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SEMINAR 2: Managing Environmental and Energy Transitions in Cities

Harriet Bulkeley

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Managing Environmental and Energy Transitions in Cities: State of the Art & Emerging Perspectives

Harriet Bulkeley, Durham University

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The aim of this review is to provide an account of the current *state of the art* in the debate about the nature and dynamics of the opportunities and challenges facing cities as they seek to undergo environmental and energy transitions and to identify *emerging perspectives* that will enable new thinking and stimulate novel approaches for supporting transformative urban governance.

The review will comprise of four parts. Part I will provide an overview of the scope of the environmental and energy challenges facing cities and a brief history of the emergence of urban responses to these challenges. It will suggest that cities are now at a crossroads in terms of the ways in which they are seeking to manage environmental and energy challenges: on the one hand, we are witnessing increasing efforts to systematise urban responses at the global level, on the other hand we see renewed attempts to enable urban experimentation and a growing range of actors engaging in urban sustainability efforts. Navigating these often conflicting imperatives will be at the heart of shaping the conditions under which new forms of transformative urban governance are made possible.

Part II will focus explicitly on reviewing the state of the art concerned with how environmental and energy transitions can be managed or *governed*. It will chart the shifting debate concerning the multilevel nature of energy and environmental governance, the recognition of the importance of socio-technical systems and their dynamics to urban governance in these domains, the growth of evidence concerning the importance of experimentation as a means through which governing is conducted and finally the growing momentum behind the notion that urban governance for environmental and energy issues needs to be *transformative*. It will suggest that while there are multiple, competing, definitions of what constitutes transformative governance available, the essence of any such approach has to be concerned with addressing issues of social and environmental justice.

Drawing on the state of the art review undertaken in Part II, Part III will identify a series of *emerging perspectives* that challenge existing thinking and approaches to environmental and energy transitions. It will argue that while trends taking place at the global level (Part I) may be directing the management of urban environmental and energy transitions towards more formal, systematised processes of knowledge production and governance, evidence gathered from how cities are successfully engaging with environmental and energy transitions suggests that space needs to be maintained for alternative approaches. Drawing on examples from different sustainability domains (e.g. energy, mobility, climate adaptation, biodiversity), the potential and consequences of these emerging perspectives for how, by whom, and with what consequences environmental and energy transitions should be managed in cities will be considered.

Finally, Part IV will provide a summary of the review and consider its implications for how we might start to think about and approach the challenge of governing environmental and energy transitions in cities with these emerging perspectives in mind and what this in turn will mean for the prospects of enabling transformative urban governance towards sustainability.

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To be added

1. Introduction

Given the now seemingly ubiquitous presence of cities on global agendas for addressing environmental and energy challenges, it is increasingly hard to imagine a time when urban transitions were not seen as critical to addressing the intertwined issues of climate change, biodiversity loss and sustainable development. Yet cities have been relative latecomers to the global environmental governance scene, and the potential and limitations of urban action towards global goals has only recently started to receive extensive and critical scrutiny. Taking stock of the current state of the art understanding of why and how urban environmental and energy transitions can be managed or governed, and with what consequences, this report reflects on key trends in the literature and draws attention to alternative, emerging perspectives that potentially raise new opportunities – and limitations – for how policy-makers and practitioners working at all levels of government need to engage with the urban dimension of addressing global goals for climate change, biodiversity and sustainability.

Paragraph providing the outline of the report when it is completed

1.1 Part of the problem ... and part of the solution?

Ever since the 1986 Brundtland Report established the need to move towards sustainable development, cities have come to be framed as both part of the problem and part of the solution to contemporary global environmental and energy issues. As realisation of the global scale of environmental challenges grew in the late 1980s and early 1990s, so too did the potential for 'thinking global, acting local.' Pioneering activities of municipal governments in North America and Europe began to establish targets for reducing greenhouse gas emissions and put in place the foundations for city-to-city co-operation through ICLEI's Cities for Climate Protection programme, the German-based Climate Alliance and the Energy Cities network. As national governments agreed Agenda 21 at the United Nations Conference on Environment and Development at Rio in 1992, *Local Agenda 21* was formulated for local authorities to both pledge their commitments globally and develop plans of action locally. Cities, advocates of the urban sustainability movement argued, were both part of the problem and a crucial part of the solution to emerging global challenges, most notably climate change (Rosenzwig et al. 2018). As centres of economic activity and concentrations of population, cities were not only responsible for a large proportion of GHG emissions but also potentially vulnerable to the impacts of a changing climate. At the same time as a result of their planning and regulatory capacities cities offered (highly varied) potential for taking action in the energy, mobility, waste, water and built environment sectors that shape emissions trajectories and future vulnerabilities and a means through which to engage stakeholders and communities in policy processes on the ground for addressing global challenges.

Fast-forward a quarter of a century and the centrality of cities as both the problem and the solution to global environmental and energy challenges has now been firmly established. It has become widely accepted that cities may contribute up to two-thirds of energy-related GHG emissions and as urban areas concentrate vulnerable populations, financial assets and critical infrastructure systems they are highly vulnerable to the impact of climate change (Bertoldi et al. 2018; Castan-Broto 2017). At the same time, converging global agendas, from the formulation of the Sustainable Development Goals and the New Urban Agenda, to the Paris Agreement on Climate Change, have placed cities as central to achieving the fundamental environmental and energy transitions required to meet global goals. For example, the IPCC 1.5 Degree Special Report "identifies cities and urban areas as one of four critical global systems that can accelerate and upscale climate action" (Bazaz et al. 2018). Likewise, the recent IPBES Global Assessment Summary for Policy Makers identified land-use change as the major driver of biodiversity decline, positioning urbanisation as a key direct driver of the loss of nature (Diaz et al. 2019). When coupled with the indirect role of urbanisation n driving climate change, it is clear that environmental and energy transitions in cities will be needed to address this major challenge. Yet it is vital to recognise that it has not been through positioning cities as a *threat* to global environmental

problems that they have come to take a central place in being part of the solution, but rather by recognising that cities provide important and in some sense *unique opportunities* for addressing these challenges. These opportunities are seen to range far and wide in the literature, from the direct powers and capacities of municipal authorities, to the important role that cities have in relation to infrastructure systems that need to be placed on a sustainable trajectory, as sites of innovation, efficiency and learning, and perhaps most importantly as a means through which political leadership can be galvanised and extended through transnational networks to form a coalition pushing for progressive action on the global stage (Bulkeley & Betsill 2013; Castan Broto 2017; Reckien et al. 2018; Smeds & Acuto 2018).

The recasting of cities from being the root of the problem to offering a critical site for environmental and energy solutions has been highly effective (Castan Broto 2017). Yet for some the hope now being invested in cities as the means through which these issues can be addressed is misplaced, over-romanticised and based on a "worrying lack of robust evidence for their effectiveness and ability to fulfil this role" (van der Heijden et al. 2018: 2). As cities come to take centre stage, understanding both the possibilities and limitations for action is therefore increasingly critical. Such analysis needs to move beyond the assessment of the capacities municipal authorities have to develop *policies, plans and strategies* to address environmental and energy issues, and also examine their role in enabling *transitions* towards sustainability. While policy frameworks and instruments developed by municipal authorities can be vital in both seeding and providing the context for such transitions, research suggests that it is vital to consider the ways in which they are shaped by broader dynamics of *governance* as well as the possibilities for (re)configuring *infrastructure* systems and social *practices* (Grandin et al. 2018).

The remainder of this introduction first reviews how cities have come to take a central place in addressing environmental and energy transitions over the past three decades and the outcomes and consequences of these efforts before turning to consider some of the key issues cities are facing as they seek to determine how to tackle the renewed urgency of the challenges ahead and the different directions in which they could travel.

1.2 *Three Decades of Urban Action*

At the heart of urban responses to environmental and energy challenges over the past three decades has been the issue of climate change. As the global prominence of the climate change agenda has grown, cities across the world have found themselves at the forefront of this agenda. Urban responses have been driven both by individual cities and political champions but also through the growth of transnational networks connecting municipal authorities and their partners across national boundaries. Analysis suggests that the nature and dynamics of this response have shifted over time, from an initial focus during the 1990s on the voluntary actions that municipal authorities could take to the emergence in the 2000s of efforts to position climate change as an issue of strategic importance for urban development and security (Bulkeley & Betsill 2013; Davidson et al. 2019; Hodson & Marvin 2010).

It is important to recognise that this is not a wholesale shift, but rather that strategic urbanism approaches have been developed in addition to municipal voluntarism and are far from universally adopted. The rise of strategic urbanism has been driven in part by the growing interest in climate change in global cities and by a variety of organisations – from philanthropic foundations to development banks – who have supported urban climate action in cities in the global South as an imperative for addressing issues of development and resilience. It has also been shaped by the prospects of the availability of multiple forms of climate finance – from development assistance to green bonds – and the need to create investible projects which offer either an economic, social or environmental return on investment. At the same time, climate change has come to be seen as a crucial means through which a range of other sustainable development goals – from addressing air pollution, health and well-being, poverty, energy access, water security and so on – can be addressed. The growth of strategic urbanism has not therefore always been led by climate change, but as cities have sought to address a range of urban sustainability concerns that are seen to pose a significant risk to their social and

economic development climate change has come to be a means through which other goals (sometimes termed 'co-benefits' in the climate change literature) can be addressed.

Analysis suggests that several thousand cities have now made commitments to address climate change. In their assessment of how non-state actors can contribute to the goals of the Paris Agreement, Hsu et al. (2018a) find that in 2015 "7,025 [cities] from 99 countries, representing 11 percent of the global population" were committed to action on climate change, rising to "7,378 [cities] from 133 countries, representing 16.9 percent of the global population" in 2017. Through this mobilisation, cities have undertaken a variety of measures – reducing emissions from their own operations, investing in alternative forms of energy and mobility provision, introducing measures to reduce waste, bringing in standards for energy efficiency in buildings, undertaking measures to develop green and blue infrastructure in cities and so forth (Fuhr et al. 2018). Evidence suggests that the range and number of measures being undertaken is significant. Davidson et al. (2019: 2) report that under the C40 Cities Climate Leadership Group, 96 cities which encompass 650 million people and 25% of global GDP have undertaken over 14,000 actions, whilst the 100 Resilient Cities Network has supported 40 city resilient strategies that contain 2000 actions with a further 60 strategies in preparation. Some analyses suggest that the cumulative effect of such actions is already making a contribution towards global goals. Bertoldi et al. (2018: 71) reporting on assessments published in 2014, suggest that the "global aggregation of 228 cities' climate commitments reporting under the carbonn Climate Registry and the Carbon Disclosure Project Cities Program, covering 436 million inhabitants, finds that GHG emissions could decrease by 402 Mt CO2 -eq in 2030, compared with a reference scenario, and by 430 Mt CO2 -eq in 2050." Further, research by Reckien et al. (2014) found in an assessment of 200 large and medium-scale urban areas across 11 European countries that "if the planned actions within cities are nationally representative, the 11 countries investigated would achieve a 37% reduction in GHG emissions by 2050, translating into a 27% reduction in GHG emissions for the EU as a whole" (Bertoldi et al. 2018: 72). While there is considerable concern about the multiple baselines and metrics used for generating such findings, as well as the varied nature of the methodologies used, there is at least an indication that there is potential in the promise of urban action on climate change.

At the same time, research has found that the actual implementation of plans and measures to address climate change on the ground has been highly varied. In the largest assessment of climate change action planning conducted to date, Reckien et al. (2018) surveyed the nature of climate action planning taking place in 885 urban areas in the EU-28. They found that of eight different kinds of climate action plan, three different types of 'stand alone' plan could be identified – those developed autonomously, those created in response to national requirements, and those produced for international climate networks. Analysing their prevalence, they found that "approximately 66% of EU cities have a ... [stand alone] mitigation plan, 26% an adaptation plan, and 17% a joint adaptation and mitigation plan, while about 33% lack any form of stand-alone local climate plan" (Reckien et al. 2018: 208). They identify city size as a critical factor, with 80% those over 500,000 inhabitants having comprehensive stand-alone mitigation or adaptation plans – supporting the argument that *strategic urbanism* is an important driver for climate action, as it is in such cities that the strategic importance of climate change as a political, economic and social issue has been most clearly articulated. They also found that where local climate change planning is required by national governments (Denmark, France, Slovakia and the United Kingdom), cities are nearly twice as likely to produce local mitigation plans, and five times more likely to produce local adaptation plans, compared to cities in countries without such legislation. (Reckein et al. 2018: 208). Transnational municipal networks were also a critical driving factor, with plans produced for these networks most likely to be found where there are limited autonomous plans. These driving factors are similar to those that have been identified by the majority of the literature on cities responses to climate change over the past two decades, which list enabling policy environments, socio-economic conditions, individual champions and the strategic importance of climate change to local populations as important in shaping the differential uptake of climate change agendas in cities (Fuhr et al. 2018).

