The governance of sustainable city business models

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Abstract

This paper analyses how sustainability and climate action relating to mobility, buildings and energy networks are governed in European cities. To this end, different modes of governance for sharing burdens, costs and risks of innovative low-carbon experiments, projects and demonstrations in ten European cities in seven countries are compared. Some cities succeed by co-producing planning and policy-making with a wide range of public, private, academic and community stakeholders through new forms of intermediation. Other cities rely on a hierarchical approach reliant on in-house expertise and policy-agendas for the delivery of experiments, projects and demonstrations. Others again rely heavily on entrepreneurial governance through outsourcing. Instead of descriptive best-practices and prescriptive one-size-fits-all solutions for replication and upscaling, this paper concludes that place-specific governance approaches, taking into account historical, cultural, social, political and administrative complexities on the one hand, and citizens alongside different institutional actors at local, regional and national level on the other, are necessary for the delivery of sustainable city business models.

Introduction

The governance of European cities is changing. In many countries, spending cuts have been imposed on all but the most essential of public services following the financial crash of 2008. These developments have dramatically altered both the volume and source of revenues available to cities. Many cities and municipalities have responded with strategies to simultaneously reduce spending and generate growth by allocating resources through markets and competition (Osborne et al., 2015; Sancino and Sicilia, 2013).

This retreat of the state places public services at odds with economic policy. The result is often that statutory requirements and public policy priorities, such as those regarding health, wellbeing and the environment, increasingly stand in opposition to economic policy. The latter is usually the remit of different organisational structures within cities and local authorities than those responsible for addressing inequality and environmental issues. More often than not, 'inclusive and sustainable growth' is an ambition rather than an outcome. At the same time, cities are increasingly considered the 'interface' where solutions to overarching environmental problem such as climate change are likely to emerge and take effect (UNFCCC, 2015; IEA, 2016; Reckien et al., 2018; C40, 2019). Cities already host over 50 % of the global population, account for about two-thirds of primary energy demand, emit 70 % of total energy-related CO_2 emissions (with transport and buildings among the largest contributors) and account for about 80 % of the world's GDP (IEA, 2016; Reckien et al., 2018; UNEP, 2019).

Cities have been identified as key actors for the delivery of Sustainable Development Goals (SDGs), which were ratified at the UN General Assembly in September 2015 (OECD, 2016a). Cities are considered instrumental for achieving long-term sustainability of the global energy system, especially if local and national actors can be aligned to meet the sustainability objectives at both levels (IEA, 2016). As of 2018, over 7,000

cities from 133 countries have already pledged climate change mitigation action (UNEP, 2018).

Many cities and inter-city organisations such as the C40 Cities, ICLEI and the Covenant of Mayors are actively setting their own decarbonisation targets in line with the Paris Agreement on Climate Change (UNEP, 2018). This trend is supported by a wide range of dedicated funding streams (e.g., H2020 and Climate-KIC in Europe). The result is a continuous stream of good practice and replication guides with many projects linking cities across national jurisdictions, suggesting that 'proven sustainability fixes' can be imported from elsewhere with little attention given to national and local governance, cultural, historical, social, political, economic and administrative contexts (Martin et al., 2018).

Yet, sustainable city business models necessarily integrate a wide range of stakeholders and perspectives for sustainability and climate action in line with the Sustainable Development Goals (UN, 2015) and the Paris Agreement on climate change (UNFCCC, 2015). This paper combines data gathered from a survey of nine European cities (Brighton, Brussels, Copenhagen, Cork, Exeter, Frankfurt, Ljubljana, Malmö, and Trier) in 2016 as part of Climate-KIC's Transition Cities project with in-depth research of another (Bristol) between 2017–19 to establish how sustainable city business models are governed. By focusing on the key areas of mobility, buildings and energy, it identifies circumstances where replicable solutions worked, and others where more context specific solutions were needed, especially in relation to the size and population and relative political, economic and cultural 'importance'.

The specific research questions are:

- How is sustainability and climate action governed in cities and municipalities?
- How does the governance of sustainability and climate innovations in the areas of mobility, buildings and energy networks differ?
- Which successful governance innovations are suitable for replication relative to the size and 'importance' of cities?

The following section provides background information on cities and climate action. The methodology section introduces the analytical framework and explains the methodology used for the survey and the in-depth case study. The results section presents the results of the survey and the case study. The discussion section analyses the results in relation to the analytical framework and the final section concludes.

Governing sustainability in cities

SUSTAINABILITY AND CLIMATE ACTION IN EUROPEAN CITIES

European cities face a unique set of challenges. Europe is aging unevenly with differentiation already evident between as well as within countries. One-size-fits-all policies appear decreasingly appropriate, as events in France in late 2018 suggest. A planned increase in fuel taxation in the name of climate change was suspended as a result of violent protest. Similar protests can be expected elsewhere if issues around fairness, necessity, legitimacy and governance are not addressed. Yet action is required in the wake of the Volkswagen diesel scandal and German cities in particular are facing legal challenges to curb pollution. These issues are particularly relevant for secondary and tertiary cities (cities with populations below 500,000 or non-capital cities – see Methodology section) which are already experiencing population decline, often coupled with economic decline, while capital and primary cities are generally faring better (McKinsey, 2016).

