management the allocation of resources within the city government in particular is affected, including authority/decision-making powers, as well as the organisational culture. This influences the adaptive capacity of sustainable city regime actors, in particular normative capacities around visioning and communications, stakeholder engagement, and research and data analysis. Through these increased adaptive capacities regime actors are able to shape selection pressures, in particular changing legislation (including institutionalising change) and setting and enforcing hard targets (including accountability through reporting to the mayor's office and public reporting).

Whilst the normative pillar provided the means for change through high adaptive capacity, the underlying drivers for initial action were cultural-cognitive and regulatory selection pressures. These drivers are heavily shaped by historicity and context: a history of air pollution and concerns; a thriving civic sector; existing legislation; and recent weather events.

For the Clean Heat initiative the cultural-cognitive concerns around health provided strong selection pressure to act. These were shaped and strengthened by adaptive capacity to gather and communicate evidence, through strong data, visuals and narratives and voiced by a thriving civic sector. Political pressure around air pollution and health exerted strong regulatory selection pressures. Added to which New York had high regulatory adaptive capacity to enforce upgrades through boiler permitting requirements, and additionally to shape regulatory selection pressures around legislation in favour of the initiative. Furthermore, only a minority of buildings were still burning low grade heating oil – a credible, viable alternative was already established as the norm. The fact that easy, low cost and low risk solutions were available meant there was relatively little selection pressures acting against the initiative.

For green storm water management the cultural-cognitive concerns were generated by extreme weather events. However this cultural-cognitive driver is highly variable, it is strongest immediately after flooding, and in those areas impacted. Whilst the 2007 storm created concern around inland flooding, Hurricane Sandy diverted concern towards coastal flooding. An important difference compared with Clean Heat is that the green storm water management initiative faced significant barriers from cultural-cognitive selection pressures in the form of traditional grey infrastructure ways of thinking. Regulatory selection pressures regarding water quality were a driver for action, but the focus of legislation on water quality not quantity, and the underlying traditional grey infrastructure approach, led to mixed regulatory pressure that both enabled and inhibited. The first sub-section addresses the first research question regarding what processes are at play, and the second sub-section explores the second research question regarding variation, and whether processes enable or constrain progress.

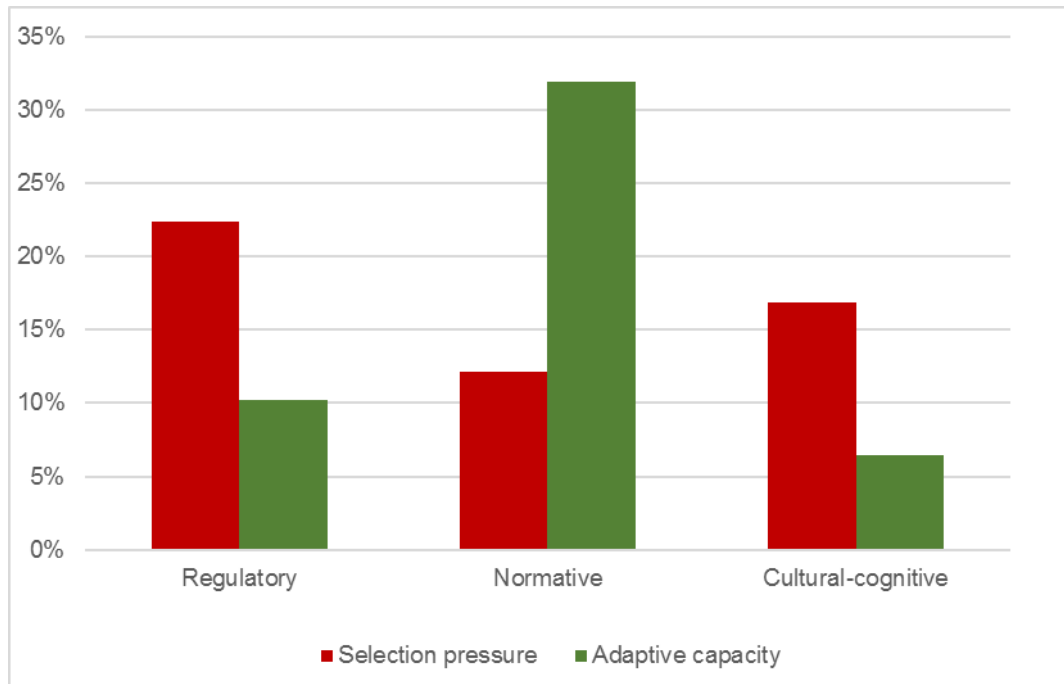
5.2.1 What are the institutional and quasi-evolutionary processes that drive regime-level decision, actions, outputs and outcomes?

Table 5.1 summarises the main findings, and the following sections provide details organised by the three institutional pillars (regulatory, normative, then cultural-cognitive), and then for each institutional pillar by selection pressure and by adaptive capacity. Figure 5.2 presents the relative frequency of the processes occurring by institutional and quasi-evolutionary process.

Table 5.1: Summary of the New York case study findings by institutional pillar and selection pressure/adaptive capacity, showing the main processes identified.

Regulatory		Normative		Cultural-cognitive	
Selection pressure	Adaptive capacity	Selection pressure	Adaptive capacity	Selection pressure	Adaptive capacity
<ul style="list-style-type: none"> • Legislation, including city powers (e.g. EPA water quality regulations) • Political pressures, both pressures and priorities • Market factors, mainly cost (e.g. cheap gas prices) • Targets, and importantly timescales (e.g. 80% GHG reduction by 2050) 	<ul style="list-style-type: none"> • Legislative change (e.g. introducing new laws) • Political campaigning (e.g. environmental justice campaigns) • Financial capacity (e.g. to make a strong business case) • Planning and project management (e.g. developing sustainability plan and reporting mechanism) 	<ul style="list-style-type: none"> • Vision (e.g. the most sustainable big city in the world) • Best practice (e.g. in relation to other city performance) • Operational priorities and risks (e.g. clean drinking water) 	<ul style="list-style-type: none"> • Organisational change (e.g. creating a new Mayor's Office of Sustainability) • Networks and stakeholder engagement (e.g. consultation processes) • Visioning and communications (e.g. training and outreach) • Data collection and research (e.g. air quality monitoring) • Leadership (e.g. commitment to goals) 	<ul style="list-style-type: none"> • Personal experience and immediate problems (e.g. Hurricane Sandy) • Credibility (e.g. scepticism of new approaches) • Working cultures (e.g. traditional grey infrastructure approach of engineers) 	<ul style="list-style-type: none"> • Narratives and visualisation (e.g. maps and pictures of pollution) • New ways of thinking (e.g. interdisciplinary work to break silos) • Empowered voice (e.g. privileged and/or well-connected individuals) • Work around and/or better fit with selection pressures (e.g. solutions designed to fit with current lifestyles)

Figure 5.2: The relative frequency (y-axis) of New York case study processes occurring in each institutional pillar and by selective pressure or adaptive capacity.



5.2.1.1 The regulatory pillar

Regulatory processes are the formal and explicit legislation and ‘hard’ targets; the enforced rules, *how things must be done* (Scott, 1995) - see the literature review chapter for a full description.

Regulatory processes account for around one third of the processes cited during the interviews. Within this over two thirds are selection pressures and just under one third is adaptive capacity.

The main regulatory selection pressures emerging from the case study data are: legislation and city powers; political pressures, both pressures and priorities; market factors, mainly cost; and targets, and importantly timescales. The main regulatory adaptive capacity emerging from the case study data are: legislative change; political campaigning; financial capacity; and planning and project management.

Of these main regulatory processes three in particular influence overall progress and are distinctive features of this case study: regulatory selection pressures in the form of political pressure and city powers (e.g. boiler permitting powers) that acted as drivers for Clean Heat; and regulatory selection pressures from water quality legislation that acted

as a driver for the green storm water management initiative – albeit a mixed driver given the focus on quality and not quantity of water.

Regulatory selection pressures

This section details the main regulatory selection pressures emerging from the case study data: legislation and city powers; political pressures, both pressures and priorities; market factors, mainly cost; and targets, and importantly timescales.

Starting with legislation and city powers this was cited as the primary reason that action was being taken for the green storm water management initiative. Specifically EPA legislation around water quality: *“the driver initially was compliance with the clean water act” (interview N10).*

Although legislation was a driver, it was also referenced as a barrier; rigid, inflexible legislation enforced unnecessary action and prevented implementation of best practice solutions. For green storm water management the focus on water quality led to neglect of the issue of water quantity, i.e. flooding:

“they are not governed by water quantity but by water quality, when they are asked to do urban drainage project it is in order to control and improve water quality and not quantity, that is an institutional, a regulatory barrier” (interview N19)

For Clean Heat, legislation both at state and city level were frequently mentioned as driving action. However the legislation was as a direct result of efforts by New York City, and others, and as such it is captured as an adaptive capacity – though of course once such legislation has been created it then effectively acts as a selection pressure.

There were references to the powers that the City of New York government has, and does not have, and importantly the impact of this on implementation. For Clean Heat the permitting power of the DEP was critical to effectively outlawing grade six heating oil, as well as grade four from 2030 onwards. The DEP renews boiler permits every three years and from 2012 onwards started to phase out permits for boilers using grade six heating oil, successfully eliminating it from the city by 2015:

“the Department of Environmental Protection issues permits for these emitters... they basically said... we will no longer be reissuing your permits for this oil, the number six oil, therefore you are not legally allowed to do it” (interview 20)

As noted above for green storm water management the EPA has power over water quality regulations at a national level. The lack of power at city level to govern, or influence, this was a barrier to progress.

The second group of regulatory selection pressures are around political pressures. Throughout the interviews there were references to political pressure as a key regulatory selection pressure, in relation to both civic and business groups, as well as direct pressure from voting citizens. For Clean Heat the support for improving public health created political pressure, and opportunity: *“I think public support certainly was a big factor, you know where could we get credit was very important, could we legitimately claim success and get the honours” (interview N11).*

However, political pressure was also applied against the Clean Heat initiative: *“the real estate industry control and not wanting to spend money, having lots of political influence” (interview N18).*

There were also references to the political cycle and changing political priorities. Whilst this provides an opportunity for change with each political cycle, it also risks a lack of continuity with sustainability policies. For New York this risk seems to have mostly been avoided and sustainability policies have continued from the Bloomberg administration when they were introduced, through the current De Blasio administration. However, interviewees did mention a change in the level of priority and commitment and a change in focus from sustainability to equity:

“under Bloomberg, there was commitment in the mayor’s office... stronger than it is now, I think now leadership at the top, I think partly for political reasons, meaning mayor De Blasio doesn’t view it as his unique policy so he has to make his mark some other way” (interview N11)

Positively there were references to sustainability becoming a cross-party issue. This reduces the risk around continuity for sustainable city visions and policies:

“it wasn’t a debate whether a candidate would have a sustainability agenda... it was about what they were going to do not whether they were going to do it, and I think that was a land shift of a change” (interview N6)

There were frequent references to the next group of regulatory selection pressures around market factors, mainly cost and the high level of concern over the affordability of policies. These processes played out differently for the two initiatives, but in both cases

cost is often expressed as ‘the bottom line’ in terms of motivations for or against action. For Clean Heat the main concern of the stakeholders affected (e.g. building owners, heating oil and gas suppliers) was about cost: *“the argument was always about cost, this is going to cost me more money” (interview N20).*

However selection pressures around cost acted for as well as against progress: *“the attraction of things like energy was that there was a payback... especially after 2008 the great recession” (interview N11).* In particular this was bolstered by much cheaper gas prices with the development of the natural gas fracking in the US: *“a lot of people wanted to convert to gas, at that time gas was really cheap, it was a lot cheaper than oil” (interview N20).*

Given that these stakeholders were predominantly private sector businesses the need to remain competitive was also a driver (Wolfram, 2016) – particularly for the heating oil industry. This created selection pressure in favour of Clean Heat, as the heating oil industry felt the need to provide cleaner heating oil options in order to remain competitive.

“one of the two big utilities in New York City became very aggressive in converting homes from heating oil to natural gas... going after our customers, and we needed tools to preserve our product and we saw this as an opportunity... [to] promote a cleaner product” (interview N21)

For green storm water management cost was not a concern expressed as a selection pressure against sustainable action, rather it was one of the main motivations for pursuing a green (instead of a grey) infrastructure policy: *“they wouldn’t be doing it otherwise, they are doing it because green infrastructure is cheaper than grey infrastructure so that’s why they’re going with this option” (interview N17).*

The final grouping of key regulatory selection pressures is around targets, in particular ‘hard’ targets that are quantified and time-bound. There were frequent references to overall sustainability targets as motivators for action. Importantly targets were being used as a measure of success, and this increased their selection pressure: *“the number one criteria for success was the fact that we were actually able to achieve our targets” (interview N8).*

The timescales associated with targets emerged as an important factor, the shorter the time-scale the greater the selection pressure exerted by the target. Timescales were determined by a number of factors from Mayoral terms to funding requirements: *“but all*

these things are pretty strict timelines and we have all those milestones I mentioned, so that's moving full steam ahead... we have to spend the money by 2021" (interview N9).

There were also a number of interesting comments questioning how meaningful longer-term targets really are: *"I worry that many cities in general by thinking of big goals that are far in the future lose some of that tangible, sense of urgency, and clear pathway of how to get there" (interview N6).*

Regulatory adaptive capacities

This section details the main groupings of regulatory adaptive capacity emerging from the case study data: legislative change; political campaigning; financial capacity; and planning.

Starting with legislative change, the case study data indicated a high level of adaptive capacity with several examples of successful efforts to amend legislation. For Clean Heat changes at state level to improve number two heating oil were pivotal in generating impetus for change: *"we worked with various legislators in Albany to reduce the sulphur in number two oil, that's really where it started" (interview N21).*

For green storm water management this was about ongoing negotiations with the EPA to accept green infrastructure solutions in response to regulatory requirements. EPA consent was critical to whether or not green infrastructure would be a viable solution for New York – and whether the selection pressure around water quality legislation would drive green or grey infrastructure: *"we convinced EPA to allow us to try to reduce storm water overflows through green infrastructure and had a consent order that allowed us, that was the main driver initially" (interview N10).*

A particularly interesting element of the New York case study is the introduction of legislation by the Bloomberg administration to ensure longevity of key elements of the sustainability plan beyond his mayoral term: *"one of the brilliant things that mayor Bloomberg did is that he established in law an office of sustainability that would outlive him... and a mandate with markers and a life beyond" (interview N21).*

For Clean Heat in particular relevant requirements were introduced to ensure local air quality monitoring continued: *"the city council... passed a law that required the Health Department to continue NYCAS, this neighbourhood air monitoring effort, so there has been some institutionalisation" (interview N22).*

The next group of regulatory adaptive capacity is around political campaigning. In the previous section political pressures were cited as a prevalent group of regulatory selection pressures. Much of this is due to the adaptive capacity of sustainable city

actors to campaign, which shaped the selection pressures in play. Throughout the interviews there were references to this:

“There are a lot of things that matter in a city so you need groups that have a focus on the environment in this sense, and those groups outlive every administration. You just need that pressure, because nothing happened in the city or anywhere without pressure” (interview N21)

Here the history of a strong civic sector, previous campaigning successes and the networks, connections and influence of campaigners were all important in increasing adaptive capacity. These are outlined further in the normative and cultural-cognitive sections.

The next group of regulatory adaptive capacity processes are around financial capacity. References here concerned the ability to make a strong business case and to secure (or provide) funding. With regards to making a strong business case, this was a critical capacity in order to respond to, rather than shape, the powerful selection pressure around cost: *“the cost benefit case that has been critical to every, making the business case has really been critical to everything we have ever done” (interview N9)*. This was relevant for both Clean Heat and green storm water management.

In terms of securing (or providing) funding, there were several references to the role of funding in stimulating progress and overcoming market failures that otherwise may have prevented action. This funding might be from grants or through financing. As well as creating an opportunity, funding also creates an obligation, as referenced in the selection pressure section, to spend funds by a certain time which can help accelerate progress, and to spend funds in a certain way that can both help or hinder implementation of sustainable city vision initiatives:

“the wastewater resiliency plan I worked on after Sandy, we got \$156 or \$165 million in to implement that from the EPA, and so we are issuing the contracts now and we have to spend all the money by 2021, so there is a lot of fast movement” (interview N9)

This available funding seems to have been a pivotal factor supporting certain important steps for both initiatives: for Clean Heat external funding supported the air quality monitoring that provided critical evidence of the heating oil problem; for green storm water management money was allocated to undertake initial pilots.

As well as grant funding, efforts were made to provide other finance solutions, in particular for Clean Heat. These involved creating a non-profit organisation (the New York City Energy Efficiency Corporation), and working with banks to make finance available to building owners to support upgrades to heating systems (the latter links with normative adaptive capacity to engage stakeholders – outlined in the next section).

The last grouping of regulatory adaptive capacity is around planning. The capacity to plan is critical in translating visions into ‘hard’ targets that then act as selection pressures (as referenced in previous section). In addition, the ability to undertake rigorous project management and reporting is key to enforcing these hard targets:

“every one of our initiatives had milestones... we did an update every 12 months... a public report... which created a certain cost to lack of performance... if you are running some agency and you are not delivering the PlaNYC initiatives, and it got the Mayor bad press, at some point you were at great risk of hearing about it, and so that was an enforcement mechanism” (interview N3)

5.2.1.2 The normative pillar

Normative processes are the vision and values of *what should be done*, and *how it should be done*, set out in e.g. standards, professional best practice and guidance (Scott, 1995) - see the literature review chapter for a full description.

Normative processes account for around 45% of the processes identified in the interview data, through analysis. Within this just over one quarter are selection pressures and just over three quarters is adaptive capacity.

The main normative selection pressures emerging from the interview data are grouped around: vision; best practice; and operational needs. The main groupings of normative adaptive capacities from the New York case study are: organisational change management; networks and stakeholder engagement; visioning and communications; research and data analysis; and leadership.

A high prevalence of aligned, strong normative adaptive capacity is a distinctive feature of this case study. The main normative adaptive capacities listed above have a substantial impact on overall progress: purposive organisational change efforts supported by; visionary and committed leadership; allocation of resources; visioning; stakeholder engagement; and research activities.

Normative selection pressures

This section details the main normative selection pressures emerging from the interview data: vision; best practice; and operational needs.

Starting with normative selection pressures around sustainable city visions, these were referenced throughout the interviews as strong pressures that directed efforts. This was most strongly and frequently expressed by city government staff but was also referenced by other stakeholders. As well as an overall sustainable city vision, there were goals more closely associated with Clean Heat around having the cleanest air quality of any big US city.

One interviewee referenced the situation before the vision, with much less focused efforts:

“PlaNYC itself which was the governing vision for all of this stuff, I had worked on some pre-PlaNYC initiatives so I was lucky to see what it was like before the mayor cares about the environment in that way, it was much more organic, initiatives bubbling through the agencies” (interview N18)

This demonstrates the importance of a vision in directing resources more effectively. This reference also captures the importance of who sets or endorses the vision, here the commitment of the mayor is seen to carry particular weight.

However it was also noted that whilst visions provided good direction they might also result in too singular a focus: *“the office was... obsessed with energy efficiency and climate change to the exclusion of things that were primarily public health-based” (interview N11).*

The next group of normative selection pressures was around best practice, and there were several references to this as a driver for action, in particular references to other cities. This was both from the perspective of simply understanding and implementing best practice, as well as competing with other regions and cities to be the best:

“they are seeing what’s going on in California, they are seeing what’s going on in Europe, and they are saying why are we here, so there was a lot of pent-up sense that we were way behind and could be doing so much more” (interview N2)

For Clean Heat the vision itself, to have the best air quality of any US city, pitches New York in competition with other cities. For green storm water management it was more

about using best practice defined by others as the criteria for what New York should be doing:

“New York City wasn’t at the forefront of unveiling green infrastructure I feel like Philadelphia and other cities really pioneered that... we could look to these other cities and kind of model our programs after what worked and what didn’t work” (interview N17)

The final group of normative selection pressures concerns the theme of operational priorities and risks. In particular for green storm water management ensuring clean, safe water was paramount: *“(DEP) operating bureaus are more of a military organisation top-down management because if anyone makes a mistake you potentially threaten public health” (interview N10).*

Normative adaptive capacities

This section details the main groupings of normative adaptive capacity from the New York case study: organisational change management; networks and stakeholder engagement; visioning and communications; research and data analysis; and leadership.

The first group of normative adaptive capacity is around organisational change management. There were many references, both implicit and explicit, to the impact of organisational change management on the progress of sustainable city initiatives. Interviewees cited the need to make organisational changes in order to overcome institutional inertia. In contrast instances where goals are set without accompanying resources being reallocated (including staff capacity, funding, and decision making powers) were seen as doomed initiatives from the start. Operational needs to keep the city functioning and delivering existing goals present a barrier to change unless new initiatives are resourced. References were relating to government processes and mainly in relation to the overall PlaNYC, however there were also notable examples from Clean Heat and green storm water management:

“city bureaucracy is a gigantic institution... it’s very hard to change, and so to think about it as a change management technique, the really cool insight is once you actually embed this kind of thinking into an agency it also it’s really hard to change, and what we realised over time is that you had to have the change agent in every agency... having those people inside the agency turned this from some stupid

mayoral idea that we're going to try and fend off and wait till he leaves office into this is how our agency works" (interview N3)

The establishment of new teams and/or the embedding of sustainability staff within existing teams was seen as critical to driving change, both for the overall vision and for Clean Heat and green storm water management. In addition the creation of governance structures as well as delivery teams was also noted: *"we put together a governmental infrastructure... we created a sustainability advisory board" (interview N6).*

Finally the legacy of making these changes was noted:

"we wound up being a talent pool and that's also a very big deal, because if you can seed city government under senior level with talent that has worked on these issues and understands them, and has that set of values, it does change the course of the bureaucracy" (interview N3)

The next group of normative adaptive capacity processes are around networks and stakeholder management. The role of networks in supporting a vibrant civic and business sector was an important adaptive capacity that emerged from the case study data. There were several references to the history and context of a vibrant advocacy community in New York, and to how this existing capacity was strengthened by coming together in networks:

"we are an alliance of different community-based organisations and environmental justice organisations... we came together because we would be stronger if we have a united front" (interview N17)

Particularly noteworthy is the creation, by the city government, of a PlaNYC coalition, who were pivotal in supporting the plan when it was launched, as well as maintaining pressure once a new administration was in place. Here the Mayor's Office of Sustainability convened a group, of which all the individual membership organisations already existing, but by bringing them together a stronger group was created which outlived the administration which first established it. This points to powerful potential to create adaptive capacity:

"we created a sustainability advisory board... they were very, very important in ensuring continuity, I think not because sustainability wasn't

necessarily a focus of the current administration during the transition but because it wasn't the biggest [priority]" (interview N6)

Several interviewees noted the convening capacity, and power, of the new Mayor's Office for Sustainability:

"[the Mayor's Office of Sustainability] had the power of convening, that was a big power that we had used well to bring agencies together, there are a lot of like-minded people in the agency so it was a way to crystallise momentum, get something done" (interview N11)

Stakeholder engagement was frequently mentioned, for both initiatives but particularly for Clean Heat, and for PlaNYC more generally there was a huge engagement effort. Predominantly this is in regard to city government purposefully engaging with relevant stakeholders, aiming to build awareness, participation and support for their initiatives:

"that was the way we developed PlaNYC, so it was an intensely consultative process... we did many, many, many painful workshops where we were going through ideas with lots of people and being willing to listen... at the end we asked them to support it and every single member institutionally endorsed it" (interview N3)

The next group of normative adaptive capacity are visioning processes. As noted in the previous section on normative selection pressures sustainable city visions provide direction for change. The adaptive capacity to develop and communicate a compelling vision is fundamental in creating and shaping this selection pressure, and helping actors purposively navigate through the complexity of sustainable city transition. The case study data shows that there was considerable adaptive capacity to develop and communicate this vision. These communications were aimed at both internal and external stakeholders, and to ensure that there was senior buy-in and support:

"we did a training session for all the city agencies regarding the overall messaging of One NYC and I said obviously you will go out all the time to these communities and neighbourhoods, all we are asking is that you remind people that whatever you're talking to is part of a larger plan" (interview N1)

A number of interviewees also referenced framing as an adaptive capacity used to help communicate the vision in a way that resonated with stakeholders: *"it's an exercise in*

framing a lot of the time” (interview N12). This is reinforced by the different mayoral framing for these efforts, e.g. the way de Blasio reframed PlaNYC around equity.

There were frequent references to the next group of normative adaptive capacity around data and research. The capacity to collect data and undertake research, including available funding and research partners, enabled better identification and understanding of the problem, and the solutions. This was important for both Clean Heat and green storm water management.

As well as data and research, work has been undertaken to develop modelling tools. These were used to help develop and agree solutions, including stakeholder engagement and alignment, for both Clean Heat and green storm water management: *“we did a heating oil summit, we bought them together and we built a dynamic model and we said here are all our assumptions, let’s debate this” (interview N6).*

References to the lack of data, and the impact of this in terms of restricting progress also serve to illustrate the importance of data and research as an adaptive capacity. These data gaps were mostly referenced in relation to green storm water management, in contrast the data gaps for Clean Heat had been largely filled by earlier research efforts:

“really being able to understand the impacts [of green storm water management] when we have certain magnitude events, so it’s a gap and it’s made it really hard for us to get this money towards the storm water project” (interview N13)

The last grouping of normative adaptive capacity to emerge from the case study data is in relation to leadership. There were frequent, very explicit references to the role of leadership in progressing sustainable city initiatives. In particular Bloomberg’s leadership whilst mayor was often referenced; as sustainability was a priority of his mayorship this is perhaps not surprising. However other aspects of his leadership were also referenced, openness and engagement with private and civic sector, willingness to commit to a goal, including investing resources and political risk taking: *“We had a mayor who really loved data and who was committed to sustainability and had some political courage” (interview N22).* It should be noted that many of the interviewees were those that had worked during the Bloomberg administration so this will have impacted results.

Other leadership was referenced by interviewees, including private and civic sector efforts: *“the heating oil industry which didn’t really want to change but they had some enlightened leadership” (interview N18).*

Finally an interesting finding regarding normative adaptive capacity is the way sustainable city actors in New York combined adaptive capacities to support greater progress. For example combining data with stakeholder engagement, planning and vision setting:

“we were able to do quantitative analysis of the building data that we had for the very first time to inform a stakeholder process that generated a roadmap for the city with which to think about decreasing greenhouse gas emissions in buildings towards an 80 x 50 goal” (interview N4)

5.2.1.3 The cultural-cognitive pillar

Cultural-cognitive processes are the beliefs, habits and heuristics of *how things are* and *how things are done* (Scott, 1995) - see the literature review chapter for a full description.

Cultural-cognitive processes account for just under one quarter of the processes cited during the interviews. Within this just under three quarters are selection pressures and just over one quarter is adaptive capacity.

The main groupings of cultural-cognitive selection pressures to emerge from the case study data are: personal experience and immediate problems; credibility and conceivability; and entrenched working cultures. The main groupings of cultural-cognitive adaptive capacity from the New York case study are: narration and visualisation; new ways of thinking; efforts to work around, rather than shape, selection pressures; and finally affluence and influence.

From these main cultural-cognitive processes two influence overall progress and are distinctive features of the case study: personal experience and immediate problems generate cultural-cognitive concerns (e.g. air pollution and floods) that then act as selection pressures driving the initiatives; and cultural-cognitive working cultures and ways of thinking support traditional grey infrastructure solutions and inhibit green infrastructure solutions.

Cultural-cognitive selection pressures

This section details the main groupings of cultural-cognitive selection pressures to emerge from the case study data: personal experience and immediate problems; credibility and conceivability; and entrenched working cultures.

Starting with personal experience, there were frequent references to how this has a marked impact on perception and prioritisation of the problems that need to be tackled, in particular extreme weather events. Recent experiences result greatly enhanced

political pressure to act, as well as allocation of funding. For the New York case study Hurricane Sandy was a dominant reference but the earlier August 8 2007 storm was also referenced, largely as it shut down the subway which has a huge impact on the whole city. References to events were solely linked to green storm water management. The lack of urgency in the absence of such events further supports the impact of events on progress:

“the things that would prompt it to happen would be a major rain event or something, in lieu of that large event happening it’s more just about a gradual shift in design... because we don’t yet have a driver for full implementation” (interview N9)

There were a number of references to the window of opportunity created by these sorts of events, with the strength of the selection pressure strongest in the immediate aftermath and then fading over time:

“the number one thing that is driving people to think about resiliency is past experience, and we know that as time passes people’s concern will quickly fade but when something happens and it’s in near-term memory then it gives them anxiety and it drives them to action” (interview N8)

Similarly to personal experiences of extreme events, immediate, clear, tangible problems generated cultural-cognitive selection pressure. For Clean Heat the immediate health impact is a clear driver for action:

“a lot of people can get behind cleaner air... you go out of your building and breathe this stuff, the moment you switch to something cleaner, not only is the whole city cleaner but your immediate neighbourhood round your building is cleaner” (interview N20)

Finally one interviewee noted that focus on immediate problems, and resulting short-term thinking, is baked into the political system: *“no mayor’s actual primary job is long-term sustainability, people have too many near-term needs” (interview N3).*

The next group of cultural-cognitive selection pressures concern credibility. There were frequent references to credibility and how scepticism of results is a barrier to progress, especially for any new initiative. Though this was cited for both initiatives, green storm

water management in particular faced a high level of scepticism from stakeholders accustomed to traditional grey infrastructure:

“the state were, they like the popular programme but at the same time weren’t willing to pressure their own engineers who were very sceptical about the long-term effectiveness... they (the EPA) basically didn’t trust any of our numbers” (interview N23)

For Clean Heat, the fact that it was only a small minority of buildings burning number six oil, meant credibility of alternative solutions was easy to establish as the majority of buildings in New York were actively demonstrating this.

Credibility and legitimacy, or lack of, was also impacted by whether initiatives were funded or not:

“you can’t do this stuff if on day one you aren’t funded... when everybody saw that these were funded line items in the mayor’s budget the credibility of what we were doing went through the roof” (interview N3)

Additionally it was noted that stakeholder support was linked with legitimacy: *“that coalition that we had assembled, that gave it legitimacy and gave it momentum, and what was really important as well was that we had the credibility with all of those groups” (interview N3)*

Working cultures and ways of thinking were the next group of prevalently cited cultural-cognitive selective pressures, for both Clean Heat and green storm water management. These were manifest as entrenched ways of thinking, for example working in silos or professional ways of framing and solving problems, as well as unquestioned measures of success, such as money:

“their incentives are to get big dollars... they are assessed by dollars they could get the city to commit to and so they almost don’t have an incentive to get the city to commit fewer dollars, so cost savings aren’t really something that are important to them” (interview N23)

These working cultures were predominantly referenced in relation to green storm water management where they seem to have been particularly problematic within the older, larger agencies:

“one [barrier] is cultural, that you are dealing with a water department that is made up of engineers who know how to build big pipes, and how to build things and structures to overcome problems, and that’s a big cultural shift to a distributed system of planted areas and something that is not as well defined in the textbooks”
(interview N15)

One interviewee for the Clean Heat initiative suggested that the mayor’s support for the expansion of the gas infrastructure in New York was because as an engineer he “got it” (interview N18).