Yet focusing on climate change action plans and the measures they contain provides only a partial view of how urban responses to environmental and energy transitions are unfolding. Accompanying the rise of strategic

urbanism as a response has been the growth of climate change experimentation (Bulkeley & Castan Broto 2013; Peng et al. 2018). As Bouzarovski and Haarstad (2018: 256) argue "socio-technical interventions, experiments and initiatives aimed at reducing the energy and carbon intensity of human activities in cities are proliferating across the planet ... [seeking to engender] low-carbon transformations in the development and utilisation of urban infrastructural systems." Research suggests that such forms of urban sustainability experimentation are not confined to addressing the carbon intensity of urban infrastructure systems (Evans et al. 2016), but also extend to social practices of consumption (e.g. food production and sharing), sustainable living, urban water security, climate resilience and biodiversity (Capriotti & Cowley 2017; Chu 2016; Davies & Evans 2019; Farrelley & Brown 2011; Moloney et al. 2010). The rise of urban sustainability experimentation suggests that "whereas early research focused on analysing climate policy commitments and frameworks put in place by local governments, understanding urban climate governance in the post-Paris era requires a broader conceptualisation of governance that unpacks how a multiplicity of urban experiments are governed in the city" (Smeds & Acuto 2018: 550). In turn, this means that many of the lessons about how to support urban environmental and energy transitions that have been derived from research that has focused on the development of urban capacity for climate action planning may need to be revised if a key axis for intervention switches towards urban sustainability experimentation.

As the rest of this report sets out, the changing conditions for urban climate governance and the rise of urban experimentation are driven by a range of factors. Perhaps most fundamentally, however, it reflects a shift in our understanding of the climate problem from the focus on *end-of-pipe* emissions reductions through targets and timetables and individual adaptation measures in the 1990s to a recognition of the need to *decarbonise* the economy and enhance *resilience*. This shift in problem framing has led to a reframing of the possible solutions that are required. If emissions reductions and adaptation measures could be addressed through singular policies and measures, decarbonisation and resilience require that complex systems through which energy, mobility, waste, water and housing services are provided are reconfigured towards sustainability – an effort that can not be achieved through traditional approaches to urban planning or policy-making, and which entails the involvement of a wide array of actors operating across different levels of governance and through different sites. In short, if cities are now regarded as part of the problem with respect to vulnerable, high carbon infrastructure provision and social practices, then to be part of the solution urban responses must shift towards interventions that enable the reconfiguration of these infrastructures and practices towards sustainability. Experimentation has come be the dominant response to this challenge, primarily undertaken through the rationale of strategic urbanism that sees new (economic) opportunities for cities as they undertake this work.

Yet amidst the landscape of continuing voluntary municipal and strategic urbanist responses, there are signs that a new wave of action is beginning to surface even if its form can not yet be precisely delineated. Features of this new wave of urban climate response include its *multivalent* character - such that what constitutes the urban dimension of climate change is expansive (from car sharing schemes to community gardens, solar panels to campaigns against fast fashion) and the meanings and values it generates diverse, contested and often conflicting – as well as its capacity to act as a fulcrum for many underlying urban and environmental concerns. As what constitutes the urban climate change problem begins to shift once more, three particular facets of its new found concerns are particularly apparent. First, urban climate change is increasingly linked to issues of sustainable production and consumption. Transnational municipal networks, notably C40, have started to advocate for the need to use *consumption-based* accounting in order to properly capture the urban aspects of climate change. Their 2018 analysis suggests, for example, that "total consumption-based emissions of the 79 C40 cities included in this study are 3.5 GtCO2e ... [representing] a 60% increase on the 2.2 GtCO2e emissions estimated for the same cities" using sector-based emissions accounting approaches, though the balance between consumption-based and production-based emissions varies significantly between cities in the global North and global South (C40 2018: 8). Second, urban climate change responses are increasingly being linked to achieving a wider set of sustainable development goals, and most notably to ensuring that climate action does not jeopardise the capacity for their realisation. Drawing on calls from recent IPCC

assessment reports and the IPBES Global Assessment, the problem of climate change can no longer be considered in isolation, but must be addressed in relation to the sustainable development goals and the imperative of reversing the long-term decline in biodiversity. Evidence for the growing salience of this aspect of the new wave of urban climate action can be found in the growing interest amongst conservation organisations in developing urban alliances through which to promote the importance of cities working with nature towards biodiversity, climate and sustainability goals. Third, and related to both of the above, is a growing concern to ensure that urban responses to climate change address issues of social and environmental justice. Towards this end we witness growing calls for cities to engage in work on a *just transition* and to consider the ways in which their action can be *transformative* of current political, economic and social conditions.

This new framing of the urban climate problem as one that requires not only environmental and energy transitions, but wholesale transformations across a multiplicity of socio-material entities and networks that currently sustain high carbon and vulnerable infrastructures and social practices towards multiple ends also invites new solutions. To date, the response has been one of examining how existing forms of policy or experimentation can be scaled up to address these dynamics. Yet, as the rest of this report explores in detail, "what is meant by scaling is often vague and not defined" (Smeds & Acuto 2018: 552) and even when this is the case, a call for 'scaling' may be inadequate or even inappropriate. We are already witnessing new forms of calculation, new actors and new politics emerging in order to seek responses to the challenge of transformative urban responses. Others point to a series of profound absences in how climate change planning and experimentation has so far taken shape that may limit its capacities to address the transformative agenda. For example, much of the research to date has been based in larger cities or in central urban areas, so that we have very limited evidence of what it will mean to engage with addressing climate change in smaller urban centres or in the vast swathes of suburban and peri-urban areas where the majority of the world's population live. In their assessment of urban climate responses being undertaken in the US, Homsy & Warner (2016: 65) suggest suburban municipalities are laggards in terms of environmental action compared to their urban counterparts, and given their weight and significance in terms of where the majority of the US population live this poses very real challenges to realising urban environmental and energy transitions. In her research on climate change responses in Europe, Kern (2019) similarly finds that capacity to act has been limited in smaller towns and cities and suburban regions, suggesting that it is in these areas that the significant potential for action lies. A second set of critical absences in our current debate concern the extent to which trade-offs between climate change and other sustainable development priorities, or across different aspects of responding to the climate problem, are leading to inertia or to conflict has yet to be understood in detail (Landauer et al. 2018). While such conflicts are known to exist, how and with what effect they are emerging and being explicitly addressed has yet to be documented in detail. For some, the emphasis remains on achieving consensus-based urban responses, whilst others suggest that if we are to realise truly transformative approaches at the urban scale a degree of conflict is not only necessary but also desirable (Castan-Broto 2015).

1.3 Cities at the Crossroads?

The first of these conundrums relates to whether, and if so how, urban action towards environmental and energy transitions has been effective. The remarkable rise in the number of cities that have pledged commitments on climate change and who have documented actions towards these ends has led to a strong belief that action is and can be taken that makes a significant contribution, both at the level of individual cities and in terms of their collective action. Yet critics suggest that progress to date has yielded at best "rather modest GHG reductions which are often only a by-product of measures that were actually implemented to serve other needs" and that "cities largely operate in the shadow of hierarchy and have only limited capacities to tackle the problem of climate change independent of other levels of government" (Fuhr et al. 2018: 3). Admonishing cities for a failure to govern 'alone' appears to be a rather anachronistic critique, given that a growing body of research, reviewed in Part II of this report, suggests that as cities seek to move forward to support environmental and energy challenges it will be imperative for the range of urban actors with both

responsibilities and capacities for acting on these challenges to be engaged. Equally, as cities are now seeking to move beyond single, end-of-pipe type, actions to address particular environmental or energy challenges one by one, it is perhaps to be expected that any action towards one goal (in this case, GHG emissions reductions) would routinely need to be accomplished as part of the governing of a wider array of urban challenges. It is then perhaps difficult to sustain the critique that 'proper' urban governance of environmental and energy transitions is only taking place if cities have a singular purpose and mission. Nonetheless, there remain very real concerns about the effectiveness, outcomes and consequences of efforts to govern such transitions on the ground. This has provoked ever more co-ordinated and well-resourced efforts to account for the actions of cities and to ensure that they can be harmonised with national and global goals, in order to make sure that they 'count' in the right ways. Whether or not this imperative to integrate and co-ordinate urban action is in turn effective in sustaining the very dynamics which have led to cities being at the forefront of this effort is however debateable, and an issue to which this report will return.

The second, and related, conundrum is whether the growth of experimentation as a mode of governing environmental and energy transitions is going to be sufficient in the face of the scale and urgency of the challenges facing society. There is now a growing consensus that experimentation is a vital means through which cities are governing environmental and energy transitions, but significantly divergent views on whether and if so how experimentation can make a significant contribution to the challenges ahead. For most commentators, experimentation is only of importance as long as it *leads to something more* – there is a strong focus on how lessons can be learnt and diffused, and experimentation 'upscaled' in one way or another until it has sufficient scale to make a tangible difference. Yet others suggest that experimentation is not an isolated set of initiatives which forces 'external' to these contexts can control towards higher purpose, but has instead come to be the means through which governing is itself conducted, suggesting instead that what matters about experimentation is the extent to which it can become embedded and rooted in the make up and operation of the multiple organisations, entities, infrastructures and flows that are already part of the growing mode of experimenting with sustainable urban futures. How experimentation matters in the governing of urban transitions and the implications for debates on the scaling and embedding of experiments as a means through which transitions can be achieved is explored in detail in the remaining parts of this report.

The third conundrum rests on whether and if so how such urban environmental and energy transitions can be *transformative*. For some, this is akin to the debate concerning the imperative of scaling up current efforts to ensure that widespread, *systemic* change is taking place at a pace and scale commensurate with the urgency of the problems facing the global environment and sustainable development. For others, discussions of transformative change have opened up the question of whether and how addressing key environmental and energy concerns should also enable *structural* change either in the institutions and processes of governance and decision-making, or more broadly in relation to underlying social, economic and political inequalities. A crucial conundrum for the urban sustainability transitions agenda is where cities position themselves in relation to these two related, but not always readily compatible, aspects of transformative change and what it will mean, in both political and practical terms, to enable a transformative approach to environmental and energy transitions in and through the urban arena.

Part II: Assessing the Evidence Base

When it comes to the matter of the ways in which society can respond to environmental and energy challenges, questions of how, by whom and to what ends climate change can and should be *governed* have been central. Governing, in its broadest sense, involves directing or guiding the actions of others. Although frequently associated with the work of *government* research in the social sciences over the past three decades has pointed to the rapid rise in multiple forms of *governance* as the means through which governing takes place. As Ruggie (2004: 205) suggests, "governance, at whatever level of social organization it may take place, refers to conducting the public's business—to the constellation of authoritative rules, institutions, and practices by means of which any collectively manages its affairs." Rather than being confined to specific sets of actors and institutions, a focus on governance points to the multiple sites, forms and agents involved in *governing*. What sets governing apart from other forms through which power is deployed is that it requires *authority*. Power can be exercised without authority – such as through coercion or violence – but to govern is to deploy authoritative power, that is power that is recognised as legitimate.

The question of how and by whom environmental and energy transitions can be realised has also in large part focused on issues of governance. From diverse perspectives, researchers have sought to examine the ways in which the capacity to respond to these challenges is generated and the different modes that it takes, the ways in which socio-technical systems are governed towards sustainability transitions, the emergence of new modes of governing through experimentation, and the extent to which any such interventions are capable of achieving transformative change both in the sense of systematic shifts in current orders and in terms of addressing entrenched issues of social and environmental justice. Part II of this report reviews these different perspectives on the governing of urban environmental and energy transitions, highlighting some of their core assumptions alongside commonalities and differences in their approaches in order to identify areas of the evidence base where there is now widespread consensus about the challenges ahead and action that needs to be undertaken as well as those areas where such a consensus is yet to be established.