The challenge for the coming decades lies in future-proofing European cities in light of climate change, demographic change and environmental quality while ensuring that equity, accessibility to and affordability of services are not reserved to those who can afford them. Yet, European cities' ageing populations coupled with ambitious climate targets and its long-standing and strong civil society and institutional engagement in environmental matters also provide unique opportunities to shape and be shaped by accelerating sustainability and climate action. This depends on their ability to overcome significant barriers. Such barriers include a lack of access to finance and restrictive budgeting cycles, which tend to conflict with long-term developments and planning horizons required for deep socio-ecological transformation (Climate-KIC, 2015). Others relate to the lack of skills and capacities to engage with the long-term governance required to tackle intergenerational issues, especially regarding legitimisation by the local population (While et al., 2004; Martin et al., 2018).

Decarbonising **mobility** is one of the greatest sustainability challenges. Place specific pricing policies (i.e. congestion charging, tolls and carbon pricing), regulatory policies (i.e. access restrictions and registration caps) and investments in subsidies for public transport and non-motorised mobility can help decarbonise urban transport but decarbonising mobility is still in its very early stages. Modal shifting, (e.g., the expansion of cycling infrastructure), new mobility concepts (e.g., 'mobility as a service'), that allow for the incorporation of digital innovations into urban transport (e.g., as a means of provided integrated public transport services or the eventual advent of autonomous vehicles), and the suitability for electric vehicles (2- and 4-wheelers) thanks to low range requirements and density of charging points, promise a wide range of emerging opportunities (IEA, 2016; Barr et al., 2017). At the same time, it is necessary to ensure that such innovations do not increase the 'digital divide' between those who have the capacity to access innovative services and those reliant on conventional mobility provisions.

Local energy networks and distributed generation are likely to play an increasingly important role in facilitating city and municipal climate action and to provide low-carbon power for sustainable mobility. Rapid innovation across all scales, ranging from hydrogen generation for natural gas and mobility networks to district heating networks, smart grids, microgrids and peer-to-peer trading promise great opportunities. Cities benefit from peer proximity and increasingly from technology affinity of city dwellers. This provides space for experimentation and innovation. Smart (urban) energy networks promise increasing operational flexibility and could perform balancing services for national energy systems or provide the basis for an entirely new energy market architecture. Depending on the scope for balancing variable renewable generation in the national energy system and the business model behind them, investments in smart integrated urban energy networks could reduce the need

for investment in national energy infrastructure (IEA, 2016; Parag and Sovacool, 2016).

Buildings account for around 40 % of energy consumption and 36 % of CO_2 emission in the EU. Urban buildings account for two-thirds of final energy consumption in the buildings sector. High-efficiency new buildings, deep energy retrofits of existing buildings and the deployment of low-carbon space heating and cooling technologies are considered the most important approaches to reducing building related GHG emissions. Smart and digital innovations are expected to reconceptualise buildings as integral elements of increasingly interlinked mobility and energy systems. More importantly, targeted improvement of building energy performance can enable vulnerable households to escape fuel poverty, which provides legitimisation for climate action (EC, 2018a, b).

To sum up, cities provide experimental niches for the integration of innovative technologies (e.g., electric vehicles, building-integrated PV), systems (e.g., increasing 'servitization' of mobility), finance mechanisms (e.g., crowd funding) and governance approaches (e.g., municipal energy service companies). At the same time, the use of 'smart' technology as part of 'smart cities' agendas appears to be supplanting sustainability and climate action agendas (Martin et al., 2018). This is discussed in more detail in the discussion section.

THE GOVERNANCE OF SUSTAINABILITY AND CLIMATE ACTION IN EUROPEAN CITIES

Cities commonly share direct control, if not ownership, over public-sector property, such as buildings, street lighting, or vehicles, which provides opportunities to encourage more sustainable usage patterns and implement innovative technologies and business models. Public procurement can specify environmental and social criteria alongside economic priorities. Some cities may be directly or indirectly involved in the provision of services such as water, heating, cooling, electricity, mobility and waste removal. Others may act as metropolitan leaders for inter-municipal initiatives, which may include technical infrastructure or transport provision that transcends city borders. Cities may also encourage citizen-led innovation by providing appropriate governance frameworks (Bulkeley and Betsill, 2003; OECD, 2010; Broto and Bulkeley, 2013; Climate-KIC, 2015, Reckien et al., 2018).

Cities are also increasingly the focal point of transformative change experiments, often involuntarily imposed by the retreat of the state and the overarching transition to a low carbon economy. Governments as well as supranational bodies such as the EU are actively providing funding and support for cities to engage in innovative low-carbon experiments, projects and demonstrations. Among the many projects spanning national boundaries, two are of particular importance for this paper:

- Climate-KIC Transition Cities (2012-2016): Frankfurt, Germany; Budapest, Hungary; Birmingham, UK; Modena, Italy; Wroclaw, Poland; Valencia, Spain.
- REPLICATE (2016–2021): Bristol, UK; San Sebastian, Spain; Fiorentina, Italy.

Although Frankfurt is the only Climate-KIC Transition City that was subject to investigation for this research, the project itself guided the analytical thinking that culminated in this paper by providing funding to undertake an analysis of climate action in the areas of mobility, energy networks and buildings among mostly secondary and tertiary cities (see Methodology). Bristol is the only REPLICATE project city that was investigated as part of an in-depth case study and provides a more up-to-date insight.