Cultural-cognitive adaptive capacities

This section details the main groupings of cultural-cognitive adaptive capacity from the New York case study: narration and visualisation; new ways of thinking; efforts to work around, rather than shape, selection pressures; and finally affluence and influence.

Considering first narration and visualisation, the findings suggest that the ability to raise awareness of a problem helps shape cultural-cognitive selection pressures around what the immediate problems are. This is similar to normative adaptive capacity regarding data and research, the difference here is that awareness is shaping the deep-seated perception and framing around underlying problems vs the more conscious identification of issues and options that take place in policy development. Interview references were predominantly for Clean Heat, however there were also references relating to green storm water management as well as overall sustainability concepts, especially climate change.

There were frequent references during interviews to telling stories, using narratives, visual aids (e.g. maps), pictures and samples to shape cultural-cognitive concerns:

“a report called bottom of the barrel which really told the whole story of heating oil... using this map, and these vials of heating oil... you can see the back smoke coming out of boilers... those maps and those visuals were so important in changing the status quo” (interview N18)

These efforts were often undertaken by civic groups exerting pressure, but were welcomed by city government staff in helping them advance progress.

The second group of cultural-cognitive adaptive capacity concerns efforts to shape ways of thinking. This capacity was cited by a number of interviewees, specifically efforts by the Mayor's Office of Sustainability to breakdown silo thinking, short-termism and attempts to create creative spaces for problem solving. These efforts are specifically cited in the city plan: *"OneNYC is a citywide effort. Nearly all City agencies came together in cross-cutting working groups... This process helped break down agency 'silos'"* (City of New York, 2015). There were a number of specific references to the culture introduced by Bloomberg and the staff he brought in:

"part of the Bloombergian aspect to our office... the person who came in to run it was from a consulting background, and we also had McKinsey and a couple of other consultants, so there was a real consultancy framework that was bought in" (interview N18)

The third group of cultural-cognitive adaptive capacity is around privilege and agency. A particularly interesting theme from the cultural-cognitive data was the enhanced capacity to influence of certain 'empowered' individuals – either through social standing and connections, or financial independence, or both. For both initiatives impact upon richer neighbourhoods led to greater concern, triggering action:

"these weird connections between the most affluent influential people, leaders in the city and our efforts on the ground, and the Mayor's... that influence gave his agencies and his advisers cover to push harder" (interview N18)

The final grouping of cultural-cognitive adaptive capacity relates efforts to work around and/or better fit with selection pressures – as opposed to attempting to change them. Several interviewees referenced how adaptive efforts were aimed at, or successful because they make it easy for people to change, or further still require no change at all: *"we are not asking people to do anything other than live in their homes and their buildings and get warm but it's [the Clean Heat initiative] a huge impact"* (interview N21).

5.2.2 How do the institutional and quasi-evolutionary processes vary and why, do they enable or constrain progress?

The previous sub-section set out the results from the analytical framework in identifying what institutional and quasi-evolutionary processes are involved (responding to the first research question). This sub-section looks at how these processes vary and why, and whether they enable or constrain progress (responding to the second research question).

Looking at how processes vary Figure 5.3 shows the relative frequency, both overall and by initiative. This shows that processes are at play across all institutional pillars and both quasi-evolutionary selection pressures and adaptive capacities.

The graphs show a broadly similar pattern in terms of prevalence of processes occurring across regulatory, normative and cultural-cognitive pillars. For Clean Heat regulatory processes are more prevalent than for green storm water management, a third compared with just over a quarter. For both initiatives normative processes represent just over 40% of all processes. For green storm water management cultural-cognitive processes are more prevalent than for Clean Heat, just under a third compared with a quarter. Again both initiatives show a broadly similar pattern across quasi-evolutionary processes; selection pressures are more prevalent within the regulatory and cultural-cognitive pillars, whilst adaptive capacity is relatively more frequent for the normative pillar.

So the variation between the initiatives is primarily that Clean Heat has a higher proportion of regulatory processes, whilst green storm water management has a higher proportion of cultural-cognitive processes. In addition Clean Heat has a slightly higher prevalence of adaptive capacity vs selection pressure, whereas for green storm water management it is the reverse - and for the case study as a whole there is a slightly higher proportion of selection pressures than adaptive capacity.

However, overall the two initiatives have a broadly similar relative frequency of processes. There are not any marked variations. Whereas looking at the detail of the case study data, it is the alignment and strength of these processes, not the frequency, where variation occurs.

Similar to the London case study, a fundamental finding is therefore that whilst the prevalence of processes across institutional pillars and quasi-evolutionary selection pressures and adaptive capacities is broadly similar, there is greater variation in the *alignment* and *strength* of processes with the two initiatives. This suggests that the difference between the success of the two initiatives lies in the overall configuration of processes and whether they are predominantly aligned and enabling progress or misaligned and inhibiting progress, and the relative strength of processes.

Table 5.2 summarises the variance between the two initiatives in terms of the main processes at play and their alignment and strength.

Figure 5.3: The relative frequency (y-axis) of institutional and quasi-evolutionary processes in the New York case study, overall and for each initiative.



Table 5.2: Summary of the variance between the two New York initiatives in terms of the main processes at play and their alignment and strength.

Regulatory		Normative		Cultural-cognitive	
Selection pressure	Adaptive capacity	Selection pressure	Adaptive capacity	Selection pressure	Adaptive capacity
Clean Heat (more successful initiative)					
<ul style="list-style-type: none"> • Aligned political pressure, strongly and effectively articulated by civic sector and empowered individuals • Aligned, strong regulatory selection pressure via boiler permit restrictions, coordinated with state law on heating grade oil 	<ul style="list-style-type: none"> • Local powers to permit (or not) boilers support regulatory selection pressure • Aligned lobbying to change state laws around heating grades for oil 	<ul style="list-style-type: none"> • Aligned, strong vision, enforced through reporting and direct accountability to the mayor • Aligned, strong best practice – goal in relation to/competition with other US cities, supported by well-established global standards (WHO) 	<ul style="list-style-type: none"> • Very strong, well aligned capacity supported by resources (staff, decision-making authority, budget): • Organisational change, established and embedded sustainability office and air quality survey • Stakeholder engagement, inc. use of data and models • Research to evidence problem and solution 	<ul style="list-style-type: none"> • Aligned, strong concerns about air pollution and health, bolstered by research and communications 	<ul style="list-style-type: none"> • Aligned, strong communication – strong visuals and narrative of air pollution • Aligned, strong credibility as only minority of buildings still using low grade heating oil – alternative widely used and clearly viable.
<ul style="list-style-type: none"> • Aligned history and context – legacy of air pollution and associated hard and soft infrastructure (e.g. monitors and awareness), easy, low risk alternative solution already widely used 					

Regulatory		Normative		Cultural-cognitive	
Selection pressure	Adaptive capacity	Selection pressure	Adaptive capacity	Selection pressure	Adaptive capacity
Green storm water management (more challenging initiative)					
<ul style="list-style-type: none"> EPA regulations provide pressure but alignment is mixed given focus on quality, not quantity Political pressure supported by cultural-cognitive concerns generated by flooding events acts as a driver for action, but alignment within inland flooding is mixed after Hurricane Sandy storm surge 	<ul style="list-style-type: none"> Capacity to engage in efforts to change legislation, but lack of power relative to EPA Aligned capacity to make a strong business case 	<ul style="list-style-type: none"> Clear vision through green infrastructure plan, initially mixed buy-in from DEP Strongly misaligned operational pressure to eliminate any risks to drinking water 	<ul style="list-style-type: none"> Strong, aligned capacity supported by resources (staff, authority, budget): Organisational change, established team, but initially isolated in DEP Stakeholder engagement, though key actor, EPA, harder to influence - misaligned interests (water quality not quantity) Weaker research and evidence base 	<ul style="list-style-type: none"> Strong peaks in concern related to events, mixed alignment and fade after time Misaligned, strongly competing professional cultures based on grey infrastructure 	<ul style="list-style-type: none"> Aligned efforts to break down silos between Mayors Office of Sustainability and DEP
<ul style="list-style-type: none"> Mixed alignment of history and context – 2007 flood strongly supporting inland storm water concerns, 2011 Hurricane Sandy drawing efforts away from inland to coastal. 					

Having explored how processes vary between the two initiatives, the remainder of this section expands on the tabled summary of variation in processes, exploring the reasons for why such variations occur. Possible explanations are differences in: the processes acting as the driver for action; the adaptive capacity to respond to these drivers; the role of power and resources; the history and context of each initiative; and the overall configuration of processes. These are detailed below.

The processes acting as the driver for action

Starting with the drivers, the evidence suggests that for the two initiatives the initial cultural-cognitive and regulatory selection pressures driving action varied. For Clean Heat cultural-cognitive concerns around air quality and the resulting health impacts provided strong and stable selection pressure. For green storm water management the 2007 storm and Hurricane Sandy generated a peak in cultural-cognitive selection pressure that led to the prioritisation of flood management and, in the case of Hurricane Sandy resulted in a huge flow of funding for this. However, this concern was greatest immediately after the events and then faded and the focus on coastal storm water management generated by Hurricane Sandy diverted resources away from inland flooding (which had been a priority after the 2007 storm). Here the data suggests a difference in the nature of the cultural-cognitive concern between the two initiatives; a relatively stable concern about health impacts, compared with a relatively unstable concern about flooding that shifted depending on the latest event. This indicates the importance of consistency of concern in supporting ongoing progress.

Considering next the regulatory selection pressures acting as drivers, for the Clean Heat initiative there is strong political pressure, especially from civic groups - including empowered individuals with a high level of agency and with Mayoral influence. This regulatory political pressure was strengthened through normative adaptive efforts around data collection and analysis, which underpinned regulatory adaptive capacity for political campaigning and cultural-cognitive adaptive capacity for narratives and visualisation. As previously observed, the strong cultural-cognitive concerns, together with their effective articulation, are a prerequisite for the political regulatory selection pressure. This builds on Smith et al.'s (2005) premise that selection pressures have to be articulated to have impact, and shows how such articulation and pressure play out across institutional pillars. For green storm water management the primary driver for action here was regulatory selection pressure from the EPA water quality legislation. As already noted this focus on water quality, not quantity, weakened the selection pressure. This regulatory selection pressure is imposed from a national level, rather than the locally exerted

political pressure for Clean Heat, and therefore was not underpinned by cultural-cognitive concerns and regulatory political pressures. However, in the aftermath of the 2007 storm and Hurricane Sandy cultural-cognitive pressure did lead to regulatory selection pressure in the form of increased political pressure. This indicates the importance of a wider configuration of processes that support the initial barriers, and again suggests that the stability of processes is important.

The adaptive capacity to respond to these drivers

Turning from the variation in initial selection pressures to the variation between adaptive capacity to respond, the first consideration is why there was such strong normative adaptive capacity for the New York case study. For both initiatives the purposeful process of organisational change management greatly increased the normative adaptive capacity of regime actors. This process was enabled during the Bloomberg administration and was focused around sustainability. The case study evidence suggests the creation of a new office, the Mayor's Office for Sustainability, was crucial to this process of change. As part of this new staff from different backgrounds brought in outside thinking, including Bloomberg himself. This change introduced a strong culture of data driven action, open engagement with the private and civic sector and commitment through both investment and political risk taking.

The sustainable vision prioritised by Bloomberg was not a given, so this normative capacity could have been aimed in any direction. Another important factor contributing to the level of adaptive capacity could have been around available resources. The change management and development of PlaNYC occurred during 2006/7, before the global recession and New York City had a good level of resources available.

Looking at how this organisational change process impacted upon, and varied between initiatives it can be seen that both Clean Heat and green storm water management created new teams to support the initiative. However, Clean Heat seems to have been closer to the new Mayor's Office and the associated cultural epicentre, whereas green storm water management was based in the Department for Environment, where leadership and culture were much more departmentally influenced and less effectively impacted – as a result more cultural-cognitive barriers were encountered around professional ways of thinking. Interestingly here, when key staff from the Mayor's Office of Sustainability transferred to DEP and there was a change of leadership in the department, this unlocked greater progress for green storm water management. This indicates the importance of cultural-cognitive ways of thinking, in particular how they impact upon adaptive capacity - and furthermore how the structure of organisations can

impact this culture, and vice versa. In addition, the significant impact from organisational change efforts indicates the importance of power and resource allocation in relation to adaptive capacity.

The role of power and resources

Continuing with this theme of coordination of power and allocation of resources, networks and stakeholder engagement are considered next. A primary strategy for the overall sustainability vision was around stakeholder engagement, and the process to establish a PlaNYC coalition effectively coordinated power by creating a group that together had greater influence than its individual components. Though this group was created by the Mayor's Office of Sustainability during Bloomberg's administration, once created the coalition had its own life and was an important champion of the sustainability vision during De Blasio's administration. Here the role of collective power and agency in altering the selection environment of the regime is clear (Barnes et al., 2018). For Clean Heat positive engagement with key stakeholders such as the heating oil association, real estate board and state legislators was critical to the success of the initiative. For green storm water management the main stakeholder was the EPA, and whilst actors were able to engage the EPA evidence suggests they were harder to influence. This implies the importance of underlying interests and whether these are aligned or not, also the imbalance of power between a city administration and federal agency.

In addition here the context of a strong civic sector impacts upon coordination of power. For both Clean Heat and green storm water management NGOs play a significant role in coordinating and leveraging power to push for change. Within this, individual empowerment appears as a theme in the case study data. For Clean Heat there is a notable difference in terms of stakeholder empowerment, relative to green storm water management. Some of the worst air pollution was in the highest income neighbourhoods and many of the stakeholders were highly empowered individuals with direct connection to the mayor. This suggests that the relative levels of empowerment and connection of actors (both organisations and individuals) influences the strength of adaptive capacity.

In considering the role of power, the level and nature of competition is important. The presence of strong political leaders, both in terms of personalities and priorities, suggests that despite the stable party politics competition between mayoral candidates is strong. In addition the importance of stakeholder engagement in aligning various interests (e.g. heating oil industry, EPA regulators) reflects a wide range of competing vested interests. Within such an environment priorities are continually contested. For Clean Heat there is a strong alignment of stakeholders around clean air and health and limited pushback

given the relatively painless solution – though it is important to note the extensive stakeholder engagement involved that helped facilitate this consensus. For green storm water management there is a greater level of conflict amongst stakeholders, reflecting contested views and values from the mixed regulatory selection pressures, variation in cultural-cognitive concerns from inland to coastal flooding and competition from traditional grey infrastructure ways of thinking. Progress for inland green storm water management is limited by these competing processes. This shows the impact of competing processes and implies the increased importance of coalitions and aligning priorities in determining the relative strength of selection pressures at play. Furthermore competition between cities, not just within New York City, influences selection pressures. A clear example of this is the vision behind Clean Heat to have the best air quality of any big US city; here performance is defined in relation to (and hence in competition with) other cities. Such global level competition likely impacts upon mayoral approach, strengthening selection pressure to differentiate via bold, ambitious leadership.

In terms of formal powers, for the Clean Heat initiative the City of New York issues permits for boilers and this power meant they could very effectively enforce the initiative through refusing to issue permits for boilers still using number six heating oil. In addition, legislative powers at state level were important for introducing legal standards around grade two heating oil. Here, city actors were successful in efforts to work with state actors to achieve change. For green storm water management the regulatory powers were held at the national level by the EPA, and regime actors had to lobby hard to influence these – with mixed success. Important to note here is the difference in what the state and national legislators were asked: for Clean Heat the request was for consistent heating oil standards; for green storm water management the request was for exceptions to water quality regulations, given the associated risk to human health, this was a much greater ‘ask’. Despite this difference, the variation implies that formal powers locally greatly increase adaptive capacity and furthermore city actors have more agency to influence at the state level than national. This may reflect New York’s importance in state level governance as the largest municipality.

Turning next to the allocation of resources, the impact upon adaptive capacity is clear. Overall resource allocation supports adaptive capacity via the process of organisational change, specifically the new teams/offices, decision-making authority and budgets allocated to sustainable city initiatives. The findings also show the importance of data and knowledge as a resource that supports adaptive capacity, providing evidence, credibility and legitimacy. For Clean Heat there are investments (supported by grant funding) early on in research and data gathering. Air quality is measurable and the

science around health impacts is well established. For green storm water management there is less available data on effectiveness and proof of concept is (perceived to be) lacking.

Finally the interplay between selection pressures and adaptive capacity is explored. The two quasi-evolutionary processes shape and are shaped by each other in a constant dynamic. Selection pressure creates an initial driver for action, this influences the coordination of power and allocation of resources, and this impacts upon adaptive capacity, which in turn shapes selection pressure. For Clean Heat this interplay is evident: cultural-cognitive concerns generate regulatory political pressure; this creates the mandate for normative visioning around clean air, and leads to investment of resources creating greater adaptive capacity for data collection and research, which creates greater cultural-cognitive adaptive capacity to raise awareness and communicate the problem and greater regulatory adaptive capacity to revise heating oil standards; which in turn reinforces the original cultural-cognitive concerns. Thus there is a positively reinforcing interplay that increasingly strengthens and aligns selection pressures in favour of the Clean Heat initiative. For green storm water management the initial selection pressure is regulatory, with variable cultural-cognitive concerns linked to flooding events. Here again the flow of power and resources in line with selection pressures is evident. The difference is the mixed-alignment of regulatory pressures that focus on water quality and not quantity and the 'competition' for priority and resources between inland and coastal flooding events. In addition there are a very strong cultural-cognitive heuristics in favour of grey infrastructure. This mixed- and misalignment of selection pressures results in a similarly mixed-alignment of power, resources and adaptive capacity, which further reinforces an ongoing mixed-alignment of selection pressure. This indicates both the potential for change (via a positive reinforcing cycle that continually increases alignment of the regime selection environment with the initiative), and the potential obduracy (via reinforcement of mixed, misaligned selection environments). It also indicates that a system shock, such as a flooding event, creates a peak in selection pressure and a window of opportunity for change, but the selection pressure fades over time and this makes it harder to create lasting changes in this interplay and the overall configuration of processes.

The history and context of each initiative

The role of history and context is important. In particular the impact of extreme weather events has a large influence on the green storm water management initiative. The 2007 storm and Hurricane Sandy are critical drivers of cultural-cognitive selection pressure, and in turn regulatory level political pressure (including at a national level with regards to

Hurricane Sandy) – with accompanying allocation of resources that is so pivotal for progress. There is also a long-standing tradition of grey infrastructure that is entrenched in cultural-cognitive ways of thinking and regulatory approaches. For Clean Heat the evidence shows the impact of historical air pollution and the legacy of hard and soft infrastructure this leaves: the ‘hard’ air quality monitoring infrastructure that provides underlying data driving; the ‘soft’ infrastructure of awareness and cultural-cognitive concern.

The overall configuration of processes

In considering how processes vary and why, the *alignment* and *strength* of processes is critical. The alignment both within and between processes is important. For example for Clean Heat visioning processes are well aligned within normative adaptive capacity; there is a strong consensus around the vision for cleaner air and better health. Between processes there is also a good consensus; cultural-cognitive selection pressures around health support this clean air vision, and in turn lead to strong regulatory selection pressures in terms of political pressure to act. By contrast for green storm water management there is less consistent alignment with the vision for green solutions, due to competing ways of thinking around grey infrastructure. In addition there is less alignment between processes: variation in cultural-cognitive concerns over time and space, e.g. Hurricane Sandy creates concern around coastal flooding, competing with and diverting resources from inland flooding; and regulatory selection pressures from water quality regulation are strongly misaligned.

This indicates that the alignment, or misalignment, of processes is critical to progress. Misaligned, strongly competing processes can limit the progress of initiatives. Indeed a clear difference between the configurations of both initiatives was the presence, or absence of processes acting as barriers to change. For the green infrastructure initiative cultural-cognitive selection pressures around credibility, working cultures and personal experiences act as barriers to progress (scepticism around data and forecast results of green solutions, traditional grey infrastructure professional ways of thinking, and concerns around coastal flooding in the aftermath of Hurricane Sandy that diverted all attention and resources away from inland storm water management). Whereas in contrast, for Clean Heat there were no similar barriers. This was due to the well-established, easy, low-cost, low-risk, proven alternatives available. For Clean Heat the switch in fuel required less fundamental changes in cultural-cognitive ways of thinking than a shift from grey to green infrastructure solutions, and hence encountered less resistance. This indicates the difficulty in going against existing, entrenched cultural-cognitive selection pressures. It also suggests that the stage of change impacts the

processes at play. Clean Heat was at the tail end of a move to cleaner heating oil whereas green infrastructure solutions are at the vanguard of a change in approach to storm water management. This could account for the difference in cultural-cognitive selection pressures around credibility, and (perceived) certainty and risk. Furthermore it suggests that configurations take time to align favourably around a vision or initiative. This reinforces early findings on the importance of history and context, and it supports the notion of pathway dependence and lock-in (Unruh, 2002; Köhler et al., 2019), but importantly shows how this can change over time as actors reconfigure the regime selection environment.

However, the findings from the case study also demonstrate actor tactics to 'work around' rather than modify selection pressures that they (perceive) they cannot change (at least in the short-term). This is consistent with Smith and Raven's (2012) notion of how niche innovations 'fit-and-conform' within the regime selection environment, or 'stretch-and-transform' it. This research draws on this thinking but challenges the notion that such conforming or transforming only happens externally to the regime – instead exploring how endogenous processes of regime change can both fit with the existing selection environment or modify it. In addition, it challenges the view of the regime as a barrier to change and suggests that actors may also be employing a 'work with' strategy where the existing regime processes enable change.

For the New York case study a distinctive findings is the overall approach of 'combining tactics' by which actors purposefully attempted to combine and align processes with initiative goals (e.g. by combining the use of data with stakeholder engagement in order to support planning and vision setting). This reflects the high agency level of agency within the New York case study actor network, and the clear direction for this purposive mobilisation of adaptive capacity. Furthermore, it suggests that the actors within the network collectively share both the knowledge and the intention required for second order system change. This is likely supported by the wide range of actors involved and the 'outside' thinking brought in by the Bloomberg administration (Schot and Geels, 2008).

The configuration of processes across scales of governance is also important. For Clean Heat there is cohesion between city and state level in terms of regulatory adaptive capacity with city and state cooperating to revise heating oil standards – leading in turn to coordinated regulatory selection pressures. In addition there is alignment with national policies on energy regarding natural gas, leading to favourable regulatory selection pressures around market forces and the cheap price of gas. This demonstrates how natural resource availability influences decisions (Köhler et al., 2019). For green storm

water management there is an inconsistent approach between city and national governance, creating uncoordinated regulatory selection pressures. There is also misalignment between the national-level reactionary approach to funding and city-level efforts to maintain green storm water management of inland flood risk.

This latter point clearly illustrates how configurations vary over time. As well as changes in cultural-cognitive concern relating to flooding events, the impact of political cycles, specifically mayoral terms, introduces temporal variation. The interview evidence highlights changes in priorities with new mayors, both as an enabler and barrier to progress. These findings are supported by the literature which points to the impact of events and changes in governance on initiative progress (Barnes et al., 2018). For the Bloomberg administration sustainable development was a leadership priority and commitment. For the De Blasio administration this commitment was maintained but priorities varied, with an increased focus on equity. As previously noted, this is in large part due to the competitive nature of mayoral leadership and the need for each leader to define their vision in opposition with others. However, the stability of party politics in New York likely mitigates this to some extent. For example De Blasio continued with the sustainable development commitments of the previous administration instead of throwing them out entirely.

Here a distinctive aspect of the New York case study should be flagged; during the Bloomberg administration adaptive capacity was actively used to institutionalise the sustainable development priorities and commitments beyond the current mayoral term. Legal requirements to report on progress, appoint certain roles and maintain the Mayor's Office for Sustainability were put in place. This helps to create a stable selection environment and arguably strengthens selection pressures through this longevity. As well as this active institutionalisation, the PlaNYC coalition endured beyond the Bloomberg administration that created it and was effective in exerting selection pressure for the sustainability vision with the new De Blasio administration. This indicates the importance of consistency over time in determining the strength of selection pressures. Furthermore it shows how purposeful introduction of regulatory selection pressures (legal requirements and political pressure through the coalition), can create a stronger alignment of processes with greater longevity.

This leads to the overall observation that the configuration, in particular the alignment and strength, of processes at play are fundamental to progress. There are multiple processes all interacting with, and impacting upon, each other; they are not operating in isolation (Köhler et al., 2019). The alignment relative to the sustainable city vision and initiatives, and the strength relative to other, competing processes determines how

(un)favourable the regime selection environment is. The ability of actors to ‘reconfigure the selection environment’ to support initiative progress is central to transition efforts (Barnes et al., 2018).

Do these institutional and quasi-evolutionary processes constrain or enable progress?

Similar to the London case study, the findings suggest that the institutional and quasi-evolutionary processes themselves are agnostic, they can both constrain or enable progress. The evidence shows that the overall pattern of processes is broadly similar between initiatives. The variation is in the *alignment* and *strength* of the processes. This further suggests that it is the outcome towards which process are directed that determines whether processes enable or constrain. In other words, aligned processes enable and misaligned constrain, overall the prevalence and strength of aligned, supporting and misaligned, competing processes will determine progress.

These findings further support those from the London case study in terms of the plurality of processes at play, leading to a contested environment with competing outcomes. The emergence of an overall constraining or enabling configuration of processes in such a contested environment sets the overall direction of travel. Again, in keeping with findings from London, the evidence suggests that the desired outcomes, and alignment and strength of processes constantly change and evolve over time.

5.2.3 Overall findings in terms of research aims and questions

Having set out the results from the New York case study, what do these findings tell us? How do they help address the research gaps and answer the research questions?

The findings from the case study address the weakness and gaps identified in the literature review. First, the importance of processes, and furthermore the overall configuration of processes, is shown as fundamental to transition progress. Second, the importance of regime-level processes is clear, including the concept of regime selection environment and importantly endogenous alteration of this. Third, the significant role of social, non-technical processes is highlighted – from political and financial regulatory processes, to normative leadership, through to cultural-cognitive concerns and professional ways of thinking. In particular the cultural-cognitive pillar of the institutional lens helps elucidate the importance and impact of everyday habits and heuristics (ways of thinking) in enabling or inhibiting progress. Finally, the role of power and agency is explicitly foregrounded. The role of power is clearly illustrated in the importance of coordination of power and resources, and the major impact of competing processes and

visions on progress. The role of agency is clearly illustrated through the capacity of actors to undertake this coordination power, and the adaptive capacity of actors to shape the processes acting upon them, for New York there are particularly high levels of normative adaptive capacity.

Considering the first research question regarding what processes are involved the data shows an overall pattern. The initial drivers for action were cultural-cognitive and regulatory selection pressures. However, the most effective means for change was through the very high normative adaptive capacity. Regime actors were able to push forward an ambitious action through greatly increasing their adaptive capacity. This was achieved through purposeful resource allocation, directed and underpinned by strong leadership and coalition building which coordinated power around the normative sustainability vision. This increase in adaptive capacity in turn enabled city actors to shape selection pressures across all institutional pillars in favour of sustainable city initiatives. Though the normative pillar provided the means for change, the underlying cultural-cognitive and regulatory selective pressures created competing processes that provided both the lower and upper boundaries for change.

Considering the second research question, how these processes vary and whether they enable or constrain progress, the evidence suggests that despite the very high normative agency of actors, the capacity to steer progress is still 'bounded' by the wider configuration of processes. In particular the harder to influence cultural-cognitive and regulatory selection pressures constrain, and enable progress. Additionally the evidence suggests that the 'favourability' of history and context, and the presence or absence of strongly competing, misaligned processes are important differences affecting initiative progress. It is clear that processes both enable and constrain progress, and that it is the overall configuration, the alignment and strength, of processes that delineates the lower and upper boundaries of change. The case study evidence suggests that this configuration is what shapes the direction and speed of transitions, and furthermore demonstrates how actors are actively reconfiguring the selection environment of the regime to better align with sustainable city vision and initiatives. These findings are consistent with the London case study, strengthening the conclusions drawn. The next chapter covers the Copenhagen case study, offering the final set of evidence and further testing these conclusions.

Chapter 6 Copenhagen case study

This is the final of three case study chapters which offer results and insights from using the analytical framework developed in chapter two. The distinctive features of this case study are: the very high normative adaptive capacity and normative institutional processes as an effective means for regime actors to coordinate power and resource allocation; however, cultural-cognitive and regulatory processes still provide the initial drivers for action; and, the overall configuration of processes sets the lower and upper boundary for change, in particular competing processes that act as a barriers initiatives.

These findings provide a third set of evidence that addresses the knowledge gap and answers the research question. The Copenhagen case presents some new findings distinctive to London and New York, but the overall conclusions support the previous case studies. Specifically, the case study data further addresses the four research gaps identified in the introduction and literature review: first, the importance of processes in achieving long-term outcomes; second, that regime-level processes in particular are central to this; third, that non-technical, socio-cultural processes have significant impact on transition progress – particularly cultural-cognitive habits; and finally, the role of power and agency are foregrounded. This analysis provides insights into the research question, identifying what processes are at play, how they vary and why, and whether they enable or constrain change.

This chapter is structured to: first introduce the case study; second set out the processes involved by institutional pillar (regulatory, normative, cultural-cognitive) and then for each pillar by quasi-evolutionary process (selection pressures and adaptive capacity); third to compare between the two initiatives as to how these processes vary, and why, and whether they enable or constrain progress; and finally to summarise the findings and their implications.

6.1 Introduction

This section provides an overview of the city, sustainable development generally and the sustainable city vision more specifically, together with a summary of two initiatives; promoting cycling and buildings energy retrofit.

Copenhagen overview

The municipality of the City of Copenhagen, Københavns Kommune, is the largest of four municipalities that make up Copenhagen, along with Dragør, Frederiksberg, and

Tårnby, with a total population of 616,098 (Danmarks Statistik, 2018). The City Government consists of seven Mayors and administrations, and the City Council has 55 members, elected for a four year term. The Lord Mayor chairs the City Council and the Finance administration, and six Mayors who chair the remaining 6 administrations⁶: Children and Youth; Culture and Leisure; Employment and Integration; Health and Care; Social Services; Technical and Environmental. The Technical and Environmental administration are responsible for leading on the sustainable development work, though there is a lot of overlap with other administrations.

Copenhagen has a relatively stable political context. The Social Democrats are the dominant party, and Copenhagen has had a Social Democrat Lord Mayor for the last 111 years. Surrounding regional administrations are also social democratic majorities. However the six Mayors represent a variety of political parties, and so party politics is not entirely absent.

At the time of the data collection, April – July 2017, there were upcoming Mayoral elections scheduled for November 2017. The current Mayor, Frank Jensen, was re-elected in those elections, and has been in post since January 2010. The previous mayor, Ritt Bjerregaard, was also referenced by several interviewees especially in relation to the cycling initiative.

Copenhagen and sustainable development

Copenhagen has a history of environmental and sustainable goals: in 2008 it set out an Eco-Metropolis vision; in 2009 the City Council unanimously committed that Copenhagen will become the world's first carbon neutral capital by 2025; and in 2012 the European Commission announced that Copenhagen will be the 2014 European Green Capital. The city is a world leader in green growth (Sharpe et al., 2012) and active, sustainable mobility with cycling as the favoured means of transport (City of Copenhagen, 2018). The City of Copenhagen has an overall city vision called 'Co-create Copenhagen' with sustainable development as an underlying principle throughout (City of Copenhagen, 2015), and it has a Climate Plan Copenhagen 2025 (City of Copenhagen, 2012) which sets out a road map to achieve carbon neutrality in 2025 and a Climate Adaptation Plan (City of Copenhagen, 2011).

