Retrofitting Cities for Tomorrow’s World
Retrofitting Cities for Tomorrow’s World

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Carla De Laurentis is currently completing an EPSRC doctorate study that investigates how place and context-specific conditions influence the mobilization of resources, governance capabilities and actor-networks in energy transitions. She has worked as a researcher for Cardiff University since 2002. Since joining the Welsh School of Architecture in April 2011, she has worked on the EPSRC project Re-Engineering the City 2020-2050 Urban Foresight and Transition Management, investigating sustainability transitions at city-region level. During her research career she has gained extensive knowledge and expertise in innovation, local and regional development and clustering dynamics in high technology sectors (particularly renewable energy, ICT and new media). Her current research interests lie within the study of innovation, energy policy, renewable energy and sustainability transitions. She has contributed to a number of publications exploring the role of regions in the dynamics of innovation and transformation of the energy sector towards sustainability.

Tim Dixon is Professor of Sustainable Futures in the Built Environment at the University of Reading. With more than 30 years’ experience in education, training and research in the built environment, he leads the Sustainability in the Built Environment network at the University of Reading and is co-director of the TSBE (Technologies for a Sustainable Built Environment) doctoral training centre. He led the Urban Foresight Laboratory work package of EPSRC Retrofit 2050 and is currently working with local and regional partners to develop a ‘Reading 2050’ smart and sustainable city vision which connects with the UK BIS Future Cities Foresight Programme. He is also currently working on a smart cities and big data project for RICS Research Trust. He is also a member of the international scientific committee for the national ’Visions and Pathways 2040 Australia’ Project on cities.

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Miriam Hunt is a PhD student at Cardiff University, where her work is concerned with social inclusivity and the museum. She previously worked as a research assistant on the Retrofit 2050 project based at the Welsh School of Architecture, Cardiff University, during which time she explored sustainability and socio-technical transitions in the built environments of South East Wales and Greater Manchester, as well as questions of equity in energy systems. Her academic interests include sustainable regeneration, and social and economic development and inclusiveness.

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Simon Lannon is a Research Fellow at the Welsh School of Architecture, Cardiff University who has undertaken research activities that cover the subject of computer modelling of the built environment. The models and tools he has developed are based on building physics principles and are used at all scales of the built environment, from individual buildings to regional energy demand models. As a member of the EPSRC Retrofit 2050 team Simon was a work package leader responsible for translating scenarios into visualizations of neighbourhood case studies predicting future energy use pathways.

Derk Loorbach is Professor of Socio-economic Transitions and Director of DRIFT, the Dutch Research Institute For Transitions, at Erasmus University Rotterdam, the Netherlands. He was amongst the first researchers to develop the concept and approach of transition management for sustainability since the start of his career in 2000. He develops transition management in an iterative way; through constant interaction between theory development and practical application in diverse social settings. It is therefore also an example of a new form of research labelled ‘sustainability science’ which combines fundamental with action research to contribute to sustainable development. Part of this approach is the so-called transition arena: a small network of selected innovators that reframe complex societal issues and develop alternative strategies that lay the foundations for a much broader governance process. He has been involved as researcher, facilitator, analyst and organizer of these arenas. His main research focus over the last few years has been on Urban Transitions and their Governance. He is series editor for the series Theory and Practice of Urban Sustainability Transitions.

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Allan Teale is a registered Valuer/Licenced Real Estate Agent and is an Associate member of the Australian Property Institute (API). He has over 30 years of experience in the property industry, which includes civil works, Commercial/Residential and Industrial Sales and Leasing. He is presently undertaking a PhD where the research focus is Transparency in Governance in the delivery of Transport Infrastructure in NSW by way of Public Private Partnerships. He is also an aboriginal Australian a member of the Wiradjuri people from western NSW, originally from the Nyngan area, in the state of NSW.

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Katie Williams is Director of the Centre for Sustainable Planning and Environments (SPE) at the University of the West of England. She specializes in sustainable urban environments and is known for her work on sustainable neighbourhood design (in relation to sustainable behaviours and climate change adaptation), urban form (compact cities) and land reuse. She has held visiting lectureships in the USA, Thailand, Peru and the Netherlands and has authored over 100 academic papers and reports and edited 3 books on sustainable urbanism. She is a member of the International Advisory Board for The Stockholm Centre for Sustainable Communications and a member of the Board of the International Urban Planning and Environment Association as well as being a REF Panel member for Architecture, Built Environment and Planning for the REF2014.
The world’s cities cannot continue as they are. The planet and its inhabitants are changing at an astonishing rate — and with it our cities must adapt.