2.1 A World of Multilevel Governance: shaping the capacities and levers for urban transitions

Central to analyses of urban environmental and energy transitions has been the question of where, how and by whom the *capacity* and *levers* to govern can be generated. Early research established that governance capacity was highly differentiated across urban areas, both within and between different regional and national contexts, as a result of the *multilevel governance* conditions within which urban climate responses takes place (Betsill and Bulkeley 2006). The term multilevel governance refers to more or less formalised institutional arrangements within which urban actors are embedded and which structure their roles and responsibilities in relation to key sectors related to environmental and energy issues, legal powers, access to finance, knowledge resources, level of autonomy etc. A significant body of work has now established that both 'vertical' relations between municipal governments and other levels of government and 'horizontal' relations across different policy departments and through links with other municipalities regionally and globally has significant implications for the capacities of municipal actors in relation to environmental and energy challenges (Dabrowski 2018; Fuhr et al. 2018; Hsu et al. 2018; Kern 2019; Lee and Koski 2015). For example, where 'vertical' multilevel governance conditions have been favourable, municipalities have been able to access specific financial and knowledge resources which have enhanced their capacity to respond. Early initiatives by national governments in Sweden and Japan were seen as vital in providing both the legitimacy and financial support required by municipalities to move ahead with taking action to mitigate climate change (Granberg & Elander 2007; Sugiyama & Takeuchi 2008). Current research shows that for the four countries in the EU where national governments have mandated urban action on climate change – Denmark, France, Slovakia and the UK - climate change planning at the local level is more advanced (Reckien et al. 2018). Elsewhere, research has shown that the absence of a favourable regional or national context for action can be compensated by membership of transnational and regional municipal networks (Reckien et al. 2018; Kern 2019). In Southeast Florida, a voluntary Regional Climate Change Compact has been formed as a partnership between "four

counties (Broward, Miami-Dade, Monroe, and Palm Beach) and twenty-six municipalities within those counties to advance climate adaptation strategies" leading to higher levels of engagement and action than derived from national policy alone (Vella et al. 2016: 36). In Brazil, research found that in "Belo Horizonte, national involvement in the city's waste management strategy helped to spread and scale effective waste management strategies to other cities in Brazil" demonstrating how vertical and horizontal forms of multilevel governance can be mutually reinforcing (Hsu et al. 2018: 429). Yet on balance, research suggests that it has been the *horizontal* networking forms of multilevel governance that have provided the most impetus for governing environmental and energy transitions in cities to date. Recent work in the USA examining local climate action in 591 municipalities found that "the strongest horizontal forces are more powerful in influencing climate mitigation actions than vertical forces—particularly for climate mitigation actions that require the greatest commitments from cities (Lee & Coski 2015: 1502).

Whilst multilevel governance conditions shape the overall capacities and effectiveness of efforts to govern environmental and energy transitions, they are particularly acute at the urban level where institutional fragmentation may be particularly high and where the 'fit' between the remit of urban institutions and actors and the issues to be tackled is often poor. In large metropolitan areas, municipal authorities can exist at regional and local levels, with poor levels of co-ordination in relation to key sectors such as water, energy, waste and housing. For example, in Mexico City Romero Lankao (2007) finds that the relevant scope and scale of urban processes in environmental and energy terms is only partially related to administrative boundaries, which are themselves overlapping and fragmented. Multiple processes which affect the direct use of energy and resources in the city – from commuting areas to watersheds, waste disposal sites and the production of electricity – cross-cut administrative boundaries in ways that create multiple challenges for governing environmental and energy transitions. Once private and civil society actors are also considered as part of the urban governance landscape this picture becomes ever more complex. For example, private sector actors located in downstream urban areas dependent on water quality and quantity who seek to engage in adaptation and resilience may find that they have limited capacity to shape the actions of upstream land managers and water users. By creating highly differentiated governance capacities within and between municipal governments and other urban actors, multilevel governance conditions can either severely constrain or enable the governance of urban transitions.

Operating within this highly differentiated and often fragmented landscape means that the specific capacities and levers that municipal governments have at their disposal to effect urban transitions also varies significantly (Bulkeley & Kern 2006). Where municipalities have either direct ownership or a high degree of control with respect to key sectors – such as energy or waste – we can witness the use of modes of governing that seek to directly intervene to *regulate* for sustainability transitions (e.g. in terms of the proportion of renewable energy that is supplied to local residents within a public utility, or in relation to building standards for energy efficiency). Municipal governments operating under such conditions or with a high level of autonomy can also seek to govern through *provision* of key services, technologies or incentives – for example providing free bike schemes, supporting domestic instillation of solar panels, or providing subsidies for public transport. Research has also identified the dominance of *enabling* modes of governing, which seek to govern through harnessing the capacities of other agents (individuals, communities, civil society groups, corporations) towards particular ends. Most often, efforts to effect environmental and energy transitions contain a 'governance mix', utilising different modes (and the specific levers or instruments they contain) in combination as the situation demands. The mix of governance modes deployed can also vary across the policy process. In a study of urban adaptation governance in five 'forerunner' cities (Basel, Chicago, London, Stuttgart and Rotterdam), Mees (2018: 379) finds that "that public responsibility is quite dominant, certainly in the early stages of the policy process. Local authorities take on roles for agenda setting, knowledge creation, policy formulation and strategy making in all five cities" yet private and civil society actors are required during stages of implementation, where municipal governments adopt more enabling roles in order to secure their participation.

Across many urban arenas, these multilevel governance conditions and diverse modes of governing have opened up space for a host of actors to engage in urban environmental and energy transitions. Particularly significant has been the role of transnational municipal networks, which have grown in scale, scope and diversity over the past three decades. Research has also shown a significant role being taken by communities, civil society organisations and the private sector, often in partnership with municipal authorities but also acting independently by using incentives, private standards and forms of self-regulation as well as enabling mechanisms to engage residents, consumers and employees in taking action. These actors play important roles in supporting municipal governments through the developing their capacities to act, directly through the provision of financial resources, tools and knowledge and indirectly through generating political support, recognition and legitimacy for the action being taken on climate change. Taken together, such actors provide significant capacity for governing environmental and energy transitions, albeit that to date evidence suggests that their explicit involvement policy development and implementation may be rather moderate (Mees 2018). At the same time, the sheer range of actors involved and their potential contribution to addressing these challenges – from land owners to institutional investors, insurance companies to community gardening groups – reinforces the need to recognise that the capacity and authority to govern such transitions is highly distributed in the urban arena. It is vital to recognise that "cities are not singular, homogenous entities that act in one particular way or another; instead they are complex and dynamic sites of contested interests, concerns, and powers" (van der Heijden et al. 2018: 3).

If the capacities and levers for supporting urban transitions – the multilevel governance conditions, multiple modes of governing, and range of actors involved – have now come to be fairly well understood with respect to those pieces of the urban puzzle with a direct bearing on environmental and energy challenges such as climate change mitigation (e.g. energy, mobility, waste) and adaptation (e.g. water, sanitation, coastal defence), our understanding is much more limited when it comes to considering the ways in which urban areas contribute to the these challenges beyond their immediate boundaries. As outlined in Part I of this report, there has been a growing interest in cities globally in taking account of how cities *consumption* of materials and resources shapes their impact on key environmental problems, with the growth consumption-based accounting for GHG emissions and the use of 'water' and 'ecological' footprints for the consumption habits of urban populations. Recent analysis for UNEP (Swilling et al. 2018) suggests that urbanisation is also driving climate change through the consumption of cement and steel – two carbon intensive products – whilst the IPBES Global Assessment suggests that urbanisation is a major driver of land-use change and changing diets which in turn are affecting biodiversity and ecosystem service provision. Most municipal governments have limited direct control over these processes, and will have to develop their modes of governing and partnership working in order to be able to build the capacity required to ensure environmental and energy transitions are implemented which can address these underlying drivers of change.

2.2. Governing Transitions in Urban Socio-Technical Systems

If research on urban environmental and energy transitions initially focused on institutions and agents, a key development over the past decade has been an increasing recognition that such transitions are fundamentally *socio-material*. If cities are to reduce the GHG emissions they emit, their levels of air pollution or improve water quality, it is not only a matter of socio-economic and institutional change but fundamentally of a change in the material basis of urban life.

Critical in developing our understanding of the socio-material make-up of cities and the ways in which transitions take place has been work on *socio-technical systems*. Drawing on work in science and technology studies that goes back several decades, this literature has provided us with two critical insights. First, that the socio-technical systems are a vital building block of national and urban economies and are co-produced by the interaction between social and material entities – institutions, wires, norms, vehicles, washing machines and everyday practice combine to shape the provision and use of key services and their environmental impacts and energy intensity (Coutard and Rutherford 2014; Hughes 1983). Second, that although such socio-technical

systems can seem relatively inert, they result from an ongoing processes of innovation and resistance and are "neither centrally controlled nor directed towards a clearly defined goal" (Hughes, 1983: 6). From these starting points, research has sought to examine how and why rapid realignments of these systems – termed *transitions* in the literature – could emerge. Of particular importance has been the insight developed through the *multilevel perspective* (MLP) which developed a heuristic to distinguish between the *regime*, a relatively coherent configuration of actors, institutions, infrastructures, practices and technologies which is embedded in a stable *landscape* that establishes the prevailing economic, social, political and cultural conditions for regime formation (Geels & Schot 2007; Smith et al. 2010). Regime stability leads to the 'lock-in' of socio-technical systems, which are relatively resistant to change. However, innovations are able to 'breakthrough' and disrupt the regime, potentially creating realignment between major social and technical components of the regime of such significance as to generate a transition from one regime to another.

The socio-technical systems approach has proven to be particularly fruitful for considering the conditions required to leverage transitions towards sustainability. Innovation has been at the heart of the theory of change developed within this approach – if innovations can be generated within 'niches', relatively protected environments which are not subject to the prevailing orthodoxies or interests of the regime, they have the capacity to generate the momentum to disrupt existing social and material orders and provide the basis for the development of alternative regimes. For Smith & Raven (2012), "the function of such protective spaces in transitions to sustainability is to provide an environment where regime selection pressures are held off in a way that allows path-breaking innovations to be nurtured and further developed." While providing important insights about the relation between innovation and incumbent socio-technical regimes, research in this field was heavily critiqued for its assumptions that such niches were aspatial, taking place locally within the context of a national socio-technical regime (Hodson & Marvin 2010), leading to a neglect of regional and urban actors in transitions and assumptions that urban places could be regarded as containers or backdrops for transitions but with little influence over their nature or direction (Bulkeley et al. 2010; Geels 2010). More recent research has actively sought to draw attention to the urban dimensions of socio-technical transitions for sustainability (Coenen & Truffer 2012), demonstrating the important role that cities play as sites for the development of exemplars, the mobilisation of key constituents, and fostering inter-firm and inter-organisational learning (Coenen et al. 2012; Spath & Rohracher 2012; Hodson & Marvin 2010). From a more nuanced engagement with the geographies of transition, it has become clear that sustainability transitions take place across multiple levels and sites, intersecting with and involving a range of sectors simultaneously (Frantzeskaki et al. 2017; Luque-Ayla et al. 2018).

Niche innovations have therefore become firmly established as central to the pursuit of environmental and energy transitions. Such innovations can be primarily technical in orientation – such as the introduction of novel technologies or materials – or they can be socially constituted – including innovations in policies, finance, practices or norms. Research in the field of *strategic niche management* (SNM) has sought to develop approaches through which such niches can be fostered. This work has found that three key processes are essential for efforts to deliberately manage transitions (Schot and Geels 2007): the articulation of visions and expectations for the innovation, to generate visibility and engagement; the development of social networks that provide sufficient resources, leverage and support for innovations; and processes of learning, through which niches can adjust, enrol new participants, grow and build momentum (Sengers et al. 2016). Rather than simply shielding innovations from prevailing regime conditions, this literature suggests that niches offer a means through which they can be actively nurtured towards sustainability transitions (Smith & Raven 2012). The active management and nurturing of niche innovations for sustainability has therefore been shown to be a key means through which the governing of environmental and energy transitions in cities can take place. For example, in their study of the development of a pilot project for energy efficiency retrofitting in public housing in Toronto, Hughes et al. (2018: 7-8) find that they are valuable to the extent that they provide a space for demonstration and learning that is able to address four related challenges facing the implementation of such measures, including financing, technical expertise, institutional barriers and political will.