Progress towards the carbon neutral vision is reported annually to the Technical and Environment committee as well as publically. The Technical and Environment committee consists of a cross-party group of 11 elected officials.

⁶ Lord Mayor is equivalent to Mayor in UK terminology, and Mayors are equivalent to Deputy Mayors.

Sustainable City Vision

There are three main documents that capture the sustainable city vision of Copenhagen; the Co-create vision, the Climate Plan Copenhagen 2025 and the Climate Adaptation Plan. The Co-Create vision provides an overarching strategy for Copenhagen based on three principals:

- A liveable city – focusing on: better everyday life in urban spaces; the world’s best city for cyclists; and more urban nature
- A city with an edge – focusing on Flexibility and creativity (experimentation and innovation); and unique neighbourhoods that belong together (balancing community diversity and unity)
- A responsible city – focusing on: becoming the first carbon neutral capital city; no waste of resources; and climate-proof with greater value (developing climate resilience solutions that can be exported boosting Copenhagen’s green economy)

The strategy refers to quality of life, and ensuring the city is a “*good place to be*” and in particular that “*Copenhagen is one of the top global cities in 2025*” (City of Copenhagen, 2015, p.1). Population growth and climate change are highlighted as particular challenges that the city is facing:

“An extra 100,000 inhabitants by 2025 means more of us in the same space. We will have to work harder to keep the city together – both physically and socially... We will need to cope with rising water levels as a result of climate change... Challenges and opportunities such as these will require significant – and proactive – planning and development to release the potential of the city.” (City of Copenhagen, 2015, p.1)

Furthermore, the strategy acknowledges the local and global levels, points to Copenhagen’s reputation as a global climate and environmental innovator and leader, and finally talks of the need for everyone to work together to ‘co-create’ the vision.

There are explicit references to sustainable development, including the United Nation’s sustainable development goals, but more frequently the strategy refers to climate and environment, in particular Copenhagen’s vision to be the world’s first carbon neutral capital in 2025. The Climate Plan Copenhagen 2025 sets out how this vision of carbon neutrality will be achieved and, as above, progress against this plan is reported annually. The Climate Plan does refer to sustainability, but these are specific references (e.g. in relation to biomass used in energy generation) rather than an overarching goal.

Overall, Copenhagen has a very climate change focused vision, though wider sustainable development concepts are referred to – particularly within the over-arching co-create strategy.

Case study initiatives: cycling and retrofit

As per the methodology outlined in chapter three, two initiatives were explored in order to achieve the ambition of a city-wide, cross-sector research approach but still enable depth of research. Additionally initiatives with differing level of success were selected, enabling a range of critical insights. Through the key informant interviews two current and prominent initiatives were identified: cycling – as an initiative progressing well; and retrofit – as a more challenging initiative.

Cycling was identified by all three key interviews as an obvious and clear area where progress has been very successful. Furthermore Copenhagen is widely recognised as a successful ‘cycling city’ and has even greater ambitions to be the world’s best city for cycling.

Retrofit was identified as an area of challenge by key informant interviews, with specific reference to this as a persistent challenge, not just for Copenhagen but globally. For this case study ‘retrofit’ refers to retrofit of existing building stock to increase energy efficiency, and in particular the ‘Energy Leap’ partnership to engage landlords. The retrofit initiative aims primarily to increase energy efficiency and thereby reduce energy demand. However an important secondary aim is to off-set increased costs of energy generation by reducing total usage in order to ensure that delivering the Carbon Neutral vision is cost neutral for Copenhagen citizens (i.e. the cost of energy for Copenhagen’s citizens does not increase as a result of the Carbon Neutral vision).

Nine interviews were undertaken for both the cycling and retrofit initiatives (one interview covered both topics). Cycling interviewees included a range of political, technical, architect, academic and planning roles across the public, private and civic sector (public, 6; public/civic, 1; public/private, 2). Retrofit initiatives included a range of policy, architect, technical and strategic roles from the public, private and civic sector (public, 1; private, 4; civic, 2; public/civic, 1; public/private, 1). For details see the full table of interviewees in Table 3.3 in the methodology chapter.

6.1.1 History and context

This section describes the history and context of the case study, and covers the story of cycling and retrofit that emerges from the case study data.

An important aspect of the context for both initiatives is the political consensus culture in Copenhagen, and Denmark more broadly, as well as the stable party politics – the city has had a social democrat Lord Mayor for over 111 years. This impacts upon both initiatives through a less contested political backdrop. However, it is important to note that there is still contestation and competing powers at play within the Copenhagen case study.

In addition the forecast growth for the city, with an extra 100,000 inhabitants anticipated by 2025 (just over 16% growth), is a major driver for action (City of Copenhagen, 2015). Economic growth is another key driver, both the climate mitigation and adaptation plans reference green growth as an associated opportunity:

“Climate adaptation must therefore be part of the green growth strategy for Copenhagen by attracting both national and international projects and investors for the development and production of systems for climate adaptation. The municipality will ensure that part of the investment in climate adaptation is recouped in the form of growth.” (City of Copenhagen, 2011, p.6)

“the City of Copenhagen sets out concrete goals and initiatives which, taken together, should help reach the goal of carbon neutrality – while also providing Copenhagen with a sound local government economy and the most favourable conditions for green growth.” (City of Copenhagen, 2012, p.6)

In addition to the economic rationale, there is an awareness around resource-dependence and security, particularly in relation to energy (van Doren et al., 2020). Generated initially by the 1970’s oil crisis, this is still embedded in Copenhagen’s collective mentality today, as a deep-seated emotional logic for sustainable energy and mobility.

Cycling

There is a long history of cycling in Copenhagen going back to the turn of last century when cycling was ‘imported’ from Britain. The Danish Cycling Federation was established in early 1900s to support cycling and lobbied for the creation of cycling infrastructure. It quickly gained a large membership and successfully used this and cycle count data to lobby for smoother surfaces, interestingly in alliance with the motor car associations.

During the 1950’s and 1960’s car culture developed globally, however Denmark as a nation did not manufacture cars, so there was not such a strong car lobby and culture as

in neighbouring Sweden and Germany. In addition to this Denmark had, and still has, a very high car tax⁷. Although fiercely debated, plans to develop a system of major motorways in Copenhagen were eventually approved, however implementation was delayed due to financial restrictions (Gössling, 2013). Meanwhile as a global culture of increased protest and activism developed Copenhagener's became more active in opposition to the motorway plans. Cycling demonstrations were linked with environmental activism, and cycling became a symbol of a struggle for a sustainable, liveable city (Jensen, 2013; Gössling, 2013). In April 1968 the local newspaper 'Politiken' ran a front page against the motorway plans and this proved the tipping point for the campaign against the scheme. As a result the motorway development never went through and Copenhagen retained a much more cycle-friendly infrastructure.

In more recent history there has been a drive to support and increase cycling from already high levels around 30% to an ambitious target of 50% and to be the world's best cycling city (Nielsen et al., 2013). This was catalysed by a political alliance between the Lord Mayor and Mayor for the Technical and Environment Administration that led to priorities and budgets favourable for cycling. The municipality doubled the budget available for cycling initiatives in line with the increase in ambition. A 'bicycle boss' and a specialist bicycle secretariat greatly increased the skills and capacity of the city council. The following years saw an increase in investment in cycling infrastructure; additional cycle lanes, widening and improving of existing lanes, improvements to signalling, bike parking, coordination with other forms of transport (bikes were, and are, allowed on trains) and improvements in the overall network linkages (Jensen, 2013). The re-design of a major transport route into the city, Nørrebrogade, to increase pedestrian and cycling facilities and restrict all except local car traffic was mentioned by many interviewees as a particularly high profile project, highly contentious because of the restriction on vehicle traffic but now, post-implementation, cited as a major success.

Copenhagen developed a method for socio-economic evaluation of investment in cycling infrastructure that mirrored the process for evaluating investment in other transport infrastructure – it showed that cycling was the cheapest, most effective transport investment that the city council could make (Gössling, 2013). In addition they undertake a cycle survey every two years and publish results in a report; the Copenhagen Bicycle Account. This provides the data required to set targets, and make the case for associated investments, as well as monitoring progress and information about cyclists' choices (Nielsen et al., 2013). Interestingly this evidence shows that 53% of

⁷ Up until 2016 this was 180% of vehicle value for all vehicles over 81,700 Danish kroner, in 2016 this was lowered to 150%.

Copenhagengers cycle because it is the fastest form of transport, and 50% because it is the easiest, while only 7% choose to cycle for environmental reasons (City of Copenhagen, 2017).

Buildings retrofit

Building retrofit is part of the Climate Plan Copenhagen 2025. Although emissions from buildings only account for 8% of total carbon emissions, retrofit is important for managing costs associated with the energy generation element of the plan (City of Copenhagen, 2012; van Doren et al., 2020). Part of the commitment of the plan is that it should not result in increasing costs for householders. In order to achieve this energy efficiency needs to be improved to mitigate the increased costs of a transition to more sustainable energy production.

Buildings retrofit progress has been challenging, largely for the same reasons that any city finds it difficult. The owner-tenant paradox was mentioned by many interviewees as a crucial barrier, owners bear the costs of retrofit and tenants reap the benefit of lower bills and increased thermal comfort – hence there is no incentive to invest (Linares and Labandeira, 2010). Even where this is not the case the potential savings are low as the price of energy is relatively cheap (van Doren et al., 2020). Specifically for the Danish context regulations that control rental prices have been changed leading to greatly increased rates, this means that landlords cannot recoup costs invested in retrofitting through rent as rates are already maxed out.

In the social housing sector, where one might expect to see less market influence and potentially more retrofit work, retrofit progress has also been challenging. Social housing governance is through tenant boards and tenants tend to want to keep rent low, where investments are made new kitchens or bathrooms are seen as preferable. This mirrors comments across the board from interviewees that consumer preference did not support retrofit – people simply did not see the value, partly because energy is too cheap and partly because people do not value energy efficiency over cost and aesthetics. Also mentioned by most interviewees was the lack of regulation to mitigate these market failures.

Measures taken by the City of Copenhagen to achieve their targets for retrofit have focused around a number of initiatives, including the recently launched Energy Leap ('Energispring') (van Doren et al., 2020). This is a partnership of the largest landlords in Copenhagen, currently with 26 partners covering 11% of building stock. The partnership was launched formally in April 2017, though a long period of stakeholder engagement preceded this. The partners commit to reducing energy use in their buildings by 3%

annually. The aim is to send a market signal and demonstrate best practice, achieving this with a large enough percentage of the city's building stock to have an impact on the local market and practice. The initiative was co-designed with the partners, and each year the partnership sets the focus. Training and knowledge exchange are an essential part of the process and training workshops are provided regularly covering a variety of topics and aimed at a variety of staff/roles within the retrofit chain. Energy Leap has been successful at gaining support amongst building owners, they are hoping to achieve 40 members representing 40% of the building stock in the near term.

In addition Energy Leap has gained good political support, being mentioned in city communications, including press releases and political announcements and talks. This is particularly remarkable as it overcomes several barriers to political support cited by interviewees: retrofit work is not particularly visible to or valued by voters and therefore there is less drive for politicians to prioritise it; the lack of visibility also means retrofit work is not appealing as a tangible legacy of a politicians work, not in the same way you might point to a new cycle lane or school and say 'I did that'; finally the Carbon Neutral Plan has been successful in focusing political minds and will on lowering carbon emissions, and as mentioned earlier the retrofit programme does not deliver a large carbon saving relative to the energy production work – its aim is more to keep costs lower, and this is slightly complicated to explain and less effective in gaining political priority. It is important to note here that there was not reference to any objection to retrofit from politicians, simply that it was not prioritised.

6.2 Results: What are the regime-level processes, how do they vary and do they enable or constrain progress?

This section sets out the findings from the Copenhagen case study data with regards to the research questions: what are the evolutionary and institutional processes that drive regime-level decision, actions and their outcomes within sustainable cities? How do they vary and why, and do they enable or constrain progress??

For cycling the evidence suggests that cultural-cognitive selection pressures dominate, creating a strong selective environment in which cycling as the most convenient way to travel is a routine, habitual behaviour. Normative adaptive capacity is then deployed, first through the vision to be the best cycling city in the world, and then through translating this into hard targets and coordinating power and allocating resources in line with the vision and targets. Whilst this mobilisation of power and resources reflects existing selection pressures and adaptive capacity it in turn shapes these, creating even greater capacity and pressures aligned with the cycling vision. The result is an ever

strengthening alignment of processes in support of the cycling vision and culture. This is only challenged when it runs up against competing processes, e.g. an entrenched cultural-cognitive 'car culture'. The history and context provides a very strong and supportive backdrop for regime actor efforts around promoting further cycling.

For retrofit the evidence suggests that regulatory selection pressures dominate, though pivotally these selection pressures are often misaligned with the retrofit initiative, inhibiting rather than enabling, progress (e.g. market forces that dis-incentivise investment in retrofit). There is a notable absence of cultural-cognitive selection pressures driving retrofit action. Instead these processes are often misaligned with the retrofit initiative, for example cultural-cognitive habits that favour the easiest and cheapest option (at least in the short-term) exert pressure against retrofit. However, there is still substantial adaptive capacity which is used to create an overall normative vision and then translate this into hard targets and building and planning regulations that act as regulatory selection pressures. This is all against an unfavourable context, mainly in terms of price with the low cost of energy meaning the business case for retrofit is weak.

The first sub-section addresses the first research question regarding what processes are at play, and the second sub-section explores the second research question regarding variation, and whether processes enable or constrain progress.

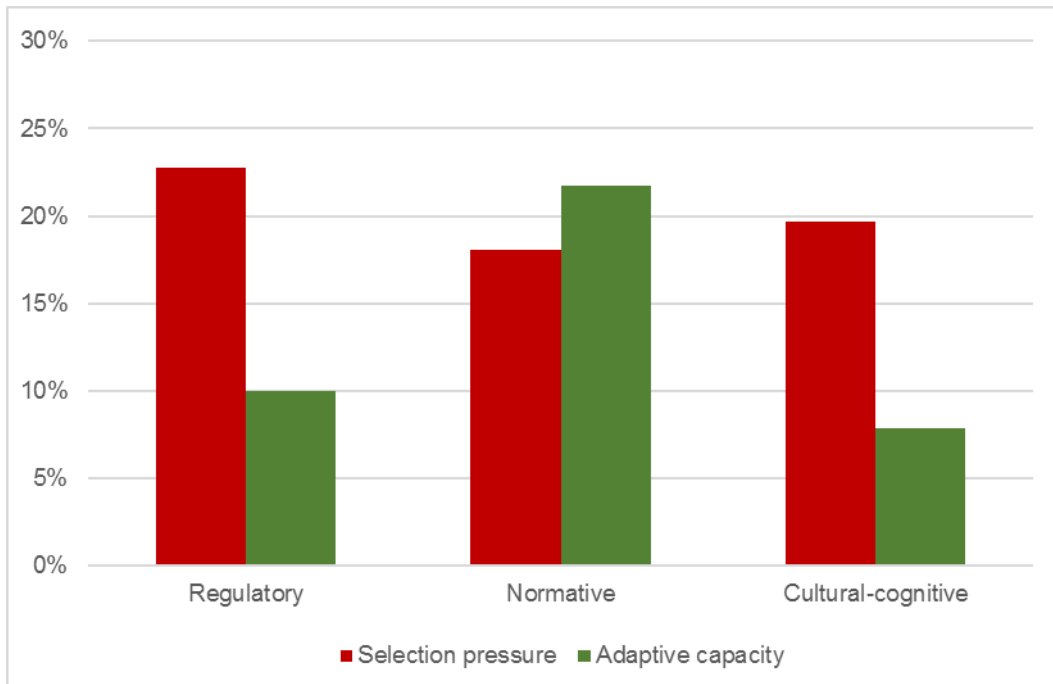
6.2.1 What are the institutional and quasi-evolutionary processes that drive regime-level decision, actions, outputs and outcomes?

Table 6.1 summarises results, and the following sections provide details organised by the three institutional pillars (cultural-cognitive, normative, then regulatory), and then for each institutional pillar by the two quasi-evolutionary processes (selection pressures and adaptive capacity). Figure 6.1 presents the relative frequency of the processes occurring by institutional and quasi-evolutionary process.

Table 6.1: Summary of the Copenhagen case study by institutional pillar and selection pressure/adaptive capacity, showing the main processes identified.

Regulatory		Normative		Cultural-cognitive	
Selection pressure	Adaptive capacity	Selection pressure	Adaptive capacity	Selection pressure	Adaptive capacity
<ul style="list-style-type: none"> • Hard targets (e.g. measurable and time-bound goals within the climate roadmap) • Legislation – city, regional, national and international (e.g. building and procurement regulations) • Market forces (e.g. energy prices and rental rates) 	<ul style="list-style-type: none"> • Planning – (e.g. translating vision into hard targets in the Climate roadmap) • Lobby for regulatory change (e.g. sustainable construction lobbying for improved building regulations) • Work around and/or better fit with selection pressures (e.g. providing financial incentives for retrofit) 	<ul style="list-style-type: none"> • Visions and values (e.g. Climate Neutral vision) • Standards and best practice (e.g. green building standards) 	<ul style="list-style-type: none"> • Organisational change (e.g. setting up a cycling secretariat) • Framing visions (e.g. health and economic co-benefits) • Developing and demonstrating new/better practice (e.g. professional standards around cycling, architecture competitions) 	<ul style="list-style-type: none"> • Articulated concerns around problems and alignment around solutions • Heuristics/ways of thinking (e.g. sustainability ethos, car culture) • Habits and behaviours (e.g. travel routines based on ease, convenience and cost) 	<ul style="list-style-type: none"> • Storying telling and symbols (e.g. the bike as a symbol of Copenhagen) • Work around and/or better fit with selection pressures (e.g. making cycling to fastest and cheapest form of transport)

Figure 6.1: The relative frequency (y-axis) of Copenhagen case study processes occurring in each institutional pillar and by selective pressure or adaptive capacity.



6.2.1.1 The regulatory pillar

Regulatory processes are the formal and explicit legislation and 'hard' targets; the enforced rules, *how things must be done* (Scott, 1995) - see the literature review chapter for a full description.

Regulatory processes account for one third of the processes cited during the interviews. Within this just over two thirds are selection pressures and just under one third is adaptive capacity.

The main regulatory selection pressures are: hard targets, measurable and time-bound goals; legislation; and market forces. The main regulatory adaptive capacity is: planning; lobbying for regulatory change; and efforts to 'work around' and/or better 'fit with' selection pressures.

Of these main regulatory processes several influence overall progress and are distinctive features of the case study: adaptive planning capacities and associated 'hard' target selection pressures driving progress; and in particular for retrofit mixed regulations and misaligned market forces (both selection pressures) limiting progress.

Regulatory selection pressures

This section details the main regulatory selection pressures from the Copenhagen case study: hard targets, measureable and time-bound goals; legislation; and market forces.

Starting with hard targets, the evidence shows very effective translation of normative sustainable city visions into measureable and time-bound targets. These targets then act as regulatory selection pressures. For example Copenhagen's Carbon Neutral vision has been translated into a roadmap with specific targets for carbon emissions reductions from each source, with both overall and four year targets and annual milestones. One retrofit interviewee commented on the impact of this on retrofit efforts: *"it all connects to the roadmap and to the climate plan because in the climate plan there is a goal saying that we should reduce energy consumption in all buildings in the whole of Copenhagen"* (interview C4)

Similarly for cycling the overarching vision to be the world's best city for cycling is translated into 'hard' targets that act as regulatory pressures:

Figure 6.2: Excerpt from the 2017 Copenhagen Bicycle Account (City of Copenhagen, 2017, p.2).

The ambition of the City of Copenhagen is to be the world's best city for cyclists. In addition, a range of ambitious goals for 2025 have been decided by the city council and are monitored annually.

THE GOALS

By 2025, the city aims to:

- Increase the percentage of commuters who cycle to work or education to 50%
- Increase number of cycle tracks in the Copenhagen PLUS-net with 80%
- Reduce cyclists' average travel time by 15%
- Increase the number of cyclists who feel safe in traffic to 90%
- Decrease the number of seriously injured cyclists by 70%
- Increase the share of cyclists who find cycle tracks well maintained to 80%
- Increase the share of citizens who think that bicycle culture affects the city's atmosphere positively to 80%
- Increase citizens satisfaction with bicycle parking to 70%

Whether such targets were mandatory or not influenced the strength of the selection pressure: *"they do what they can but on a voluntary basis"* (interview C14).

Interestingly here reporting publically against targets was referenced as important and provides some sort of accountability, if not enforcement, which enacts a political selection pressure:

“there has been a status in the technical and environmental Council showing where are we on implementing the plan, these documents are all public... projecting where we should be now looking at getting to carbon neutrality in 2025, we are 300,000 tonnes behind... so that of course also brings a heightened awareness I would say with the politicians around which are the bits and pieces of the plan that are not going so well” (interview C30)

Considering next legislation, the evidence shows that legislation and regulations act as regulatory selection pressures, primarily for retrofit more than cycling. For example building regulations set by the City of Copenhagen increasing energy efficiency requirements support retrofit work: *“we have to follow the building regulations ... in the years to come the building is not allowed to consume as much energy as they do now” (interview C6).*

This selection pressure was cited as both enabling and inhibiting progress. The rigidity of building and planning regulations, and the focus on one aspect of sustainability without thinking more holistically about knock-on effects, was raised as a misaligned selection pressure. For example there were a number of comments regarding the need to update, or even undo, regulation:

“you need regulations, but I think there is, and that is also a global tendency, that when we do regulate we keep regulations that we did five years and 10 years ago, so we don’t change the regulation that we had before... we just put on top of everything and don’t understand that the context is changing, so therefore the regulation sometimes just really is a dilemma for itself” (interview C11)

Retrofit interviewees also referenced national and international regulations, for example EU procurement regulations or national regulations promoting investments in wind energy:

“in fact the competition regulation in the EU has been, it was really difficult to set the environmental performance part of the rating of the proposals that high and also to have it as a majority part of your decision, and that has been opened much more” (interview C2)

Finally, market forces create a set of regulatory selection pressures. There were frequent references throughout all the interviews, but particularly retrofit interviews, to the influence of the market and financial dis-incentives. Retrofit is challenging because in a relatively low cost energy environment it is hard to make a strong financial case. Furthermore costs often sit with one party (a building owner or landlord) whilst savings are enjoyed elsewhere (by the tenant in lower bills). Tenants demand low rent, and energy costs are not significant enough to be a priority when selecting an office or house so there is no way of recouping investments in retrofit:

“It is very difficult to get owners of large buildings to do some kind of retrofit, it is even more difficult to get private, one family home owners to do anything, because they have also other priorities. If you ask them what is the most important to you, is it the money or is it the environment, is it the climate and so on, it will always be the money. If they are true in their answer it would be money” (interview C19)

However there were also examples of where market selection pressures incentivised cycling and retrofit initiatives, for example: cycling as the cheapest form of transport for individuals and the most cost-effective investment for government; high car tax as an appealing source of revenue for government; and low-cost building design and materials as the most sustainable and energy efficient.

Regulatory adaptive capacity

This section details the main regulatory adaptive capacity from the Copenhagen case study: planning; lobbying for regulatory change; and efforts to ‘work around’ and/or better ‘fit with’ selection pressures.

The first group of regulatory adaptive capacities are used by regime actors to translate a vision into ‘hard’ targets (and, as above, these then act as effective selection pressures). For example Copenhagen municipality undertook significant planning efforts to develop a detailed roadmap for how to deliver the Carbon Neutral vision, including interim targets, clear responsibility and reporting mechanisms:

“the climate plan are organised that we have four work streams... and we have a project group with the people that are responsible for the four areas... with milestones and key performance indicators and so on and reporting on that twice a year” (interview C2)

Interviewees frequently reference Copenhagen's Roadmap and annual reviews against progress as evidence of this translation of the vision into hard targets. These documents demonstrate the efficacy of such adaptive efforts as the annual reviews show good progress across most initiatives and an overall decrease of 38% carbon emissions. Though as previously referenced it should be noted that whilst this shows Copenhagen's leading efforts, there is still an implementation gap in achieving their vision (City of Copenhagen, 2016).

This planning process was applied to both cycling and retrofit initiatives, with goals set for 2025:

Figure 6.3: Excerpts from Climate Plan Copenhagen 2025 (City of Copenhagen, 2012, pp.16, 18).

MAIN AREAS	GOALS FOR 2025
ENERGY CONSUMPTION	<ul style="list-style-type: none"> • 20% REDUCTION IN HEAT CONSUMPTION COMPARED TO 2010 • 20% REDUCTION IN ELECTRICITY CONSUMPTION OF COMMERCIAL AND SERVICE COMPANIES COMPARED TO 2010 • 10% REDUCTION IN ELECTRICITY CONSUMPTION HOUSEHOLDS COMPARED TO 2010 • INSTALLATION OF SOLAR CELLS CORRESPONDING TO 1% OF TOTAL CONSUMPTION

THEME	GOALS FOR 2025
GREEN MOBILITY	<ul style="list-style-type: none"> • 75% OF JOURNEYS IN COPENHAGEN ARE DONE ON FOOT, BY BIKE OR BY PUBLIC TRANSPORT • 50% OF ALL JOURNEYS TO WORK OR EDUCATION IN COPENHAGEN ARE DONE BY BIKE • 20% MORE PASSENGERS USING PUBLIC TRANSPORT COMPARED TO 2009 • PUBLIC TRANSPORT IS CARBON NEUTRAL • 20-30% OF ALL LIGHT VEHICLES USE NEW FUELS • 30-40% OF ALL HEAVY VEHICLES USE NEW FUELS

The second group of regulatory adaptive capacities are around lobbying for changes in legislation and regulation. The case study data shows that as well as utilising regulatory adaptive capacities to create new selection pressures (through translating visions into 'hard' targets), they are also used to lobby for changes in regulatory selection pressures, e.g. regulation and legislation. For example one interviewee referenced efforts by more

progressive construction sector companies to improve regulation: *“some of the suppliers to the building industry that also are to the forefront globally, they really push for stronger [more sustainable] commitments, regulation” (interview C2).*

The ability to regulate here is critical and multiple references from the interviews talked about formal powers, in particular the good implementation powers for cycling were referenced. Though it should be noted that this was mixed, references to lack of powers at a local level regarding congestion charging, car tax and parking regulations were noted by a number of interviewees. In addition the power of the police in approving (or not) proposed changes to traffic were referenced as creating a barrier to progress. For retrofit planning powers were referenced, but mainly the lack of power was noted; *“they work under this very weak legislation” (interview C14).* In particular the lack of power to enforce retrofit targets on private landlords leading to voluntary targets for Energy Leap: *“we don’t have anything we can, any tools, any regulations that we can use, so we are forced to use voluntary methods” (interview C3).*

Finally actors can take an alternative approach to efforts to shape regulatory selection pressures - instead using adaptive capacity to attempt to modify sustainability initiatives to better ‘fit with’ existing selection pressures. For example making retrofit cheaper to fit better with the strong selection pressure for the most financially cost-effective option, or introducing new mechanisms for financing retrofits that work with the existing market selection pressures, e.g. green leases that shares the costs and benefits of retrofit work between owner and tenant. The ability to ‘work around’ existing selection pressures (rather than change them) was referenced a number of times as critical to success. For example finding creative approaches to navigating existing financial, legal or policy constraints:

“there was a right-wing [national] government and they did everything that they could to make obstacles for this [social housing programme]... there was a very visionary and creative economist in one of the large housing corporations, and he managed to construct a financial system, he found his way through so it was possible to make tenders for these affordable housing developments, and it has succeeded” (interview C15)

Another example was given of navigating around political selection pressures by using strategies to keep the sustainable city vision non-party political and thus less vulnerable to partisan political selection pressures:

“why can’t you be nationalistic or right wing and still think that clean air is a good thing, so I think what Copenhagen has succeeded compared to a lot of other cities is not making environmental policies into a right-wing, left-wing thing” (interview C5)

6.2.1.2 The normative pillar

Normative processes are the vision and values of *what should be done*, and *how it should be done*, set out in e.g. standards, professional best practice and guidance (Scott, 1995) - see the literature review chapter for a full description.

Normative processes account for approximately 40% of the processes cited during the interviews. Within this around 45% are selection pressures and 55% is adaptive capacity.

This section details main normative selection pressures from the Copenhagen case study: visions and values; and standards and best practice. The main groupings of normative adaptive capacity processes are: organisational change; framing visions; and developing and demonstrating new/better practice.

The high adaptive capacity and very strong normative vision are distinctive features of this case study. The sustainable vision provides a strong backdrop for both initiatives, and an effective means for change through high normative adaptive capacity – the normative pillar is the best entry point for actors to affect change, in particular organisational change.

Normative selection pressures

This section details main normative selection pressures from the Copenhagen case study: visions and values; and standards and best practice.

Normative selection pressures manifest themselves through strong buy-in to city visions and values. For example interviewees frequently referenced the Co-create Vision for Copenhagen which sets out the values that are important such as *“better everyday life in urban spaces”* and stressing that neighbourhoods must be *“attractive and organised in a way that supports both the individual choice and the emergence of new communities”* (City of Copenhagen, 2015, pp.6, 10). Equally, the ambition to be the world’s best city for cyclists is a clear normative value that creates a strong selection pressure for regime

actors. Rather than a measureable, quantifiable regulatory process, it is a qualitative statement of intent.

The second group of normative selection pressures set out standards and best practice as a further set of effective processes defining how things should be done. These are described in e.g. accreditation and guidance or best practice benchmarking against professional peers or other cities. For example, company specific building guides and voluntary green building codes (such as building guides for Scandinavian hotel chains or the Norwegian Green Building Council's 10 recommended measures for buildings (Norsk Eiendom, 2016)) were mentioned by interviewees as affecting how they undertook retrofit work.

Best practice benchmarking was also referenced frequently, often in relation to other cities. Amsterdam was noted as a global competitor in terms of cycling, and a spur for Copenhagen to set the ambition to be the world's best cycling city. Other cities' progress creates the ambitious targets and standards as one person commented: *"now they are finally talking about forbidding big trucks in the city centre, which has been done in the German cities for the last 20 years or so"* (interview C16).

Normative adaptive capacity

This section details the main groupings of normative adaptive capacity processes: organisational change; framing visions; and developing and demonstrating new, better practice.