Such experimentation is considered a key tool for opening up new spaces for sustainability and climate change governance to foster 'an unprecedented level of cooperation, not only between countries, but also between different levels of Governments and the private sector' (De Boer, 2009:1, quoted in Broto and Bulkeley, 2013). Climate change action therefore requires coordination of mutually dependent actions beyond public institutions (Bulkeley et al., 2009). The concept of 'climate change experiments' is derived from urban studies (Broto and Bulkeley, 2013; Bulkeley and Broto, 2012), governance experiments (Hoffman, 2011), urban sustainability transitions (Frantzeskaki et al., 2017) and the notion of 'urban laboratories' (Evans, 2011):

> First, an intervention is experimental when it is purposive and strategic but explicitly seeks to capture new forms of learning or experience; second, an intervention is a climate change experiment where the purpose is to reduce emissions of greenhouse gases (mitigation) and/or vulnerabilities to climate change impacts (adaptation); third, a climate change experiment is urban when it is delivered by or in the name of an existing or imagined urban community. (Broto and Bulkeley, 2013: 93)

Experimentation in the areas of mobility, local energy networks and buildings is considered essential to encourage innovation and ultimately systemic approaches to climate change mitigation (Climate-KIC, 2015). Yet, for cities to engage actively in experimentation and to realise and develop their potential, a series of social, organisational and institutional innovations are required. Once a series of 'soft factors' have been recognised and organised in a structured approach, new structures which could potentially lead to more systemic changes might be created (Adams and Arnkil, 2013). It is widely assumed that experiments will have the greatest impact if they are implemented as part of a coherent plan (Climate-KIC, 2015; Rivas et al., 2015; Reckien et al., 2018).

Several studies have been undertaken to analyse such experiments through in-depth case studies (see for example Gustavsson et al., 2009; Hodson et al., 2013; Schwanen, 2015; Williams, 2016; Martin et al., 2018) and large-scale surveys of climate action (see for example Broto and Bulkeley, 2013; Rivas et al., 2015; EU, 2016; OECD, 2016; Reckien et al., 2018). These studies suggest that city size, national legislation and international networks often determine the scale and scope of experimentation and how they are embedded in low-carbon plans (LCPs).

Municipal administrations that take the lead in mobilising and managing different stakeholders to find mutually advantageous solutions have proven more successful in developing LCPs (Rivas et al., 2015). Yet, there is also evidence suggesting that the inclusion of climate change aspects into other plans, as opposed to comprehensive stand-alone plans, can prove more successful for actual implementation by integrating these issues into other local policy processes (Reckien et al., 2018). Interestingly, there appears to be North-South divide in Europe

with stakeholder engagement and management particularly pronounced in northern countries and cities while southern countries and cities appear less inclined to develop specific stakeholder engagement strategies (Rivas et al., 2015).

In the context of sustainability and climate change, cities can be classified according to the resources they allocate to sustainability and climate action (Rivas et al., 2015) and dedicated LCPs (Reckien et al., 2018):

- Cities with comprehensive and standalone LCPs which usually entails dedicated resources and specific units or teams in place for developing and implementing LCPs.
- Cities with mainstreamed and inclusive LCPs which usually entails the creation of specific units or teams for the task.
- Cities with limited LCPs, often addressing partial aspects of climate change which usually organise work within pre-existing structures not specifically appointed for this purpose.

The foundation for a systemic approach to climate change action is a baseline emission inventory. These, alongside the depth and scope of LCPs in general, depend on the size of the city, available resources, national legislation and international networks. The following methodology section provides an overview of the sample criteria and the analytical framework.

Methodology

METHODOLOGY AND SAMPLE CRITERIA

This paper combines data gathered from structured interviews with representatives of nine European cities (Brighton, Brussels, Copenhagen, Cork, Exeter, Frankfurt, Ljubljana, Malmö, and Trier) as part of Climate-KIC's Transition Cities project with in-depth research of another (Bristol). The Climate-KIC project involved interviews with at least one representative of each of the cities, such as the municipal climate change or sustainability manager (see Table 1 for an overview of the number of interviewees per city). Where these positions did not exist, as is the case with many small cities, somebody with a good grasp of the key areas of mobility, buildings and low energy networks was interviewed, which tended to skew opinions of successful LCP intervention towards particular sectors (see Figure 1). The choice of cities was opportunistic: It is a sample of convenience because interviewees were identified through existing networks, networking at conferences and snowballing.

The aim was to interview both representatives from small-medium cities with populations between 100,000 and 500,000 and representatives from large/primary cities. A somewhat dated study by Griffinger et al. (2007) suggest that of around 260m Europeans living in city regions, around 44 % live in cities with populations between 100,000 and 500,000. It is estimated that close to half of the world's urban population lives in cities with fewer than 500,000 inhabitants (UN, 2018). On a European scale, cities with populations between 100,000 and 500,000 can be considered small to medium-sized. Such cities often have detailed LCPs in place while the targets of large cities (+500,000 inhabitants) tend to be more stringent and integrated into comprehensive and standalone LCPs (Reckien et al., 2018).