Yet despite the important role that these perspectives have had in both drawing attention to the socio-material nature of urban systems and hence their transitions and to the critical role that innovation can play in fostering transitions, they have been found to be limited in relation to explaining the dynamics of power at play as transitions unfold. With a focus on questions of agency and innovation, there has been a tendency to neglect the structural dynamics through which lock-in is maintained and urban socio-technical systems resist change. In seeking to redress this imbalance, Smith & Raven (2012) sought to examine the ways in which innovations might be *empowered* to either 'fit and conform' with existing regimes, such that they are taken up within existing socio-technical systems generating incremental change, or where they instead 'stretch and transform' regimes, by undermining existing social and technical orders and providing alternatives. Here, they argue for the central importance of *narratives* and the actor-networks through which innovations are mobilised and come to compete with existing understandings of environmental and energy challenges and how they might be resolved. Other studies have pointed to the importance of incumbent regimes as potential sources for innovation, questioning the coherence within existing regime configurations and suggesting that shifting political economic conditions can provide the incentives and drivers for innovations to emerge that disrupt the regime from within.

Related to how power and authority are addressed within the literature on socio-technical transitions, questions have also been raised about the processes through which niche innovations are thought to develop sufficient momentum to breakthrough or disrupt regimes. As set out above, much of the literature has focused on how innovations can be supported – through protection, nurturing and empowering. In contrast, the work on socio-technical transitions has paid relatively less attention to how existing regimes shift and change, to how existing forms of 'lock-in' come to be challenged and undone. Recent studies have pointed to the important roles that incumbent actors can have in designing and implementing niche innovations, and in turn to ensuring that they become part of existing regime structures (Geels et al. 2016). Yet the broader conditions which shape the capacity for innovation, the pathways through which it evolves and the wider political economies of which it has been a part remain mainly absent from this body of work.

2.3 From Niche Innovations to Governing through Experimentation

A as we have seen, at the heart of the socio-technical transitions approach are niche experiments which provide bounded, real-world examples through which new social networks are established and learning takes place which in turn allows such innovations to build momentum, scale-up and challenge, extend or replace existing regimes, in turn shaping how infrastructures and services are provided in the city towards sustainable outcomes. Such experiments may come in many different shapes and sizes, including urban living laboratories, pilot projects, testbeds, best practices, innovation districts, demonstration sites, platforms, eco-city districts, experimental neighbourhoods, alternative economies and so forth (Bulkeley et al. 2016; Bulkeley et al. 2018; Evans et al. 2016; Grandin et al. 2018; Karvonen 2018; Karvonen & van Heur, 2014; Marvin & Silver, 2016). Yet despite the ubiquity of experiments in the urban arena, they tend to be treated in isolation from one another. The socio-technical transitions studies approach has tended to focus on innovations in one sector or domain and consider how these specific interventions shape the potential and trajectory of sustainability transitions. Researchers examining how cities are responding to environmental and energy challenges examining the roles of specific actors and their strategies and interventions have noted the ways in which forms of demonstration project and best practice are central to building authority and the capacity to act in the context of otherwise adverse political economic circumstances. Yet why and how experimentation has become so ubiquitous, and with what consequences for the governing of environmental and energy transitions is only now coming to the forefront of analysis.

In their analysis of urban climate change experiments taking place in one hundred cities globally, Bulkeley & Castan Broto (2013) find that their emergence is related both to wider dynamics shaping a growing momentum behind governance experimentation in the climate change domain concerning the shifting nature of authority between state and non-state actors (Hoffmann 2011) as well as to the political economies of urban

development. As such, they suggest, we can expect urban climate change experimentation to both a general phenomenon, arising as a result of a growing impetus to govern climate change but the limited capacities and authority of traditional institutions to do so, but also to be manifest in specific ways in relation to the particular socio-material and political economic conditions of specific urban contexts. In this reading, experiments are not singular interventions designed with the express purpose of fostering learning and building social networks to gain traction for particular innovations, but rather need to be regarded as a new *mode of governing* which occurs where the authority to govern is dispersed, capacities to intervene are limited in time and space, resources scarce, the actions required potentially running counter to existing political economies and what it means to improve the urban condition in relation to climate change indeterminate – that is, where there are multiple possible 'good' urban futures which are contested and often conflicting.

Rather than being a matter of the multilevel governance dynamics shaping the capacities of actors and institutions or the result of how individual niche innovations are scaled up through processes of learning and extension, Bulkeley et al. (2014) suggests that the governing of energy and environmental transitions through experimentation is both a political and a socio-material process. As a form of governing, experimentation operates through "the conduct of conduct"; that is, "modes of action, more or less considered and calculated, that were destined to act upon the possibilities of action of other people" (Foucault, 2000a: 341). In other words, governing "… "is done through the arrangement and management of people and objects, producing the material conditions that make particular ways of being comprehensible and possible" (Gabriel 2014: 42). From this conceptual perspective, governing takes place through distinct rationalities or discourses that frame the problem to be addressed the potential of different solutions as well as the practical techniques and interventions that are undertaken to configure a "a sort of complex of men and things" (Foucault, 2009: 96) in order to improve their condition towards specific ends (e.g. climate change, health, biodiversity). Across the social sciences, a number of literatures point to the importance of such processes of alignment and intervention as a means through which governing can be realised. Whilst diverse in their theoretical assumptions, they provide the important insight that "governing is not seamlessly implemented but comes to cohere at the level of particular interventions, shaped at particular scales through relations forged between constituent elements" (McGuirk et al. 2015: 3). In short, they suggest that interventions – in this case in the form of experiments – are the means through which governing takes place.

Such interventions govern not only through bringing particular institutions and actors into alignment, but through reconfiguring socio-material relations into particular assemblages which are invested with particular purposes and ambition. Indeed, in their work on the role of experiments in shaping energy efficiency in buildings in China, Peng et al. (2018: 304) argue that the experiments are effective in so far as they enable "a realignment of actors, a realignment of resources, and a realignment of institutional arrangements" and that it is the "dynamic processes of the three realignments [that] are of particular importance, as they illustrate how a social-technical configuration emerges in a specific context." Equally in their work on the emergence of experimentation with mobility provision in Manchester, Hodson et al. (2018: 1481) find that "successfully materially embedding 'new' sustainable infrastructure interventions in a particular place requires configuring place-based interests, infrastructural technologies and forms of knowledge in ways which aren't always clear a priori. Experimentation, in this sense, can be understood as a process of governing that constitutes local capacity to materially embed 'new' interventions in place and learn from them." Research on the emergence of low carbon experiments in Sydney, Australia, including projects as diverse as Solar City programmes designed to both generate renewable energy and mange peak demand as well as demonstration homes intended to showcase multiple forms of sustainable living practice, shows that they also rely on the capacity to (re)configure socio-material networks and everyday practices through creating new discourses, techniques for calculating the benefits of interventions, and new forms of association in ways that require continual work and are always subject to disruption (McGuirk et al. 2016).

Think for example of the different entities that are bought together in order to realise increased traffic flow in contrast to those required to make space for cycling in the city – many of the entities are the same (road traffic

agencies, pavements, signalling, municipal budgets, users associations and so forth) but the means through which they are configured, the discourses, rationalities, forms of calculation and emotive associations created, diverge. Nonetheless, in each case governing relies not only on institutions, actors and their mechanisms, but the practical reconfiguration of social and material elements on the ground. Viewing experimentation as a means through urban governance is undertaken, Bulkeley et al. (2014) propose a three-fold framework for understanding how and why experiments come to have an effect on the nature of energy and environmental transitions through *making, maintaining and living* which collectively shape the extent to which experimentation is able to configure and enable shifts towards sustainability (see also Castan Broto 2017). The *making* of experiments involves processes through which they come to be conceived, designed and enacted, related to particular urban environmental and energy problems and designated as potential solutions, corralling the requisite actors and entities in order to be implemented. *Maintaining* experiments refers to the dynamic processes through which they come to be embedded within particular sites and wider social and material circulations whilst at the same time preserving their experimental quality. As the literature on socio-technical transitions illustrates, experiments are always interventions in existing systems and regimes, within which they have to both become integrated and also signal their exceptional characteristics. Successful experiments have to both become sufficiently accepted so as to take place within these regimes but at the same time retain their experimental qualities in such a way as to challenge prevailing orders. Also central to ensuring that experiments come to be embedded and sustained is the process of *living* experiments, a set of practices through which they come to be normalised within the daily practices and routines of the organisations and actors who are involved in their upkeep and circulation, creating new kinds of subjectivities that enable the experiment to shape everyday conduct and ways of relating to both the city and to the environmental and energy issues at hand. For example, such that those who are living in low carbon housing come to regard this as normal in terms of their actions and use of energy, but also think of themselves as 'low carbon residents' whose actions and behaviours come to be emulated by others as a form of desirable urban life.

Thinking of experimentation as a means through which governing energy and environmental transitions is carried out, rather than as singular illustrations or best practices of governance processes that take place through the workings of institutions, shifts our perspective on where the scope for intervention towards sustainability transitions lies and how it takes place. As Karvonen (2018: REF) has recently argued, the implication is that "experiments might not simply serve as one-off trials to provide evidence and justification for new low-carbon policies, regulations, and service provision through existing circuits of policymaking and regulation. Instead, these activities are emerging as a new mode of governance in themselves." In this framing, the task is then not one of considering how to evaluate and scale up individual experiments, but to consider what it means to work with experimentation as the primary mode through which environmental and energy transitions can be delivered in a "city of permanent experiments" (Karvonen 2018: REF). The implications of this perspective on experimentation and its consequences for how we might govern environmental and energy transitions is explored further below (Section 3.2).

2.4 Towards Transformative Governance?

Despite the rapid growth in urban initiatives intended to accelerate environmental and energy transitions, there remains widespread concern that the mode of experimentation that now dominates urban sustainability governance will prove to be too little, too late in response to the challenges we face. The growing body of research concerned with understanding how cities are realising responses to critical issues such as climate change, air pollution, water quality and so on has pointed both to the limited evidence connecting the development of new governance arrangements with action on the ground (Ballard et al. 2018; REFS) as well as to an apparent lack of 'scaling up' from experiments so that they are established as mainstream. These limitations are coming under ever more scrutiny in the light of calls for *transformative* change as essential for realising the scope and scale of the responses required. Broadly speaking, the "term 'transformation' is invoked to describe what cities must do to simultaneously improve climate resiliency and achieve the positive

effects of low-carbon sustainable development" (Rosenzwig & Solecki XXXX). In contrast to transitions, which might take place within bounded systems, the term transformation implies large-scale changes to underpinning social, economic and political orders (Holscher et al. 2018; REFS). Yet while momentum behind the discourse of transformative change has recently gathered pace through the IPCC 1.5 Degrees Report, the mobilisation of social movements for Extinction Rebellion and the declaration of a Climate Emergency, as well as the recent IPBES Global Assessment, there remains a lack of coherence and not a little confusion as to what transformative change might entail and how it can be realised.

Within the literature on socio-technical transitions, the notion of transformation was initially elaborated by Berkhout et al. (2004) as an emergent process, arising "from uncoordinated pressures, outside the regime, often driven by small and new firms" (Geels and Schot 2007: 401). Subsequent revisions to the concept of transformative socio-technical transitions have continued to stress its emergent, incremental nature. For example, Geels & Schot (2007: 409) argue that under this pathway "new regimes grow out of old regimes through cumulative adjustments and reorientations" through the adoption of emerging technologies, the addition of new knowledge, and small scale changes in institutions and social networks that comprise the regime. More recently, again revisiting the foundations and dynamics of the multi-level perspective on socio-technical transitions, Geels et al. (2016: 898) argue that alongside such incremental dynamics, transformative pathways can occur when "incumbent actors do not ... remain 'locked in' to the existing regime ... [but instead] change strategic direction and reorient themselves" to embrace radical change in ways that take place at different 'depths' "depending on the kinds of organizational elements that are adjusted" and whether these encompass day to day operations or underpinning beliefs and values. Here, *transformation* is interpreted as a set of processes through which existing regimes are gradually transformed in terms of technologies, institutions and culture in turn enabling environmental and energy transitions.