Demographic shifts have brought about an explosion in the size of the world’s middle classes. In 2000, there were one billion people on the planet who spent between $10 and $100 a day. By 2013, that number had doubled. It looks set to reach five billion by 2030. And with this new-found wealth comes increased consumption — of energy, water, food, land and other natural resources. Our cities are magnets for this burgeoning middle class, and they already show the signs of its arrival, accounting for 80% of global greenhouse gas emissions and consumption of 66% of the world’s energy.

Those numbers only look set to increase. The best predictions suggest that, by 2050, 70% of the world’s population will be living in urban areas. But while our cities certainly create emissions and demand energy, they are also undeniably a part of the solution. Concentrated centres of population offer potential for efficiencies that the rural and suburban environment cannot, from modern mass transit that beats the motor car to combined cooling, heat and power systems that satisfy the energy needs of entire districts.

Cities in their infancy can embrace this kind of sustainability from the start. But older cities will need to adapt, to re-engineer themselves for the future. As the editors show in these pages, there are obstacles to be overcome in the process — but they are far from insurmountable.

The efficiencies to which I refer are, perhaps surprisingly, easiest to capitalise upon in some of our oldest cities. Medieval settlements that went on to become some of the world’s most iconic cities — London, Barcelona, Rome — were created with people in mind. Their citizens worked within walking distance of their homes; they shopped in nearby markets; and relaxed in local hostelries and parks. These ways of life were, and still are, inherently positive — they are sustainable, low-carbon, and promote a healthy lifestyle. The good news is that cities originally built in that state can be returned to it easily enough.

Retrofitting provides us with a chance to refocus cities everywhere back into being developed for the needs of humans. Many of our older cities have already started, though the means through which it is achieved varies. To reduce car traffic in the city, for instance, London is leveraging its market economy to make it prohibitively expensive to drive into the centre of the city; meanwhile officials in Bogotá are achieving similar results by making changes to the hard infrastructure of arterial road networks, replacing five-lane highways dominated by cars with pedestrian, cycle and bus lanes.

Foreword
In cities developed after the arrival of the motor car, things are not so easy. Modern cities were rarely developed with humans in mind — one need only look to North American cities like Huston and Los Angeles, where dispersed housing and amenities demands motorised travel. Here, the sprawl and traffic congestion represents a different series of retrofitting challenges that need to be overcome, in order to urbanise areas that are closer to the suburban in feel, creating walk-able and cycle-able downtown areas that feel as if they were designed for citizens themselves. That might require any combination of approaches, from redeveloping large industrial complexes and building higher density housing, to re-wilding overly developed districts to re-introduce green space and encourage healthier lifestyles.

Retrofitting these newer cities may be difficult, but it is certainly not impossible. As this book points out, though, if our cities are to adapt to the needs of the future, a more systemic approach is required — and that starts with governance. Traditionally, urban development has paid little attention to global issues: planners focused on local impacts, national government on larger-scale economic concerns. But we now live in a globalised world where local and global issues are inextricably linked. More than ever, there is a need for both national government and city administrations to work together, thinking of cities not as a series of discrete services — energy, transport, healthcare and so on — but as a constellation of systems that must work together, with policies and regulations in place to encourage them to do so.

To achieve this will also require a dramatic change in the way cities are developed, from the skills and practices required to undertake the work to the way new initiatives are chosen and managed during their deployment. It will require city administrations, national governments, businesses and academia to work together, to turn cutting-edge research into practicable products and services that can help improve cities. It will need new skills, from data science to ethnography, to be enlisted alongside more traditional urban development approaches like town planning and civil engineering. And it demands inscrutable economic analysis and forecasting, to ensure that future developments represent the kind of investment opportunities that external bodies are willing to pursue.

None of this is straightforward, and in this book we see just that: the light and dark of urban development, both now and in the near future. Some chapters reveal the promising work being carried out in cities across the world; others point out that retrofitting is still often hindered by needless complexity and conservatism. Ultimately, of course, we need to ensure that these kinds of learnings are fed back into the system as quickly and efficiently as possible, helping shape current and next best practice for urban development so that cities everywhere know what works and what does not.