The first observation regarding normative adaptive capacities is that they are directly impacted by the organisational change, whereby coordination of power and allocation of resources are deliberately modified. One clear example is the establishment of the new bicycle secretariat. Bringing in an expert team, giving them decision making powers and doubling the budget available increased adaptive capacity and enabled a much greater level of cycling activity and progress:

"all this financial support from the city council made a lot of things easy, and also easy to suggest the next step and being more and more ambitious and saying why don't we go from increasing the cycle share from 30 to 50%" (interview C10)

Though here it should be noted that resources for cycling were still much smaller than for other transport:

“we have more trips by bicycle than by cars, or by buses, or by Metro, or by train, but when you look at how many people work with the underground system or the train system or the car system then it is difficult to compare” (interview C9)

Here the case study data shows how the coordination of power around a sustainable city initiative influences decision making and the allocation of resources, affecting adaptive capacity (which in turn then shapes selection pressures): *“it is also about who gives money to what kind of knowledge get into what kind of decisions that are made” (interview C13).*

We can also see how adaptive capacity influenced the allocation of resources and coordination of power:

“the arguments and the logic behind it and all the technical stuff was so well-trained in my staff and in myself that when they took the city council suggesting a new thing our politicians were not able to drag it down... so we made a lot of influence also by being very, very clever also in the approaching the city council or the committee” (interview C10)

In contrast securing money for retrofit was much harder: *“for instance Energy Leap, I think we tried that many times and they [the budget committee] prioritised something else, even though it was a small amount [being requested]” (interview C30).* However, through creating a network of large landlords representing a significant proportion of the city building stock actors were able to eventually win budget to support the initiative. This demonstrates how adaptive capacity was used to create a partnership, coordinating power and influencing the selective environment:

“we are working quite a lot with partnerships, voluntary partnerships, we have one on buildings called Energy Leap... [representing] 10 – 11% of the building stock in Copenhagen, the aim is to get up to around 40 partners and close to 20% of the building stock and then I think we will stop because that is enough to try to influence the market” (interview C2)

Moving on to the second group of normative adaptive capacity the case study evidence showed that regime actors effectively framed city visions to align them with citizen or political priorities. For example the Carbon Neutral vision states that:

“In 2025, Copenhagen will be the world’s first carbon neutral capital city. As well as being an important milestone in the fight against climate change, this will have other positive effects, in the form of less noise, cleaner air, healthier citizens and more green jobs” (City of Copenhagen, 2015, p.14).

One interviewee commented that: *“the plan is not only about CO2 emissions any more, now it is a broader plan, a broader vision, and it is about liveability and all sorts of other social sustainability issues”* (interview C18).

Finally, the adaptive capacity to establish new standards and best practice is considered. The case study evidence shows how adaptive capacity is deployed in developing and demonstrating new and better practice through redefining and raising the bar of what ‘good’ looks like. The development of professional standards and the *“seriousification”* of cycling is a clear example of this (interview C9). Expected standards have been created over time through discussions, journal articles and conferences. These are then set out in guidance, specifications and training and educational material, and importantly form the basis for development of regulatory selection pressures e.g. planning requirements for cycling: *“there was a need to work in a bit different way, you can call it different or you can call it professionalise, but there was a need to do a bit differently to standardise procedures and so on”* (interview C9).

Another example is how the cycling secretariat actors developed socio-economic modelling methods to better value cycling within transport decision-making:

“infrastructure decisions are also made based on socio-economic models... socio-economic models are extremely strong, one of the very clever things that the cycle secretary in Copenhagen municipality did was... a socio-economic calculation, in the same way that as you do with everything else, on biking... they use the same system to show something different, and that was quite interesting and actually also quite efficient, because all these calculations made, that is what we make political decisions based on” (interview C13)

Competitions and pilots also create effective adaptive capacity supporting the development of better practice: *“launching a lot of different pilot projects and initiatives*

that really gained new knowledge and new methodologies and new types of data” (interview C9). They demonstrate new approaches and at the same time can legitimise those new approaches through the prestige that the competition brings. For example, one retrofit interviewee commented:

“we won a large, high profile competition about sustainable social housing... and it was quite an important project for the office too, not economically but in terms of how you are defined (as)... experts in sustainability” (interview C15)

6.2.1.3 The cultural cognitive pillar

Cultural-cognitive processes are the beliefs, habits and heuristics of *how things are* and *how things are done* (Scott, 1995) - see the literature review chapter for a full description.

Cultural-cognitive processes account for just over one quarter of the processes cited during the interviews. Within this around 70% are selection pressures and 30% is adaptive capacity.

The main groups of cultural-cognitive selection pressures are: articulated concerns around problems and alignment around solutions; heuristics, ways of thinking; and habits and behaviours. The main groups of cultural-cognitive selection pressures are: storytelling and symbols; and efforts to ‘work around’ and/or better ‘fit with’ selection pressures.

Of these main cultural-cognitive processes two in particular influence progress and are distinctive features of this case study: aligned cultural-cognitive habits acting as the driver for the cycling initiative - supported by adaptive capacity to ‘fit with’ this driver (and by strong cycling culture and story-telling); misaligned cultural-cognitive pressures acting against retrofit (cost, convenience and aesthetics) – reinforced by the less visible, harder to understand retrofit initiative.

Cultural-cognitive selection pressures

This section details the main groups of cultural-cognitive selection pressures: articulated concerns around problems and alignment around solutions; heuristics, ways of thinking; and habits and behaviours.

The first group of cultural-cognitive selection pressures are around what problems are regarded as priorities and what solutions are most desirable. Retrofit is not a visible, desirable option: *“it is not that sexy, getting new windows or more insulation or a new pump, people have more focus on a new kitchen or a new bathroom” (interview C2).*

Overall the more 'visible' and understandable the initiative the stronger the selection pressure: *"my main focus when I was a politician was cycling... I understood cycling"* (interview C5). Cycling was visible and simple, whereas retrofit was less tangible and the initiative goal itself was not straightforward:

"for example retrofitting buildings, first of all it is difficult to understand that it is not CO2, because we will have CO2 neutral energy supply by 2020, but the reason why we have to do it is because we have to reduce the amount of energy consumption... otherwise we have to [build a new power plant in 2025], but that is far away" (interview C2)

These cultural-cognitive pressures support a wider way of thinking that embeds sustainable development as part of Copenhagen culture. Such heuristics are extremely important, so much so that going against them inhibits action as one interviewee commented:

"is it legitimate to be against it [the sustainable city vision]? I would say no it is not, it is not legitimate for politicians to say 'I don't think Copenhagen should be a green city', there is no way you would get anywhere with that... if it is against it you are uphill already" (interview C12)

However, whilst there is broad support for long-term sustainable visions, it is important to note that these goals are competing with other priorities: *"of course we are fighting every year for the budget and have to compete with schools and elderly"* (interview C2). In particular unsustainable cultural-cognitive selection pressures around economic growth and car culture:

"this old and very locked in, or path dependent idea that more cars give more growth... is so firmly rooted in people... that the car gives freedom, and that is a freedom that for many people are seen as a basic right" (interview C13)

Although the cultural-cognitive economic growth paradigm is often in competition with sustainability visions, it is also a central part of Copenhagen's sustainability aspirations: *"trying to connect Danish companies with other cities like New York in order also to promote the green growth agenda which is also part of the whole sustainability agenda"* (interview C3).

Unconscious ways of thinking can also be embedded within wider decision-making ‘infrastructure’. For example the socio-economic modelling that cycling officials developed (previously referenced in the normative adaptive capacity section) was important in combating previously unconscious bias in decision-making. Here it can be seen how the ability of normative adaptive capacity to develop standards can first highlight and then challenge and change unconscious ways of thinking.

Considering the final set of cultural-cognitive processes, the evidence shows that habits and behaviours also exert strong selection pressure. Cycling is a good example of this. People cycle because it is the most efficient, convenient option, not because it is sustainable:

“when we... ask why people they are biking, it is not because of environmental issues, it is only 2% who say that, it is because it is the fastest and most convenient way to get about the city, that is more than 80% that answer that” (interview C2)

In contrast, with regards to retrofit, people want the cheapest and easiest option and the upfront costs and inconvenience of retrofit create cultural-cognitive selection pressures against this – especially with cheap energy available in Denmark:

“the system whereby you make a proposal to invest in energy saving but you increase the rent, the tenants don’t support this because they can’t afford the increase in rent, sometimes you hear the argument that if you make the right energy retrofit measures you’ll save money not spend it, but... energy prices are too low” (interview C14)

Cultural-cognitive adaptive capacity

This section details the main groups of cultural-cognitive selection pressures: storytelling and symbols; and efforts to ‘work around’ and/or better ‘fit with’ selection pressures.

Taking the first of these main groups, storytelling and symbols, there were multiple examples of how regime actors used these to effectively respond to and shape cultural-cognitive beliefs and thinking. For example the bike is widely used as a symbol for Copenhagen, not only by the municipality but a range of NGOs and businesses. Many interviewees talked about the power of this symbol for Copenhageners and hence the use of it by city actors to support a pro-bike culture.

Several interviewees also cited that the bike became a symbol for the environment movement in general:

“the bike is the symbol of the green city, the green city unfolds itself with the way we treat our water, the way we clean our waste and so on, so it has many things underneath, to be green is many things, so sometimes you need a very strong symbol” (interview C12)

Similarly one retrofit interviewee talked about Samsø energy island, a Danish project to create an exemplar sustainable energy community. Here the creation of a strong brand successfully influenced people’s behaviour, generating selection pressure to support the new ‘renewable energy island’ identity. This approach was used to create a Climate Block project in Copenhagen as a way to make retrofit more tangible and attractive to gain political support:

“we saw that it [climate block] was easy to communicate politicians... there is lots of visibility, it is a place that you can bring visitors to see it, it is easy to communicate, so we could just see that this would be perfect for budget negotiations because with a not huge amount of money allocated for this they could be potentially a big political win” (interview C30)

The next group of cultural-cognitive adaptive capacity is around efforts to modify sustainable city initiatives to better fit with existing selection pressures (as opposed to efforts to shape selection pressures themselves). For example investment in infrastructure to make cycling the easiest option to fit with selection pressures around convenience has been a major part of cycling promotion. For example: working on key connections to speed up the network; introducing faster ‘greenway’ traffic light systems; and investment in pedestrian and cyclist bridges that make cycling significantly faster than going by car. There has also been significant investment in cycling infrastructure to make it the most desirable option as well; to make cycling visible and attractive, especially as an alternative to the car. For example designing prestigious cycling bridges and adding in cycling footrests at junctions:

“if you look at some of the bicycle infrastructure you also see a very high level of aesthetic and it is not to do bling, bling or anything, the idea behind it is to make that alternative extremely visible, to say to the car drivers it looks really nice maybe I should try that one day” (interview C5)

6.2.2 How do the institutional and quasi-evolutionary processes vary and why, do they enable or constrain progress?

The previous sub-section set out the results from the analytical framework in identifying what institutional and quasi-evolutionary processes are involved (responding to the first research question). This sub-section looks at how these processes vary and why, and whether they enable or constrain progress (responding to the second research question).

Looking at how processes vary Figure 6.4 shows the relative frequency, both overall and by initiative. This shows that processes are at play across all institutional pillars and both quasi-evolutionary selection pressures and adaptive capacities.

The graphs show a broadly similar pattern in terms of prevalence of processes occurring across regulatory, normative and cultural-cognitive pillars. Across the case study normative processes are the most prevalent. The main difference between the initiatives is that for cycling cultural-cognitive are the next most frequent group, whilst for retrofit it is regulatory processes. Looking at quasi-evolutionary processes for both initiatives selection pressures are more prevalent within the regulatory and cultural-cognitive pillars, whilst adaptive capacity is relatively more frequent for the normative pillar. For cycling the proportion of adaptive capacity to selection pressure is slightly, but not markedly, higher.

Overall then, considering the relative frequency of the processes for the two initiatives they show a broadly similar pattern. As for the London and New York case studies the greater variation is in the *alignment* and *strength* of these processes with each initiative. Again for the Copenhagen case the evidence suggests that whilst the prevalence of processes across institutional pillars and quasi-evolutionary pressures and capacity is similar, there is greater variation in the *alignment* of processes with the two initiatives. This indicates that the difference between cycling progressing well and retrofit progressing less well is due to the overall configuration of processes; are they aligned and enabling, or misaligned and inhibiting?

Table 6.2 summarises the variance between the two initiatives in terms of the main processes at play and their alignment and strength.

Figure 6.4: The relative frequency (y-axis) of institutional and quasi-evolutionary processes in the Copenhagen case study overall and for each initiative.

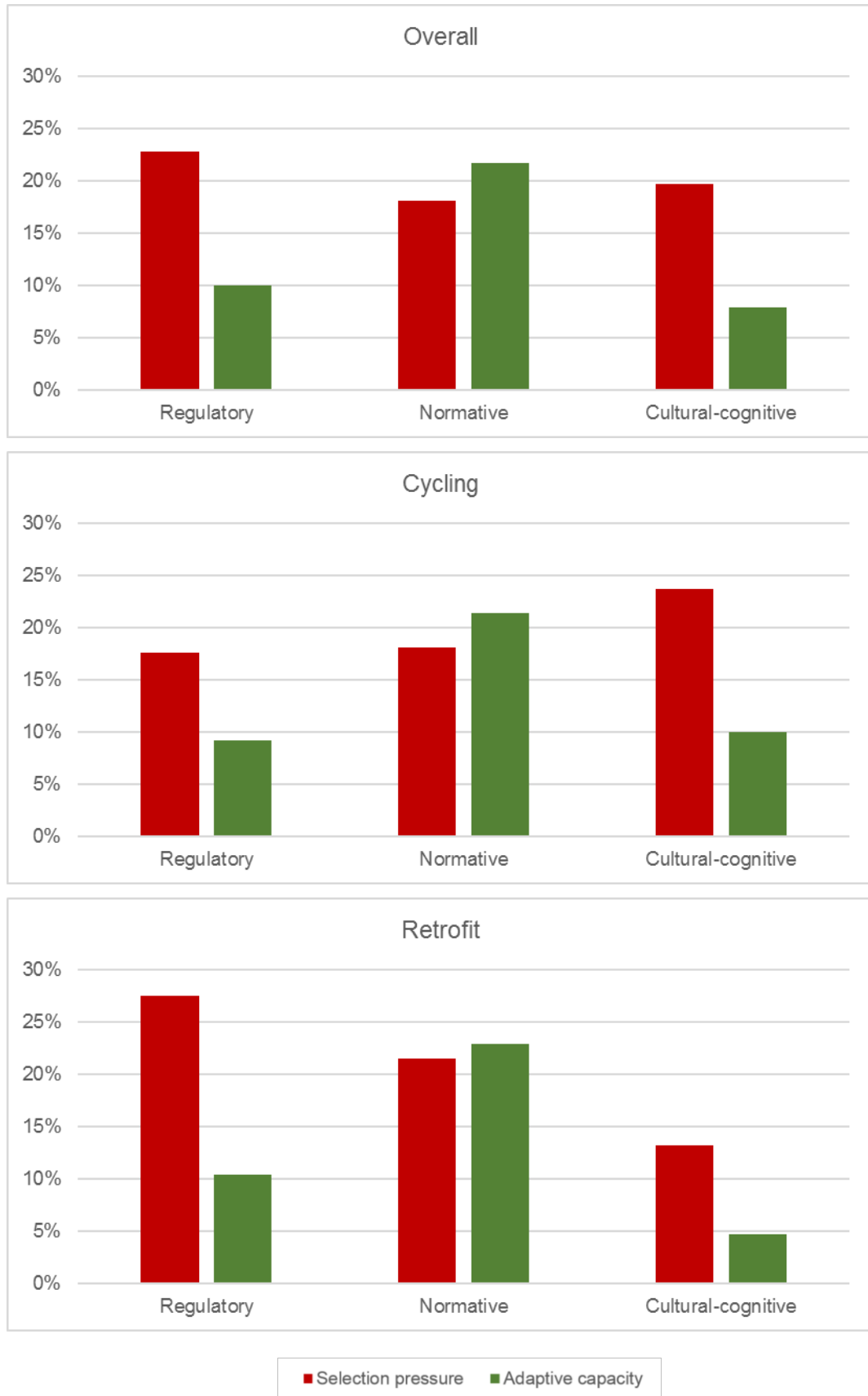


Table 6.2: Summary of the variance between the two Copenhagen initiatives in terms of the main processes at play and their alignment and strength.

Regulatory		Normative		Cultural-cognitive	
Selection pressure	Adaptive capacity	Selection pressure	Adaptive capacity	Selection pressure	Adaptive capacity
Cycling (more successful initiative)					
<ul style="list-style-type: none"> • Aligned, strong political pressure supported/driven by cultural-cognitive habits, and visible nature of cycling • Misaligned competing political pressure acts strongly against any limit to car freedom • Aligned hard targets provide strong pressure for continued investment 	<ul style="list-style-type: none"> • Strong adaptive capacity to plan and set 'hard' targets with clear accountability and deadlines • Aligned, good level of transport power but limited (e.g. congestion charge, parking, safety) 	<ul style="list-style-type: none"> • Aligned, extremely strong vision supported by consistent, cross-party commitment and resources • Standards and best practice benchmarking including against other cities 	<ul style="list-style-type: none"> • Allocation of resources generates very strong, well aligned adaptive capacity, e.g. establish bicycle secretariat with budget, decision-making authority, professional expertise and data • Strong, aligned capacity to develop best/better practice ('seriousification') 	<ul style="list-style-type: none"> • Aligned, strong driver from travel habits supported by infrastructure investments • Aligned, strong cycling culture and identify – supported by/supporting visibility • Misaligned, strongly competing car culture acts as barrier where cycling threatens car freedom 	<ul style="list-style-type: none"> • Aligned, strong capacity to 'fit with' habitual drivers - investments in infrastructure that continue to make cycling fastest, cheapest, most desirable option • Aligned, strong symbol and story telling
<ul style="list-style-type: none"> • Strongly aligned, favourable history and context – over 100 years of cycling culture, relatively less strong car culture e.g. high national taxes, not car producing nation, and lack of investment in car infrastructure in 1950's and 1960's 					

Regulatory		Normative		Cultural-cognitive	
Selection pressure	Adaptive capacity	Selection pressure	Adaptive capacity	Selection pressure	Adaptive capacity
Retrofit (more challenging initiative)					
<ul style="list-style-type: none"> • Aligned 'hard' targets, but weak voluntary enforcement • Mixed regulatory pressure, both enabling and inhibiting building regulations • Misaligned market forces 	<ul style="list-style-type: none"> • Strong adaptive capacity to plan and set 'hard' targets but mixed 'quality' of targets set • Power to regulate results in mixed alignment regulations 	<ul style="list-style-type: none"> • Aligned vision, less strongly supported as harder to understand 	<ul style="list-style-type: none"> • Limited and slower allocation of resources, not political priority – harder to understand, less visible political 'win' than cycling • Aligned stakeholder engagement creating Energy Leap partnership - collective network power and clear, understandable goal finally secure resources 	<ul style="list-style-type: none"> • Misaligned cultural-cognitive pressures – low rent, aesthetics and convenience stronger than sustainable, energy saving concerns • Misaligned lack of driver due to low energy prices, and lack of visible, experienced problem 	<ul style="list-style-type: none"> • Limited story-telling and symbols (e.g. climate block) – but less widely and successfully deployed
<ul style="list-style-type: none"> • Misalignment, unfavourable history and context – low price of energy results not only in weaker drivers for change but competing regulatory and cultural-cognitive pressures. 					

Having explored how processes vary between the two initiatives, the rest of this section expands upon the summary Table 6.2, detailing the reasons behind these variations in alignment and strength. Possible explanations are differences in: the processes acting as the driver for action; the adaptive capacity to respond to these drivers; the history and context of each initiative; the role of power and resources; and the overall configuration of processes.

The processes acting as the driver for action

For the two initiatives the initial processes driving action are different. For cycling the dominant selection pressure is from cultural-cognitive habits around convenience; cycling is the quickest, easiest and cheapest way to get around. For retrofit the initial driver comes from the normative climate neutral vision and the associated regulatory 'hard' targets and building and planning regulations. The findings from the case study suggest that this normative driven approach to retrofit is weaker than the cultural-cognitive driven cycling initiative. The cultural-cognitive driver is from entrenched travel habits that act as a strong selection pressure for cycling. This is supported, and reinforces, a very visible, strong cycling culture in Copenhagen (Gössling, 2013). By contrast retrofit, and energy efficiency is less visible and less 'experienced' leading to a lack of cultural-cognitive selection pressure. For retrofit concerns about money, convenience and aesthetics are stronger cultural-cognitive selection pressures; people care more about low rent, and/or nice kitchens and bathrooms than energy efficiency. These differences in initiative drivers and progress indicate that a strong cultural-cognitive driver is important for unlocking substantive progress. Attempts to compensate via normative visions and regulatory targets and planning requirements are partially successful for the retrofit initiative but progress is much slower and incremental.

Linked to the 'visibility' of cycling vs retrofit are the political regulatory and cultural-cognitive selection pressures. Investing in cycling leaves a tangible, physical legacy for a politician that resonates with large share of the voters given the number of cyclists in Copenhagen. By contrast retrofits are less visible and tangible, they are less appealing to the electorate and ergo to elected officials. In addition, the importance of energy efficiency targets was cited as being harder to understand than for energy generation. The majority of carbon emissions comes from energy generation and elected officials and senior decision makers could easily understand the importance of-, and approach to-, lowering this. Whereas, the need for reduced energy use to keep prices level was a more convoluted argument, and being less intuitive it was less appealing. This indicates that visible, tangible, understandable selection pressures are particularly effective,

especially in terms of cultural-cognitive pressures that then exert political pressure at the regulatory pillar as well.

In terms of the 'hard' targets and building and planning regulations acting as selection pressures the evidence shows a mix of enabling and constraining regulatory processes. For retrofit there are several examples of targets set to support progress that actually inhibited it, including both out-of-date building regulations and one-dimensional, rigid planning requirements. Potentially here the difference between the highly regulated building sector and much more flexible cycling arena is impacting the speed and ease with which regulatory selection pressures can be aligned in support of a sustainable city vision, or initiative. Also of note with regards to 'hard' targets is the question of enforcement and/or sanctions – this is important in institutional processes, in particular regulatory ones (Scott, 1995). Retrofit targets for non-municipal buildings are voluntary and lack any real enforcement or sanctions if not met. This indicates that effective enforcement of enabling regulation is required in order to have strong, well-aligned regulatory selection pressures, and importantly that what makes a 'good' regulation will change over time and needs to be reviewed. This evidence of both enabling and inhibiting regulatory selection pressures also challenges the 'long argued' notion that regime rules and institutional structures are universally well aligned with existing, less sustainable activity and 'lock-out more sustainable alternatives' (Rip and Kemp, 1998; Geels, 2004; Barnes et al., 2018). Whilst the more established regulatory environment of the building sector does create more barriers, the evidence shows a multiplicity of processes and mixed alignment.

The adaptive capacity to respond to drivers

Turning from the initial selection pressures driving action to the adaptive capacity to respond to them the evidence shows similarities and differences between the initiatives. For both initiatives normative visioning capacity is very strong, though to a large extent this has already been deployed and translated into selection pressures around the carbon neutral vision and targets. The regulatory adaptive capacity to translate the vision into targets is strong for both initiatives, with clear, measureable, time-bound goals set for both cycling and retrofit. This reflects the capacity provided by the overarching carbon neutral vision in terms of dedicated staff time, expertise, authority, budget and leadership commitment.

The normative adaptive capacity to develop and demonstrate new, better practices is important for both initiatives. For example the 'seriousification' of cycling and sustainable building competitions and pilots. However, the evidence from the case study suggests

this capacity is stronger for cycling. This is linked with the stricter, more entrenched standards in the building sector, compared with the relatively 'clean slate' for cycling standards. In addition this normative adaptive capacity for cycling supported associated cultural-cognitive adaptive capacity to change ways of thinking. Cycling initiative actors actively challenged traditional transport methods, models and hierarchies that were taken for granted and used routinely. For example developing new socio-economic modelling methods and adapting models to better account for cycling (Gössling, 2013). For retrofit, competitions and pilots seem to be an effective way to focus innovation efforts in developing new, better practices. This could be due to the profile and prestige from such competitions, and the associated legitimacy that this lends the actors, organisations and ideas involved. The role of experimentation (such as pilots and competitions) is well established in transition literature though mostly viewed as a niche-level activity (Bulkeley et al., 2014; Sengers et al., 2019). However, this evidence supports the idea of endogenous change as regime actors (e.g. politicians commissioning pilots and architects responding to them) engage in experiments (Matschoos and Repo, 2018).

In terms of cultural-cognitive adaptive capacity, there is high capacity associated with the cycling initiative. The bike as a strong symbol for Copenhagen and the associated storying telling are used effectively to build on and strengthen cultural-cognitive selection pressures in favour of cycling. In contrast for retrofit there is not the equivalent adaptive capacity, this may be both a cause and effect of the lack of strong cultural-cognitive selection pressures. As outlined above energy efficiency is neither visible nor desirable to people and hence there is not much of a story or symbol here to leverage. This builds on research acknowledging the importance of symbols and stories in creating cultures and cultural identity (e.g. Seyfange et al. (2010) and Geels (2011)) by providing empirical evidence that suggests under what conditions and in which place- and initiative-specific contexts actors might be best able to employ them.

All of the above demonstrates the agency of actors to actively challenge and change selection pressures. In addition it suggest the importance of the normative pillar as an effective entry point to doing so, and at the same time highlights that where such normative capacity can be used to support cultural-cognitive and regulatory adaptive capacity this leads to a much greater influence on selection pressures. In particular through the translation of a normative vision into regulatory hard targets, or to strengthen cultural-cognitive beliefs. For example normative adaptive capacities around professionalisation of cycling influenced the development of hard targets for cycling

(e.g. % journey by cycling, or cycling related local planning requirements), and through stories and symbols reinforced cycling culture within Copenhagen.

History and context

Where actors lack agency to challenge and change selection pressure adaptive capacities are instead used to work around, or better fit with selection pressures. For cycling there have been highly successful efforts to make cycling the fastest, easiest and cheapest way to get around (e.g. through improving cycle lanes, bridges, signalling) – hence fitting with the existing cultural-cognitive selection pressures around convenient travel instead of changing them. Whereas for retrofit efforts to make energy efficiency measures cheap and convenient have been much less successful. This is in large part due to the history and context relative to both initiative. For cycling there has been over 100 years of work, creating a legacy of hard, physical infrastructure and softer, institutional infrastructure that is well aligned with cycling goals. Whereas for retrofit the wider context of owner-tenant paradox and cheap energy, entrenched, hard to change standards and regulations, are all misaligned with retrofit goals. This indicates the importance of history and context for progress towards sustainable city visions. It also points to the variance between initiatives in terms of what stage they are at; the context is likely to be much more favourable if there has been 100 years of work already.

The role of power and agency

The case study findings show the significant role of power and agency in enabling or inhibiting imitative progress. Both power and agency operate in different ways at different institutional pillars. For the two initiatives regulatory rules are often imposed through external political and market systems, normative values are often promoted by city-level coalitions, and cultural-cognitive beliefs primarily emerge from embedded social hierarchies. So whilst the evidence suggests that power configurations are at play in significant ways across all three pillars, it is the normative pillar where power is most effectively mobilised by sustainable city actors. Regulatory and cultural-cognitive aspects are less open to adaptation by regime actors given they have little agency over supra-city political and market forces and deeply embedded cultural trends. Instead the case study evidence shows that city actors have to ‘work around’ regulatory and cultural-cognitive selection pressures, or use their agency and adaptive capacity to modify sustainability initiatives to better ‘fit with’ powerful selection pressures that they cannot change.

In terms of formal powers, good transport powers that supported the cycling initiative (Nielsen et al., 2013) - though these were not unlimited: the ability to introduce a

congestion charge was blocked by surrounding municipalities and national government; measures that alter traffic and parking need police approval which was not always forthcoming; and car tax is set at the national level. For retrofit there were very limited formal powers; as previously mentioned for non-municipal buildings measures were voluntary based on normative values, vs enforced regulatory rules. Such normative voluntary processes are much weaker than regulatory processes. This introduces a dilemma, the evidence shows that the normative pillar is where actors have most ability to intervene through adaptive capacity, however it also shows that the normative pillar is weaker than regulatory enforced processes and cultural-cognitive unquestioned ones. Here structuration theory could offer a potential explanation. Geels (2011) employs structuration theory in relation to the degree of structuration between MLP levels, the same notion could be applied to the institutional pillars. The case study evidence suggests that from the perspective of city level actors the normative pillar has the lowest degree of structuration, whilst regulatory and cultural-cognitive pillars have higher degrees of structuration. Taking this further and drawing on Giddens (1984) the link between structure and agency can be made. This potentially explains the higher level of normative adaptive capacity, i.e. agency (and lower degree of structuration), and stronger regulatory and cultural-cognitive selection pressures, i.e. structural power (and lower degree of agency).

In terms of informal powers the coordination of power and collective agency through coalitions and networks are important for initiative progress. For example the political alliance between the then Lord Mayor and Mayor for Technical and Environment Administration created the power base to set even more ambitious cycling targets and supported the decision to double the cycling budget. In contrast efforts to bid for budget for retrofit were much less successful, with budget requests being rejected multiple times despite the small amount requested. However, the new Energy Leap project used normative adaptive capacity to engage stakeholders, creating a partnership of 26 of the largest building owners in Copenhagen, representing 10-11% of the building stock (at the time of interviews). This agglomeration has led to greater support from politicians and business stakeholders. Moreover, once successfully established these coalitions and networks alter the power dynamics in the regime by creating greater adaptive capacity through allocation of resources and generation of collective agency.

These new patterns of power and agency can create a self-reinforcing cycle. Adaptive capacity can be used to coordinate power (e.g. network building), this increases selection pressure (e.g. political pressure/support) and influences the allocation of resources (e.g. budget setting), which in turn increases adaptive capacity and enables actors to shape,

or at least better adapt to, selection pressures leading to further alignment of power and resources. This creates a virtuous circle in support of sustainable city initiatives (or indeed theoretically a vicious circle against). This pattern is revealed by the quasi-evolutionary lens, which highlights the interplay between selection pressures and adaptive capacity, and the impact of this on the availability and coordination of resources, and hence the overall 'form and direction' of transitions (Berkhout et al., 2004; Smith et al., 2005). Drawing on (quasi-)evolutionary perspectives foregrounds the role of agency (the adaptive capacity to respond to and shape structure) and power (the selection pressure that enables and constrains through structure) (Smith et al., 2005; Shove and Walker, 2010). This explains how actors both shape and are shaped by regime-level processes at the same time (Giddens' (1984) duality between structure and agency). This interplay between selection pressures and adaptive capacities is ongoing and the lines between the two are blurred. For example, the adaptive capacity to create and communicate a sustainable city vision leads seamlessly to the selection pressure of having a strong vision. This demonstrates how actors are both shaped by, and shape their selective environment. For the cycling initiative the strong initial selection pressure from cultural-cognitive travel habits is translated into regulatory political pressure, and this leads to greater coordination of power and resources, in turn increasing adaptive capacity, and creating an ongoing reinforcing loop. For retrofit, the initial normative vision and regulatory targets did not create sufficient selection pressure to mobilise enough power and resources to enable substantive progress.

Another clear pattern regarding power is the level of contestation, more specifically the presence (or absence) of competing, misaligned processes. For Copenhagen the overall Carbon Neutral vision, and general sustainable development ethos, is widely accepted. The point at which such visions become contentious is when they come up against competing visions or when agreeing the details of implementation. A clear example of this is the strong support for cycling up until the point at which it impacts upon car traffic and/or parking, at which time it becomes highly contested and faces strong opposition. This demonstrates a normative vision competing with cultural-cognitive selection pressure in the form of car culture. With retrofit this can be seen when normative visions compete with much stronger regulatory market forces.