From the perspective of socio-technical transitions approaches, then, transformation is a matter of *systemic change*, such that change occurs at the level of the system (regime) rather than being contained to specific sites or places (niches) and involves both the widespread uptake of new technologies and the changes in institutions, practices, beliefs, knowledge and actors such that it becomes 'locked in'. As a transition pathway, transformation is incremental rather than disruptive, in contrast to the way that pathways engendered by 'de-alignment' and 're-alignment' take place through the collapse of incumbent regimes in the face of strong external pressure (Geels et al. 2016: 899-900). For some, such radical shifts in power, authority and institutional arrangements are a fundamental part of the *structural change* implied by the term transformation (Pelling 2011). In this perspective, transformative change is not (only) a matter of ensuring systematic change through the widespread uptake of new technologies, social practices, rules, norms and so on, but of transforming the socio-material conditions that have led to environmental degradation in the first place. As proposed by Pelling et al. (REF, quoted in Scholsberg et al.) in relation to climate adaptation, transformation in this reading requires a "reorientation of development pathways towards social justice and sustainable development." Requiring a shifting of priorities, power and privilege, transformation as structural change is inherently political and overtly contested.

The notion of transformation as a form of structural change is also increasingly related to calls for matters of social and environmental justice to be taken into account in the design and implementation of environmental and energy transitions. While questions of justice have been at the heart of the sustainability debate, they have until recently been notably absent from both thinking on environmental and energy transitions and from the specific concern with how urban sustainability transitions can be realised (Bulkeley et al. 2014; REFS). Initial attempts to take account of questions of justice in urban sustainability transitions focused on long-standing concerns within planning and development theory related to access to decision-making processes, especially amongst those often marginalised by most affected communities (REFS). Subsequently, studies also sought to explore how the distribution of rights and responsibilities for the benefits and risks of climate change might be shaped through the governing of environmental and energy transitions within cities, and with what consequences for both the equity of their outcomes and their legitimacy (REFS). Work on the justice

dimensions of urban environmental and energy transitions has since grown in sophistication and complexity in two important ways. First, a wider range of concepts of justice have been deployed to illuminate the ways in which climate justice might be conceived and enacted. Principally this has involved going beyond approaches which seek to improve the mechanisms of participatory or distributive justice to ensure more inclusive processes or fairer outcomes and instead to engage with principles of justice that require both recognition of the ways in which prevailing socio-economic orders serve to perpetuate injustice and inequalities on the one hand and of the need to ensure that certain capabilities for living a sustaining life are met on the other. Second, growing attention has been paid to what a *just transition* might entail, in the context where particular communities and individuals may be more exposed to the negative consequences of environmental and energy transitions, whether that be by virtue of their position in the urban landscape (e.g. where populations deemed vulnerable to the impacts of climate change are moved in order to enhance their resilience, but with limited attention to the subsequent implications for their access to work or social networks) or the economy (e.g. where those working in high-carbon sectors of the economy may be at risk of losing their livelihoods). Calls for approaches to environmental justice which take account of the political economies of uneven urban development and seek to redress inequalities and enhance capabilities hold much in common with structural approaches to transformative change. At the same time, those which seek to call attention to the importance of a just transition – for social, economic and political reasons – signal how rapid or accelerated processes of transformative change may run counter to ambitions for social and environmental justice.

In practice, notions of *systemic* and *structural* change are often combined in calls for transformative environmental and energy transitions. For the IPCC, the concept of transformation underscores "the need for urgent and far-reaching changes in practices, institutions and social relations in society. Transformations towards a 1.5°C warmer world would need to address considerations for equity and well-being" (IPCC 2018 Chapter 5, p.468). Similarly, the recent IPBES Global Assessment (SPM 2019: 5) defines transformative change as "a fundamental, system-wide reorganization across technological, economic and social factors, including paradigms, goals and values" though it is less explicit in terms of questions of equity and justice. For the IPCC, even if it is noted that the "form and process of transformation are varied and multifaceted" it is nonetheless assumed that there is a fundamental connection between interventions "that will enhance the prospects for effective climate action, as well as enhanced poverty reduction and greater equity." To reach 1.5 degrees what are therefore needed are "climate-resilient development pathways ... trajectories that strengthen sustainable development, including mitigating and adapting to climate change and efforts to eradicate poverty while promoting fair and cross-scalar resilience in a changing climate" (IPCC 2018, Chapter 1 p.73). Calls for transformative urban climate governance have also taken up this position, such that urban climate governance should be regarded as "part of the quest for urban transformations towards sustainability and resilience ... [where] climate mitigation and adaptation are not any more isolated objectives, but integrated within the need for radical and structural changes in urban systems to create and maintain environmental integrity, social equity, human well-being and economic feasibility in the long-term" (Holscher et al. XXXX).

If there is some level of agreement that transformative environmental and energy transitions require both *systemic* and *structural* change, there is much more dissonance about how this might be achieved. For those working in the tradition of socio-ecological systems thinking – most often associated with the development of the concept of resilience – the self-organising, emergent nature of transformative change requires governance approaches which are both *co-evolutionary* and *co-designed* (REF). Essential to any approach to transformation, according to this approach, is that governance systems themselves transformed in the quest for sustainability, such that they are capable of becoming adaptive, flexible and resilient and in turn able to navigate emerging transformations (REFS). While there is significant emphasis on the need for responsive governance systems, such approaches have also called for interventions capable of re-designing governance processes towards transformation, for example in the creation of 'transformative spaces' (REFS) or co-creation processes, through which goals can be articulated, shared norms developed, and the requisite social and political capacities required for transformative change developed and harnessed (REFS).

For others, transformative change is only possible to the extent that the governing of environmental and energy transitions explicitly takes issues of justice into account. The imperative to adhere to principles of procedural justice is in this sense a "benchmark" by which to assess the extent to which governance systems have themselves been transformed and are capable to generating transformative change (Scholsberg et al. XXXX). As "failure to identify, make clear, and engage the broad public about ... potential trade-offs [both in terms of what is valued and how it is valued] will lead to the marginalization of those without power and influence, and lead to climate impacts that are 'morally unacceptable' and, so, unjust" only governance approaches that actively seek to address these issues can claim to be authentically transformative (Scholsberg et al. XXXX). However, whilst issues of procedural justice have come to the fore in questions concerning what processes of and for transformative governance might look like, there has been less attention given to the other dimensions of urban environmental and energy justice, such that issues of the ways in which transformative change should follow principles of recognition in relation to the distribution of rights and responsibilities remains underexplored (Bulkeley et al. 2014).

Beyond reform to governance systems and processes or the more or less comprehensive inclusion of principles of justice in the design and implementation of environmental and energy transitions, some calls for transformative change focus on avowedly political processes of contestation, disruption and the dismantling of existing institutions, production processes, technological systems, social practices and cultural norms. For the most part such calls are confined to social movements and public debate, though an increasing number of municipal governments are now declaring a 'Climate Emergency' as a means through which to mobilise action for environmental and energy transitions. Arguably, discourses advocating for transformation as a form of structural change – as endorsed by national governments through the IPCC 1.5 and IPBES reports, for example – necessarily require the design and implementation of interventions which are explicitly intended to 'un-do' or 'unlock' existing systems if their ambitions in terms of the scale and scope of action are to be met. Yet both the means and the consequences of such interventions has yet to be systematically investigated. In relation to urban transitions, XXXX conclude that while the politics of low-carbon (and resilient) transitions have now been widely studied, "*the crucial issue of the politics surrounding their deliberate acceleration, however, remains under-examined*." Furthermore, the assumption amongst many advocates of transformative change is that this necessarily politically progressive, enabling and emboldening claims for social and environmental justice. Yet as Stirling (2014: XX) cautions this need not be the case, for there are at least "two radically contrasting forms of prospective global 'transformation' – respectively 'progressive' and 'conservative' with respect to entrenched regime interests."

If the question of how to achieve the level of *systemic* change regarded as necessary to meet environmental and energy challenges has proved vexing, acknowledging the level of *structural* change that is required both to undo existing forms of lock-in and address social and environmental justice concerns adds ever more complexity. At the city level it is at least clear that interventions are needed that challenge current patterns of lock-in and injustice, not only because addressing environmental and energy transitions at any social cost is amoral but also because it is unlikely to be politically effective. Yet the way ahead remains unclear. For some, the next critical steps require the reformulation of governance systems and the design of new institutions capable of delivering transformative change, explicit and reflexive decision-making processes where interventions are designed and evaluated in relation to their transformative potential, coupled with the widespread scaling up and mainstreaming of social and technical innovations. Others question the extent to which such an approach is likely to be successful, given the political challenges that would likely ensue and questions over whether the assumptions about the workings of power and control that such approaches embody are justified (Newell 2019; Stirling 2014).

2.4 Summary

Overall, we can see that in parallel to the shift within urban responses to the challenge of environmental and energy transitions different approaches have been advanced by the research community to understand how and with what implications cities engage in the governing of sustainability transitions. Much of this literature has been derived from the climate change domain, which has dominated urban environmental and energy agendas over the past two decades. It has revealed the multi-level, multi-actor and multi-faceted nature of urban climate governance and increasingly emphasised that governing urban transitions is not adequately conceived of in terms of *policy and institutions* but must also take account of how urban *socio-material* systems through which environmental and energy challenges are generated are reconfigured by *niche innovations and experimentation*. There is now a growing consensus that experimentation is a primary mode of governing urban environmental and energy transitions, though the dynamics and implications of experimentation are seen in very different ways across this body of work. To simplify a much more nuanced picture, it is possible to identify two primary schools of thought. First, a body of work which regards experimentation as a means through which policy goals are translated into pilot projects or tested within urban living laboratories, in order to generate networks of actors with the capacity of taking these experiments forward and to generate learning that can be taken up within policy and planning frameworks, generating interventions 'at scale' that will enable transitions to take place. Second, an approach which regards experimentation as new mode through which governing is taking place, potentially replacing urban planning and policy as a means through which urban sustainability is realised. Each approach aids our understanding of the ways in which transitions are unfolding in the urban realm, but draws different conclusions concerning how capacity to govern transitions can be generated and with what consequences. More recent work is challenging the pace and scale of such transitions through calls for *transformative* approaches to urban sustainability, capable of addressing multiple sustainability objectives at the same time as responding to ongoing challenges of social and environmental justice. Whilst often used interchangeably, there is an important distinction to be made between those advocating *systemic* change and those for whom transformation necessarily involves *structural* change.

Part III: Generating New Perspectives

"One way or another, it is through various kinds of power dynamics, that any social transformation comes to be realised or suppressed" (Stirling 2014: 84).

For all its diversity, our understanding of how urban transitions can be governed towards sustainability are largely based on particular understandings of the urban and of governance that place more or less implicit limits on how we come to view these dynamics and the ways in which they can be further enabled. One approach to moving this agenda forward is not to seek to further deepen our analysis, but to change our perspective. Viewing things from a new position allows different aspects of the problem and its solutions to come into focus, shifting how we see the whole and its dynamic parts and where we might look for solutions. This section takes as it starting point two such positions. First, that we should understand the 'urban' not as a static or bounded spatially distinct entity, but in *relational* terms such that cities and urban governance are viewed "as created and changed through the various types of relationships that constitute them — socially, politically, and materially" (Grandin et al. 2018: 16). Second, that we can adopt a conception of power that views it as both facilitative and immanent to social relations. Power is of course a complex social concept, and its definition, meaning and consequences highly contested across the social sciences. Yet not withstanding its central importance for understanding the nature and dynamics of urban environmental and energy transitions as Stirling (2014) makes clear, it is rarely explicitly discussed in the literature in this field. For the most part, approaches to urban transitions operate with assumptions about the working of power that assume it is "an instrument of domination, a capacity of some resourceful mix" (Allen 2010: 2899) held by some actors over others, to be wilfully deployed and with clear and immediate effect (Bulkeley 2012). In short, that holding power – in this case, the specific form of power as authority to govern – provides both the legitimacy and means for control (Stirling 2014). Yet shifting our perspective on power brings about very different possibilities. Across many traditions in the social sciences, power is regarded as a facilitative, enabling capacity: "where power itself is not conceived as a resource but as something generated by the application of resources and skills over tracts of space and time" (Allen 2010: 2900). Equally, power can be seen not as a capacity that exists *outside* of social/material relations, but as generated through them – as immanent to those relations and inseparable from its effects (Allen 2003; Bulkeley 2012, 2016; Foucault 2000; Li 2007).