Fortunately, many cities are waking up to this need. That is perhaps best demonstrated by an increasing number of urban innovation centres — such as Future Cities Catapult, of which I am Chairman of the Board of Directors. At these organisations, city administrations, researchers and businesses can come together, to share experiences, identify best practice and imagine and develop the cities of the future. They can reflect on the kinds of works described in this book, ascertain what the best approaches are, and champion them around the world. That way, our cities can be adapted in a way that makes them work more effectively — for all of us.

Sir David King

The Foreign Secretary’s Special Representative for Climate Change and Chairman of the Board of Future Cities Catapult (2013–2017), Partner, SYSTEMIC (from 2017)
Preface

Learn from yesterday, live for today, hope for tomorrow. The important thing is not to stop questioning

Albert Einstein (1879–1955)

This book is the culmination of a four year programme of research called ‘Re-Engineering the City: Urban Foresight and Transition Management (Retrofit 2050)’ (2010-2014). Funded under the EPSRC Sustainable Urban Environment (SUE) programme, the EPSRC Retrofit 2050 programme was led by Professor Malcolm Eames at the Welsh School of Architecture, Cardiff University in the UK. The EPSRC Retrofit 2050 research aimed to advance and explore both theoretical and practical understandings of the systems innovation and transition that will underpin a shift towards sustainability in the built environment between 2020 and 2050. The academic project partners comprised Cardiff University, University of Reading, Cambridge University, Salford University, Durham University and Oxford Brookes University. Non-academic partners included Tata Colours, Arup, Core Cities, RICS, Defra and BRE Wales. Regional collaborators included Cardiff, Neath Port Talbot and Manchester Councils, the Welsh Government, Environment Agency (Wales) and Manchester City Council.

The EPSRC Retrofit 2050 research also drew on, and synthesised, findings and expertise from UK and international contexts. This came to fruition through an international conference (‘Retrofitting Cities for Tomorrow’s World: Urban Sustainability Transitions to 2050’) on the 12th and 13th of February 2014, held at the Wales Millennium Centre Cardiff Bay, which showcased work emerging from the project, alongside contributions from invited experts in the UK and internationally.

This book highlights and explores some of the innovative and diverse ways of imagining and re-imagining urban retrofit perspectives, set in the context of ‘futures-based’ thinking. To do this, the book draws not only on the 2014 conference papers, but also on further specially commissioned chapters from UK and overseas experts. The book therefore explores how to determine the best way to plan and co-ordinate a more sustainable urban future by 2050 through urban retrofitting approaches to both residential and commercial property; how cities need to ‘govern’ for urban retrofit; and specifically, how future urban transitions and pathways can be managed, modelled and navigated.

We would therefore like to thank all our co-authors who have contributed to this volume, and also the support of EPSRC (Grant Number EP/1002162/1) in funding the EPSRC Retrofit 2050 work, and which has led to the publication of this book as one of a number of related publications and outputs.
At a personal level, the editors would each also like to thank their families for their patience, love and support during the editing of this book.

For some in our wider ‘family’, the completion of this book coincided with a very difficult period, and we sincerely hope things continue to improve for them.

Cardiff and Reading, 2016

Malcolm Eames
Tim Dixon
Miriam Hunt
Simon Lannon
Reviews

‘Retrofitting Cities for Tomorrow’s World brings together leading thinkers to explore the theoretical and practical understanding of the systems innovation required for a global shift to sustainability of the built environment by mid-century.’

Professor Steve Rayner, James Martin Professor of Science & Civilization, Co-Director Oxford Programme for the Future of Cities

‘This collection offers innovative ways to imagine the city through urban retrofitting. Written by some of the leading experts in their fields, the book makes a stirring contribution for us to think through and manage a more sustainable urban future.’

Professor Mark Tewdwr-Jones, Director, Newcastle City Futures, Newcastle University

‘This publication represents one of the most comprehensive guides to date on the multi-faceted process of retrofitting the city. Unlike some other studies it makes a herculean effort to examine how different systems and approaches within the city can become more fundamentally aligned to achieve the best possible results for a place, ranging from built environment and technical approaches to issues of governance, scale and culture.’