Small to medium-size cities rarely receive the attention they deserve, even though the challenges they face can be rather different to those of large/primary cities which often readily receive funding for experimentation and innovation flagship projects. Large/primary cities are in *italics* in Table 1:

In some cases, small-medium-size cities stand in competition with larger cities even though they often lack the critical mass, resources and institutional capacity to compete on an equal basis. Larger cities and/or primary cities are therefore more likely to receive disproportionately more funding (and attention) than smaller ones (Griffinger et al., 2007; Reckien et al., 2018). This increases the challenge for small to medium-size cities not only in terms of economic development but also in terms of their capacity to act on sustainability and climate change. This paper seeks to establish what role population and relative importance (in terms of primary, secondary and tertiary status in relation to political, economic and cultural importance) play in cities' capacity to act on these issues in the key areas of buildings, mobility and energy networks.

For the city survey, structured interviews (8 open questions plus 37 closed questions with Likert-scale 1–5 ranking) with city and municipal representatives took around one hour and notes were taken throughout for subsequent evaluation. A

Table 1. Sample cities.

City	Country	Interviewees	Population
Brighton	United Kingdom	2	280,000
Bristol	United Kingdom	7	445,000
Brussels	*Belgium*	*1*	*1,175,000*
Copenhagen	*Denmark*	*1*	*600,000*
Cork	Ireland	2	125,000
Exeter	United Kingdom	1	125,000
Frankfurt	*Germany*	*2*	*710,000*
Ljubljana	*Slovenia*	*1*	*280,000*
Malmö	Sweden	1	310,000
Trier	Germany	1	115,000

desk-based study of literature was combined with attendance at conferences and meetings. For the Bristol case study, several sustainability and climate action representatives both within and outside the municipal administration were interviewed using semi-structured interviews (3 core areas, 5 questions each), several meetings relating to the development of a sustainable city business model attended and several strategic (draft) documents analysed.

Qualitative data was analysed using an excel spreadsheet where all the answers were grouped together both according to questions and recurring themes. Quantitative data from the structured interviews was analysed using excel to concretize some of the emerging trends from the interviews with numbers. The small sample (n=9) of Climate-KIC's Transition Cities project did not warrant more sophisticated statistical analysis.

ANALYTICAL FRAMEWORK

This paper assumes that different sustainable city business models are the result of different governance approaches. The following four different forms of local governing are of relevance to this paper (Bulkeley and Kern, 2006; Martin et al., 2018)

- Governing by provision whereby local authorities shape practices through the delivery of practical, material and infrastructural services.
- Governing by authority through traditional top-down regulation and sanctions.
- Governing through enabling which is based more on argument and incentives.
- Governing through entrepreneurialism by handing over responsibility to private and community enterprise

In relation to sustainability and climate action, cities' governance response is characterised by (Broto and Bulkeley, 2013; Hodson et al., 2013; Reckien et al., 2018):

- Multiple modes of governing through which municipalities seek to govern climate change.
- The importance of institutional capacity, including resources, knowledge and organisational structures.
- The critical role of individuals, political champions and policy entrepreneurs.
- How multi-level governance structures opportunities and limits for municipal action.

It is assumed that cities will govern climate change and sustainability related experiments as well as the development of LCPs in-house if they have sufficient skills and institutional capacity to do. If they are lacking in-house skills and capacity for action, but are fortunate enough to benefit from progressive governance, it is assumed that cities are likely to form partnerships and engage with a wide range of stakeholders. Where either are missing, it is assumed that experiments and comprehensive LCPs are lacking, and that climate change is, at best, addressed through pre-existing institutional structures or governed through entrepreneurialism by outsourcing responsibility. Skills and capacities for experimentation and LCP development are intrinsically linked to the governance of mobility, local energy network and building service provision (Polzin et al., 2016).

Given the holistic nature of climate change, mitigation governance approaches tend to involve a wide range of stakeholders. This coincides with the trend of partnerships increasingly defining the governance of cities (Stoker, 1998; Glodstein and Mele, 2016). Networks, stakeholder management and intermediaries are therefore crucial elements for the governance of sustainable city business models (Hodson et al., 2013). With the increasing emphasis on resource allocation through markets and competition (entrepreneurs), such networks move beyond the 'public' and the 'private' sector to include universities and civil society as part of 'smart specialisation', often under the guise of co-creational innovation processes (McAdam and Debackere, 2017; Morgan, 2017). Various methods and tools have been developed to enable and facilitate multi-stakeholder governance, such as C40 Cities' Climate Action Planning Programme (C40, 2018) which includes stakeholder engagement guides and a communications toolkit or Climate-KICs Visual Toolbox for System Innovation (Matti, 2016).

In this paper, sustainable city business models are understood as an evolution of innovation-led growth that emerged from public-private partnerships associated with the allocation of resources through markets and competition towards triple and quadruple helix innovation models which include civil society and universities as part of a greater emphasis on open and co-creational innovation processes (McAdam and Debackere, 2017; Morgan, 2017).

The following section analyses how cities differ in the governance of climate change experiments and the development of LCPs according to the four different local governance forms (Bulkeley and Kern, 2006; Martin et al., 2018) and their relation to sustainability and climate action (Broto and Bulkeley, 2013; Hodson et al., 2013; Reckien et al., 2018). It provides several examples in each of the key areas of buildings, mobility and energy systems to explain how the cities go about developing LCPs and implementation strategies by ranking them according to their relative success and resource dedication in these areas. All the information provided is from personal communication, except where clearly indicated through citations.