Together, this leads to a perspective on the governing of transitions which regards governing as "an active, dynamic and provisional process that is continually being sought through "programmes" or "projects" that seek to intervene in the existing social (and material) order to achieve particular ends" such that their "configuration or design realises new kinds of capacities and capabilities" (Bulkeley et al. 2016). From this starting point, Part III of this report considers the new perspectives which might be generated on the three key conundrums raised in the Introduction – how to address the multiple, fragmented nature of the governance of urban transitions, how to realise the potential of experimentation, and how transformative approaches to addressing environmental and energy challenges might be enabled.

3.1 What if governance fragmentation is really the solution rather than the problem?

As detailed above, research has established that the governing of urban environmental and energy transitions is *multilevel*, distributed vertically across tiers of governmental institutions, private sector and non-governmental agencies and horizontally between operational divisions, neighbouring authorities, state and non-state actors. This highly fragmented governance landscape is driven not only by the capacities and resources that different actors can bring to bear on environmental and energy challenges, but also by their *authority*. If governing is by definition the legitimate use of power, then how and where authority is

constituted is central to understanding and resolving the governance challenge. Evidence suggests that addressing environmental and energy challenges requires not only the use of formal powers (e.g. in regulation, land-use planning or taxation) but also the capacity to marshal and generate multiple modes of governing through which such transitions can be realised, each of which draw on different forms of power in doing so (Allen 2003). Arguably, the multilevel, multi-actor and multi-sited forms of governing environmental and energy transitions that have been documented to date are then not only a result of the lack of capacities, resources and powers, but also an outcome of their proliferation – as the entities, infrastructures and practices that need to be governed shift from 'end of pipe' emissions and single adaptation measures to the decarbonisation of systems of energy and mobility to provision, to shifts in the nature of the economy and everyday life, so too the authority to govern that needs to be enrolled towards these ends also expands.

There is however a widespread assumption within both policy and research communities that the ongoing expansion of governance, the multiplicity of agents involved and the diverse ways in which the conditions to govern are constituted represents a *fragmentation* of governance capacity. This of course rests on the assumption that such capacity is finite (rather than generative), and in this view the emerging patchwork of responses which it generates are problematic in terms of generating efficient and effective governance for addressing environmental and energy challenges. In response, two strategies are usually recommended. First, to develop and *formalise* the capacities of specific actors through for example strengthening the knowledge base for decision-making or increasing their formal powers. Second, to seek *integrate* dispersed forms of authority either within specific institutions or through the standardisation of policies and measures as well as their evaluation. In each case, the emphasis is on *concentrating* power and seeking to design and *control* how it is used.

For example, a study of local Climate Action Plans in Denmark finds that many local authorities are proposing targets for climate mitigation equal to or in advance of those at the national level, but that the scope and range of their actions towards these ambitions is highly varied (Damsø et al. 2016). In realising the potential of local planning, they suggest, an "integrated national planning framework" could provide the means through which to harmonise and enable local action (Damsø et al. 2016: 18). Yet at the same time, this research points to a key tension between *harmonisation and integration* and enabling *context-specific* approaches, which "by tailoring activities to fit more closely to contextual preferences and limitations, mitigation activities can likely be implemented faster and better, while also being integrated into other local hooks (e.g. job creation), thereby increasing the societal value of the activities." (Damsø et al. 2016: 18)

Similarly, in Canada research has found that climate adaptation is strongly shaped by the multilevel governance conditions in which it takes place (Oulahen et al. 2018). Across a governance landscape stretching from federal to local governments, across diverse municipal authorities and departments, and between state and non-state actors, barriers relating to a lack of resources and knowledge, but tellingly also the misalignment of policies and a lack of centralised authority and political champion to provide what was regarded as the necessary integration. As the researchers argue, the most common proposals to respond to these challenges include establishing "integrated, comprehensive" management authorities to "synchronize efforts within and across levels of government" and to legislate for adaptation planning so that "local governments are required to develop a strategy, implementation plan, and regular monitoring and reporting." (Oulahen et al. 2018: 412). Such calls have been made, for example, in relation to findings concerning the challenges of climate change adaptation at the municipal level in the Netherlands, which concluded that there was a clear need for national legislation to ensure that municipal governments were given appropriate responsibilities and both incentives and potentially coercive measures to provide direction for climate adaptation strategies and actions (Dabrowski 2018: 851). Similar findings emerge from a comparative study of climate change responses of *two*

cities regarded as front-runners globally, New York and Rotterdam (Hölscher et al. 2019). While governance capacities had been created by "informal governance processes like envisioning, experimentation, coalition building and learning" which had "contributed to momentum for systemic, long-term, multi-actor and learning-based climate governance approaches" there was a perceived need to strengthen "institutional and organisational conditions for more decisive prioritisation of long-term climate investments and actions, better funded collaboration mechanisms and improved space for (learning from) experimentation." (Hölscher et al. 2019: 851).

Across a diverse set of studies of the governance conditions under which environmental and energy transitions in cities must take place, the urge to recommend policy integration and formalisation has been strong. Indeed, the need for integration across different disciplines, knowledge practices, departmental silos and policy arenas has been clarion call across much of environmental governance for at least the past thirty years, with the resulting focus on approaches such as integrated assessment modelling and integrated planning as the means through which to guide policy interventions. Yet this integrative impulse rests on some heroic assumptions which often go unquestioned and, in the case of urban sustainability transitions, is based on particular ideas about both the urban and governance which do not encompass the full scope of possible ways of thinking about this challenge or how to respond to it. First, that it would be practically possible to integrate the range of sites, actors, dynamics and decisions involved in environmental and energy transitions. The challenge of integration may have been complex when the task was one of 'joining up' thinking within and across municipal authorities, but given the multiplicity of agents and forms of intervention involved as the remit of what counts as the governing of environmental and energy transitions expands, comprehensive integration is likely impossible. This is not only for practical reasons, but also political (economic) ones. Environmental and energy transitions are at best viewed in highly diverse ways and driven by a range of co-benefits and at worst often controversial, such that forging the kinds of consensus required to integrate those with diverging interests, modes of operating and attachments to the issues concerned is likely to take more political capacity than any one actor is capable of marshalling in most urban contexts. More fundamentally, the mantra of integration and formalisation rests on the assumption that such forms of power are more effective than the informal, 'soft' power which they seek to replace and that it is possible to design institutional forms and processes that are capable of controlling the urban system from 'above' (or 'outside'). As Stirling (2014: 84) reminds us, "even in relatively straightforward organisational settings, simple deterministic pictures of control can be problematic. And they are often better understood more as instrumental fictions necessary for the assertion of privilege, than as disinterested accounts of actuality."

Questioning the basis of calls for the formalisation and integration of governance capacities as a means of enabling more effective environmental and energy transitions leaves us with a dilemma. The current multilevel conditions and fragmented landscape of governing authority for addressing urban sustainability challenges appears inadequate to the task at hand. At the same time, calls for the formalisation and integration of authority to govern are likely impractical, political naive, and based on questionable premises about the nature of power and urbanisation. Alternative perspectives can point us towards some promising ways in which this dilemma can be overcome. Rather than seeking *integration* a number of studies point to the important role of *orchestration*, *boundary spanning* and *intermediation* as means through which governing can be enabled through co-ordination and configuring different governance capacities and forms of authorisation (Guy et al. 2011).

The notion of *orchestration* has come to be seen as an increasingly significant means through which non-state actors can govern global challenges in the absence of formalised powers or coercive authority, and defined by "an attenuated relationship between governor and governed: the orchestrator works through an intermediary

in order to govern a target audience" (Gordon & Johnson 2017: 695). While who or what is an orchestrator can not be predetermined, it is assumed that orchestration is intentionally designed to achieve specific outcomes for particular target audiences – in other words, that orchestration operates as a form of power *over* specific (urban) entities. Orchestrating capacity is seen to be especially significant at the urban scale "for encouraging, coordinating and assisting action in alignment with shared long term goals" (Holscher et al. 2019: 846). Whereas within the transnational arena, orchestration is regarded as taking place through various forms of 'soft' power, at the urban level some researchers suggest that it is best effected through the development of integrated and centralised institutional spaces, such as cross-departmental offices and processes for knowledge co-creation or establishing co-creation spaces that bring together state and non-state actors to develop visions, strategies and interventions (Holscher et al. 2019). Research on the Covenant of Mayors (CoM) that was formed in 2015 from the merger of existing organisations shows how it has provided "a forum for collaboration and multilevel governance through complex nested responses to climate problems" through a "combination of voluntary approaches, data sharing, and scientific coordination" which combine both formal orchestration with soft power and as a result "has helped to achieve some key aspects of adaptive governance, particularly related to community-based action and social learning at the local government level"(Vella et al. 2016: 372; see also Kern 2019).

Approaches rooted in the concepts of boundary-spanning and intermediation in contrast start from *within* the urban socio-material networks, infrastructures and practices that are at the centre of transition efforts and are less concerned with the integration of existing efforts than with bringing them into alignment. In the case of the Southeast Florida Regional Climate Change Compact, research finds that it has been successful as a result of three key factors, each of which entails the alignment of the priorities, practices, infrastructures and ideas of the partners involved: "first, the partnership provides a forum through which local and regional actors can combine resources, technical capabilities and data to enhance the capacities of each of the participating local governments. Second, the Compact demonstrates that voluntary collaboration can yield agreement on baseline greenhouse gas emissions data, existing conditions, and sea level rise projections, which are necessary if local governments are to work collectively on climate change adaptation. Third, the development of the RCAP has yielded a framework for climate action to guide local policies and programs." (Vella et al. 2016: 374). From the perspective of science and technology studies, interventions such as policies, measures, initiatives, experiments and so forth create new 'boundary objects' that trouble existing boundaries between different actors, forms of authority, socio-material assemblages and so forth and require the work of 'boundary-spanning' agents capable of "coming to terms with different problem frames and actor configurations in the different policy arenas" (Dabrowsk 2018: 840). In this case, the Compact itself has created both the boundary-objects and the boundary-spanning agents that have enabled the pursuit of collective goals for climate change adaptation.

Similarly, intermediary organisations are seen to be those who act as "facilitators, brokers, instigators and network builders" (Matschoss & Heiskanen 2017: 85) across diverse interests and differentiated capacities. Central to the work of intermediaries is precisely the notion that such entities *mediate*, in the multiple senses of "bringing about agreement or reconciliation; to intercede" or intervene with, to be the "medium concerned in bringing about (a result) or conveying (a message, gift, etc.)" and to "occupy the space between ... things ... to be transitional between" (OED Online). In these senses, intermediaries are entities that can both act as 'conveyors' between others (of e.g. resources, knowledge, capacities) but also serve to intervene, disrupt and configure those relations, such that they "make connections, enable a relationship between different persons or things. Intermediaries are not simply arbitrators; they play a role in ordering and defining relationships" (Hodson et al. 2013: 1408). Both boundary spanning and intermediary organisations have primarily been understood as providing vital 'joining up' capacities across fragmented governance landscapes and providing

new spaces within which novel interventions can be developed and implemented (Castan Broto 2017; Guy et al. 2011; Hodson & Marvin 2009; Hodson et al. 2013; Matschoss & Heiskanen 2017).

From the standpoint of relational urbanism and the notion of power as an emergent phenomenon, the work of boundary-spanning and intermediaries can be seen as crucial in terms of the *relational* work that such entities perform, enabling diverse actors and capacities to 'come to terms' with one another in such a way that they are reconfigured in the process (Castan Broto 2017; Rohracher & Spath, 2014). This work of alignment and 'bringing into agreement' is seen to be vital to generating effective interventions, because it is a means through which new forms of authority can be generated (Bulkeley 2012, 2015). Authorisation is then not a stable, given phenomenon, but can be generated through 'the complex assemblage of diverse forces ... such that aspects of the decisions of individuals, groups, organisations, and populations come to be understood and regulated in relation to authoritative criteria' (Rose & Miller 1992: 183). In this sense, boundary-spanning and intermediary work are not the *outcome* of governance, but rather *generative* of new governance capacities. Rather than focusing only on how such intermediaries can be established, this suggests that in order to create capacities to govern environmental and energy transitions it is important to enable and ensure that interventions that give rise to boundary-spanning and intermediary activities are able to make good on this generative capacity through supporting the ongoing work of alignment and assemblage that such entities undertake, rather than moving towards the integration, centralisation and formalisation of these capacities.