The overall configuration of processes

This leads to the observation that the configuration of processes is fundamental in determining progress. It can be seen that the alignment within institutional or quasi-evolutionary processes is important, but furthermore that alignment between them also impacts progress. For example the cycling initiative has strong alignment of cultural

cognitive selection pressures in favour of cycling (habits) - alignment within processes. This is also aligned with strong normative selection pressures (visions and standards), and regulatory selection pressures (political pressure) - alignment between processes. However, progress is effectively bounded by misaligned, competing or existing, entrenched processes. For cycling this is largely selection pressures in favour of the car (cultural-cognitive 'car culture' and associated regulatory political pressure, as well as professional norms around transport and planning). Considering retrofit the good alignment between the normative vision and regulatory hard targets supports progress with the initiative. However, this is severely limited by strong, misaligned regulatory selection pressures (market forces and existing, entrenched regulations) and cultural-cognitive pressures (cheap rent and/or prioritisation of aesthetic improvements). This suggests that not only are the initial drivers of change important for setting the minimum acceptable baseline, the presence of competing processes limit change; initiatives progress within a lower and upper boundary for change.

An important aspect of the configuration of processes is the different scales of governance involved. For both initiatives the evidence shows regulatory selection pressures are often imposed through external national and international levels of governance, while normative processes are often local, city-level governance, and cultural-cognitive beliefs are often associated with wider national, or even global trends. For cycling the alignment between levels of governance was favourable in terms of a national backdrop of high car taxes and general environmental awareness, and a strong cycling culture. Notably here other 'cycling cities' both nationally and internationally influenced Copenhagen's progress, as can be seen clearly by a vision defining progress in relation to these other cities (i.e. the vision to be the world's best cycling city). For retrofit, alignment was less favourable, national and international market selection pressures were misaligned (e.g. cheap energy and the owner-tenant business model (Linares and Labandeira, 2010)), as were wider cultural-cognitive processes – here the cultural-cognitive selection pressures around cost and aesthetics are global trends associated with the consumer society.

A second important aspect of configurations is how they change over time. As has been seen with cycling, the long history of cycling efforts in Copenhagen have led to a very favourable alignment of the soft and hard infrastructure (e.g. cultural identity and city-wide cycle network). By contrast the newer retrofit initiative is struggling with an existing set of processes that are not well aligned, in particular out-of-date regulation that inhibits progress (e.g. procurement rules). Political cycles and changes in elected officials also influence the configuration of processes. Notably for the cycling initiative the political

alliance between the Lord Mayor and Mayor for Technical and Environmental Administration catalysed a step change in cycling from around 35% to 50%. Conversely a distinctive feature of the Copenhagen case study is the relatively stable political environment generally, but particularly the strong, cross-party acceptance of sustainable development. This consistency over time and between political parties provides a strong normative selection pressure that has started to become entrenched in cultural-cognitive ways of thinking (e.g. it is no longer 'legitimate' to be against sustainable development).

In considering how actors influence the configuration of process at play it has already been observed that the normative processes are the ones which actors have most agency to affect. It has also been observed that normative pressures are not as effective as regulatory or cultural-cognitive drivers, which are often harder for local, city actors to influence. Therefore the use of this normative adaptive capacity to translate normative processes into regulatory and cultural-cognitive pillars is critical to embedding change and creating substantive progress. This is especially true for normative visioning, the cycling initiative is most effective because the visions and values created at the normative pillar are both based on and build upon strong cultural-cognitive drivers and regulatory selection pressures (convenience and political pressure). For retrofit the lack of regulatory and cultural-cognitive drivers meant that the initial drivers and subsequent translation efforts were weaker and progress is more limited by misaligned cultural-cognitive and regulatory selection pressures. This evidence supports the argument that actors do have agency to shape their selection environment (Barnes et al., 2018), and importantly elucidates the possibilities and constraints in trying to reconfigure regime processes.

Do these institutional and quasi-evolutionary processes constrain or enable progress?

The Copenhagen case study data suggests that the institutional and quasi-evolutionary processes themselves are agnostic, they can both constrain or enable progress (further supporting the findings from the London and New York case studies). The evidence shows that the overall pattern of processes is broadly similar between initiatives. Instead the variation between initiatives (and progress) is in the *alignment* and *strength* of the processes. This further suggests that it is the outcome towards which process are directed (or the outcome with which processes are aligned) that determines whether processes enable or constrain. Furthermore, given the multiplicity of processes at play it is the overall alignment and relative strength of the wider configuration of processes – not single processes – that determines an enabling or constraining selection environment. Given this multiplicity of processes involved and the contested nature of

the regime, caution should be taken to avoid interpreting an overall enabling or constraining configuration as a homogenous environment. Indeed this would undermine the value of the framework in providing a granular analysis of regime-level processes. Instead it is important to be mindful of both the overall configuration and the contestation within it.

6.2.3 Overall findings in terms of research aims and questions

Having set out the results from the Copenhagen case study, what do these findings tell us? How do they help address research gaps and answer the research questions?

The findings from the case study address the weakness and gaps identified in the literature review. First, the importance of processes, and in particular the configuration of processes, is shown as fundamental to transition progress. Second, the importance of regime-level processes is clear – evidence shows the impact of the regime selection environment on progress. Third, the significant role of social, non-technical processes is highlighted – for the cycling initiative the strength of cultural-cognitive habits is notable. Finally, the role of power and agency is explicitly foregrounded, including the dilemma that the normative pillar is the entry point for change as it is easier to influence than the more entrenched regulatory and cultural-cognitive processes, however this means that it is also a weaker driver for change because it exerts less structural power. This is a potentially important finding in understanding why so many sustainable initiatives have such strong commitment but so little progress. This finding reinforces the need for translation of normative processes into regulatory and cultural-cognitive processes to order to drive substantive change.

Considering the first research question regarding what processes are involved, the evidence suggests an overall pattern. The initial drivers for action were cultural-cognitive and regulatory selection pressures. However, notable for Copenhagen in particular is the very strong normative vision, so much so that it has started to become embedded in cultural-cognitive ways of thinking. This provided a strong backdrop for both initiatives, and an effective means for change through high normative adaptive capacity – the normative pillar is the entry point for change. Regime actors were able to push forward an ambitious action through coordination of power and resources, in turn greatly increasing adaptive capacity. This increase in capacity enabled city actors to shape selection pressures across all institutional pillars, translating normative processes (e.g. standards and best practice), into cultural-cognitive and regulatory processes (e.g. symbols and planning requirements). The overall configuration of processes is critical; misaligned, competing processes act as a boundary, limiting the progress. Hence

although the normative pillar provided the means for purposive change, the cultural-cognitive and regulatory selective pressures provide both the lower and upper boundaries for this change. This responds to the second research question regarding whether processes enable or constrain change; and supporting previous case study findings that suggest it is the overall configuration (both the alignment and strength) of processes that determines whether progress is enabled or constrained. This provides further insights for how and where actors can have most and least agency to reconfigure the selection environment of the regime.

Through explicitly identifying the institutional and quasi-evolutionary processes driving transitions the analytical framework offers a finer grained analysis of the regime. This reveals the complex and evolving configuration of processes at play. The Copenhagen case study evidence reinforces findings from London and New York that suggest this configuration is what shapes the direction and speed of transitions, and in addition that actors have the agency to purposefully reconfiguring the selection environment of the regime in favour of initiatives. Having explored all three case studies individually the next chapter discusses the results across all of the cities.

Chapter 7 Case study comparative discussion

The three previous chapters set out the main findings for each of the case studies. This chapter compares the findings across the case studies and critically interrogates the similarities and contrasts, particularly between the more and less successful initiatives. The insights and implications from this comparison are discussed in relation to the research gaps and questions (detailed in the introduction and literature review chapters and summarised here). The gaps in research concern: first, the challenge of complexity and resulting need to understand the processes driving transitions; second, the need to understand regime-level processes in particular; third, the neglect of non-technical, everyday aspects of transitions; and fourth, the lack of attention to the role of power and agency in transitions. The research questions critically explore: first, what are the institutional and quasi-evolutionary processes that drive regime-level change; and second, why and how do they vary, and do they enable or constrain change?

The main findings are: cultural-cognitive and regulatory selection pressures provide the stronger drivers for change; normative processes, especially visioning, provide the entry point for change; and the overall configuration of processes shapes the speed and direction of transitions.

Power and agency underlie this pattern: the higher degree of structural power exerted by cultural-cognitive and regulatory selection pressures means these pressures are stronger drivers; the lower structuration, and higher degree of agency offered by normative processes means they are the entry point for change; and competing processes impact the overall configuration. The influence of history and context on the existing configuration of processes demonstrates path dependency and the importance of place- and initiative-specific analysis of change. Overall there is a high degree of agency for actors to (re)configure the selection environment of the regime in favour of initiatives, however this is bounded by competing, misaligned processes.

This chapter is structured as follows: the first section reviews the utility of the analytical framework in enabling greater insights into regime-level change; the second section critically explores the cross-cutting findings and insights into the research questions; and the third section summarises the overall findings in terms of research aim and questions.

7.1 The analytical framework and insights into regime-level processes

This section explores whether the analytical framework is effective. Looking across all three case studies the framework has yielded a number of insights that can deepen analysis of sustainability transitions. These insights contribute to addressing the research gaps and gaining a better understanding of processes, especially regime-level, non-technical processes and the role of power and agency.

First, the framework enables a finer grained analysis of processes occurring in transitions, and facilitates greater understanding of the complex adaptive system change involved in sustainable urban transitions. And second, in the case of this analysis the framework enables finer grained analysis of *regime*-level processes in particular. Institutional theory is well suited to analysis of regime level processes, supporting exploration of the deep structure that creates stability and inertia (Geels, 2014; Fuenfschilling and Truffer, 2014; Barnes et al., 2018). Specifically the framework helps to highlight: first, the processes driving initiatives, demonstrating that change is not vision-determined (e.g. air pollution and health concerns in London and New York); second, the agency actors have to respond to and shape transitions through adaptive capacity, evidencing that actor efforts can be purposeful and showing that whilst normative visions might not control or determine outcomes, they do have an important role in helping steer transitions (e.g. the Carbon Neutral vision in Copenhagen); and third, that these driving selection pressures and shaping adaptive capacity processes are playing out within a wider configuration with a plurality of aligned and misaligned processes, illustrating the importance of the overall selection environment (e.g. the ULEZ in London, with aligned cultural-cognitive concerns and regulatory pressures, and misaligned efforts of the motor lobby and political concerns regarding affordability). These insights from the framework show clearly that the regime is a complex, contested configuration of myriad processes that impact to varying degrees on sustainable city initiatives to both enable and constrain progress. This finding challenges the concept of the regime as a monolithic barrier, and responds to calls for greater understanding of the regime level of the MLP (Smith et al., 2005; Grin et al., 2010; Geels, 2011). Furthermore, the framework provides important insights into how actors can react to and shape the configuration of the regime, through mapping the alignment and strength of processes at play and delineating the lower and upper boundary for vision-steered change.

Third, using institutional theory helps to draw out the role of processes across the spectrum from 'harder' regulatory processes and more intentional normative processes

to the 'softer', unconscious cultural-cognitive processes. This enables analysis of a wider range of processes, highlighting the everyday, normal processes of the regime and responding to the neglect of non-technical, non-novel aspects of transitions. For example, the importance of heuristics and professional culture (e.g. the traditions of grey infrastructure in New York), and of financial and legal structures (e.g. the legacy of centralised energy in London). In addition, the explicit analysis of cultural-cognitive processes addresses the need for a better appreciation of the role of practice in transitions by bringing in socio-cultural, demand-side drivers (e.g. cultural-cognitive travel habits and behaviours in Copenhagen). These insights add to the body of transition work that draws on institutional theory (e.g. Geels, 2011; Fuenfschilling and Truffer, 2014; Barnes et al., 2018), providing additional depth of analysis and new insights through explicit use of Scott's (1995) institutional pillars.

Fourth, drawing on institutional and quasi-evolutionary theory facilitates understanding of the power dynamics of regime change; the power to shape structural selection pressures and the agency of regime actors through their adaptive capacity. Analysing institutional processes highlights the deep structure that creates stability and resistance to change (Fuenfschilling and Truffer, 2014; Barnes et al., 2018). Analysing selection pressures and adaptive capacity highlights the contested and competing power dynamics shaping the city context (Geels, 2004; Smith et al., 2005; Geels, 2014). Fundamental to this is the insight that regime-level processes are 'agnostic' in that they can both enable or inhibit change. For example, in London regulatory adaptive capacity in the form of clean air campaigning supports ULEZ progress, whereas regulatory adaptive capacity in the form of lobbying by the motor industry and taxi unions constrains progress. This demonstrates that the success of any sustainable city initiative depends on the alignment of selection pressures and adaptive capacity with the vision, as well as the absence of counter-acting or misaligned processes. In other words, it demonstrates how power and agency play out through selection pressures and adaptive capacity to structure and shape (but not determine) which initiatives succeed and fail in the contested and competitive regime selection environment. Within this, the framework also helps elucidate how coordination of power and resources impacts on the configuration of processes, and vice-versa (explored further in Section 7.2.3).

Overall, the framework provides an in-depth, detailed analysis of which processes are more or less relevant for sustainable city visions for a specific place, time and initiative. This builds on earlier work on institutional theory and quasi-evolutionary theory (Smith et

al., 2005; Shove and Walker, 2010; Barnes et al., 2018), adding additional insights by combining both theories. This amalgamation of institutional and quasi-evolutionary theory unlocks another level of detail and enables finer grained analysis of the precise processes involved. The framework can be used to 'map' the contextual dynamics enabling city actors to better understand their urban selection environment and determine a place- and issue/initiative-specific strategy to best drive forward their vision. This context-specific analysis might suggest that the insights from the framework are not transferable to other urban contexts. However, the specificity makes lessons more transferable not less. The institutional and quasi-evolutionary processes used in the framework are common to any sustainable city effort. Using the framework facilitates a much finer-grained understanding the configuration of processes relevant to any given purpose, place and time. This awareness of the differences in the processes at play enables actors to more effectively introduce a solution into their particular context. For example, strong cultural-cognitive habits, normative professional standards and networks, and regulatory targets were all critical in the success of cycling in Copenhagen. For another city to achieve the same results they would likely need a similar configuration of processes. The framework can highlight similar configurations, and therefore greater likelihood for successful transfer of solutions. It can also flag gaps, such as the lack of hard targets or professional networks, which cities could work to address in order to achieve the successful import of a solution from elsewhere. This addresses one of the challenges for sustainable city transitions of how solutions can be shared between different cities and their 'unique' contexts (Torrens et al., 2018), and responds to calls for a place-based perspective (Frantzeskaki et al., 2017; Barnes et al., 2018). Furthermore, in addition to this place-based perspective the framework offers an initiative-specific perspective, which the case study evidence suggests is important given the level of variation between initiatives within the same place.

Having established the utility of the framework the following sections discuss how these insights inform the research questions and enable greater understanding of how to achieve sustainable city visions and effectively implementing transitions.

7.2 Cross-cutting findings and insights into the research questions

This section critically explores the cross-cutting findings and insights into the research questions. The first observation from the case study data is the importance of processes across all institutional pillars. In particular, the influence of unconscious cultural-cognitive

processes is seen just as strongly as more formal regulatory processes. Furthermore, the impact of both selection pressures and adaptive capacity is clear, highlighting the agency of actors to both shape, and respond to, the structural power imposed by the selective environment of the regime.

The prevalence of processes shows a broadly similar pattern across institutional pillars and selection pressure and adaptive capacity (see the graphs in Figure 7.1). Processes are spread across all institutional pillars; cultural-cognitive processes are the least prevalent but are still a significant proportion of processes in play. Selection pressures are slightly more prevalent than adaptive capacity overall, and particularly so for regulatory and cultural-cognitive processes, whilst adaptive capacity is more prevalent within normative processes. Between the more and less successful initiatives there is a pattern across cases of a relatively higher prevalence of adaptive capacity compared with selection pressure in the more successful initiatives; however, the difference is very small. The most notable variation within the graphs is the very high normative adaptive capacity in New York. Overall the clear pattern emerging across cases and initiatives is of regulatory and cultural-cognitive selection pressures driving change, and normative adaptive capacity to respond to, and shape, this change. This is the main finding in terms of the first research question, what are the institutional and quasi-evolutionary processes are driving change.

In terms of how these processes vary, and whether they enable or constrain progress, the fact that the prevalence of processes is broadly similar across initiatives suggests that variation is not caused by this; i.e. as the prevalence of processes is similar this does not appear to be the cause of variation between successful and less successful initiatives. Instead the evidence, both within and across case studies, suggests that variation derives from differences in *alignment* and *strength* of the processes. This indicates that the difference in progress of initiatives is due to the overall configuration of processes; are they predominantly aligned and enabling progress, or misaligned and inhibiting progress, and are they (relatively) strong or weak processes. This provides the second insight from the case study data: the fundamental observation that the configuration of processes, both alignment and strength, is what enables or constrains progress, shaping the overall speed and direction of transitions.

Figure 7.1 shows the relative prevalence of institutional and quasi-evolutionary processes across cases and initiatives, Table 7.1 provides a summary of the main case study findings, and the rest of this section then details these findings.

Figure 7.1: The relative frequency (y-axis) of institutional and quasi-evolutionary processes across the case studies for each initiative.



Table 7.1: Summary of case study evidence showing the main or cross-cutting findings: selection pressures acting as drivers for change; the adaptive capacity efforts to shape and steer change; history and context; and overall configuration (especially competing processes).

Successful Initiatives	London	New York	Copenhagen
	ULEZ	Clean Heat	Cycling
Main / cross-cutting selection pressures acting as drivers for change	<ul style="list-style-type: none"> • Regulatory – air quality legislation and fines • Cultural-cognitive – health concerns • (supported by normative vision) 	<ul style="list-style-type: none"> • Cultural-cognitive – health concerns • Regulatory – political pressure and boiler permitting • Supported by normative vision and mayoral leadership 	<ul style="list-style-type: none"> • Cultural-cognitive – travel habits • Regulatory – political pressure and hard targets (from habits and vision) • Supported by strong normative visions (best cycling city, carbon neutral)
Main / cross-cutting adaptive capacity efforts to shape and steer change	<ul style="list-style-type: none"> • Regulatory – transport powers • Cultural-cognitive – research capacity • Normative – stakeholder engagement 	<ul style="list-style-type: none"> • Normative – organisational change (creation of Mayors Office of Sustainability) • Cultural-cognitive – effective communication/ articulation (narratives and visualisation) • Normative stakeholder engagement 	<ul style="list-style-type: none"> • Normative – coordination of power and resources (creation of cycle secretariat) • Cultural-cognitive – aligned, strong symbol and story telling
History and context	<ul style="list-style-type: none"> • Favourable – congestion charge legacy of hard and soft infrastructure, history of air pollution concern 	<ul style="list-style-type: none"> • Favourable – easy, low risk, already deployed solution 	<ul style="list-style-type: none"> • Favourable – existing hard and soft cycle infrastructure, relatively less established hard car infrastructure
Overall configuration – competing, misaligned processes	<ul style="list-style-type: none"> • Competing regulatory adaptive capacity – motor lobby and taxi unions; and cultural-cognitive pressure – car culture. Slows progress but does not block it. 	<ul style="list-style-type: none"> • No strongly competing processes 	<ul style="list-style-type: none"> • Competing car culture acts as the upper bound (albeit a high bar) to progress

Less successful initiatives	London	New York	Copenhagen
	Decentralised energy	Green storm water management (inland)	Retrofit
Main or cross-cutting selection pressures acting as drivers for change	<ul style="list-style-type: none"> • Normative – Aligned climate vision • Regulatory – hard targets & planning requirements (weaker enforcement) • Lack of cultural-cognitive driver 	<ul style="list-style-type: none"> • Cultural-cognitive – concerns generated by flooding, and associated regulatory political pressure, but mixed alignment (events divert priority from inland to coastal flooding) • Regulatory – regulations but mixed alignment (focus on water quality vs quantity) 	<ul style="list-style-type: none"> • Regulatory – building/planning regulations but mixed alignment mixed (rigid regulations both enable and inhibit) • Lack of cultural-cognitive driver
Main or cross-cutting adaptive capacity efforts to shape and direct change	<ul style="list-style-type: none"> • Regulatory – planning and target setting capacity, planning powers to introduce requirements • Normative development of standards and best practice (e.g. Heat trust) 	<ul style="list-style-type: none"> • Normative – visioning • Organisational change, established team, but initially isolated within DEP 	<ul style="list-style-type: none"> • Regulatory – planning and target setting but mixed ‘quality’ of targets set (supported by strong normative vision) • Normative – stakeholder engagement
History and context	<ul style="list-style-type: none"> • Unfavourable context – centralised energy system 	<ul style="list-style-type: none"> • Mixed context – Hurricane Sandy diverts priority and resources away from inland storm water management 	<ul style="list-style-type: none"> • Unfavourable context – low energy price
Overall configuration	<ul style="list-style-type: none"> • Competing cultural-cognitive selection pressure – lack of trust/confidence; and regulatory selection pressure – centralised legal and financial system, ‘build to sell’ business model 	<ul style="list-style-type: none"> • Competing cultural-cognitive selection pressures (grey infrastructure culture) • Misaligned, strongly competing professional cultures based on grey infrastructure 	<ul style="list-style-type: none"> • Competing economic regulatory and cultural-cognitive selection pressures

The cross-cutting findings from the case studies are now discussed, critically comparing: first the selection pressures driving change, interrogating whether transitions are vision-determined or vision-steered; second, the main adaptive capacity efforts to respond to and shape change; third, the role of power and agency, and how agency and structural power play out across institutional pillars and quasi-evolutionary processes; fourth the impact of history and context, and how processes vary between and within cities, i.e. they are both place- and initiative-specific; fifth, how the overall configuration of processes impacts change; and finally, whether processes enable or constrain progress across the case studies.

7.2.1 Selection pressures driving change

Starting with the selection pressures driving change, this section sets out the evidence across the case studies showing: first, that transitions are not vision-determined, though they are vision-steered; and second exploring the cultural and regulatory processes that are driving change.

Transitions are not vision-determined but they are vision-steered

The first point to note is that the findings across all three case studies and initiatives suggest that transitions are not vision-determined. This is consistent with the literature (Voß et al., 2006; Geels and Schot, 2007; Grin et al., 2010; Kern, 2011), and contributes to transition knowledge by providing insights into, and evidence of, the processes that are driving initiatives. The findings show the main drivers for the successful initiatives are cultural-cognitive and regulatory selection pressures, not normative visions. For the less successful initiatives actors attempt vision-led change in the absence of regulatory or cultural-cognitive drivers, but the results show that such attempts to compensate are not as effective.

The case study evidence suggests that the complexity of urban systems is what prevents vision-determined transitions. This evidence supports the literature (Voß et al., 2006; Geels and Schot, 2007; Grin et al., 2010; Kern, 2011; Loorbach et al., 2015; Frantzeskaki et al., 2017), and goes further to elucidate the processes occurring within the complex city regime. For all initiatives, across all the case studies there were multiple processes in play – across the three institutional pillars, both selection pressures and adaptive capacity. Moreover, the alignment and strength of processes varied widely. This evidence demonstrates that transitions are a complex mix of processes, and that despite

best efforts by leading sustainable cities it is not possible to determine or control change through visions. Instead all the initiatives occurred amongst a wider configuration of regime processes. These wider processes were not related to the initiative in question, rather a range of other regime processes (e.g. in Copenhagen cultural-cognitive travel habits around convenience, and regulatory selection pressures around traffic safety). As a result actor attempts to generate a dominant process of vision-led change were over-powered by other institutional and quasi-evolutionary forces.

Investigating the alignment of processes in particular, the case study evidence shows mixed, and varying alignment of selection pressures and adaptive capacity. This is consistent with existing literature stating that selection pressures can be directed, general and undirected (Smith et al., 2005). For example, in London the case study showed evidence of regulatory selection pressures *directed* towards improving air quality, and across all cases there was evidence of *general* regulatory selection pressure from the economic recession, as well as cross-case evidence of the *undirected* pressure from population growth. Contrasting with this, adaptive capacity is inherently purposeful, and the case study evidence shows the alignment of these adaptive efforts was very mixed. For example, in London regulatory adaptive capacity in the form of lobbying is both well aligned with the ULEZ initiative e.g. London Clean Air campaign, and also misaligned e.g. motor industry efforts. Finally, the case study evidence shows the interdependent nature of the processes at play – this is consistent with transition literature on co-evolutionary nature of change (Grin et al., 2010; Foxon, 2011). For example, in New York the regulatory selection pressure from the low price of natural gas influenced the heating oil association decision to cooperate with stakeholder engagement, thus increasing adaptive capacity of the actor network. This mixed alignment and co-evolution further increases the complexity of processes involved in regime change. The evidence from the case studies suggests that this complexity precluded attempts by actors to control, or even accurately predict, the progress of all initiatives studied. This finding supports the call for a process-oriented approach in order to better understand and manage how transitions unfold and how outcomes emerge (Geels, 2011; Cook and Swyngedouw, 2012; Chatterton, 2013).

However, the second point to note is that whilst the initiatives were not vision-determined, the role of visions in all cases was significant. Visions provided directionality for adaptive capacity, in particular planning and target setting, stakeholder engagement and coalition forming, developing best practice, and story-telling and symbolising. In short visions

provided the 'purpose' for the 'purposive' actor efforts across the case studies, both overall sustainable city visions as well as initiative-specific visions (e.g. London's 'energy for all' vision). Even where there were clear cultural-cognitive and regulatory drivers, visions were still effective in focusing efforts. For example, the goal to have the best air quality of any big US city aided the New York Clean Heat initiative, supporting the strong cultural-cognitive health concerns driving action. So it can be seen that across all cities and initiatives, the evidence shows that visions support actor attempts to steer transitions. These successful efforts at vision-steered change suggest that the selection environment is not a blind evolutionary landscape, but is a political, contested playing field where power and agency are often directed towards certain goals. In response, sustainable city actors are taking purposive action and adopting strategic game play in order to attempt to shape the selection environment in favour of sustainable city outcomes. For example, in New York actors were actively employing, and furthermore combining, adaptive capacity by creating visions to distinguish political leadership efforts, and establishing coalitions of support around these visions.

So if visions are not the driving forces, albeit important for steering, what then are the drivers of transitions? Considering the selection pressures that act as initial drivers for action, the pattern that emerges is the importance of cultural-cognitive and regulatory selection pressures.

Cultural-cognitive processes provide the underlying belief and behaviours that drive change

Considering first cultural-cognitive selection pressures, the findings show that all the successful initiatives had strong cultural-cognitive drivers. For the London ULEZ and New York Clean Heat initiative this was concern around air quality and health. For Copenhagen cycling this was cultural-cognitive travel habits around convenience. The less successful initiatives had either a lack of cultural-cognitive selection pressures acting as drivers, or mixed drivers. For New York cultural-cognitive concerns associated with flooding were very strong, but also highly variable and Hurricane Sandy diverted concern from inland flooding. For London decentralised energy and Copenhagen retrofit initiatives there was no strong cultural-cognitive selection pressure, instead normative adaptive capacity around the sustainable city vision is the initial driver. The significance of cultural-cognitive drivers supports the social practice scholars' claims of the importance of behaviours within transitions (Shove and Walker, 2010; Hargreaves et al.,

2013) – particularly the Copenhagen cycling initiative where transport habits and associated culture of practice, are the main drivers of change.

For cultural-cognitive concerns visibility, awareness, density, legitimacy and articulation varied between cases and the more and less successful initiatives. How visible, tangible, understandable and immediate an issue is (perceived to be) impacts the strength of the selection pressure exerted. For example, energy is less visible, and for most people is not an immediate problem (acknowledging of course that some people face energy poverty). Whereas for air quality and health the impacts are immediate and tangible, and for cycling the concept is easy to understand and very visible. In terms of personal experience of flooding this acts as a very strong selection pressure, albeit in the case of New York an inconsistent one. The variance between the successful and less successful initiatives suggests that local, immediate threats are effective in stimulating concern, over the more global, long-term sustainability challenges. This finding supports observations by Geels (2011) on the importance of immediacy, visibility and how tangible problems are. Furthermore, this case study evidence contributes additional insights into how this perception and experience of problems plays out at a local level within specific initiatives. Whilst this can effectively drive change for more immediate, visible and tangible problems, it poses a fundamental challenge in addressing global, longer-term sustainability challenges that lack local 'bite' and therefore do not generate cultural-cognitive selection pressure for change.

Visibility and awareness of a problem can be further bolstered by research and communication. All of the successful initiatives had good evidence of the problem (e.g. air quality monitoring and transport data), that was well communicated and easy to understand for stakeholders (e.g. Clean Air Campaign London and Copenhagen's bicycle account). Furthermore, the concerns were perceived to be legitimate because of the source (e.g. the independent academic and NGO community championing clean air in London) or the density (e.g. frequent media coverage in the Evening Standard and large stakeholder coalitions such as Energy Leap). Effective articulation was a crucial aspect of all three successful initiatives. The case studies showed a range of ways these concerns were expressed, e.g. through voter preferences, consultation responses, high-impact visualisation, leveraging connections with key decision-makers, effective campaigns and media coverage. This supports existing theory that selection pressures need to be articulated to exert force (Smith et al., 2005), and furthermore that politicisation of issues strengthens selection pressure (Köhler et al., 2019). The empirical

data and framework analysis take this thinking further and elucidate the specific processes by which articulation and politicisation occur: the former, articulation, as outlined above; and the latter, politicisation, occurs as cultural-cognitive concerns impact decision-making through voting preferences and patterns, generating associated regulatory political selection pressures.

Regulatory processes provide the mandate to impose and enforce change

Regulatory selection pressures also emerged across the cases as important initial drivers for action. Again all the successful initiatives across the three cities had strong regulatory selection pressures. For the London ULEZ this was EU and UK air quality legislation and in particular the threat of fines. For the New York Clean Heat initiative this was political pressure – though it should be noted that this very much reflected the strong cultural-cognitive concerns. For Copenhagen and cycling this was political pressure reflecting the impact of cycling on regulatory political pressures (i.e. the large cycling population represents a sizeable proportion of voters). As mentioned above, this supports the notion that politicisation of issues is required (Köhler et al., 2019). Furthermore it suggests that a combination of cultural-cognitive and regulatory selection pressures is particularly impactful in driving initiative progress. This may be because cultural-cognitive drivers provide the underlying belief and behaviours that demand change, and regulatory pressures provide the mandate to impose it.

The strength of regulatory selection pressures relates to whether these mandates are enforced or not. For London the evidence suggests that externally imposed legislation, with accompanying threat of fines, acted as a stronger regulatory driver than the regulatory political pressures in New York and Copenhagen, which were self-imposed and with less severe consequences for failure (though in both cases public reporting strengthened the selection pressure by increasing accountability and scrutiny).

7.2.2 Adaptive capacity to respond to and shape change

Turning to the adaptive capacity to respond to and attempt to shape these initial drivers and the wider selection environment, the evidence from the case studies suggest three key findings: first that actors have most agency in shaping normative processes, specifically normative visioning processes; second, adaptive capacity was commonly and effectively used to build networks and coalitions; and third, that the agency to create second-order system change is possible.

