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Urban retrofitting: Identifying disruptive and sustaining technologies using performative and foresight techniques

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ABSTRACT

Cities, which are now inhabited by a majority of the world's population, are not only an important source of global environmental and resource depletion problems, but can also act as important centres of technological innovation and social learning in the continuing quest for a low carbon future. Planning and managing large-scale transitions in cities to deal with these pressures require an understanding of urban retrofitting at city scale. In this context performative techniques (such as backcasting and roadmapping) can provide valuable tools for helping cities develop a strategic view of the future. However, it is also important to identify 'disruptive' and 'sustaining' technologies which may contribute to city-based sustainability transitions. This paper presents research findings from the EPSRC Retrofit 2050 project, and explores the relationship between technology roadmaps and transition theory literature, highlighting the research gaps at urban/city level. The paper develops a research methodology to describe the development of three guiding visions for city-regional retrofit futures, and identifies key sustaining and disruptive technologies at city scale within these visions using foresight (horizon scanning) techniques. The implications of the research for city-based transition studies and related methodologies are discussed.

1.0. Introduction

Today the majority of the world's population (more than 50% or 3.5 bn) live in cities but between now and 2050, the global urban population is expected to increase by 84% to 6.3 bn [1]. This rapid urban growth carries costs and benefits for cities. On the one hand, the expansion of cities and the associated quest for economic growth have huge implications for the global environment and resource depletion, and for climate change: cities are, for example, responsible for about 75% of global energy consumption and 80% of greenhouse gas emissions [2]. Yet cities can also offer huge potential advantages for scaling up deployment of relevant technology, services and infrastructure to offset environmental impact and combat climate change and also to act as centres or hubs of innovative social practice and learning [3,4]. Cities, therefore, come to be seen not only as a major 'cause' of environmental impacts and climate change, and as 'victims' as they struggle to come to terms with mounting environmental and socio-economic pressures, but also as central to the solution of these problems [5]. In response, and through a developing 'sustainable urbanism' agenda, many countries have focused on developing new 'eco-city' projects, based on new city development, particularly in China and the Middle East but also in Europe and USA [6]. However, in the latter countries there has also been an increasing focus on dealing with an ageing built environment and infrastructure. This is not surprising, given that for example in the UK some 70% of the total 2010

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building stock will still be in use in 2050 [7] and that renovation and refurbishment rates are currently less than 10% of existing stock [8,9].

Indeed in these countries this emerging focus on 'retrofitting', or 're-engineering', existing urban structures to mitigate the impacts of climate change has led to new thinking. Viewed through the lens of the city, this envisages a systemic long-term 'transition' in existing built environments through 2020 and to 2050 and beyond, requiring not only 'zero carbon' or 'low carbon' futures but also promoting transitions which create economic security, social inclusion and resilience [3,10,11]. There is therefore a body of work which suggests the critical challenge for contemporary urbanism is to understand how to develop the knowledge, capacity and capability for public agencies, the private sector and multiple users in city-regions to systemically re-engineer their built environment and urban infrastructure [12,13]. Cities around the world are increasingly focused on developing long-term visions, promoted and underpinned by initiatives such as the global C40 cities group and the low carbon agenda of the Core Cities group in the UK [5,14–16].

However, the concept of 'scaling up' sustainable urban retrofit to a city scale from simply an individual building level requires the development of an integrated or co-evolutionary perspective on long-term system innovation, referred to as 'socio-technological transitions' [17]. The large-scale and complex nature of city retrofitting requires cities to bring together two disconnected issues: "what" is to be done to the city (technical knowledge, targets, technological options, costs, etc.) and "how" will it be implemented (institutions, capacity, publics, governance). Currently, in policy and disciplinary terms, there is still too large a separation between the "what" and "how" questions characterised by: disciplinary fragmentation; absence of appropriate governance frameworks; and a failure to learn from projects and experiments and incorporate these into systemic transitions [18].

The inherent complexity and interdisciplinary nature of the problem are also exacerbated by the co-evolutionary and non-linear nature of change which incorporates a range of actors and networks operating over long-term timescales [19]. Within the emerging interdisciplinary field of sustainability transition research the multi-level perspective (MLP) has to date provided the dominant analytical–conceptual model (or a 'flexible heuristic') [20] seeking to explain the dynamics of large-scale socio-technical system change in terms of the interplay between niche, regime and landscape [20,21], whilst Transition Management (TM) has provided the field's principle contribution towards the development of innovative reflexive-governance practices. This raises issues about the role that particular methodologies such as (i) 'participatory backcasting' and (ii) 'roadmapping', when they are used in TM, play in shaping and directing socio-technical system changes or technological transitions [22,23]. Both these techniques, for example, are 'performative' in the sense that the creation of shared expectations about the future is intended to play a major role in shaping the way in which technologies develop through an alignment of actors around common goals. As McDowall puts it: '*Roadmaps, alongside transition scenarios and participatory backcasting, can thus be seen as 'purposefully performative' futures exercises, in which the explicit aim of the process is not just to inform decision-making, but to actively shape the behaviour of actors in the innovation system through the development and deployment of a view of the future*' [[]: p534]. This view of the future may be based on 'closed down' options focused on a consensus around a single or limited transition pathway or, more desirably, an 'opened up' set of guiding visions which enable more pluralist and diverse views to be developed [[]]. Nonetheless, the very fact that such techniques are inherently engaged in the production and reproduction of 'shared expectations' (through their performative nature [25]) may mean that the potential for the emergence of more 'radical' and 'disruptive' technologies (or indeed social innovations) is not necessarily captured or debated. There is therefore a need to use additional foresight techniques such as Delphi studies, or other parallel 'horizon scanning' survey work [26–28] which can capture not only 'sustaining' technologies (that can deliver incremental improvements at lower cost) but also more disruptive technologies which occur at the margins of established markets [29].

Set against this background this paper presents initial results from a participatory backcasting and scenario foresight exercise undertaken as part of the EPSRC Retrofit project[5] which seeks to inform the transition to urban sustainability by working with key stakeholders to produce socio-technical scenarios of the systemic retrofit of core UK city regions [19,30]. The paper is structured as follows. Section 2.0 sets the context for the paper by discussing the relationship between urban retrofitting and transition theory and presents a working definition of urban retrofit. This part of the paper also: compares 'disruptive' and 'sustaining' technologies in the context of 'eco-innovation' and 'disruptive innovation theory' (DIT); examines the methodological issues surrounding the relationship between 'backcasting', 'visioning' and 'roadmapping' techniques; and examines the concept of 'low carbon roadmaps' and the associated research gaps at city level. Section 3.0 discusses the development of an integrated methodological framework, linking performative backcasting, foresight and horizon scanning techniques within the EPSRC Retrofit 2050 project. Section 4.0 discusses the main findings from the research, which includes an overview of three generic urban retrofit city visions and the identification of sustaining and disruptive technologies. Finally, Section 5.0 presents conclusions on how the research informs the debate on linking 'backcasting' and 'roadmapping' techniques with transition theory and governance at city level.

2.0. Background and context

2.1. Cities and urban retrofitting: scale challenges and the role of transition theory

Over the past 10–15 years there has been a growing appreciation that cities should not be viewed as simple deterministic 'linear systems', but that they should be understood as more analogous to an 'organism' or biological, rather than a purely mechanistic, system [31]. This thinking has not only informed the development of urban metabolic models with complex feedback loops, but has also led to the development of

[5] For further information see www.retrofit2050.org.uk.