3.2 What if experiments can not be scaled up?

> *"it is arguable that the entire notion of experimentation needs to be critically considered against the wider socio-ecological crisis facing humanity in the urban age. The time left for urban testing and trialling may be rapidly coming to an end in the face of manifest shocks, especially climate change"(Davidson et al. 2019: 12)*

As we saw in Sections 2.2 and 2.3, across studies of socio-technical systems and the politics of urban sustainability the balance of evidence now suggests that we are living in an age of experimentation. Although the beauty to be found in the art of experimentation lies with the beholder such that their dynamics and politics are viewed in diverse ways, analysts find that experimentation is now prevalent in diverse urban contexts and through generating new visions, networks, techniques, forms of learning and experiences can create capacities to change infrastructure systems, social practices and established norms and ways of working that contribute to environmental and energy transitions. Importantly, this literature regards governing as a *socio-material* endeavour – governing by experiment works not only by changing the ideas, interests and institutions that are bought to bear on a particular challenge but as the means through which "both the material fabric of places and socio-technical infrastructure systems" are reshaped in turn serving to alter "metabolic flows and circulations into, through and out of the city ... in complicated and patchwork ways" (Hodson et al. 2018: 1481).

As interventions in urban socio-material fabric and flows, experiments serve to create important 'boundary objects' and spaces of intermediation around which new actors and entities are aligned and novel capacities for governing are generated. Governance by experimentation can at least in part be seen to be a result of the growing recognition that the governing of environmental and energy transitions requires multiple sites and forms of intervention, across numerous aspects of urban social and material systems – from infrastructure networks to everyday practices – over which municipal authorities and other government actors have only limited capacity to directly control or intervene and where a range of other actors – from communities to companies – have critical roles to play. Experimentation, because of the ways in which it produces the need

for (and generation of) novel configurations across and between existing urban entities, can be seen as both generated by and emerging as a response to the fragmentation of authority found in the governing of environmental and energy transitions (Bulkeley et al. 2014; Hodson et al. 2018).

That experimentation plays a key role in environmental and energy transitions is now widely accepted. There are, however, strongly divergent views about what that role does and should involve and as a consequence contrasting ideas about how and when experimentation comes to be significant in relation to societal goals for sustainability. For those writing in transition studies tradition, experiments and the niche innovations they produce are fundamentally regarded as a *stepping stone* towards a form of system change which involves the breakdown or removal of existing regimes and their replacement with the novel socio-technical configurations developed within niches. Experiments in this sense are regarded as spatially and temporally discrete moments that provide the testing, breeding and learning grounds for widespread system change, and the central challenge that must be overcome is the *scaling up of experiments* (Davidson et al. 2019; Karvonen 2018; Peng et al. 2019: 303). Indeed, "part of the allure of experimentation is based on the assumption that it is possible to scale up from an individual project to the city through a process of trialling, learning and rolling out." (Evans et al. 2016: 4). The power of this allure is not only driving the curiosity of the research community, but also fuelling an increasingly dominant strategy of implementing diverse forms of experimentation on the basis that they can be scaled. For example, an assessment of municipal climate policy in Germany, finds that "the 'replication principle' can be observed as an influential rationale ... and that best practices are a widespread governing technique in the field of urban climate governance" (Nagorny-Koring 2019). Underpinning this interest in scaling up are fundamental assumptions within both urban planning and transition studies that acting 'at scale' is both necessary to achieve widespread urban change and desirable in terms of efficiency and effectiveness. For example, in a recent analysis of climate change action in European cities, Kern (2019: 126) explicitly states that her operating assumption is that "that system-wide transformation requires climate actions in all municipalities", while van Doren et al. (2016) suggest that low carbon urban initiatives will only be able to contribute to global mitigation efforts unless they are extended and applied beyond the initial forerunner cities in which they currently take place. Whether or not experimentation is or can be 'scaled' has hence come to be regarded as a key determinant of its success (Bourazovski & Harstad 2019; Castan Broto and Bulkeley 2018).

Such forms of scaling can come in different varieties. For example, Peng et al. (2018) distinguish between the *multiplication* of experiments, where through forms of policy diffusion and mobility such as that undertaken by transnational municipal networks experiments developed in one site are taken up in another, and 'upscaling' where the experiment serves to lead to policy changes at higher levels of government. Similarly, Hughes et al. (2018: 8-9) deploy a distinction initially made by Douthwaite et al. (2003) between "scaling up ... the "widening of the scale of operation"" and "scaling out ... the expansion geographically of a pilot project from the city to other jurisdictions, including other cities and other levels of government." Kern (2019) extends this approach through a considered analysis of the multilevel governance conditions within which scaling takes place. She suggests that three forms of upscaling can be identified: expansion, in which local experiments are extended within the particular city in which they were established; diffusion, a voluntary process by which experiments are shared across city boundaries through various processes of networking and learning; and transformation, in which upscaling is achieved through the adoption of experiments across a territory and which requires the involvement of all municipalities in that domain (Kern 2019: 128). These forms of upscaling can be achieved *horizontally*, *vertically*, or *hierarchically*, depending on the multilevel governance conditions in which experiments are situated and the capacities and dynamics of the cities involved. Kern (2019) argues that because of the complexity of these dynamics, a new form of *embedded upscaling* is now emerging, in which horizontal networks are increasingly being enrolled in to forms of hierarchical and vertical governance

in order to achieve governmental objectives. While Kern (2019) focuses on the example of the Covenant of Mayors, evidence from other transnational municipal networks suggests that they are less able to generate upscaling of this kind. Smeds and Acuto (2018: 553) argue that "based on our research on, and practical engagement with, the C40 network we would argue that networked experimentation undertaken by C40 member cities reaches its limit in scaling up to city-wide urban policy. Our argument is that, on the whole, this networked urban experimentation materially results in 'scaling out' of experiments globally, rather than 'scaling up' beyond the urban level of governance."

It seems that, with the notable exception of recent work by Kern (2019) to embed an understanding of the processes of scaling within the context of multilevel governance and despite the considerable effort that is put into scaling efforts, most notably through "cross-city exchange platforms such as C40 and ICLEI" ... "little is know about ... how successful experiments and innovations travel across contexts or about how they are transferred" (Peng et al. 2019: 303). Indeed, Smeds and Acuto (2018: 554) caution that "the pathways through which 'scaling up' occurs in cities, or could ideally occur, remains relatively unclear with limited systematic analysis within city networks or academia." Likewise, concerns are also expressed about a lack of understanding concerning how such processes contribute to change in urban systems and processes of transition taking place in response to contemporary environmental and energy challenges (Hughes et al. 2018; see also Nevens et al. 2013). It has been widely assumed within the literature that scaling emerges as the result of *successful* experiments, that is where actors are able to provide the right level of protection, nurturing or empowerment to enable innovations to become established such that they challenge, transform or replace existing socio-material configurations as social agents involved in experimentation are able to either extract and replicate particular elements of the experiment or able to translate learning from one experiment into another context. In short, processes of scaling up remain confined by an ontology which views experimentation as a protected niche with limited attention being paid to how its that "enlightened ideas" move out of such enclaves or "how complex translocal relationships support that process" (Bouzarovski & Haarstad 2019: 258).

Recent detailed studies of the process of scaling that have been undertaken are however instructive, for they suggest that rather than being a matter of *extracting* key artefacts or ideas in the form of particular technologies, techniques, policies, practices or lessons and *diffusing* them either horizontally or vertically, *scaling* itself involves complex, embedded processes of negotiation and navigation. In examining how a pilot project concerned with energy efficiency retrofits of social housing in Toronto was able to both 'scale up' and 'scale out', Hughes et al. (2018: 19) find that *bridging agents* provide important capacities in terms of "their ability to navigate complexity, develop links between key actors, and translate information for policymakers." Scaling, they suggest, is not a primarily technical process of policy learning or transfer, but rather requires continuous *navigation* of "the political, financial, technical, and institutional challenges to innovation" that are encountered as the socio-material configuration that comprised the pilot project is mobilised into new contexts and gathers momentum through the engagement of additional actors. These findings from Toronto have significant similarities with those recorded in the analysis of the uptake of Energy Performance Contracting in Shanghai, which found that *contextualisation* was vital for the multiplication of initial experiments and that this was achieved through a "new social, economic and institutional configuration that emerged" through the processes of realignment between actors, resources and institutional arrangements that such experiments generate, a process that "goes far beyond learning and copying from previous successful examples" (Peng et al. 2019: 310).

If the promise of scaling experiments appeared to lie in the possibility of *abstraction*, extracting salient elements and facts from specific contexts and transferring them to other situations in which they are then

adopted, detailed case-studies suggest that this is not borne out by experience (Evans 2011; Nagorny-Koring 2016; Smeds & Acuto 2018). Such assumptions about the nature of how the scaling of experiments could work have of course primarily been derived from innovation studies, and the traditional focus on either single products or historical examples of transitions in sectors which were relatively contained. The scaling of sustainability experiments under conditions of multilevel governance and fragmented authority appears to operate counter-intuitively. Rather than working through processes of abstraction and uptake, what appears to be at work are more intricate processes of *embedding* and *(re)contextualising* experiments.

This suggests that if we are concerned with the extent to which experiments can support environmental and energy transitions we need to move our focus from scaling up to the ways in which such experiments come to be mobilised within an already dynamic and relational urban landscape. Experimentation works within urban contexts that are already connected through their inherent relationality and are always in the making – in short where experimentation is already taking place at and across diverse socio-spatial relations that comprise the urban and in situation of ongoing (re)configuration. In her work on the ways in which experimentation with urban water management in the Netherlands has circulated globally, Goh (2019) calls our attention to the presence of *network formations* as a means through which resources, ideas, actors and power come to be held in relation to one another and create the capacity to intervene in diverse urban contexts. As Castan-Broto & Bulkeley (2018) have also argued, what comes to matter for the uptake of experiments is therefore not the extent to which they can be extracted and transferred, but the means through which they come to circulate through the more-or-less spatially extensive or socially-politically 'dense' networks of which they are already part. Experiments come to take effect in this perspective to "the extent to which the circulation of economic and ecological flows are maintained or re-configured; the extent to which a 'metabolic adjustment' takes place and the experiment re-works flows" (re)embedding them in the urban networked space and in so doing bringing together socio-material entities that create new possibilities for addressing urban challenges (Hodson et al. 2015; see also McGuirk et al. 2015).

Considering the challenge of life beyond experimentation in this way – not as a matter of scaling up but of enabling circulations and the emergent forms of urban relationality and power they engender – has important implications for the ways in which we seek to work with experiments as a means of generating transitions. As analysis of urban climate change action plans suggests, the "current overemphasis on generalizable instead of experiential knowledge makes best practices sticky and, consequently, also lowers their learning potential" (GERMAN REF). Perhaps counter to what might be expected, by focusing on how knowledge might travel and experimentation might scale, our current approaches tend to ensure that learning does not take place and the potential of experimentation is not harnessed. Equally important, where the conditions for experimentation are too tightly circumscribed, the potential of experimentation comes to be (unintentionally) constrained. In their study of alternative approaches to urban retrofit for energy efficiency in Manchester, Hodson et al. found that "place-based priorities [for particular types of economic growth and political ends] have tightly conditioned both the kinds of infrastructural interventions that are 'selected' in Greater Manchester and, importantly, the ways in which these are materially embedded through experimentation ... conditioning of experimentation [in such a way that it] sets parameters for action and limits discretion (Hodson et al. 2018: 1490). Similarly in Toronto, research has found that current policy systems are "designed to receive and respond to certain modes of demonstration and learning" recorded through particular kinds of metrics such that the potential for experimentation to be taken up comes to be constrained (Hughes et al. 2018). If the "appeal of experimentation lies in its ability to harness *radical contingency* in the service of urban development" (Karvonen et al. 2014: 106), then overtly instrumental or narrowly determined forms of experimentation are likely to be of limited value in enabling environmental and energy transitions. It should,

of course, be remembered that some forms of experimentation may be established with precisely this kind of political intent in mind.