Actors have most agency in shaping normative processes

First, the findings show that across the case studies there was high normative capacity. Initial normative adaptive capacity visioning efforts successfully created a strong normative selection pressure through an accepted and committed sustainable city vision. All three case studies had strong sustainability visions as this was a criteria for selection. The potential bias arising from the research design may explain the pattern of normative adaptive capacity. Alternatively it could be because normative processes are easier for local actors to influence than regulatory and cultural-cognitive processes. Regulatory selection pressures are often supra-city and therefore hard to influence (e.g. regionally or nationally imposed legislation, national and global political and economic systems). Whereas normative selection pressures around visions, values, standards and best practice can be more local, and where they are national and/or international they are often less rigid than regulatory processes (e.g. values vs legislation). Cultural-cognitive selection pressures are often based on broader social trends, and are sub-conscious (hence mainly unquestioned) and in many ways harder to influence than normative processes. The case study evidence suggests that normative adaptive capacity is less constrained by structural power that is beyond the influence of city actors, compared with imposed regulatory and embedded, unquestioned cultural-cognitive selection pressures. With less constraint through structural power comes greater agency (Giddens, 1984). Therefore city actors have greater agency to shape normative processes. This finding suggests that niche innovations are most able to penetrate the regime through normative processes, first adaptive capacity to create visions, values, standards which then act as normative selection pressures around those same visions, values and standards. However, the case study evidence suggests that much of the innovation came from within the regime. Given the boundaries are purely analytical and hard to define (Barnes et al., 2018), it is often difficult to delineate between niche and regime. For London, the ULEZ was first suggested by the Mayor and developed by TfL, for Copenhagen the cycling targets were proposed by the Mayor and deputy mayor – all very firmly regime actors. However interestingly for New York the Mayor's Office for Sustainability spearheaded both the Clean Heat and green storm water initiatives, suggesting the creation of a (semi-)niche space at the heart of the regime. In addition, for the Copenhagen cycling initiative a cycling secretariat was established, again potentially creating a similar (semi-)niche space. However, this (semi-)niche innovation could also be conceptualised as regime innovation, creating spaces within the regime where actors can adapt to and shape the current regime processes. This challenges the prevailing

view that niche innovations have to come from 'outside' the regime (Van De Poel, 2000; Geels, 2011; Elzen et al., 2012). It suggests that rather than shielding innovation from regime selection pressures in a protected environment, a better strategy may be to create space for innovation within a favourable regime selection environment. Though the distinction may seem subtle the case study evidence suggests it is important; initiatives supported by wider regime selection pressures (especially cultural-cognitive and regulatory) were much more successful. This concept of innovation within the regime collapses the vertical hierarchy of the MLP, with niche and regime levels much more intertwined.

This creates a dilemma; whilst normative processes provide the best entry point for actors to affect change, they are relatively weak in comparison (and competition) with imposed regulatory and embedded cultural-cognitive processes. The case study evidence suggests that, in response to this, actors use their adaptive capacity to translate the normative vision into regulatory selection pressures via planning and target setting (e.g. Copenhagen's Carbon Neutral roadmap and associated targets). These hard targets were further strengthened by effective enforcement through accountability and reporting. Furthermore, for the most successful initiatives the vision was also translated into cultural-cognitive selection pressures (either creating new selection pressures or bolstering existing ones). For Copenhagen, actors used stories and symbols to translate the cycling vision into cultural-cognitive selection pressures. For London and New York, actors used research and communications to raise awareness of air quality and health impacts with decision-makers, especially through effective visuals and narratives. The evidence suggests that this process of translation is significant in supporting initiatives to compete and progress within the regime selection environment.

Finally, as noted previously, transitions can be vision-steered, but of course a sustainable vision is a prerequisite for doing this. The normative visioning and translation processes outlined above show how actors undertake purposive efforts to adapt and shape the selection environment in favour of the sustainable city vision (and initiatives). Moreover actors are operating in an environment with many competing, alternative visions, not least of all the status quo (Frantzeskaki et al., 2017). Therefore setting a strong sustainability vision is required not only to provide purpose but also in order to successfully compete.

Adaptive capacity was commonly and effectively used to build networks and coalitions

One of the most prevalent and effective ways actors used this shaping adaptive capacity was to build networks and coalitions, coordinating power in support of initiative goals and sustainable city visions. For the more successful initiatives coalition building avoided competing power struggles. For example in New York, a major factor in the success of the Clean Heat initiative was the lack of opposition from the heating oil industry, due in large part to successful stakeholder engagement by the municipality. For London extensive efforts to engage the motor industry eventually gained support for the ULEZ (albeit with continued contestation of the details of delivery).

In addition, the evidence suggests that strong coalitions provide consistent capacity to support sustainable city visions. In particular the influence of civic and private sector networks provides consistent support across political cycles, because the actors, and causes they are championing, remain constant. For example, for New York the GreenNYC coalition of private and civic sector actors applied pressure to the new de Blasio administration to continue the sustainability efforts started by the Bloomberg administration.

Network and coalition building happen in a variety of ways across the case studies: top down from government (e.g. GreenNYC coalition); or bottom up from the civic sector (e.g. Danish Cycling Federation); as well as examples from the private sector (e.g. in London the motor association lobby). This reflects what Bulkeley et al. (2010) refer to as the governance not government of transitions.

Comparing across the case studies and initiatives the results suggest that variation in the success and strength of networks is influenced by density, legitimacy and cause. The impact of density, i.e. the (perceived) level of support created through networking, strengthens processes and supports efforts. For example, for New York NGO coalitions provided a collective instead of an individual organisational voice. The case study evidence also suggests that the range and nature of stakeholders engaged can strengthen processes through lending legitimacy to a cause (e.g. academics providing independent scientific evidence, or civilian groups representing the voice of the people). Across all the successful initiatives the role of networks, in particular the voice of the civic sector, in articulating cultural-cognitive concerns emerges as a significant aspect of success. This demonstrates both the power of collective agency and the legitimacy of the 'voice of the people' in creating cultural-cognitive pressure, and associated regulatory

political pressure. As previously referenced, for the less successful initiatives there is an absence of strong cultural-cognitive concerns. It follows that the lack of concern means there is (perceived to be) no urgent cause around which to unite, potentially hindering the success and strength of network and coalition building.

Actors have the agency to create second-order system change

The final cross-cutting finding for adaptive capacity, and actor efforts to shape transitions, is the degree to which such attempts are aimed at, and achieve, second-order system change. This finding is particularly relevant as such systemic change is one of the desired outcomes of transitions; i.e. how to achieve more radical second-order change of the system itself, instead of incremental first-order change within the system (Grin et al., 2010; Markard et al., 2012). Particularly from the New York and Copenhagen case studies there are strong examples of this systemic, second order change – what interviewees referred to as organisational and/or institutional change. For Copenhagen the creation of a cycling secretariat and for New York the creation of the Mayor's Office of Sustainability was pivotal to success. In both of these instances the allocation of staff resources, as well as decision making powers and budget, significantly increased the level of power and agency, and hence overall progress of initiatives. Both these examples are particularly interesting as they are overt efforts at structural change. Interviewees were explicit about the need for organisational reform in order to achieve the desired level of ambition. Significant changes to the city government organisational structures were made, with ongoing support and commitment from the Mayor and senior staff. Such changes shifted the structural power of selection pressures, and actor agency and adaptive capacity, aligning them in favour of both the Clean Heat and cycling initiatives, and hence significantly impacting progress. Furthermore for New York adaptive capacity was used to very purposively institutionalise changes, by creating laws for mandatory roles and reporting, to ensure the structural changes made out-last the administration that implemented them.

For the less successful initiatives the creation of a team, though it may have helped, was not enough to overcome other barriers. For example, London established a decentralised energy team and New York established a green infrastructure team. The resource allocation to set up these teams did support progress, just not as much as for the successful initiatives. From the evidence, potential explanations are that these teams were not as centrally 'located' and hence further from the seat of regime power; or that they were not as well resourced; or that they faced greater barriers from competing

initiatives; or indeed a combination of all of these. This reinforces the central role of resources and power (both the lack of aligned and the presence of competing processes).

Within the attempts at structural change, purposive attempts to destabilise existing regime structure also emerge as a common and effective shaping adaptive capacity. Actors employed a range of tactics from destabilising rules, reducing support, controlling policies and making changes in social networks and key actors. For example, in New York actors employed adaptive capacity to lobby and negotiate for changes in state-level laws relating to heating oil, thus destabilising the existing rule-set; in Copenhagen the use of adaptive capacity to coordinate power and allocate resources away from incumbent initiatives and technologies effectively reduced support for the dominant technology, e.g. restricting car traffic and increasing the cycling network; and in both London and New York control policies were used to constrain previously dominant technologies, e.g. the ULEZ constricting car travel and Clean Heat restrictions phasing out boiler permits for number six heating oil; and for all initiatives making changes in social networks and replacement of key actors impacted stability of existing coalitions and associated power dynamics (e.g. bringing in new staff and/or network members). This is consistent with the literature referencing destabilisation of regime change as crucial for transitions (Geels, 2014; Turnheim et al., 2015; Kivimaa and Kern, 2016), furthermore it provides empirical examples of, and insights into, how such destabilisation occurs, who enacts it and what their motivations and intentions are.

7.2.3 The role of power and agency

Exploring next the role of power and agency, the framework successfully foregrounds this, highlighting how agency and structural power play out across institutional pillars and quasi-evolutionary processes. The evidence from the case studies suggests three key findings: first, that formal city powers support initiatives to more effectively progress; second, that the interplay between adaptive capacity and selection pressure impacts upon the allocation of resources and coordination of power, and is fundamental to progress; and third, that the competition and contestation within the regime impact on the configuration of processes and overall progress.

Formal city powers support initiatives to more effectively progress

Formal powers varied between cities and initiatives and had a significant impact on progress, mainly the regulatory adaptive capacity to shape selection pressures (e.g. in

New York regulatory adaptive capacity in the form of permitting powers is used to create regulatory selection pressure through permit restrictions). Evidence showed a clear pattern between successful and less successful initiatives; the former having a good level of city power, the latter less so. For example, in London and Copenhagen good levels of city control over transport were used to introduce the ULEZ and supporting cycling, and in New York strong formal power to authorise or decline boiler permits was used to very effectively phase out number six heating oil. For the less successful initiatives there was formal power but it was relatively limited and/or deployed less effectively. For example, for green storm water management in New York the main regulatory powers over water quality were held at the national level by the EPA. In Copenhagen for the retrofit initiative there were very limited formal powers, resulting in voluntary instead of enforced regulatory rules. In London the picture is more mixed: the GLA has good planning powers to set planning requirements, this provides strong adaptive capacity, but less power within the energy sector – e.g. less powers than utilities for installing and fixing underground infrastructure. The London case study shows how the GLA used planning powers to put in planning requirements for decentralised energy. This was enough to stimulate change despite the range of other challenges but not enough to drive significant progress in the face of the other competing processes. This indicates that good powers are necessary for progressing an initiative but they need to be effectively deployed, and even then such efforts might not be sufficient where wider processes are strongly misaligned.

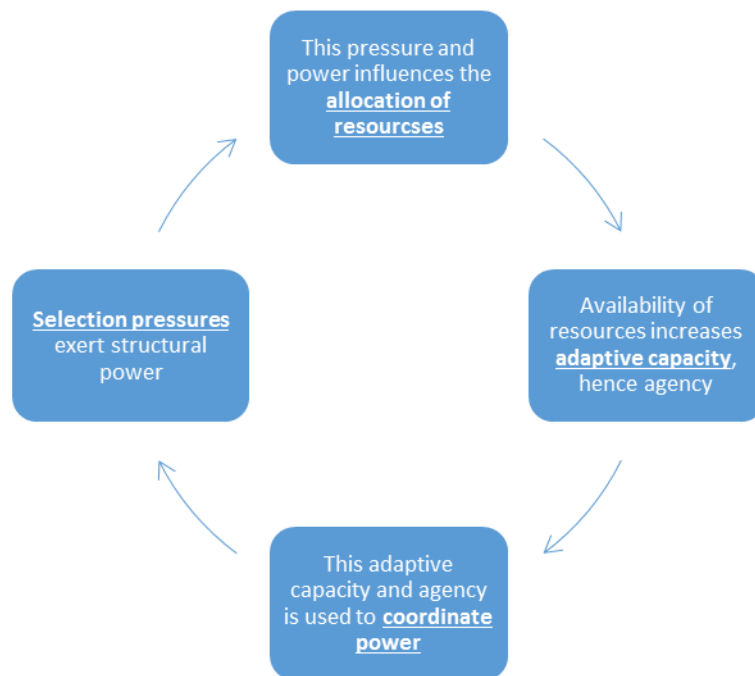
The interplay between adaptive capacity and selection pressure impacts resources and power and is fundamental to progress

This leads on to the second key finding on the interplay between adaptive capacity and selection pressures, i.e. between agency and structure. Across all initiatives and case studies this interplay impacts the allocation of resources and coordination of power and is fundamental to progress. The evidence shows the use of individual and collective agency (via adaptive capacity) to attempt to influence selection pressures by coordinating power (e.g. through coalition building to generate political pressure). The resulting selection pressures then influence the allocation of resources, in turn impacting adaptive capacity. For example, in Copenhagen actors used normative networking adaptive capacity to coordinate power through creation of the Energy Leap partnership; this generated greater regulatory selection pressure in the form of political impetus, in turn influencing the allocation of resources, e.g. budget allocated to the initiative. This

adaptive capacity is enabled or confined by the structure of existing selection pressures, and the associated allocation of resources. Yet at the same time this adaptive capacity shapes the existing structure, and allocation of resources and power, and in doing so creates the (adaptive) capacity required for initiatives to succeed.

This potentially creates a self-reinforcing cycle whereby coordination of power and allocation of resources in alignment with the sustainable city vision increases adaptive capacity to shape selection pressures and lead to further alignment of power and resources – see Figure 7.2.

Figure 7.2: Visual representation of the interplay between power and resources as enacted by the quasi-evolutionary selection pressures and adaptive capacity.



This finding regarding the interplay between adaptive capacity, selection pressure, power and resources aligns with the transition literature drawing on earlier (quasi-)evolutionary perspectives of adaptive capacity as a combination of the *availability* and *coordination* of resources to adapt to these selection pressures, thereby shaping the form and direction of regime change over time as processes are reproduced and modified (Berkhout et al., 2004; Smith et al., 2005; Shove and Walker, 2010). As outlined in the literature review chapter, this thesis contributes further theoretical insights by conceptualising the role of agency as adaptive capacity and the role of structural power

as selection pressure. This approach captures the duality between structure and agency proposed by Giddens (1984), providing both an analytical framework to capture, and empirical evidence of, the specific processes by which actors both shape and are shaped by regime structure at the same time. The implications of this are explored further in the conclusion.

Whilst, it is challenging to separate this adaptive capacity and selection pressure from the confines of the selection environment in which they are operating, and acknowledging that the boundaries are purely analytical, this theoretical exercise is a useful aspect of the framework that foregrounds the agency of actors to shape change. It also flags where the structural constraints of competing, misaligned selection pressure may prevent successful intervention (e.g. the New York green infrastructure storm water initiative where misaligned regulatory and cultural-cognitive selection pressures reinforced an ongoing mixed alignment of processes. Thus the evidence indicates both the potential for change (via a positive reinforcing cycle), and the potential for inertia (via reinforcement of a mixed or misaligned selection environment).

Where structural power is (perceived) to constrain change, actors have responded with 'work around' and 'fit with' approaches. The case study data shows several examples where selection pressures are (perceived to be) entrenched, and how actors responded with a pragmatic approach to 'work around' them. For example, in Copenhagen efforts were undertaken to 'work around' national restrictions for social housing by creatively developing a financial solution that enabled successful tendering for development. In contrast actors also used structural power to drive change, where possible adapting initiatives to better 'fit with' the existing entrenched selection pressures. For example, in London the overall approach for decentralising energy is to resolve the environmental impact of energy without the consumer needing to change; the selective environment is unchallenged, the solution is adapted to 'fit with' existing pressures. Across the case studies a pattern emerges; this 'work around' and/or 'fit with' approach was commonly used in response to strong often external imposed regulatory and strong highly ingrained, unconscious cultural-cognitive pressures. This supports the previously noted finding that actors have relatively less agency to change regulatory and cultural-cognitive processes compared with normative processes. This may reflect the higher degree of structuration associated with regulatory and cultural-cognitive processes due to their 'imposed' and 'implicit' nature. This suggests that the *degree* of structuration influences the *strength* of selection pressure. Such thinking follows a similar approach by Geels (2004; 2011);

however, whereas he applies this to the degree of structuration of the MLP levels, here this research takes a novel approach in applying it to institutional and quasi-evolutionary processes. Hence the framework supports not only the identification of the processes exerting structural power (i.e. selection pressure), but also offers insights into the strength of such selection pressures.

Critically exploring this concept of structuration and comparison with MLP thinking further, there are more insights to be gained. Geels (2004; 2011) proposes that the nested hierarchy of the MLP reflects the differing degree of structuration, from weak at niche, to strongest at landscape level. If the externally imposed regulations are considered as landscape factors acting on the regime then these are more rigid than regime-level regulatory processes and hence exert greater structural power. This finding, suggesting a stronger influence of externally imposed regulations, is also interesting in terms of debates around endogenous and exogenous change, where most scholars see regime change originating outside the regime (Van De Poel, 2000; Geels, 2011; Elzen et al., 2012). For both New York and Copenhagen, despite the self-imposed nature of the regulatory selection pressure for Clean Heat and cycling (compared with the externally imposed air quality regulations for the London ULEZ), this selection pressure was strengthened through public reporting, increasing accountability and scrutiny and generating 'credibility pressure' (Geels, 2010). This suggests that endogenous change, albeit weaker than exogenous change, is possible. Such discussions depend entirely on what is deemed internal and external, which itself rests on the analytical boundaries selected. And whilst arbitrary analytical barriers support theorising, one should not expect to see such clear lines in the reality of case studies where no such boundaries exist (Smith, 2007; Barnes et al., 2018).

Whilst the above approach to 'work around' and/or 'fit with' is pragmatic, and showed success, it represents first-order, not second-order change, i.e. it is not altering the system itself. Across the case studies significant attempts at systemic, second order change were limited. This demonstrates the enduring nature of the existing regime, and the limitations of endogenous efforts at system reform. The examples from the Copenhagen cycling and New York Clean Heat initiative are particularly hopeful in demonstrating the potential for second order learning and change. Here the evidence showed how the actors involved consciously made structural changes as well as successfully utilising existing selection pressures, showing a highly sophisticated awareness and approach. For example, the Copenhagen cycling initiative,

demonstrated purposive organisational change (e.g. establishing a cycling secretariat), as well as successful tactics to 'to fit' with existing cultural-cognitive selection pressures around convenient travel.

Competition and contestation impact on the configuration of processes and overall progress

The third key finding from critically exploring the role of power and agency in transitions is that competition and contestation within the regime impact on the configuration of processes and overall progress.

Across the case studies the evidence points to the significant impact of misaligned, competing processes or existing, entrenched processes. In critically considering the alignment a clear pattern emerges from the findings regarding the presence, or absence, of competing selection pressures (an example of competing selection pressure is in the Copenhagen retrofit initiative is the low cost of energy which results in financial pressures acting against efforts to encourage retrofits). For successful initiatives there was an absence of strongly competing pressures, whereas for less successful initiatives there were clear, strongly competing pressures acting as barriers. This is consistent with the notion of antagonistic and synergistic power (Avelino and Rotmans, 2009). For all initiatives competing selection pressures were present, but the strength of such opposing forces varied. For example, car culture was an opposing force in Copenhagen that presented a boundary to progress of the cycling initiative. However, this boundary has been challenged and pushed back over the years and although it remains a barrier to change there is a lot of room for progress before it is blocked by car culture – i.e. the upper boundary to change is a 'high bar'. Whereas for the New York green storm water management initiative, regulatory selection pressures around water quality, premised on a cultural-cognitive grey infrastructure culture, acted as strong barriers to progress. As has been noted, where processes are (perceived to be) entrenched actors employed tactics to 'work around' and 'fit with' these existing processes – in the case of Copenhagen's cycling initiative where efforts to fit with strong cultural-cognitive travel habits were extremely successful results.

Turning finally to the contested nature of the selection environment, across the three cases there is a spectrum from a highly consensus-based environment in Copenhagen to a strongly contested environment in London: Copenhagen's city context is within a national political culture of consensus building; New York has a stable party political backdrop (the democrat party has been in power for 128 years) but a competitive

environment between running Mayors; and London has a party political context which is highly contested. It is important to note that within this overall pattern there are still instances of contestation in Copenhagen and consensus in London. This empirical evidence supports the literature citing the central role of power and politics in transitions (Avelino and Rotmans, 2009; Avelino and Rotmans, 2011), whether that is through a strong consensus or a highly contested environment. The importance of cross-party consensus is suggested from the findings, especially for Copenhagen and London, and less so for New York given that the same political party has been in power for over 100 years. For all three cities the sustainable city vision is accepted within and across political parties and this consistency strengthens the processes in support for an initiative. In Copenhagen there is a particularly strong normative vision, and evidence that this is resulting in (as well as a result of) aligned cultural-cognitive beliefs, e.g. it is no longer seen as legitimate to be against sustainable development.

7.2.4 The impact of history and context

The next cross-cutting finding common across all case studies is the significant impact of history and context on initiative progress. This framework analysis does not unpack history and context, instead it is treated as one category, and the institutional and quasi-evolutionary processes within this category are not explored in the same way as the 'current' aspects of initiatives. This is a limitation of the research, detailed further in the next chapter together with recommendations to address it. However, despite this limitation history and context still emerged as a cross-cutting theme, demonstrating the strong impact of such historical and contextual factors. The evidence from the case studies suggests three key findings: first, history and context have a significant impact upon initiative progress; second, history and context are mutable in the long-term; third, history and context vary within the same place.

History and context have a significant impact upon initiative progress

The pattern from the evidence is of a favourable history and context in the case of the successful initiatives, and an unfavourable history and context in the case of less successful initiatives. For Copenhagen there is a long history of cycling, and as a result there is favourable hard and soft infrastructure (e.g. good existing cycle lane network and culture), already well-aligned with the initiative. In contrast for London there is a long history of centralised energy and therefore the hard and soft infrastructure is misaligned with the decentralised energy initiative (e.g. lack of pipework and professional

ways of thinking). This is consistent with the literature in demonstrating the importance of path dependency and lock-in to physical infrastructures, technologies, habits and heuristics (Unruh, 2000; Unruh, 2002; Hodson and Marvin, 2012; Castán Broto and Bulkeley, 2013; Wolfram and Frantzeskaki, 2016). Furthermore this shows the importance of material infrastructures as part of the institutional 'rules of the game' (Barnes et al., 2018), e.g. the presence of existing physical charging infrastructure from the previously implemented congestion charge supported the ULEZ, or the absence of existing pipework necessary to support decentralised energy.

History and context are mutable in the long-term

However, the evidence shows how decisions made today are shaping the historicity and context of tomorrow. For example, in London for the decentralised energy initiative the policy for all new developments to be 'connection ready' with district energy will mean a much more favourable physical infrastructure in the future. The initiatives are both shaped by, and at the same time are shaping, their context. This chimes with Giddens' (1984) notion of creating our own history, as well as with Meadowcroft's (2011) 'politics of persistence' suggesting long-term efforts are required to change paths and overcome existing path dependency. This obduracy of existing infrastructures, both hard and soft, creates system stability and resistance to radical change, restricting the majority of efforts to incremental change.

This alignment of context with initiatives over time suggests a strong relationship between the stage, or age, of initiative and 'favourability' of history and context. The case study findings suggest that the longer the initiative has been running the more hard and soft infrastructure will already have been shaped in alignment with the vision. Furthermore, the evidence suggests that such alignment in turn influences the (perceived) risk and uncertainty associated with an initiative; well established initiatives will have a track record of success, hence the less (perceived) risk and uncertainty there is. Additionally, the sustainable initiative will become the 'norm' and the unsustainable alternative the outlier (e.g. cycling in Copenhagen and the Clean Heat initiative in New York where only a minority of buildings were still burning low grade heating oil). Again the evidence suggests a pattern where institutional processes change first at the normative pillar, whilst the regulatory and cultural-cognitive pillars are harder to shape (e.g. newer initiatives faced significant cultural-cognitive barriers in terms of credibility, particularly decentralised heating in London and green storm water management in New York).

History and context vary within the same place

Whilst a great deal of attention has been given to the role of place in transitions and the specifics of place-based historicity and context, much less attention has been paid to the variation within places and the specifics or particular initiatives. From the case studies the evidence shows as much variation within cities as between them; i.e. history and context are initiative specific. This has implications for how actors attempt to manage the interplay between initiatives and their context. Furthermore, this responds to the call for a better understanding of the ‘contextual dynamics’ of transitions (Torrens et al., 2018) – by adding an initiative-specific perspective to the place-based perspective this thesis creates a more holistic view.

7.2.5 The configuration of regime processes

The final cross-cutting finding common across all case studies is the impact of the overall configuration of processes on initiative progress. The evidence from the case studies suggests two key findings: first, there are multiple processes at play within the regime and it is the overall configuration of processes that determines initiative progress; second, the configuration of processes at different scales of governance and over time impacts upon initiative progress.

The overall configuration of regime processes determines initiative progress

The first key finding from the case study evidence is that there are multiple processes at play within the regime and it is the overall configuration of these processes that determines initiative progress.

As outlined in Section 7.2.1, the evidence shows that processes are not operating in isolation, there are multiple processes affecting each initiative both positively and negatively. This is consistent with the literature that acknowledges that ‘transitions are not linear processes, but entail multiple, interdependent developments’ (Köhler et al., 2019, p.2). Furthermore the evidence shows that the alignment within and between institutional or quasi-evolutionary processes influences progress. For example, the Copenhagen cycling initiative has strong alignment of cultural cognitive selection pressures in favour of cycling (habits) – alignment within processes. This is also aligned with strong normative selection pressures (visions and standards), and regulatory selection pressures (political pressure) – alignment between processes. Between more

and less successful initiatives there was a clear pattern of greater and lesser alignment. The impact of alignment is explored further in Section 7.2.6.

The configuration of processes at different scales of governance and over time impacts upon initiative progress

Furthermore, the configuration of processes at different scales of governance and over time is important. In terms of scales of governance, the case study shows that cohesion across international, national and local levels of governance supports initiative progress. For example, for the London ULEZ EU air quality regulations are translated into UK law, and the risk of EU fines is passed onto local authorities – providing a coherent, well-aligned configuration of selection pressures that supports initiative progress. Whereas for London's decentralised energy initiative there is disparity between local regulations around decentralised energy and national policy and infrastructure around national generation and supply – inhibiting initiative progress. For all case studies the evidence shows regulatory selection pressures are often imposed through external national and international levels of governance, while normative processes are often local, city-level governance, and cultural-cognitive beliefs are often associated with wider national, or even global trends. This suggests the importance of scale in relation to structuration (Giddens, 1984; Geels, 2011), limiting agency in relation to 'external' regulatory processes and global cultural-cognitive trends, and supporting greater agency for more local normative processes. As previously proposed, this could be explained through the degree of structuration of MLP levels (Geels, 2011), considering the more global, external cultural-cognitive and regulatory processes as landscape scale factors with a deeper degree of structuration, and normative local processes akin to the less structured niche level. And as previously discussed this presents the possibility of niche-style innovation but from within the regime, collapsing the vertical hierarchy of the MLP, with niche and regime levels much more intertwined. This throws up questions around endogenous or exogenous change, which to a large extent rests on analytical boundaries of what is conceived of as external and internal, or niche, regime and landscape.

In terms of configurations over time, evidence from the case studies was largely in relation to political cycles and the stage/age of the initiative, and from the New York case there is also the notable impact of extreme weather events. The impact of political cycles, specifically mayoral terms, introduces temporal variation. The evidence highlights changes in priorities with new mayors that both enable and constrain progress. For example, in New York the Bloomberg administration prioritised sustainable development;

this leadership commitment provided a huge opportunity for change, as evidenced by the very high adaptive capacity in the New York case. The New York case study also illustrates how extreme events impact upon the configuration of processes over time in terms of peaks of cultural-cognitive selection pressure. The absence of extreme weather events relevant to any of the other case study initiatives mean it is not possible to compare this finding across the case studies. However, documentary evidence from Copenhagen shows the impact of a severe flood event in 2011 generating a peak in cultural-cognitive concern (and in turn regulatory political pressure) to respond (City of Copenhagen, 2011). Again as noted in the New York case study these findings are consistent with the literature which points to the impact of events and changes in governance on initiative progress (Barnes et al., 2018).

This overall configuration of processes, and the impact it has on the progress of the two initiatives, can be conceived of as the selection environment in which transition initiatives need to compete to survive. This builds on existing transition work conceptualising the regime as a selection environment which actor efforts are seeking to alter in order to support change (Kemp et al., 2007; Kivimaa and Kern, 2016; Barnes et al., 2018). The case study evidence supports the argument that actors do have agency to shape their selection environment (Barnes et al., 2018), and importantly elucidates the possibilities and constraints in trying to reconfigure regime processes (lower and upper boundaries, temporal windows of opportunity, (mis)alignments across governance scales, processes with most agency and those with most structural power).

7.2.6 Do these current processes enable or constrain progress towards the desired long-term sustainable city outcome?

In critically exploring whether processes are enabling or constraining the case study evidence suggests two key findings: first, the agnostic nature of processes and the contested nature of the regime, hence the importance of both the alignment and strength of processes; and second, how the configuration of processes determines the lower and upper boundaries for progress, and overall speed and direction of change.

The agnostic nature of processes and the contested nature of the regime, hence the importance of both the alignment and strength of processes

The first, fundamental finding regarding whether processes enable or constrain progress is that the institutional and quasi-evolutionary processes themselves are agnostic. This is consistent with the literature documenting the enabling and constraining nature of

institutional structures, selection pressure and power and agency (Scott, 1995; Smith et al., 2005; Avelino and Rotmans, 2011). As the evidence has shown, across all three case studies and initiatives the patterns in terms of *prevalence* of processes is broadly similar. Regulatory and cultural-cognitive selection pressures act as the initial drivers for change. Normative adaptive capacity is employed by actors in response to, and/or in attempting to shape, the selection pressures that constitute the selection environment, i.e. to steer transitions. The greater variation between the more and less successful initiatives is in the *alignment* and *strength* of these processes. This indicates that the difference in progress is due to the overall configuration of processes and whether it is strongly or weakly aligned and enabling, or misaligned and constraining.

Hence, whilst processes are agnostic, whether processes are enabling or constraining depends on their alignment and strength in relation to both the sustainable city vision and wider competing processes within the regime. The emergence of an overall constraining or enabling configuration of processes is determined by the alignment, or misalignment, of processes with outcomes, and the strength of these (mis)aligned processes. In other words, whether the combined selective pressure of aligned processes are stronger than misaligned processes determines the overall direction of travel. Here there is a clear pattern between successful and less successful initiatives. Successful initiatives have well aligned, strong processes, and an absence of strongly competing, misaligned processes. This is one of the main differences between the successful and less successful initiatives across the case studies, and the determinant of whether processes enable or constrain progress.

The configuration of processes determines the lower and upper boundaries for progress, and overall speed and direction of change

Overall then the case study evidence shows that aligned selection pressures (critically cultural-cognitive and significantly regulatory) and purposeful adaptive capacity (especially normative) act as enablers, supported by a favourable history and context, creating the lower limit of ambition, the baseline for action. Competing, misaligned selection pressures (and adaptive capacity) act as a boundary to progress, creating an upper limit blocking ambition and action. The configuration of processes delineates the space for actor agency (the extent of adaptive capacity) and the confines of structural power that limit this agency (selection pressures). The evidence suggests that this configuration will be constantly changing and evolving. In conjunction with the previously noted evidence regarding the reinforcing interplay between selection pressure and

adaptive capacity (see Figure 7.2), and purposive actor efforts to shape change via normative adaptive capacity (see Section 7.2.2), this indicates how actors can use normative visioning capacity to generate reinforcing cycles of change, resulting in a modified configuration of processes. For the most successful initiatives evidence shows this reinforcing cycle over time, creating an ever more aligned, favourable selection environment, i.e. positive path dependency.