Results

Approaching wide-ranging and intergenerational problems such as sustainability and climate change requires a systematic approach to governing transformations. However, only few cities treat these issues systematically and allow them to transcend all aspects of decision-making. Figure 1 provides an overview the skills and resources dedicated to the core areas of buildings, mobility and energy system derived from the interviews (the larger the dot, the greater the skills and resources available for LCP development and implementation in the key areas).

Figure 1 indicates how skills and capacities determine a cities' capacity to address the key areas of buildings, mobility and energy system. It is evident that primary cities such as Brussels, Copenhagen, Frankfurt and Ljubljana have greater capacities to act on sustainability and climate change issues than secondary and tertiary cities. However, Figure 1 does not provide an absolute ranking. The dots indicate the relative importance of either buildings, energy and mobility in particular cities. In practice,

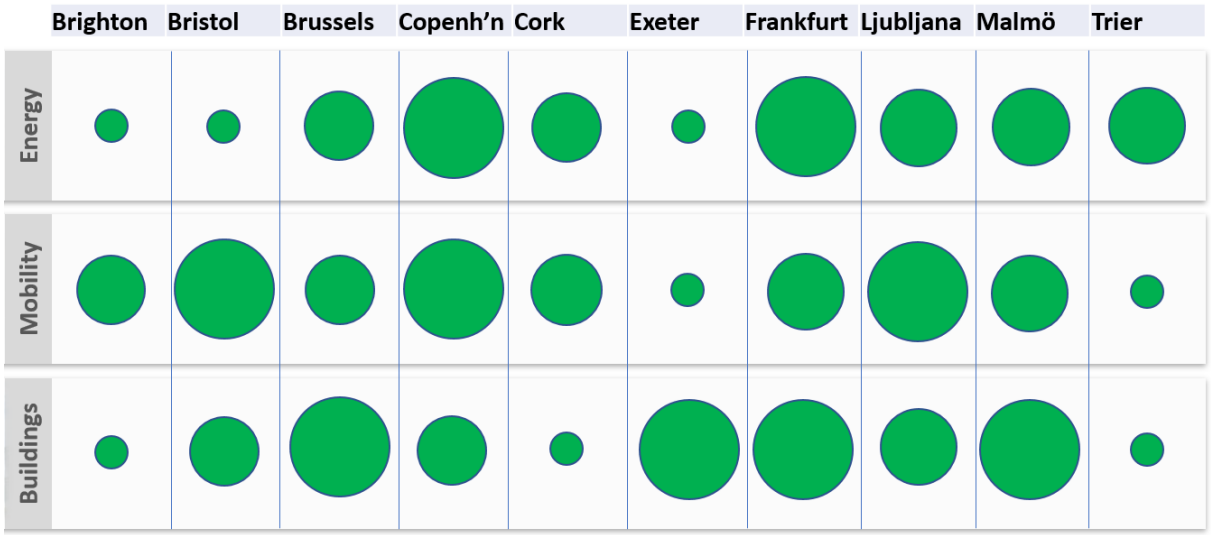

Figure 1. Relative activity in the areas of buildings, mobility and energy systems (own impression).

this implies that front runners such as Copenhagen have sufficient development and implementation capacity to dedicate skills and resources to their 2025 carbon neutrality target. Between 2005 and 2015 the city already succeeded in reducing its CO_2 emissions by 38 % despite a 16 % population increase.

Bristol on the other hand, whose City Council adopted an ambitious LCP in 2018 to move its carbon neutral target from 2050 to 2030, does not have a history of being at the forefront of low-carbon and sustainable innovation, despite it having been awarded the European Green Capital Award in 2015, one year after Copenhagen and one year before Ljubljana. While Copenhagen's strategic approach includes plans to change public transport over to EV, switch district heating from fossil fuels to biomass and even takes account of technology contingency to ultimately switch from biomass to more sustainable technologies, Bristol is still grappling with the implementation of a Metrobus system which will run on diesel for the foreseeable future.

Ultimately, 'the only driver is finance' which implies that only projects and strategies that are deemed financially viable by their CFO, given limitations and oversight by national auditing and accounting bodies, are approved. CFOs also tend to err on the side of caution which limits transformative change approaches to those with clearly defined payback periods within the current regulatory framework. Cities that lack the skills and capacity or primacy within countries, unlike Brussels, Copenhagen, Frankfurt and Ljubljana, therefore struggle to address the key areas of mobility, buildings and energy systems without governmental regulation or incentives. Consequently, many cities lack climate and sustainability planning, implementation and experimentation capacity.

Emulating the success of the likes of Copenhagen may be desirable but not always practical. Copenhagen's cycle friendliness has a lot to do with the topography and the climate while its long-standing green credentials cannot be replicated overnight. Rather than attempting to 'copy-and-paste' seemingly replicable elements from Copenhagen's low-carbon mobility success, it is often more practical to commence by reviewing local skills and capacity to envisage, experiment and ultimately deliver appropriate low-carbon mobility solutions for the locality. A detailed understanding of legal frameworks, contractual complexity and statutory requirements, especially regarding procurement, needs to provide the basis for any resource assessment, both within and outside of municipal administrations.