Framing experimentation as a spatially and temporally discrete intervention whose power and effect are determined by processes of scaling up or diffusion which are controlled through either the extent of learning they can generate in social agents or their uptake in market dynamics is therefore misplaced. At best it gives a partial reading of the potential of experimentation, and at worst puts us on the wrong track altogether. An alternative perspective, rooted in a relational urbanism and a conception of power as immanent, suggests that what matters is how far experiments are capable of becoming embedded, contextualised, reconfiguring relations and flows in such a away that new forms of service provision, social practice, infrastructure and so on that address environmental and energy challenges come to be possible and are mobilised and relayed through the dynamic network processes of which they are already a part.

Such a perspective becomes particularly significant if we move from considering experiments as singular and temporary interventions, to considering experimentation as a mode of governing that is both a response to and emergent from contemporary conditions of the dispersal and multiplicity of authority to govern sustainability challenges. If rather than serving "as one-off trials to provide evidence and justification for new low-carbon policies, regulations, and service provision through existing circuits of policymaking and regulation" we are witnessing the emergence of the "city of permanent experiments" (Karvonen 2018) then a new way of thinking about the potential of experimentation is needed. Here, experimentation is not an exercise designed to try out and find the 'best' solution to particular challenges and generate outcomes to be transferred. Instead, experimentation come to be an ongoing process of learning by doing, translating and mediating between different contingent and contested visions of urban futures, and configuring and remaking urban socio-material conditions towards diverse outcomes (Bulkeley et al. 2015; Karvonen 2018). The face of significant indeterminacy, this provides a means of governing by 'muddling through' (Lindblom 1959; cited in Nagorny-Koring 2019), harnessing the unruly potential of urbanism towards specific ends but with the continual requirement to undertake the ongoing work of experimentation.

What if transformative change can not be achieved through improving governance processes?

As Part II demonstrated, there is gathering momentum behind the need not merely for urban *transitions* but for *transformation*. Views on transformation vary considerably in terms of what it is that needs to be transformed – whether that is the institutional processes through which decisions are taken, the infrastructural networks which provide urban services and underpin environmental and energy challenges in the city, or the social practices which shape how communities, businesses, organisations and households contribute to these problems and their solutions (Grandin et al. 2018). There are also significant differences in perspective in terms of what *counts* as transformation – whether the intended outcomes are *systemic* or *structural* and the extent to which transformational change requires taking account of multiple different sustainability and justice goals simultaneously.

To date, most attention has focused on the need to transform the institutions and processes through which the governing of environmental and energy transitions is undertaken in the city. There are have been strong calls for the role of *co-production* between knowledge providers and practitioners in cities in order to develop solutions that are not only science-based but also of practical relevance in urban contexts. The strong emphasis on knowledge co-production and various other forms of transdisciplinary research in the H2020 Sustainable Cities and Communities programme (which for example currently funds a portfolio of projects examining the potential of urban nature-based solutions for sustainability valued at more than 250 million

Euros) is a marker of the significance now attached to this mode of knowledge production and urban governance. Research has also called for the opening up of urban planning, policy and governance processes in order to enable greater participation from a wider range of stakeholders and affected communities in pursuit of what is termed procedural justice – that is, that those affected by decisions are entitled to have a say in both the processes through which those decisions are made and their outcomes (Bulkeley et al. 2013; Chu et al. 2017). On the one hand, these approaches focus on the imperative of *transforming the process of governance* itself, in order to generate better decisions either because they are more informed, relevant or just. At the same time, there is a tendency within this literature to assume that if decision-making processes are improved in these ways, better *outcomes* will result. In short, that transforming governance processes is a means through which to transform governance outcomes. In their recent assessment of the role of networked experimentation in shaping environmental and energy transitions, for example, Smeds and Acuto (2018: 555) argue that to date there have been "few experiments in the form, nature and purpose of urban governance itself" and that the pursuit of transformative change rests on the development of experimental modes of urban governance, capable of shifting the nature and terms of local politics towards sustainability.

While there is significant evidence to support the notion that more inclusive decision-making can transform institutions, the connection between transformed decision-making processes and transformative outcomes – in either the systemic or structural interpretation of the term – is less clear cut. Research suggests that the relation between policy 'inputs' in the form of knowledge, participation, values and so on, is only loosely coupled to policy outcomes, a process that is complicated by power dynamics, opportunities, inertia and so forth. In particular, most of the work that promotes the importance of institutional transformation does so from a perspective that emphasises the importance of *consensus* building as a means through which to achieve transformative change. Yet research has also emphasised that a degree of *conflict* is to be expected if vested interests are to be challenged, existing orders reconfigured and new ways of knowing and practicing to be accomplished (Castan Broto 2015; Bouzarovski & Haarstad 2018). To date there has been remarkably little work on the conflicts that arise through efforts to transform institutional practices, or more broadly in terms of wider processes of transformation, a matter to which we return below.

Transforming institutions and governance processes may be one thing, but transforming infrastructures and social practices appears to be another. As discussed above, the literature on urban experimentation has sought to make the case that such transformations do not take place through the *upscaling* of experiments, but rather through the processes of reconfiguration that they engender. The transformative potential of experimentation in relation to the socio-material infrastructures and practices in which they intervene and the governance capacities that they generate is shaped not only by their capacity, but also by the 'viscosity' of the context in which they are established (Bulkeley et al. 2014; Castan Broto 2017). Experimentation serves to open up existing configurations, subjecting the logics, techniques, values, visions, practices and routines of infrastructural provision, consumption, risk calculations and so on to contestation and reworking. In this sense, experimentation is necessarily contradictory, requiring the bringing into relation of different socio-material orders and their navigation. In this sense, the "the inherent contradictions contained in energy and climate-related urban action may not themselves present an obstacle to further diffusion, but rather aid a process of active negotiation and reflection that helps build further connections and initiatives" (Bouzarovski & Harstad 2019: 266; see also Castan Broto 2015). This, as Bouzarovski and Haarstad (2019) argue, requires active processes of *rescaling* involving active processes of politicisation, enrolment and hybridisation, such that dominant interests are challenged, new actors are gathered into the experiment and novel socio-material entities created through which new forms of provision and practice are ordered.

Despite their differences, what is intriguing about these analyses is that each suggest that *structural* change – either in terms of the procedures of decision making and governance arrangements or in terms of the incumbent interests and configuration of socio-material orders – are required in order to achieve *systemic* change. Yet the evidence base points to a more worrying trend – of *systemic* change that may be taking place in a manner that serves to further embed and entrench existing interests and decision-making processes, exacerbating inequalities and – if the analyses above is correct – preventing the kinds of transformative change that are required to realise the kinds of environmental and energy transitions needed in cities to address climate, biodiversity and sustainability goals.

One area where the research on the contradictions between systemic efforts to achieve environmental and energy transitions and underlying structural inequalities has perhaps been most prevalent is in relation to green infrastructure and the emerging phenomenon of green gentrification (Anguelovski et al. 2018; Wolch et al. 2014). research suggests that urban re-naturing projects and other nature-based solutions might not only create a form of immediate socio-spatial displacement and/or immediate exclusive access, but also long-term processes of green gentrification. Since the late 2000s, research has demonstrated how new or restored nature-based amenities such as parks, greenways, or gardens contribute to demographic changes illustrating gentrification trends and to increased real estate prices through a process of "green gap" and subsequent green rent capture (Anguelovski et al. 2018). That such processes serve not only to exclude and differentiate access to the resources provided by nature in the city, but also to generate and reproduce certain views and values about nature is central to their continued capacity to shape what, and for whom, urban nature is produced. Critical scholarship has started to pay closer attention to the connections and relationships to nature different groups construct over time (Kabisch and Haase 2014; Anguelovski et al., 2018b; Zimmer et al. 2017). Such analysis helps us to understand what broader socio-cultural and neighborhood environmental aspects promote or can ensure genuine access to nature and the benefits it can generate. For instance, larger parks might create greater sense of insecurity when those parks are located in high crime zones and in many US cities residents of colour carry deep-rooted memories of violence and exclusion in urban green space (Kuo and Sullivan, 2001; Anguelovski, 2014). In that sense, green and nature is not "good" for everyone, and not all types of green spaces and nature in the city are valued in the same way. Yet, urban nature-based solutions can serve to neglect these issues and exclude certain views and values of nature because of the way they are designed, planned, and executed (Kabisch and Haase, 2014; Haase et al., 2017).

That the politics of urban environmental and energy transitions are far from neutral should not come as a surprise. In some instances, as the discussion of urban nature based solutions suggests, there is a politics imbued in experimentation itself as it seeks to improve certain urban conditions for and behalf of some and not others, demonstrating the kinds of 'splintering urbanism' that have dominated the provision and use of infrastructural networks and urban services since at least the 1990s in western economies (Graham and Marvin 2001). At the same time, experimentation encounters the politics of existing high carbon societies and economies, which more or less explicitly show resistance to change (Newell 2018; Bulkeley et al. 2016). Given such dynamics, both institutional shifts and experimental interventions directed towards environmental and energy transitions may more or less intentionally generate adverse outcomes in relation to diverse sustainability goals or in terms of social and environmental justice. In their analysis of a district solar heating demonstration project in Alberta, Canada, Nciri & Levenda (2019) find that incumbent interests seek 'sustainability fixes', interventions "that simultaneously meet profit-making and environmental goals without addressing structural inequalities" and where experimentation fails to deliver such fixes they are actively constructed to have 'failed' in order to prevent their further embedding or dissemination. At the same time there is growing evidence that a lack of attention to the ways in which the governing of urban environmental and energy transitions may create adverse outcomes for particular communities and places who may bear the

brunt of efforts for structural transformation will also meet with resistance (Patterson et al. 2018). Thus while there are good logical and moral arguments to support the idea that addressing social justice is a necessary component of transformative change, evidence suggests that this can either be overtly resisted by incumbent actors and that such arguments may equally be deployed to challenge whether addressing environmental and energy issues can always be regarded as the socially just course of action to pursue.

Much of the focus on the imperative for transformational change has focused on the need to explicitly politicise the necessity and urgency for action and to position environmental and energy transitions as a means through which other pressing urban challenges can be (re)made political in order to pursue a politics of urban rights through a sustainability lens. While such a position has much to commend it, particularly on ethical grounds, it is worth revisiting in the light of a relational urbanism perspective and that which regards power as immanent to the socio-material relations of which it is a part. From such a perspective, power and interests can not be separated from the socio-material configurations through which they are forged – in other words, power is *generated relationally* through the specific configurations of social and material entities that come together around particular visions, interventions, networks, objects and so forth. This suggests that rather than seeking to contest existing power relations 'from the outside' what may matter more is the ways in which experiments are constituted – the ingredients of which they are made – and how these are continually maintained and lived in relation to prevailing orders and forms of exclusion. Experimentation in such a perspective does not engender transformation through its overt politics, but by shifting both the flows of knowledge, finance, material, practice and by changing the terms around which what is 'right' and 'good' are viewed. The design of experiments and the parts of the urban milieu to which they are targeted is then highly significant, as are the roles of bridging or intermediary organisations able to hold diverse interests in relation to one another (see Section 3.1).

Here, we might draw insight from the pragmatist tradition. From this perspective, politics emerge as particular issues come to be considered as 'public' rather than private concerns. For the leading pragmatist thinker John Dewey, what is and is not public is not pre-determined but comes to be formed as publics are created in relation to a specific set of conditions or concerns (Le Dantec & DiSalvo 2013). How some things come to be seen as of 'public concern' takes place through a process which he terms 'inquiry' a "key practice in which situations are problematized and disclosed as undetermined, which are then given a determination and a solution" (Delgado and Callen 2017: 188). In short, it is through the process of recognising, problematising and intervening that 'matters of concern' are created which generate an affected public and are politicised as solutions are contested. Yet one of the interesting things about the kind of intervention provoked by experimentation is that it does not seek to generate specific solutions, but rather to work with the indeterminacy of the situation and its politics in order to generate new ways of understanding, investing in and acting towards the matter of concern, with the potential for generating new kinds of publics and politics as a result (Blok 2011; Marres & Lezaun 2011). Such interventions may then be incremental, but also contain the potential for radical change as new ways of acting in the present and imaging the future are generated.

3.4 Summary

TBC

Part IV: Conclusions and Consequences (2500)

The final draft prepared for the Paris meeting after feedback from the OECD will contain a couple of summary paragraphs and then some bullet points for discussion of possible conclusions and consequences emerging from the paper, together with some initial starting points as to what these new perspectives might mean for how to advance urban transitions for a range of policy-makers and practitioners.

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