This evolving configuration of processes fits with transition theory concepts of the selection environment of the regime, as put forward by Smith et al (2005), and as the rules that 'enable and constrain incumbent actors' as proposed by Geels (2004; 2014). It builds on calls from scholars to move away from viewing the regime as a hegemonic barrier to be overcome, instead providing a richer picture of the regime as a complexity of processes that can both enable and constrain progress (Smith et al., 2005; Geels, 2011). Furthermore, it suggests endogenous regime change is possible (albeit very challenging), and points to how actors can first understand and second attempt to modify the configuration of processes and shape the regime selection environment in favour of sustainable city visions.

7.3 Overall findings in terms of research aims and questions

Having critically explored and compared evidence across all three case studies, what do these findings tell us? How do they address the research gaps and answer the research questions?

The findings from all three case studies address the weakness and gaps identified in the literature review. The evidence clearly demonstrates the importance of processes in transitions, specifically identifying regime-level processes, including the role of non-technical, everyday processes and the role of power and agency.

In terms of the first research question regarding what processes are at play, there is a clear pattern across all three case studies: cultural-cognitive selection pressures drive change; regulatory selection pressures provide the mandate to impose and enforce change; and normative adaptive capacities enable actors to purposively respond to, and shape, selection pressures.

Considering the second research question, again there is a clear pattern: institutional and quasi-evolutionary processes are neither inherently enabling nor constraining – they are agnostic in nature; instead it is the alignment and strength of processes that

determine whether they enable or constrain progress; finally the overall configuration of processes determines the potential speed and scale of change possible – it is the overall alignment with the vision and the presence or absence of competing processes that determines the lower and upper ‘boundary’ for progress.

Through explicitly identifying the institutional and quasi-evolutionary processes driving transitions the analytical framework offers a more precise model of change and enables a finer grained analysis of the selection environment in which the initiatives have to compete. This granular analysis opens up the ‘black box’ of the regime, and enables ‘mapping’ of the configuration processes at play relevant to the initiatives within each city, and shows how actors are attempting to shape and change this configuration. These insights suggest that actors can use the framework to better understand, map, navigate and shape the regime selection environment to accelerate transitions.

Having critically explored findings across all three case studies, the next, concluding chapter considers the implications of these results.

Chapter 8 Conclusion

“the grand challenges related to sustainability remain unsolved, calling for continued efforts and an acceleration of ongoing transitions” (Köhler et al., 2019, p.2)

This thesis aimed to understand, and hence help overcome, the implementation gap between long-term sustainable city visions and current progress towards them. In doing so it aims to contribute towards tackling the vital challenges of our time: the ecological crisis; the necessity for more sustainable development; and the rapidly urbanising nature of our society. Specifically, the research provides a theoretical and practical contribution to the body of knowledge of how to achieve sustainable urban transitions.

This concluding chapter is structured as follows: the first section re-states the rationale behind the research and the aims of this thesis; the second section sets out the theoretical context within which the research is situated and the contribution to knowledge that it makes; the third section provides an overview of research questions and main conclusions from the findings; the fourth and fifth sections detail the implications for theory and practice; the sixth section covers limitations; the seventh section sets out recommendations for future research; and finally concluding remarks are offered.

8.1 Revisiting the research rationale and aim

We are currently facing an unprecedented ecological crisis. Given the existing and increasing scale of urbanisation, cities are both part of the problem and essential to solving it. This thesis focuses on sustainable urban transitions, responding to the ‘implementation deficit’ between visions and current progress to achieve them. Achieving the goal of sustainable cities remains elusive and the question of how to reach long-term sustainable city visions through current processes remains paramount.

Resolving the persistent problems of unsustainable urban society requires radical transformation of the system itself (second order learning). Given the complexity of dynamic, adaptive socio-technical systems, knowledge and control are limited – it is not possible to ‘know’ or control all parts of the system. Hence solutions need to move beyond modernistic command and control approaches to more reflexive governance to

purposively steer and direct. This shift in approach implies greater attention to the processes of change, versus focus on the definition of desired final outcome. Therefore greater understanding of processes enabling (or constraining) change (or stability) is crucial to unlocking urban transitions at the speed and scale required to meet the grand challenges of sustainability.

Transitions theory and the MLP offer a promising means to understanding such change. However several blind spots within transition research obscure a fuller picture of the processes and dynamics of change. The fixation with niche innovation has led to a neglect of regime-level processes, leaving unanswered questions around the endogenous dynamics of stability and change, and power structures and active resistance. Furthermore, the focus on technological innovation has led to a neglect of the broader drivers of change, in particular socio-cultural 'everyday' demand-side drivers, but also regulatory, financial and political drivers. Finally power and agency require further work to better conceptualise and explore their role in regime-level change.

This leads to the research aim to better understand the *processes* of transition in order to gain insights into how to accelerate progress towards sustainable city *outcomes*, in particular, regime-level processes including everyday, non-technical processes and the role of power and agency.

8.2 Situation and contribution

This thesis takes transition theory as its foundational construct and draws on institutional and quasi-evolutionary theory to build a more holistic model of change. This novel analytical framework provides a theoretical contribution by addressing four significant gaps in knowledge. First, a greater understanding of the processes driving change towards sustainable city outcomes is needed. As set out in the literature review this thesis acknowledges the complexity of sustainable urban transitions, and accepts the futility of blueprint, command and control outcome-based approaches of deterministic vision-led change. Instead this research takes a process-oriented approach to generate insights in support of a more learning and adaptive style of purposive, vision-steered change. By drawing on quasi-evolutionary theory and conceptualising a selection environment in which transitions develop via selection pressures and adaptive capacity processes, this thesis contributes to the ability of transition theory to account for the dynamics of complex adaptive systems, such as cities.

Second, this thesis focuses on regime-level change, in doing so addressing the neglect of the regime in the literature and challenging the implicit view of the regime as a monolithic, homogenous and largely inhibitory element in transitions. This spotlight on the meso level of the MLP helps unlock the 'black box' of the regime and illuminate the complex, contested institutional structure and evolving selection environment within which transitions play out.

Third, by drawing on institutional theory the analytical framework addresses the neglect of non-technological, everyday aspects of transitions. This contributes to the development of transition theory, and better accounts for the role of wider institutional processes, in particular bringing in the role of social practice.

Fourth, this thesis attempts to foreground the role of power and agency. Both institutional and quasi-evolutionary theory add depth to traditional transition analyses of power and agency by enabling an explicit conceptualisation of power via structural institutional rules and selection pressures, and individual and collective agency and adaptive capacity.

The research approach used comparative case study analysis of three leading sustainable cities, looking at two initiatives within each city. This approach allows the research to offer both theoretical and empirical contributions. By moving away from a sector- or technology-specific approach to look at the city system as a whole, this work contributes to an understanding of how to achieve holistic transitions that cut across sectoral siloes. By exploring three city cases, this thesis offers a comparative analysis addressing the current gap in such work and providing insights into place and initiative-based specifics of transitions. Furthermore, applying the novel framework enables a much finer grained analysis of the unique context of each place-based initiative but within a common framework of processes.

By situating this research in transition theory, but drawing on institutional and quasi-evolutionary theory to create a novel framework this thesis offers a theoretical contribution. By taking a holistic city view and comparing across three cases this work makes an important contribution to the empirical evidence. And by situating this work firmly in the reality of the challenges city actors are facing in achieving sustainable city goals, this research offers contributions to policy and praxis.

8.3 Research questions and conclusions

Having summarised the research aim and gaps, and the research approach adopted, this section briefly reiterates the research questions before going on to detail the main conclusions from the findings.

This thesis poses two research questions: first, what are the institutional and quasi-evolutionary processes that drive regime-level change; and second, why and how do these processes vary, and do they enable or constrain change?

In order to undertake an in-depth exploration of these questions a novel framework was developed to analyse and critically compare empirical evidence gathered from three case studies including successful and less successful sustainable city initiatives.

The research questions and analytical framework respond to the four research gaps summarised in the previous section and detailed in the introductory and literature review chapter (see Section 1.7 for full research questions and Section 2.2 for full description of the analytical framework), and the research approach of in-depth exploration through comparative case studies is justified as an effective approach in the methodology chapter.

The evidence and insights that answer the research questions have been set out in the case study chapters, and critically compared in the discussion chapter which presents cross-cutting themes and overall findings.

The primary conclusion to note is that the novel framework is an effective tool to enable deeper analysis of transitions. By grounding analysis in transition theory and the MLP, and additionally drawing on institutional and quasi-evolutionary theory, the framework effectively enables a process-oriented approach, better accommodating the complexity of transitions, and it enables finer grained analysis of regime-level processes by addressing the research gaps identified in the review of the literature regarding non-technical, everyday processes and of the role of power and agency.

The deeper understanding enabled by the framework highlighted the following main conclusions:

First, transitions are not vision-led, or at least not entirely determined and controlled by visions. Importantly they are vision-steered. This supports the call for a process-oriented approach and the need for theoretical developments to enable a greater understanding of processes. Furthermore it suggests that practitioners need to translate visions into

processes in order to achieve them. More attention needs to be given to the later stages of transitions that come after visioning in order to ensure that long-term, desired outcomes are underpinned by real-life, regime-level processes.

Second, the processes most strongly driving change, the underlying drivers, are cultural-cognitive and regulatory selection pressures. Therefore, sustainable city visions need to build on these underlying drivers in order to achieve substantive progress; working with, not against, the 'flow' of the regime. Transition theory needs to pay more attention to cultural-cognitive processes in particular, this research demonstrates their fundamental role yet they are currently neglected within transition literature.

Third, whilst selection pressures act as the initial drivers for change, this research shows that actors have a high degree of agency to shape and steer transitions through adaptive capacity. This agency can be used to purposively alter the selection environment in favour of sustainable city goals through normative visioning and associated efforts to build on and shape cultural-cognitive selection pressures (e.g. in Copenhagen storytelling and symbols to strengthen cycling culture) and to create and shape regulatory selection pressures (e.g. lobbying in New York for changes in heating oil regulation). Adaptive capacity is both enabled by, and enables, the coordination of power and allocation of resources. Reinforcing cycles of alignment can occur between adaptive capacity, coordination of power and resources, and selection pressure, effectively driving change over time.

Finally, actors need to understand the configuration of processes at play to more strategically and effectively shape, and navigate through, the selection environment. In particular awareness of the main drivers of change and the lower and upper 'boundaries' of the selection environment are crucial in understanding what initiatives are most likely to succeed and which processes are enabling or inhibiting process. In this way actors can target specific processes, and develop effective strategy and tactics to reconfigure processes, and shape the selection environment (e.g. policies that support cycling, vs restricting cars, work better with the selection environment in Copenhagen). This can inform when to use adaptive capacity to shape selection pressures (e.g. changing regulations as for the New York Clean Heat initiative), and when to use adaptive capacity to 'better fit with' existing pressures (e.g. 'fitting with' existing travel habits as per cycling in Copenhagen). And furthermore, understanding the configuration of regime processes can inform when and how to use second-order knowledge and capacity to purposively

attempt structural change (e.g. New York Mayors Office of Sustainability and Copenhagen's cycling secretariat).

8.4 Implications for theory: insights for current conceptual transition debates

The findings from this research both support calls for a process oriented approach (Geels, 2011; Cook and Swyngedouw, 2012; Chatterton, 2013), and help to enable this. Greater attention to processes over outcomes encourages: first understanding and awareness of the wider selection environment in which the vision and associated initiatives are playing out; and second, through illuminating the configuration, it encourages and enables purposive, second order, systemic change. Furthermore, the findings suggest that focusing on all stages of transition and paying much more attention to the wider regime environment in which they are playing out is critical to ensuring transitions successfully get beyond the visioning stage.

In particular, the results from this framework analysis provide a much better understanding of power and agency, highlighting the interplay between structural power and individual and collective agency. This reconceptualises and collapses the hierarchy of the MLP, especially the niche-regime relationship. The research shows that the powers shaping, and agency to shape, are being played out often by the same actors in the same space challenging the concept of separate niche and regime spaces and actors. This finding supports the existing research suggesting close overlap and interplay between the niche and regime (Smith, 2007; Schot and Geels, 2008; Geels, 2011; Elzen et al., 2012), and goes further in breaking down the boundary between regime and niche by suggesting that regime actors create space for innovation and shape change within the regime itself. This raises fundamental questions about whether change is external to the regime, or to what extent it is external, challenging the implicit view of the regime as a monolithic barrier to change and reconceptualising it as a heterogeneous environment, acting as a source of both stability and change. The stage of initiative, and transition, could explain the high level of niche-regime intertwinement. The successful examples from the case studies might all represent initiatives in later stages where the process of niche integration within the regime is so advanced that the margin between the two has almost entirely been eroded. What is clear is that the boundary between niche and regime is very blurred. This throws up a dilemma for practitioners. Should they create separate niche spaces for change protected from the competitive selection environment of the regime? Or is it better to develop innovation

from within the regime, by regime actors and structures, to minimise any ensuing battle for dominance. Or does endogenous change limit ambition and risk vested interests - here though one should be careful not to assume niches are virtuous spaces free from vested interests, and that regimes are inherently positioned against positive change. Collapsing the MLP, especially the niche and regime, can help to avoid overly distinguished levels (and associated systems, spaces, structures and actors), and the consequent temptation to endow traits and interests to these that do not reflect the complexity, and messiness, of reality.

The extent to which regime change is internal, and if so how such endogenous innovation can lead to structural system change needs further exploration. Some of the evidence from this research suggests that 'external' shocks and forces are necessary for change (imposed, supra-city legislation such as EU air quality laws, or flooding). On the other hand the case studies show examples of internal system problems driving change (e.g. air pollution concerns).

As well as raising questions about internal and external nature of regime change, this reconceptualisation of the hierarchy of the MLP brings the traditional vertical MLP levels into overlap with the horizontal circles of practice. This conception aids incorporation of the central role of practice into regime change, and transitions. The findings from this research contribute further theoretical insights, suggesting that in attending to the role of practice, as well as paying attention to habits, equal importance needs to be paid to heuristics as ways of thinking can exert powerful structural confines to agency and change.

Having blurred one boundary this research attempts to delineate others. The interplay between selection pressures and adaptive capacity is conceptualised in this thesis as the duality between structure and agency; structural selection pressures are both 'the medium and the outcome' of adaptive capacity (Giddens, 1984). This captures the ongoing co-evolution between selection pressures and adaptive capacity; how at the same time as structure shapes agency, agency is shaping structure. And whilst it is challenging to separate this duality, the analytical framework aims to do this, helping illuminate distinct processes at play within this complex co-evolution. In addition, this thesis attempts to distinguish a flow of change processes, starting with driving selection pressures, moving on to shaping adaptive capacity, and finishing within the overall configuration of the wider selection environment. This belies the complex reality with no neat start or finish points, but it does offer an effective analytical approach to better

understand urban transitions and how actors can influence them. Furthermore, the analytical boundaries provided by the three institutional pillars provides additional process groupings that enable more granular insights. Hence, this thesis moves beyond acknowledging the complex regime where 'everything is co-evolving with everything else' and supports a much 'finer analysis' of what the main processes at play are, and the alignment and strength of these processes (Malerba, 2006).

8.5 Implications for practice: insights into how actors can modify processes to better align with, and achieve, transitions

The insights from the framework and case study data suggest a number of potentially fruitful options for actors to modify processes in order to enable and accelerate progress towards long-term sustainable city visions. These are set out below.

First, the analysis provides empirical evidence that contemporary sustainable urban transitions are not vision-led, i.e. transitions are driven by other selection pressures, not by visions. Counter-intuitively, acknowledging this is an important first step for actors attempting transitions. Understanding that the complexity of sustainable city regimes precludes control of all the processes opens the way for more realistic, viable approaches whereby actors can attempt to map and understand the main processes in play (acknowledging that total knowledge of the whole system is not possible) (Grin et al., 2010). However, whilst transitions are not vision-led, there should be a clear, desired direction of travel that actors can use their best efforts to purposively steer towards.

As the evidence has shown, normative adaptive capacity, in particular around visioning, are the processes which actors have the highest level of agency to shape, and this should be utilised to the maximum. Furthermore case study evidence suggests that these normative visions need to build upon existing drivers and be translated into regulatory and cultural-cognitive processes, or they will struggle to survive (and certainly won't thrive) in the competitive regime selection environment. Therefore, to accelerate progress actors should employ four main strategies: (1) normative visioning to provide direction and normative adaptive capacity to shape change; (2) building on the selection pressures which are driving transitions; (3) translation of the normative vision into cultural-cognitive and regulatory processes; and (4) mapping and working with the wider context and configuration of regime. It should be noted here that these strategies are not phased, instead they need to be carried out in parallel and to some extent iteratively.

8.5.1 Normative visioning and adaptive capacity

Results from the three case studies suggest that normative processes provide the best entry point for sustainable city network actors to shape change. This is where the greatest prevalence of adaptive capacity was observed, and the examples from interviews indicate that regime-level actors have greatest potential to influence normative selection pressures, as opposed to the more embedded and less locally-determined cultural-cognitive and regulatory selection pressures.

Furthermore, results suggest that actors can purposively influence normative processes through creating a sustainable city vision and values to steer transition. Whilst visions were repeatedly mentioned across all three institutional pillars, the data shows that normative adaptive capacities were most prevalent in vision setting, enabling actors to establish a strong vision that then acts as an effective selection pressure. City actors have a high normative adaptive capacity and they need to use this to set sustainable city visions, and associated initiative visions. These should be clear, time-bound and resourced. Whilst these visions will not determine or dictate transitions they are critical in giving a clear steer for the direction of transformational change, and providing a focal point for coordination of power and alignment of resources.

Additionally city actors can develop new standards that drive decisions through generating a new set of professional selection pressures. These can be used to challenge and (albeit gradually) change cultural-cognitive beliefs, for example the supremacy of car over cycle or grey over green infrastructure.

8.5.2 Building on the selection pressures driving change

Considering strategies to build upon existing drivers, the framework can be used to 'map' out processes. In particular identifying aligned selection pressures and adaptive capacity that might support progress, and competing processes that might constrain it. This can inform better transition strategy and tactics, and the most effective use of resources. Starting with the drivers for change, actors should build upon existing cultural-cognitive and regulatory selection pressures that provide a strong functional imperative for change. Given these are not determined by the sustainable city vision, the challenge for actors is how to link existing drivers with the vision. Here the case study findings suggest opportunities to use adaptive capacity to: shape and influence problem definition of cultural-cognitive concerns; frame visions in-line with cultural-cognitive concerns;

articulate supporting cultural-cognitive concerns; and enforce supporting regulatory pressures.

For the more successful initiatives these normative visioning processes are supported by cultural-cognitive beliefs providing an underlying legitimacy and imperative for action. This politicisation is critical in providing city governments with a mandate from voters. City actors need an understanding of where this exists and where it is lacking. Mapping cultural-cognitive processes can facilitate insights into where the best support for change lies, and where support could be bolstered. Cultural-cognitive processes are harder to influence, especially at a city scale, but the evidence suggests city actors have some agency to shape cultural-cognitive habits and heuristics, in particular building on where there is already support. The case studies show the effective use of adaptive capacity to: shape problem definition e.g. using data and research to evidence air quality problems and importantly the health impact of these; build upon supportive cultural-cognitive beliefs, e.g. using stories and symbols to strengthen favourable cycling selection pressures; align initiatives with existing cultural-cognitive pressures, e.g. making cycling the most convenient form of travel, fitting with strong selection pressures in the form of travel habits; and articulate existing concerns to strengthen their selection pressure e.g. communicating air quality and health concerns to decision-makers, especially through effective visuals and narratives.

For regulatory drivers the case study evidence suggests the strongest regulatory pressures are externally imposed and enforced, and therefore least within the control of sustainable city actors. However, the case studies, particularly New York, also show the potential to influence state and national regulations – noting the challenge and mixed success of these attempts. Additionally actors can strengthen existing regulatory selection pressures through effective enforcement (e.g. Client Earth legal action against the UK government on air pollution).

Actors should also be mindful of potential competing initiatives, and consider options for working around, or fitting with strongly entrenched processes, e.g. for Copenhagen creating a cycling network that means cycling is the fastest, easiest form of transport – and hence fits with entrenched cultural-cognitive selection pressures around travel habits. In other words actors should attempt to work with the grain of the regime, endeavouring to avoid regime resistance. Acknowledging the limits to agency and recognising that agency to steer change is bounded by the structural power imposed by competing processes can support the most effective focus for efforts and resources.

Furthermore actors should be mindful of history and context, as these influence the wider selection environment. History and context are important in understanding how to facilitate decisions and action in any given context; i.e. cities need to understand their context in order to be able to best shape change. This consideration of path dependency can support strategies and tactics appropriate to the stage of initiative, and manage expectations about the degree of support required and success achieved for new vs more established initiatives. It may help to identify when sufficient alignment has been achieved to enable accelerated action.

8.5.3 Translation of the normative vision into cultural-cognitive and regulatory processes

Turning to translation of the vision, the case study evidence suggests that normative visions need to be translated into regulatory and cultural-cognitive processes in order to survive (and thrive) in the wider selection environment of the regime. The framework analysis by institutional pillars shows where actors have most agency (the normative pillar), and conversely where the balance of structural power is greater (the cultural-cognitive and regulatory pillar, especially externally influenced or imposed selection pressures). The most successful initiatives used adaptive capacity to shape the selection pressures, better aligning the structural power with initiative goals.

The case studies show that efforts to translate normative visions into regulatory selection pressures are the most prevalent tactic used by actors, suggesting this is the most accessible option. Here actors translated visions into 'hard' targets and mandatory planning requirements; for example the target to phase out number six heating oil within three years, and the mandatory planning requirement for decentralised energy. The strength of the resulting selection pressures is important. Here accountability and enforcement (e.g. mandatory public reporting, clear allocation of responsibility for progress and/or direct reporting to the Mayor) are key to the strength of the resulting selection pressure.

There were also examples of efforts to translate normative visions into cultural-cognitive selection pressures, although these were less prevalent; the evidence suggests this was a differentiating factor between successful and less successful initiatives. Here purposeful efforts to change cultures and ways of thinking were used, e.g. stories and symbols, and visuals and narratives.

The case study evidence also provides more fundamental examples of actor attempts to shape the selection environment, in particular efforts to align structural power. For example the creation of a Mayors Office of Sustainability and a cycling secretariat. Here actors talked about purposive organisational change to redistribute power and resources: importantly delegation of authority and decision-making power; allocation of budget (note Copenhagen's cycling secretariat had this, whereas the Mayor's Office for Sustainability didn't and this created barriers to progress for New York); and bringing in new staff with new mind-sets, helping to re-align cultural-cognitive selection pressures in the form of professional ways of thinking. This is where the greatest adaptive capacity and progress was seen.

Without this translation of the vision, city actors will struggle to achieve their ambition and there is the risk that visions becoming empty promises. With this translation, long-term outcomes can be effectively converted into short-term selection pressures that drive the decisions and action required to fulfil the vision.

8.5.4 Mapping the wider configuration of the regime

The findings show that whilst there are many similarities in the processes across the case studies, the configuration and context are specific to each place and initiative. This is an extremely important point; processes will play out differently for different initiatives, at different times, and in different places.

Cities can better understand the configuration of processes at play by considering both the degree of (mis)alignment with the sustainable city vision, and the relative strength (and weakness) of processes. And whilst actors cannot command and control progress towards the sustainable city vision, they do have the agency to actively and purposively shape the configuration of processes in order to create a more favourable selection environment. Furthermore, coordination of power and allocation of resources are central to attempts to shape and steer transitions. The case study evidence suggests that actors can adopt successful tactics for achieving this, principally through: network and coalition building; and generating knowledge. Identifying and realising opportunities to create reinforcing cycles of alignment between selection pressure, adaptive capacity (and resource allocation and coordination of power), offers significant potential for accelerating transitions.

This re-alignment of the overall configuration of processes represents fundamental regime change, in contrast to visions that are 'layered onto' the existing regime selection

environment (Voß et al., 2009). All too often visions are set without any systemic change (e.g. in city network formations or municipality structure), or without any real authority or dedicated resources. If city actors are serious about transformational change then they need to make these structural modifications in order to achieve it.

The case studies from leading cities show best practice in terms of purposive steering to accelerate transitions, and the considerable agency that can be deployed and success in structural reform that can be achieved. But they also demonstrate clearly the boundaries to progress from competing processes within the wider configuration. This illuminates where sustainable city actors can effectively deploy agency and suggests that some aspects of urban transitions may require additional actors and their associated agency (e.g. national government action on building regulations).

8.6 Limitations

This section sets out the limitations of the conclusions drawn. The methodological limitations are not included here having been laid out in the methodology chapter (see Section 3.7 for full details of these methodological limitations: the sampling focus on *sustainability* actors and potential bias from this; the grouping of historical and contextual factors as a homogenous residual category; and the challenges of ambiguous and complex analytical boundaries).

The first limitation to note here is that whilst city actors offer the potential for leadership and real change, cities do not offer a silver bullet solution to the sustainable challenges society is facing. There is a danger that in emphasising the critical role of cities in the transition to a sustainable society, the implicit assumption is made that cities can therefore deliver this transition. This downplays the role of other levels of governance, and overplays the capacity of cities. Furthermore, it risks the presumption that urban actors have both the will and the agency to unilaterally achieve change, and that they are awarded the responsibility for doing so. Therefore whilst it is absolutely correct to highlight the pivotal role of cities, care needs to be taken to situate this as part of wider, coordinated efforts at all levels of governance.

The second limitation is that the findings from the three case study cities are not globally representative; London, New York and Copenhagen are all capital cities, in developed, urbanised nations. And whilst the analytical framework is designed to facilitate transfer of findings by identifying the underlying regime processes that are universal to all contexts (i.e. regulatory, normative, cultural-cognitive institutional processes and quasi-

evolutionary selection pressures and adaptive capacity are common to all urban selection environments), caution should be applied in extrapolating from these case studies to very different urban contexts. More work needs to be done to explore regime processes driving urban transitions in small- and medium-sized cities, and in developing world, rapidly urbanising contexts.

The final limitation of these findings is in their accessibility. In attempting to 'manage' the complexity of transitions the framework combines three theories and requires that potential users (either in attempting analysis or interpreting results) hold several theoretical concepts in mind. This potentially limits dissemination of this approach and any resulting findings, particularly beyond academia. However, the theoretical complexity is defensible from two standpoints: first that many city actors demonstrate an extremely high capacity and are well able to handle this level of complexity; and second that in attempting to gain sufficient insights into and understanding of transitions, complexity is required - simple models are not adequate. Therefore, it is hoped that this thesis strikes the right balance between the 'irreducible complexity' of transitions and the need for a framework that is sophisticated enough to adequately analyse and model transitional change (Vasileiadou and Safarzyńska, 2010; Köhler et al., 2019).

8.7 Research recommendations

A number of research recommendations are proposed to further refine and develop the framework. First, additional case studies should be analysed to test the efficacy of the framework, and the consistency and quality of findings over a wider number of city cases and initiatives. In terms of efficacy, as noted above, the framework is designed to be generally applicable and processes are universal to all urban contexts. However this needs to be verified in different contexts to before global utility of the framework can be confirmed with confidence. In terms of the consistency and quality of findings, case studies exploring a wider variety of urban contexts including small- and medium-sized cities and developing world and rapidly growing cities are needed. Ideally future work would explore multiple cases, allowing for comparative analysis. Further application of the framework would also test the extent to which it enables comparison of results between different research projects – responding to calls from transition scholars to build up evidence and learning from across case studies (McCormick et al., 2013; Wolfram and Frantzeskaki, 2016).

Second, further analysis of historical and contextual factors is required. Instead of treating these factors as one homogenous group, analysis should treat context specific and historical path dependencies as multiple processes. This attention to history and context would provide greater insights into path dependency and to what extent historical and contextual factors are mutable, and if so, what agency actors have in shaping their history and context. In particular the impact of material, physical infrastructures on transitions merits further interrogation. This research demonstrates the impact of material infrastructures across all institutional pillars and both selection pressures and adaptive capacity. This suggests that material infrastructures might be analysed and categorised according to the framework, enabling a much deeper exploration and more detailed appreciation of the role of physical structures and artefacts in transitions.

Third, incorporating a wider range of regime actors' views in the research (i.e. not just actors associated with sustainable city initiatives), although challenging from a practical resource perspective, would supply a less biased sample of perspectives and interview data, and therefore support a better understanding of the wider regime environment. The ambition of this thesis was to understand regime processes in order to support the wider transformation of mainstream society that is so urgently needed. Therefore further research capturing data from a wider sample of regime actors, particularly those less associated with sustainable city initiatives would provide a fuller picture of regime processes – and hence greater understanding and ability to intervene. Sampling across the technical and non-technical aspects, and the novel and everyday aspects of the regime should be maintained to enable understanding of wider institutional processes at play, for example by ensuring legal and financial actors are included as well as e.g. engineers and developers.

Fourth, further exploration of the potential for endogenous change is warranted. Questions investigating where and how actors should best nurture innovation so that it results in wide-spread regime change are fundamental to the success of transitions. The findings from this thesis suggests that the potential for endogenous regime change exists and that regime processes and actors can enable, as well as constrain transitions. Further research should explore this possibility, and investigate how processes of endogenous regime change might compliment and build on the existing research concerning niche innovation. Whilst blurring boundaries between regime and niche processes might throw up initial theoretical challenges it could ultimately lead to further insights.

Of particular relevance to the above recommendation is the research finding that shows internal problems (e.g. air pollution concerns) can drive change. Research findings also demonstrated the impact of external drivers of change (e.g. extreme weather events, imposed regulation). Hence, explorations of endogenous change should not preclude exogenous sources of change; i.e. investigation of the potential of both external shocks and internal problems to drive change should be explored further. In particular exploring whether, and if so how, actors might anticipate and best 'capitalise' on these opportunities.

Finally, the framework should be extended to more explicitly take into account alignment and strength of processes. Currently the framework explicitly separates processes, but not their alignment or strength. As has been seen from the results of this research the (mis)alignment and strength of processes are fundamental to the success of initiatives. Therefore further work to explore how alignment and strength could be systematically analysed is needed. Extending the framework in this way offers further depth of exploration into understanding the enabling or constraining nature of (the configuration of) processes shaping transitions. This would enable transition scholars and sustainable city actors to gain further insights, to better understand and map the regime, and hence enable them to more effectively modify the selection environment in favour of sustainable city initiatives.

Transition scholars and practitioners are encouraged to use and adapt the framework to generate further insights and practical applications for accelerating urgently needed city sustainability transitions.

8.8 Concluding remarks

This thesis set out to generate insights into urban transitions. My aim was to contribute to addressing the persistent, and growing, gap between our visions of sustainable cities and the present day reality - and in doing so to support the committed and continued efforts of urban actors in achieving more sustainable cities. I wanted to get under the skin of what really drives change at regime level - acknowledging that beyond niche innovation and pockets of best practice and progress, we need to radically transform the mainstream of the regime. In this thesis I firmly challenge the notion of the regime as a monolithic barrier, and of dominant regime actors resisting change, instead proposing the idea (and hope) of a complex regime riddled with potential for change, and with regime actors who have the will and capacity to bring it about. Through this research I have generated insights into the processes behind change, unlocking the 'black box' of the regime and detailing the specific mechanisms of transitions. To do so I developed a novel analytical framework that can be used by city actors to better understand their urban selection environment, thereby increasing the chances that sustainable city initiatives survive and thrive within this contested and competitive regime. In bringing a practitioner view to this PhD research I have contributed to theoretical knowledge, stubbornly situating this research within a real-world context and testing the utility of transition theory to deal with the messiness of reality - and by doing so developing theoretical insights that can support the aim of transition scholars to generate impact on the ground.