The following sections provide examples of cities' successful development and implementation of LCP strategies in one of the core areas of on buildings, mobility and energy systems. These examples indicate the complexity and local embeddedness of sustainability and climate actions challenge. They also indicate cities' capacity to drive transformative change vis-à-vis their function as 'arenas' where innovation processes materialise, which is largely dependent on the interplay between the autonomy granted to, and requirements imposed upon, cities in different contexts.

BUILDINGS

Given the varying levels of municipal control and autonomy, many municipal strategies hinge on their ability to stimulate a wide range of relevant stakeholders. Exeter, for example, benefits from strong in-house drive within the municipal authority for experimentation in the priority area of buildings. Their requirement for council new builds are in excess of UK requirements and developers are pushed to innovate. In 2010, Exeter hosted the UK's first multi-residential passivhaus development and the city now plans to build the UK's first passivhaus leisure centre. Exeter is now considered world leading in area thanks to its in-house visionary drive. Yet it resembles governing through enabling and is reliant on the dedication of individuals.

Brussels, on the other hand, has achieved similar success in passivhaus development through governing by authority. According to a city representative, the adoption of the passivhaus standard happened more or less by accident: several buildings had been built according to passivhaus standard following a competitive bidding process and the municipal administration subsequently mandated passivhaus for all new builds. For Brussels such a step is nowhere near as big as it is for a small city such as Exeter. Municipal governance in Brussels can tap into a very wide range of talent and the direct and indirect availability of European funding encourages low-carbon experimentation, especially given its role as a lighthouse city.

Nevertheless, both rely on strong in-house drive to establish stakeholder networks to help raise awareness of what might be considered 'experimental' in other contexts. Exchanging ideas has helped convince higher level municipal management of passivhaus proposals. Arguably, passivhaus can already be built at conventional build cost but lack of political will is preventing other cities from introducing it as mandatory. Encouraging low-carbon standards among commercial and private developers, however, is a much greater challenge. In most countries, minimum standards for dwellings are set at national level but the Exeter example indicates how enabling governance can facilitate experimentation and implementation among small cities.

MOBILITY

Low-carbon mobility innovation is characterised by public consultations and an increasing tendency to govern through entrepreneurialism. This is often the result of commercial specialisation with 'smart solutions' and longstanding dialogues among such service providers and municipal administrations that have progressively transformed into multi-stakeholder forums to assess priority areas of action and to have the right structures in place for experimentation in case funding is made available. These forums also provide the basis for consortium building, which most cities with ambitious LCP experimentation and implementation.

Large/primary cities especially tend to have the institutional capacity coupled with enabling governing structures capable of facilitating, intermediating and managing a wide range of stakeholders. With the increasing emphasis on 'smart technologies', however, more entrepreneurial governance approaches are emerging. For cities with starved budgets, this transition is a necessity, rather than a choice. The outcome can nevertheless be comparable in terms of project delivery (such as Bristol's Metrobus system). Compared to cities where multimodal transport systems are governed by provision, such as Copenhagen and Frankfurt, this case might pale in comparison but in relation to the baseline of the most congested city in the UK and severe austerity measures, this is a success.

Governing by authority may also yield good results in relation to transport. Ljubljana, for example, won the European Sustainable Mobility Award in 2003 and 2014. Its top-down municipal administration has integrated climate action into nearly all aspects of its Vision 2025 as part of process oriented systemic change. It leaves civil servants as well as external stakeholders with no other choice but to develop innovative projects collectively through participation ('everybody cooperates because they have to'). One of Ljubljana's key successes in the area of mobility was pedestrianisation through experimentation. When some roads were closed for roadworks and diverted traffic caused fewer problems than anticipated, the roads were never reopened to traffic and subsequently pedestrianised. The next step is public transport electrification including local energy network integration through solar PV installations on the municipal bus shelter.

Yet, systems thinking is still the exception and LCPs tend to evolve around particular priorities, such as cycling or EV mobility. Networking beyond these boundaries is often down to individuals rather than strategic plans or mobilisation of resources. Beyond such focus areas, the focus tends to be even more confined to individual projects at best.

ENERGY SYSTEMS

Cork provides an example of how energy is governed through enabling. Energy Cork acts as an intermediary primarily directed at SMEs. The relevant municipal department also engages with the university and the city's biotech/pharmaceutical industries. Such triple helix cooperations appear to provide a nourishing exchange platform for experimentation. Cork's Energy Management Steering Committee facilitates discussions to help develop ideas and projects. It allows stakeholders not previously engaged with the municipal administration to take ownership problems. By reporting to the municipal administration's CEO, in-house expertise is linked up with external stakeholders to provide co-produced solutions.

Entrenched structures, on the other hand, tend to hamper in-house engagement with sustainability and climate change issues. Lack of leadership is often coupled with poor people management skills. This implies that even if the right skills are available in-house to de-risk innovative approaches, there might a culture of choosing particular approaches which avoid experimentation. This is often the case in small cities such as Trier where there is little impetus to do things differently, even though sufficient resources are available. The city aims to supply 50 % of its electricity from renewable source but greater ambition is hampered by a lack of problem ownership and control, despite the availability of an arm's length municipal energy and waste utility.