Chris Murray, Director, Core Cities UK

‘This book makes a significant contribution towards tackling the challenge of how to shape a better world. The authors show how we can both imagine and deliberately design our way towards that better future.’

Chris Jofeh, Global Buildings Retrofit Leader, Arup

‘This book identifies the challenges, and illustrates innovative approaches to retrofitting in cities at all scales, from the house and the neighbourhood to the city level. It illustrates the imperative of ‘futures thinking’, of good leadership and governance, and is essential reading for all professionals and communities involved in planning, developing and rebuilding the urban fabric, form and systems.’

Professor Rachel Cooper OBE, Distinguished Professor of Design Management and Policy, Lancaster University
‘In taking a genuinely holistic approach, the range of topics covered is extensive with discussion ranging from broad theoretical perspective to detailed individual case study examples.’

Professor Bill Gething, Professor of Architecture, University of West of England

‘An impressive work that catalogues the complex challenges of city scale retrofit using informative case studies from around the world. The book provides useful analysis of the successes and failures of a range of retrofit initiatives, from technology specific projects, to holistic regionally focused visions.’

Gareth Harcombe, Energy and Sustainability Manager, Cardiff City Council

‘Retrofit 2050 is very well timed as a publication highlighting critical issues and learnings from key research around the world – it is evidence based and explores pathways for the future of cities and their impacts.’

Scientia Professor Deo Prasad AO, CEO: CRC for Low Carbon Living (Australian Innovation Hub for Sustainable Built Environments)

‘This innovative and informative publication includes a portfolio of case studies that are brought to life with evidence-based opinion and data. Collectively these highlight the need for an integrated regulatory and economic landscape which will stimulate a collaborative approach to delivering successful and sustainable refurbishment for the future.’

Dr Deborah Pullen MBE, Group Research Director, Building Research Establishment (BRE)

‘It has become evident that the way forward has to begin with understanding the city as a physical-ecological-social-cultural system, with action requiring multidisciplinary collaboration and public engagement, and transformed visions of ‘the future city’. This is an important book for its analysis of the issues and its critical reviews of various programs and models of transformation; overall it makes a strong case for embracing ‘retrofitting cities’ as a socially and economically urgent domain for innovation.’

Professor Chris Ryan, Professor of Urban Eco-Innovation, Director, Victorian Eco-Innovation Lab (VEIL), University of Melbourne
Introduction

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Yesterday is but today's memory, and tomorrow is today's dream.
Khalil Gibran (1883–1931)

Overview

Today, a key challenge for policy and decision makers globally is how best to develop the knowledge and capacity to use resources more sustainably. Governments in the UK and across the world are therefore introducing increasingly challenging targets to reduce the impact we have on our environment, looking to issues such as the use of renewable energies, waste reduction and limits to carbon emissions. However, in what is an increasingly urbanised world, ‘piecemeal’ change cannot equip cities, as major foci of global population, to rise to the challenges of climate change. What is needed is a new approach, based on futures thinking, which embeds the ideas of ecological and social resilience into the very fabric of the built environment of cities.

Set in this wider context, the ambition of ‘retrofitting’ existing cities has therefore gained increasing prominence within research and policy agendas in recent years as Sir David King notes in the foreword to this book (see also Dixon et al., 2014, and Hodson and Marvin, 2016). Whilst cities are seen as the source of many environmental and resource depletion problems, they are also recognised as centres of major population which offer not only huge potential opportunities in ‘scaling up’ technological responses to climate change, but also to act as ‘hubs’ of innovative social practice and learning. However, city level action requires a change in thinking, and rapid intensification of mitigation and adaptation responses, not only in response to climate change, but also to the allied threat of environmental degradation. What is required at city level therefore is a much more co-ordinated, planned and strategic approach so that cities can transition to a sustainable future over the next 30–40 years.

The notion of urban or city-wide ‘retrofitting’ is anchored in the literal meaning of ‘adding (a component or accessory) to something that did not have it when manufactured’
Introduction

The term has also often been used interchangeably in the built environment with terms such as ‘refurbishment’ or ‘conversion’ (Dixon et al., 2014). However, at a city-scale, retrofit means something more comprehensive. For example, ‘sustainable urban retrofitting’ can be seen as the directed alteration of the fabric, forms or systems that comprise the built environment to improve water, energy and waste efficiencies (Eames, 2011).