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Appendices

Appendix A. Ethical review

A.1. Ethical approval form



UNIVERSITY OF LEEDS

University Research Ethics Committee - application for ethical review

Please email your completed application form along with any relevant supporting documents to ResearchEthics@leeds.ac.uk (or to FMHUniEthics@leeds.ac.uk if you are based in the Faculty of Medicine and Health) at least 6 weeks before the research/fieldwork is due to start. Dentistry and Psychology applicants should follow their School's procedures for submitting an application.

Ethics reference (leave blank if unknown)	Student number (if a student application)	Grant reference (if externally funded)	Module code (if applicable)
	993083361	ES/J500215/1	

Faculty or School Research Ethics Committee to review the application (put a 'X' next to your choice)	
	Arts and PVAC (PVAR)
	Biological Science (BIOSCI)
X	ESSL, Environment and LUBS (AREA)
	MaPS and Engineering (MEEC)
	School of Dentistry (DREC)

		School of Healthcare (SHREC)
		School of Medicine (SoMREC)
		School of Psychology (SoPREC)

Indicate what type of ethical review you are applying for:	X	Student project (PhD, Masters or Undergraduate)
		Staff project (externally or internally funded)

Section 1: Basic project details			
1.1 Research title		The processes and outcomes of sustainable cities	
1.2 Research start date (dd/mm/yy)		Proposed fieldwork start date (dd/mm/yy)	Proposed fieldwork end date (dd/mm/yy) Research end date (dd/mm/yy)
1/10/2014		07/06/2016	01/07/2017 31/03/2019
Yes	No		
X		1.3 I confirm that I have read and understood the current version of the University of Leeds Research Ethics Policy. <i>The Policy is available at http://ris.leeds.ac.uk/ResearchEthicsPolicies.</i>	
X		1.4 I confirm that I have read and understood the current version of the University of Leeds Research Data Management Policy. <i>The policy is available at http://library.leeds.ac.uk/research-data-management-policy.</i>	
X		1.5 I confirm that I have read and understood the current version of the University of Leeds Information Protection Policy and undertaken the online information security awareness training course at https://vlebb.leeds.ac.uk .	

		<i>The policy is available at http://it.leeds.ac.uk/info/116/policies/249/information_protection_policy</i>
X		1.6 I confirm that NHS ethical review is not required for this project. <i>Refer to http://ris.leeds.ac.uk/NHSEthicalreview for guidance in identifying circumstances which require NHS review</i>
	X	1.7 Will the research involve NHS staff recruited as potential research participants (by virtue of their professional role) or NHS premises/ facilities? <i>Please note: If yes, NHS R&D review may be needed in addition to University of Leeds ethical review. Refer to http://ris.leeds.ac.uk/NHSEthicalreview.</i>

Section 2: Contact details	
2.1 Name of applicant	Rachel Huxley
2.2 Position (eg PI, Co-I, RA, student)	PhD Researcher
2.3 Department/ School	Earth and Environment
2.4 Faculty	Environment
2.5 Work address (usually at the University of Leeds)	Sustainable Research Institute School of Earth and Environment University of Leeds Leeds LS2 9JT
2.6 Telephone number	07419 373332
2.7 University of Leeds email address	r.huxley@leeds.ac.uk

Section 3: Summary of the research

3.1 In plain English provide a brief summary of the aims and objectives of the research.

(max 300 words). The summary should briefly describe

- the background to the research and why it is important,
- the questions it will answer and potential benefits,
- the study design and what is involved for participants.

Your answers should be easily understood by someone who is not experienced in the field you are researching, (eg a member of the public) - otherwise it may be returned to you. Where technical terms are used they should be explained. Any acronyms not generally known should be described in full.

Cities are critical to addressing sustainable development: over 50% of us live in cities; they consume 75% of global resources and account for 70% of global CO₂ emissions. Cities have responded to this challenge with a large number committing to sustainable visions and/or initiatives such as the C40 Cities Climate Leadership group or ICLEI Local Governments for Sustainability network. From my experience as a practitioner in the field of sustainable cities these commitments are genuine. However, whilst there are pockets of best practice, cities are not achieving the scope or speed of progress required. This is backed up by the literature which broadly acknowledges that progress is insufficient and by the 'science' in terms of e.g. the findings of the IPCC fifth assessment report.

The fact that cities remain unsustainable despite commitments to the contrary is the rationale for this research. Why does this implementation gap exist between cities' long-term aspirations and their short-term realities?

The research therefore aims to address this issue of implementation by undertaking a deep investigation into whether there is a temporal and/or connectivity gap between long-term visions and current processes. Three comparative case studies of global cities (London, New York and Copenhagen) will be undertaken to explore how existing

decision making processes enable or constrain progress towards long-term sustainable city visions. Semi-structured interviews will be undertaken with 12-20 sustainable city actors, and observation with a sub-sample of these, as well as observation of a small number of meetings. Informed consent will be sought with all participants before any research is undertaken.

In addition two workshops will be undertaken with a small number of sustainable city practitioners before and after data collection in order to co-develop and validate research design, findings and recommendations.

All participation will be in a professional, not personal capacity.

3.2 Who is funding the research?	ESRC (WR DTC)
----------------------------------	---------------

Section 4: Research data

You may find the following guidance helpful:

- [Research data management guidance](#)
- [Advice on planning your research project](#)
- [Dealing with issues relating to confidentiality and anonymisation](#)

4.1 What is the data source? (Indicate with an 'X' all that apply)

X	New data collected for this research
---	--------------------------------------

	Data previously collected for other research
--	--

X	Data previously collected for non-research purposes
---	---

X	Data already in the public domain
---	-----------------------------------

	Other, please state: _____.
--	-----------------------------

4.2 How will the data be collected? (Indicate with an 'X')

X	Through one-to-one research interviews
---	--

	Through focus groups
	Self-completion (eg questionnaires, diaries)
X	Through observation
	Through autoethnographic research
	Through experiments/ user-testing involving participants
	From external research collaborators
X	Other, please state: secondary data analysis of documents and archival material.
<p>4.3 How will you make your research data available to others in line with: the University's, funding bodies' and publishers' policies on making the results of publically funded research publically available (while not compromising requirements around data protection legislation)? (max 200 words)</p>	
<p>Outputs from the research would be the thesis, journal publications during research, and conference presentations for both academics and practitioners. Papers will be submitted to high impact journals e.g. Energy Research and the Journal of Industrial Ecology and to relevant conferences such as the International Conference on Urban Regeneration and Sustainability. In terms of practitioner audiences I will target publications such as the Sustainable Cities handbook circulated globally to Minister, Mayors, Planners and other key stakeholders, the EU Sustainable Cities Platform and Centre for Cities Think Cities website.</p> <p>Potential impacts of the research are policy advice and interventions. The aim is to generate data on the factors that accelerate or inhibit the transition of cities as socio-technical systems towards greater sustainability. Disseminating these factors will support policy advice and development. Findings from the research would be used to support policy development through a number of established channels e.g. C40, EU Sustainable Cities network, ICLEI, the UK government what works growth policy centre, and directly with cities through the Sustainable Cities Network. The aim is both to influence policy levers such as funding and regulation, and on the ground delivery through wider uptake of best practice.</p>	

4.4 How do you intend to share the research data? (Indicate with an 'X')	
	Depositing in a specialist data centre or archive
X	Submitting to a journal to support a publication
X	Depositing in a self-archiving system or an institutional repository
	Dissemination via a project or institutional website
	Informal peer-to-peer exchange
	No plans to report or disseminate the data
	Other, please state: _____.
4.5 How do you intend to report and disseminate the results of the study? (Indicate with an 'X')	
X	Peer reviewed journals
	Internal report
X	Conference presentation
	Publication on website
X	Other publication
	Submission to regulatory authorities
	No plans to report or disseminate the results
	Other, please state: Practitioner events and networks, e.g. C40 cities network, the sustainable cities network, ICLEI Local Governments for Sustainability network.

Section 5: Protocols

<p>Which protocols will be complied with? (Indicate with an 'X').</p> <p>There may be circumstances where it makes sense not to comply with a protocol, this is fine but should be clarified in your application.</p>	X	Data protection, anonymisation and storage and sharing of research data
	X	Informed consent
	X	Verbal consent
	n/a	Reimbursement of research participants
	X	Low risk observation

Section 6: Additional ethical issues	
6.1 Indicate with an 'X' in the left-hand column whether the research involves any of the following:	
	Discussion of sensitive topics
	Prolonged or frequent participant involvement
	The possibility of harm to participants or others (including the researcher(s))
	Participants taking part in the research without their knowledge and consent (eg covert observation of people in non-public places)
	The use of drugs, placebos or invasive, intrusive or potentially harmful procedures of any kind
	Food substances or drinks being given to participants (other than refreshments)
	Vitamins or any related substances being given to participants
	Acellular blood, urine or tissue samples obtained from participants (ie no NHS requirement)
	Members of the public in a research capacity (participant research)

	Participants who are particularly vulnerable (eg children, people with learning disabilities, offenders)
	People who are unable to give their own informed consent
	Researcher(s) in a position of authority over participants, eg as employers, lecturers, teachers or family members
	Financial inducements (other than reasonable expenses and compensation for time) being offered to participants
	Cooperation of an intermediary to gain access to research participants or material (eg head teachers, prison governors, chief executives)
X	Potential conflicts of interest
	Internet participants or other visual/ vocal methods where participants may be identified
	The sharing of data or confidential information beyond the initial consent given
X	Translators or interpreters
X	Research conducted outside the UK
	An international collaborator
	The transfer of data outside the European Economic Area
	Third parties collecting data
	Other ethical clearances or permissions
6.2 Provide details of any ethical issues the research may involve other than those mentioned previously. (max 200 words)	
Potential conflict of interest – some of the interviewees in the case study cities will be prior contacts through my C40 work (I work part-time for the C40 Cities Climate Leadership Group) and the cities are all C40 members therefore I need to ensure that	

all participants are aware this research is independent research through the University of Leeds and that there is no obligation to take part, of if they do take part to provide 'favourable' answers. This will be done during the recruitment process by providing clear written information and then confirming verbally during the consent processes.

Translators – Some translation will be required for the Copenhagen case study. The level of English is such that interviews and individual observation can be conducted in English. For the meeting observations translation would be required. This introduces a number of potential issues/challenges. In the first instance the need for meeting observation would be reviewed after the London and New York case study research has been undertaken. Should it be decided to go ahead with this in Copenhagen then meetings would be observed in combination with a translated transcript, and/or a video of, or minutes from, the meeting would be reviewed with one of the sustainable city actors in attendance. The process of translation or review via a sustainable city actor introduces the risk of bias. This would be noted in the methodology and minimized via the researcher's attendance at the meeting and comparing translations and sustainable city actor review with notes taken directly by the researcher. If necessary a second review with another sustainable city actor in attendance at the meeting would be undertaken.

Research conducted outside the UK – 2 of the case studies will be conducted outside of the UK, in New York and Copenhagen. Additional requirements of these countries will be confirmed, e.g. additional data protection requirements, via checking with local C40 contacts who are well versed on all local policy (C40 has an office in New York and a staff member based in Copenhagen).

If the project involves none of the issues listed in section 6.1 leave out sections 7, 8 and 9 and go directly to section 10.

Section 7: Recruitment and consent process

For guidance refer to <http://ris.leeds.ac.uk/InvolvingResearchParticipants> and the [research ethics protocols](#).

7.1 State approximately how much data and/ or how many participants are going to be involved.

3 case studies involving 12-20 sustainable city actors each. For each actor there will be a semi-structured interview and sorting exercise. For each case study observation of a sub-sample of interviewed actors will be undertaken where appropriate and possible. For each case study observation of a small number of relevant meetings where appropriate and possible.

Workshops will involve 4-10 sustainable city practitioners, workshops will be recorded and typed up and a summary produced.

7.2 How was that number of participants decided upon? (max 200 words)

Please note: The number of participants should be sufficient to achieve worthwhile results but should not be so high as to involve unnecessary recruitment and burdens for participants. This is especially pertinent in research which involves an element of risk. Describe here how many participants will be recruited, and whether this will be enough to answer the research question. If you have received formal statistical advice then please indicate so here, and describe that advice.

- Sufficient actors to provide representative findings.
- Sufficient actors to provide a view from the public, private and third sector.
- Case study best practice was followed (Yin, 2014).
- Research appropriate to resources (time and finances).

7.3 How are the participants and/ or data going to be selected? (max 200 words)

Interview and observation - Sustainable City Actors will be identified and selected using a combination of sampling, snowballing and opportunistic methods.

Practitioner workshops - Practitioners participating in the workshops will be members of the sustainable cities network.

7.4 For each type of methodology, describe the process by which you will obtain freely given informed consent for the collection, use and reuse of the research data.

Guidance is available at <http://ris.leeds.ac.uk/InvolvingResearchParticipants>. The relevant documents (information sheet and consent form) need to be attached to the end of this application. If you are not using an information sheet and/ or seeking written consent, please provide an explanation.

Semi-structured interviews– these will be recorded and therefore verbal consent will be used. Verbal consent has been chosen over written consent as written consent risks creating an air of officialdom that might result in a ‘closed’ interview and sorting process.

Observation – For individual observation, participants will be informed in advance of the purpose and method of the research and how findings will be used, and provided with consent forms. Printed copies of both information and forms will be provided at the outset of the observation. For the meeting observation key contacts will be informed in advance of the purpose and method of the research and how findings will be used. I will agree with them how to inform and gain consent from all those who will be observed. All observation will take place in a work environment (general office or meetings). The key contact will be asked to confirm that all participants have been informed and consented to participate in the research.

Workshops – Information about the workshop and consent forms will be sent in advance to participants. Printed copies of both the information and consent forms will be provided on the day.

7.5 Describe the arrangements for withdrawal from participation and/ or withdrawal of data/ tissue. *Please note: It should be made clear to participants in advance if there is a point after which they will not be able to withdraw. See also <http://ris.leeds.ac.uk/ResearchDataManagement>.* (max 200 words)

Participants will be informed from the outset that they can withdraw anytime up to analysis and publication (Feb 2017). Participants can withdraw by e-mail or telephone and do not have to give a reason. Should a participant wish to withdraw then their data (both electronic and paper) will be deleted following data protection policy guidelines.

7.6 Provide details of any incentives you are going to use and explain their purpose. (max 200 words)

Please note: Payment of participants should be ethically justified. The FREC will wish to be reassured that research participants are not being paid for taking risks or that payments are set at a level which would unduly influence participants. A clear statement should be included in the participant information sheet setting out the position on reimbursement of any expense incurred.

We will be sharing the final, public findings with all participants and we will be covering some expenses and providing some food for the workshops. No incentives will be provided.

Section 8: Data protection, confidentiality and anonymisation

Guidance is available at <http://ris.leeds.ac.uk/ConfidentialityAnonymisation>

8.1 How identifiable will the participants be? (Indicate with an 'X').

	Fully identifiable
	Identity of subject protected by code numbers/ pseudonyms
	Fully anonymised
X	Anonymised but potentially identifiable
	Data only in aggregated form
	Other

8.2 Describe the measures you will take to deal with issues of confidentiality, including any limits to confidentiality. (max 300 words)

Name, specific job title, recordings and transcripts will only be accessible to and used by the immediate research team. City, generic job role, exerts, ideas and findings from the recordings and transcripts will be used in the thesis and may be used in academic publications and practitioner reports. Participants will be made aware of this and asked for their consent.

Participants will not be named but their city and job role will be stated. A generic job role will be used rather than a specific job title but there is still the risk that individual participants could be identified. Participants will be made aware of how their input will be presented and that they can request further anonymisation either for specific elements or all of their input. In addition where the researcher identifies potentially sensitive information this will be flagged with the participant to confirm they are happy with the level of anonymisation and/or the data will be further anonymized.

Anonymisation will be achieved via removing the job role, and where necessary the city. Participants will be informed of the process for data protection, confidentiality and anonymisation and of how to raise any concerns about this. Concerns will be logged and addressed, this will be checked with both my supervisors and the participants to ensure they have been satisfactorily addressed.

8.3 Describe the measures you will take to deal with issues of anonymity. (max 200 words)

As above data will only be anonymized where this is specifically requested and/or deemed appropriate by the researcher. It is not anticipated that this will be necessary. If this is necessary then we will review the extent to which anonymisation is needed – i.e. removing just job role or removing job role and city reference.

8.4 Who will have access to the research data apart from the research team (eg translators, authorities)? (max 100 words)

No one will have access to the interview data (recordings and transcripts) apart from myself and my supervisors. The exception to this is for the meeting observations for the Copenhagen case study – see below.

8.5 Describe the process you will use to ensure the compliance of third parties with ethical standards. (max 100 words)

There is potential, very limited involvement of translators for meeting observation for the Copenhagen case study. Translators will be informed of the purpose and methods for research and asked to sign confidentiality forms to ensure that any sensitive participant data that is shared with them remains confidential.

8.6 Where and in what format(s) will research data, consent forms and administrative records be retained? (max 200 words)

Please note: Mention hard copies as well as electronic data. Electronic data should be stored securely and appropriately and in accordance with the University of Leeds Data Protection Policy available at http://www.leeds.ac.uk/secretariat/data_protection_code_of_practice.html.

<p>Data will be collected in the field, this will be temporarily stored following data protection and Information Protection Policy guidelines. As soon as possible data will be transferred to the University personal storage folders. Data will be encrypted at all times. The vast majority of data will be electronic. Paper notes will be stored securely in the field and transferred to the University as soon as possible following Information Protection Policy guidelines.</p>
<p>8.7 If online surveys are to be used, where will the responses be stored? (max 200 words)</p> <p>Refer to:</p> <p>http://it.leeds.ac.uk/info/173/database_and_subscription_services/206/bristol_online_survey_accounts and http://ris.leeds.ac.uk/SecuringResearchData for guidance.</p>
<p>No online surveys are planned.</p>
<p>8.8 Give details and outline the measures you will take to mitigate any foreseeable risks (other than those already mentioned) to the participants, the researchers, the University of Leeds or anyone else involved in the research? (max 300 words)</p>
<p>See attached risk assessment.</p>

Section 9: Other ethical issues		
Yes	No	(Indicate with an 'X')
		<p>9.1 Is a health and safety risk assessment required for the project?</p> <p><i>Please note: Risk assessments are a University requirement for all fieldwork taking place off campus. The risk assessment forms and further guidance on planning for fieldwork in a variety of settings can be found on the University's Health & Safety website along with further information about risk assessment: http://www.leeds.ac.uk/safety/fieldwork/index.htm. Contact your Faculty Health and Safety Manager for further advice. See also http://ris.leeds.ac.uk/HealthAndSafetyAdvice.</i></p>
X		

	X	9.2 Is a Disclosure and Barring Service check required for the researcher? <i>Please note: It is the researcher's responsibility to check whether a DBS check is required and to obtain one if it is needed.</i>
	X	9.3 Is there scope for incidental findings, ie unplanned additional findings?
9.4 If so, what sort of findings, and what processes will be put in place to deal with these? (max 200 words)		
9.5 Any other relevant information		
9.6 Provide details of any ethical issues on which you would like to ask the Committee's advice.		

Section 10: Further details for student projects (complete if applicable)			
Your supervisor is required to provide email confirmation that they have read, edited and agree with the form above. It is a good idea to involve your supervisor as much as possible with your application. If you are unsure how to answer any of the questions do ask your supervisors for advice.			
10.1 Qualification working towards (indicate with an 'X')			
	Bachelor's degree	Module code:	
	Master's degree (including PgCert, PgDip)		
X	Research degree		
10.2 Primary supervisor's contact details			

Name (title, first name, last name)	Associate Prof. Alice Owen	
Department/ School/ Institute	Earth and Environment / SRI	
Telephone number	0113 343 6411	
University of Leeds email address	A.M.Owen@leeds.ac.uk	
10.3 Second supervisor's contact details		
Name (title, first name, last name)	Prof. Paul Chatterton	
Department/ School/ Institute	Geography	
Telephone number	0113-343-6636	
University of Leeds email address	P.Chatterton@leeds.ac.uk	
Yes	No	10.4 To be completed by the student's supervisor
X		The topic merits further research
X		I believe that the student has the skills to carry out the research

Section 11: Other members of the research team (complete if applicable)	
Name (title, first name, last name)	
Role (eg PI, Co-I)	
Department/ School/ Institute	
Telephone number	

University of Leeds email address	
-----------------------------------	--

Section 12: Supporting documents		
<p>Indicate with an 'X' which supporting documents have been included with your application.</p> <p>Wherever possible the research title on consent forms, information sheets, other supporting documentation and this application should be consistent. The title should make clear (where appropriate) what the research is about. There may be instances where a different title is desirable on information to participants (for example – in projects which necessarily involve an element of deception or if giving the title might skew the results of the research). It is not imperative that the titles are consistent, or detailed, but where possible then they should be.</p> <p>Supporting documents should be saved with a meaningful file name and version control, eg</p>	X	<p>Information sheet(s)</p> <p><i>Please note: Include different versions for different groups of participants eg for children and adults if applicable. Refer to http://ris.leeds.ac.uk/InvolvingResearchParticipants for guidance in producing participant information sheets.</i></p>
	X	<p>Consent form(s)</p> <p><i>Please note: Include different versions for different groups of participants eg for children and adults if applicable. Refer to http://ris.leeds.ac.uk/InvolvingResearchParticipants for guidance in producing participant consent forms.</i></p>
	X	<p>Recruitment materials</p> <p><i>Please note: Eg poster, email etc used to invite people to participate in your research project.</i></p>
		Letter/ email seeking permission from host/gatekeeper
		Questionnaire/ interview questions

<p>'Participant_Info_Sheet_v1' or 'Parent_Consent_From_v2'. Refer to the examples at http://ris.leeds.ac.uk/InvolvingResearchParticipants.</p>	X	<p>Health and safety risk assessment</p> <p><i>Please note: Risk assessments are a University requirement for all fieldwork taking place off campus. The risk assessment forms and further guidance on planning for fieldwork in a variety of settings can be found on the University's Health & Safety website along with further information about risk assessment:</i></p> <p>http://www.leeds.ac.uk/safety/fieldwork/index.htm. Contact your Faculty Health and Safety Manager for further advice. Also refer to http://ris.leeds.ac.uk/HealthAndSafetyAdvice.</p>
	X	<p>Data management plan</p> <p>Refer to http://library.leeds.ac.uk/research-data-manage.</p>


Section 13: Sharing information for training purposes

Yes	No	(Indicate with an 'X')
X		I would be content for information in the application to be used for research ethics and research data management training purposes within the University of Leeds. All personal identifiers and references to researchers, funders and research units would be removed.

Section 14: Declaration

1. The information in this form is accurate to the best of my knowledge and belief and I take full responsibility for it.
2. I undertake to abide by the University's [ethical](#) and [health & safety](#) policies and guidelines, and the ethical principles underlying good practice guidelines appropriate to my discipline.

3. If the research is approved I undertake to adhere to the study protocol, the terms of this application and any conditions set out by the Research Ethics Committee.
4. I undertake to ensure that all members of the research team are aware of the ethical issues and the contents of this application form.
5. I undertake to seek an ethical opinion from the REC before implementing any [amendments](#) to the protocol.
6. I undertake to submit progress/ [end of project reports](#) if required.
7. I am aware of my responsibility to be up to date and comply with the requirements of the law and relevant guidelines relating to security and confidentiality of personal data.
8. I understand that research records/ data may be subject to inspection for [audit](#) purposes if required in future.
9. I understand that personal data about me as a researcher in this application will be held by the relevant FRECs and that this will be managed according to the principles established in the Data Protection Act.

	Applicant	Student's supervisor (if applicable)
Signature		
Name	Rachel Huxley	Alice Owen
Date	05/05/2016	

A.2. Ethics review approval letter

Performance, Governance and Operations
 Research & Innovation Service
 Charles Thackrah Building
 101 Clarendon Road
 Leeds LS2 9LJ Tel: 0113 343 4873

Email: ResearchEthics@leeds.ac.uk



UNIVERSITY OF LEEDS

Rachel Huxley

Sustainable Research Institute

School of Earth and Environment

University of Leeds

Leeds, LS2 9JT

ESSL, Environment and LUBS (AREA) Faculty Research Ethics Committee

University of Leeds

28 May 2016

Dear Rachel

Title of study: The processes and outcomes of sustainable cities

Ethics reference: AREA 15-124

I am pleased to inform you that the above research application has been reviewed by the ESSL, Environment and LUBS (AREA) Faculty Research Ethics Committee and following receipt of your response to the Committee's initial comments, I can confirm a favourable ethical opinion as of the date of this letter. The following documentation was considered:

Document	Version	Date
AREA 15-124 Committee Provisional.doc (response)	1	27/05/16

AREA 15-124 InterviewGuide_v1_20160527.docx	1	27/05/16
AREA 15-124 New_ethical_review_form_RHuxley_v5.doc	2	27/05/16
AREA 15-124 Participant Information Wkshop_v3_20160505.docx	2	27/05/16
AREA 15-124 Participant Information_v3_20160505.docx	2	27/05/16
AREA 15-124 SCN workshop_v3.docx	1	27/05/16
AREA 15-124 EthicalReviewForm_Signed_RHuxley.pdf	1	05/05/16
AREA 15-124 Participant e-mail_v2_20160505.docx	1	05/05/16
AREA 15-124 DataManagementPlan.pdf	1	05/05/16
AREA 15-124 Fieldwork_Assessment_Form_medium_risk_RHuxley.doc	1	05/05/16

Please notify the committee if you intend to make any amendments to the original research as submitted at date of this approval, including changes to recruitment methodology. All changes must receive ethical approval prior to implementation. The amendment form is available at <http://ris.leeds.ac.uk/EthicsAmendment>.

Please note: You are expected to keep a record of all your approved documentation. You will be given a two week notice period if your project is to be audited. There is a checklist listing examples of documents to be kept which is available at <http://ris.leeds.ac.uk/EthicsAudits>.

We welcome feedback on your experience of the ethical review process and suggestions for improvement. Please email any comments to ResearchEthics@leeds.ac.uk.

Yours sincerely

Jennifer Blaikie

Senior Research Ethics Administrator, Research & Innovation Service

On behalf of Dr Andrew Evans, Chair, [AREA Faculty Research Ethics Committee](#)

CC: Student's supervisor(s)

Appendix B. Participant information

B.1. Participant information sheet

Sustainability Research Institute
SCHOOL OF EARTH AND ENVIRONMENT



UNIVERSITY OF LEEDS

Sustainability cities research: participant information Sheet

You are being invited to take part in a research project affiliated to the University of Leeds Sustainability Research Institute. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

The project

The purpose of this research is to better understand the current processes that drive action in the context of sustainable city goals. We are undertaking research in two other cities in addition to yours, and will be interviewing up to 30 individuals from each location. The project will be running for roughly 2 years and will result in a PhD thesis and academic publications.

Your Role

As a stakeholder in your city's sustainable goals we are keen to hear from you. Taking part in the research is entirely voluntary and refusal to do so, or to withdraw your involvement at a later stage, does not need to be explained. We are asking for up to 90 minutes of your time to complete a face-to-face interview. The interview can be arranged at a time and location that is convenient for you and can be opted out of at any time. The

interview will involve a small number of open questions around how decisions are made and action is or is not progressed in your work. This will enable us to understand what processes drive action towards goals, and inform how we might achieve better progress. As a participant we would like you to answer all questions honestly, there is no obligation to answer any questions should you prefer not to.

The interview will be recorded, subject to your approval to do so. The audio recordings of your interview will be used only for analysis by the research team. No other use will be made of the recording without your written permission, and no one outside the project will be allowed access to the original recordings.

There are no incentives involved, other than the opportunity to share your insights with the academic community and others who are interested in your work. While there are no immediate benefits from participation, it is hoped that this work will contribute to enabling better decision making processes and therefore better action towards strategic city goals. Should you agree to take part in the research we will ask you to confirm this either verbally at the start of the recorded interview or via the consent form on the next page.

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep (and be asked to sign a consent form or provide verbal consent at the interview) and you can still withdraw at any time up to analysis and publication (July 2017). You can withdraw by e-mail and you do not have to give a reason.

Confidentiality and data protection

The interview will be recorded and transcribed. Your name and job title is stored separately and securely and will not be shared beyond the immediate research team. Your city and a generic job role will be used, however you can request further anonymisation of data either through removal of job role or removal of both job role and city (please inform us by e-mail before analysis has begun, July 2017). The interview transcripts will not be used other than for the academic work and not shared beyond the immediate research team, but excerpts and ideas from the transcripts will be used in the thesis and may be used in academic publications and practitioner reports – as above this data will be linked to city and generic job role unless otherwise requested.

We may need to contact you in the future to seek permission to use particular quotes you have given or to discuss future research. However, you do have the right to request to not be contacted again. Your contact details and interview data will be stored securely at the University of Leeds for up to 5 years but you have the right to request for it to be erased at any point. However, if you decide you do not want your interview to be included in the research findings then you will need to let us know by e-mail before analysis has begun (July 2017). We will be happy to provide a copy of the final thesis and any associated publications.

Further information

The research is funded by the Economic and Social Research Council.

This research is independent academic research. It should be noted that whilst the lead researcher also works part-time for C40 this research is affiliated with the University of Leeds and independent of C40 (it should also be noted that the research is not about C40). C40 are aware of and supportive of the research but the research is not affiliated with C40 and there is no obligation whatsoever from C40 to participate in this research. As above interview transcripts will not be shared beyond the immediate University of Leeds research team but excerpts and ideas from the transcripts may be used for academic articles and practitioner publications, either independently published or in partnership with organisations which could include C40.

The research has been reviewed and given a favourable opinion by the University of Leeds Sustainable Research Institute Research Ethics Committee on 27th May 2016, ethics reference AREA 15-124.

Thank you for taking the time to read through this information and for considering participating in this research.

For further information please contact Rachel Huxley – r.huxley@leeds.ac.uk

Or a.m.owen@leeds.ac.uk

Consent form

Consent to take part in the 'processes and outcomes of sustainable cities' research project.

	Add your initials next to the statements you agree with
I confirm that I have read and understand the information sheet dated 05-05-2016 explaining the above research project, I have had the opportunity to ask questions about the project and I understand that I can withdraw from the research anytime up to analysis and publication (July 2017) by e-mail.	
I agree for interview(s) to be recorded and transcribed and I have read and understand the information on how this data will be used and stored.	
I agree for the data collected from me to be stored and used in relevant future research, I have been made aware that data will be linked to my city and generic job role (not name or specific job title), and that I can request further anonymisation of my data anytime up to analysis and publication (July 2017) by e-mail.	
I understand that relevant sections of the data collected during the study, may be looked at by auditors from the University of Leeds or from regulatory authorities where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records.	
I agree to take part in the above research project and will inform the lead researcher should my contact details change.	

Name of participant	
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Participant's signature	
Date	
Name of lead researcher	Rachel Huxley
Signature	
Date*	

*To be signed and dated in the presence of the participant.