Frankfurt, in contrast, is an example of a climate action pioneer with strong institutional structures. Its municipal energy department/agency ('Energiereferat') was established in 1990. In the same year, Frankfurt became a founding member of the Climate Alliance. Through a combination of provision and authority, the municipal authority has succeeded in developing district heating networks based on distributed CHP general in small and medium-size units, which has increased from 0.1 MWel to 31 MWel between 1990–2013. Yet, lack of leadership implies there is a lack of coordination among municipal departments and its transport department has produced its own LCP without consulting the Energiereferat. This shows that siloed thinking and acting is not limited to small and medium city administrations and that a lack of transboundary communication is evident even among dedicated sustainability and low-carbon transformation actors. Planners tend to speak a different language to engineers and as a result, risk of often poorly communicated. Cities' sustainability and climate action commitments subsequently be limited to minimal compliance with national targets.

Discussion

By comparing LCPs and buildings, mobility and energy system governance structures of small and medium-size cities with those of large/primary cities, this study confirms earlier findings (Reckien et al., 2018) that the size and primacy of cities plays an important role in their approach to energy and climate action. Small and medium-size cities tend to have either limited or mainstreamed LCPs while large/primary cities tend to have comprehensive and stand-alone LCPs (see Figure 2 – the larger the dot, the greater the skills and resources available for LCP development and implementation). As a result of national target setting, civil society engagement, systemic approaches,

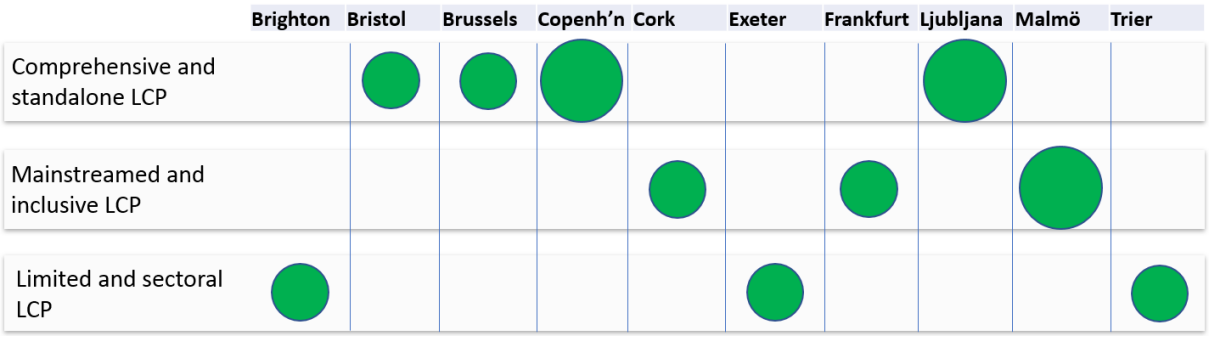

Figure 2. Relative skills and resource availability for LCP development and implementation (own impression).

policy implementation, governance, external support, data consistency and monitoring, reporting and verification, however, there are large variances across (as well as within) countries. Aside from resource availability, the nature of LCPs also appears to be linked to cities' relative bargaining power vis-à-vis national governments, the private sector and other relevant players. Federal national governance structures, such as Germany and Belgium, appear to be less likely to impose LCP development. More often than not, however, lack of planning and implementation is the result of limited dedicated resources.

Interestingly, small and medium-size cities appear be able to produce a more accurate evaluation of their current situation and their potential with a wider range of stakeholders, even in the absence of comprehensive and stand-alone LCPs, which may result in more efficient and targeted measures (see Reckien et al., 2018). This might be the result of more direct contact with the public and stakeholders. There is evidence that municipal administrations of small to medium-size cities (Ljubljana, Cork, Malmö, Bristol) prove successful at representing the level of democratically accountable government in closest proximity to the public. Public infrastructure nevertheless varies enormously, as does the 'margin for manoeuvre', which begs the question whether cities are the central actors or merely the 'arenas' where the drama unfolds (Adams and Arnkil, 2013).

According to Campbell et al. (2013:11), 'many cities do not have access to all the relevant policy levers that could potentially make a difference, as many key policy decisions are taken at the national and international levels'. When it comes to GDP, '74 % of the difference in growth in GDP between individual cities in Europe is accounted for by differences in the growth rates of different countries' (Adams and Arnkil, 2013:8). It is therefore necessary for cities to think strategically about precisely which fields they can influence and to 'prioritise what they do and how they do it in order to achieve maximum impact' (Campbell et al., 2013:11).

Many cities have legacy infrastructures which are not necessarily conductive to low carbon transformations. The sample cities are mostly dominated by infrastructural systems that were in many cases developed a century ago (Guy et al., 2001). Where austerity measures have been particularly severe, as is the case in Ireland and the UK for example, the in-house capacity of cities to act or address immediate concerns, let alone consider, plan and implement long-term transformative strategies, has been considerably hampered, despite compulsory LCPs. These cities consequently pursue an entrepreneurial approach to urban governance in line with economic policy, prioritising the reduction of production costs of public services (Martin et al., 2018). This directly affects the quality of use/consumption of these services which also affects their long-term viability and sustainability while encouraging outsourcing of local infrastructure governance to technology corporations (Hollands, 2014; Martin et al., 2018). The example of Exeter nevertheless indicates that limited resources can be effectively channelled to address areas where local leverage over sustainability and climate action appears largest.

In most cities, however, lack of skills and capacity implies that outsourcing collective public services through 'smart urban development', which seeks to make these public services more efficient and responsive, is a more likely outcome (Hollands, 2014; Martin et al., 2018). Although these approaches are not inherently flawed, there is an increasing emphasis on technological fixes employing entrepreneurial and managerial approaches as opposed to the co-creation of solutions through meaningful engagement. An increasing focus on digital innovations supports administrative and public service transaction efficiency through entrepreneurial governance as opposed to transformative citizen-government relationships and co-productive policy-making through enabling governance (McDermont, 2018). This emphasis on manageability and entrepreneurial facilitation can also lead to a neglection of sustainability objectives (Martin et al., 2018).

Sourcing relevant skills and technologies beyond city and municipal administrations is often a necessity for digital innovation management, especially in relation to mobility data. Some cites, such as Bristol, have won awards for their 'smartness' but this tends to conceal the surrender of municipal power to digital gatekeepers. These include British Telecom's 'Links' kiosks which encourage users to surrender the unique identifier of their individual wireless device in return for services (Atkin, 2018). Relevant in-house skills are nevertheless a prerequisite for governing these relationships with corporations and data companies. As a result, enabling and facilitatory governance approaches are increasingly giving way to entrepreneurial governance. If collaborative planning is integrated into the local development regime through governance by provision, there is potential for greater legitimisation. In the absence thereof, however, complexity and marketing nudges municipal administrations towards market-driven smart-sustainability fixes (Williams, 2016; Martin et al., 2018)).

Cities successfully developing and implementing LCPs, such as Copenhagen, Ljubljana and Malmö (see Figure 1), are particularly good at developing network facilitation and enabling

governance approaches which allow for replication and upscaling. Through provision and co-production, which is particularly well developed in Copenhagen and Malmö, actions can be tailored to local circumstances by recognising socially and environmentally beneficial outcomes resulting from relationship building and deriving sustainability from the transformation of user knowledge and the co-production of public services with service users. Both governance approaches are arguably more flexible than monolithic provisional governance structures which are dominant in Frankfurt and Trier.

Despite unique local circumstances, however, policy makers inevitably seek answers that can be 'copied and pasted' from other locations. This paper emphasizes the non-linearity and messiness of transformative processes (Ehnert et al., 2018). 'Projectification' of funding is therefore counterproductive because it risks organisational burn-out resulting from the necessity to survive on a project to project basis. Yet, this trend is being reinforced by intragovernmental focus on short-term funding for the production of best practice case studies as opposed to long-term funding which would sustain existing business models and foster the development of new ones (Ehnert et al., 2018; Reckien et al., 2018).

Apart from policy-makers, replication is also driven by large technology companies that seek to sell their products as efficiency optimisers even though the huge volumes of data harvested stand in no comparison to the vague benefits these digital innovations provide to service users and municipal governance in general (Martin et al., 2018). This is not to say that such solutions are not beneficial, but the volumes of data gathered and the lack of legitimisation imply that municipal administrations should err on the side of caution. Greater emphasis needs to be placed on process and technique to align political leadership, enhance governance buy-in, foster cross-departmental approaches, support upskilling, manage multi-helix engagement and de-risk experimentation to increase legitimisation of sustainability and climate action. At the same time, it is important to scrutinise approaches labelled as transformative that in practice support business as usual, especially if labels such as 'smart' and 'inclusive' are applied.

Progressing from products and technology towards process and technique therefore requires governance innovation. Given the holistic nature of sustainability and climate change challenges, solutions are usually found at the intersection of multi-helix approaches. Cities that succeed in reinterpreting their approach as that of an enabler and a co-producer appear to provide more options for harnessing local skills, capacity and legitimisation for sustainability and climate action, as is the case in Malmö and Copenhagen. Yet, the example of Ljubljana also suggests that progressive governance by authority and provision may encourage effective experimentation and LCP implementation.

Conclusion

The governance of sustainable city business models is affected by a variety of factors. Most sample cities are dedicated to sustainability and climate action but their capacity to act is strongly influenced by government policy, regulation and law. In countries where national sustainability and climate change targets are only loosely translated into city and municipal targets as well as strategies and support, sustainability and climate action tends to be the result of strong commitment by individuals and small dedicated teams. Government imposed austerity measures, on the other hand, lend themselves to governance through entrepreneurialism, which favours replicable 'smart-sustainability fixes' and increase the power and economic dominance of digital service providers while eroding democratic legitimacy.

Sustainable city business models ultimately hinge upon the interplay between national circumstances and municipal leadership with the skills and capacity to provide if possible and enable if appropriate. Entrepreneurial approaches need to be treated with caution although there is some evidence that an external shake-up can help address bureaucratic deadlock which results in cities and municipalities catering for bureaucracy as opposed to the common good. Co-production with a wide range of citizens determine the success of the most progressive sustainable city business models but the successful examples described here do not lend themselves to 'copy-and-paste' replicability. Yet, a siloed approach within cities dependent on implementation support which discourages experimentation that go beyond 'transferrable' solutions is more common.

This is reflected by the lack of dedicated personal within city and municipal administration to deal with these issues. It is no surprise then that 'smart' products and technologies promising enhanced managerial capacities through measurement and optimisation with minimal infrastructural disruptions are eagerly anticipated and implemented. Locating the public, citizens and democratic processes in these approaches, however, is more difficult although the successful development of sustainable city business models hinges upon their engagement.

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