However, research on retrofitting in the built environment has traditionally focused on either individual buildings (or building components), or neighbourhood or district level, rather than the urban, or city-wide, scale. A recent programme of research which did focus on ‘urban retrofitting’, was the EPSRC Retrofit programme (2010–2014). This was a major programme of research which recognised, in a critical sense, that when any scaled up thinking does occur, there is often a tendency to think of this kind of large-scale transformative change in terms of ‘what’ is needed and ‘how’ it can be delivered, without considering how to address the two together (Eames et al., 2013; Dixon et al., 2014; Hodson and Marvin, 2016). By bringing together an inter-disciplinary team from across the UK, and linking the public and private sectors, the research sought to take a holistic approach that would overcome this dichotomy. It therefore considered not only the innovative knowledge and technical tools available, but how to implement them in cities by 2050.

The EPSRC Retrofit 2050 research was based on the premise that cities are not a ‘blank page’. To bring about the sort of systematic change that is needed, we need to consider cities as they exist today: a complex mix of homes and workplace, and the product of centuries of evolution. By taking this approach, the project considered the ways in which cities can become ‘locked’ into patterns of resource use that are no longer viable, and seek to change them while respecting their social, environmental and economic sustainability.

Through case studies, modelling and international comparison, the EPSRC Retrofit 2050 project aimed to advance and explore both theoretical and practical understandings of the systems innovation and transition that will underpin a shift towards sustainability in the built environment between 2020 and 2050. The research, which was led by Cardiff University in partnership with University of Reading, Cambridge University, Salford University, Durham University and Oxford Brookes University, was structured around four interlocking Technical Work Packages: (i) Urban Transitions Analysis; (ii) Urban Foresight 2020–2050; (iii) Urban Options: Modelling, Visualisation and Pathway Analysis; and (iv) Synthesis, Comparison and Knowledge Exchange. Commercial collaborators included Tata Colours, Arup and BRE Wales. Regional collaborators included Cardiff, Neath Port Talbot and Manchester Councils, the Welsh Government, Environment Agency (Wales) and Manchester City Council. Stakeholder engagement was therefore a key element in the programme (Opoku et al., 2014).

The geographical focus of the EPSRC Retrofit 2050 project was on two of the UK’s major city-regions: Cardiff/South East Wales area; and Greater Manchester. Both have long industrial histories, both have suffered decline in recent decades and both are seeking to overcome this decline, regenerating themselves into modern, vibrant cities. The project therefore aimed to investigate ways of making this transition environmentally, economically and socially sustainable. Many of these themes are explored in Dixon and Eames (2013), Eames et al. (2013), Dixon et al. (2014) and the EPSRC Retrofit 2050
programme outputs (see www.retrofit2050.org.uk). Thinking about the future of cities, or the 'Tomorrow's World' of cities, is therefore at the heart of this work. This imagines a 'possibility space' for alternative futures, free from the current disconnection between short term planning horizons, and long term environmental change.

The EPSRC Retrofit 2050 programme of research also drew on, and synthesised, findings and expertise from UK and international contexts. This came to fruition through an international conference on the 12th and 13th of February 2014, held at the Wales Millennium Centre Cardiff Bay. Marking the end of a 4-year programme of work funded under the EPSRC’s Sustainable Urban Environments portfolio, this conference showcased work emerging from the project alongside contributions from invited experts in the UK and internationally.

A core aim of this book is therefore to highlight and explore some of the innovative and diverse ways of imagining and re-imagining urban retrofit perspectives, set in the context of ‘futures-based’ thinking. To do this, the book draws on UK and international expertise and experience. The book therefore explores how to determine the best way to plan and co-ordinate a more sustainable urban future by 2050 through urban retrofitting approaches to both residential and commercial property; how cities need to ‘govern’ for urban retrofit; and specifically, how future urban transitions and pathways can be managed, modelled and navigated.

This book therefore brings together a number of papers from this conference, supplemented by other specially commissioned chapters, to explore three main themes in urban retrofit:

- **Governance and dynamics of urban retrofit.** This focuses on the issues involved in the development of wider metropolitan frameworks for retrofitting activities. This includes the development of frameworks for private sector investment; the development of partnerships with market or non-market interests; and the relationships with existing local community, third sector and low income household retrofit activities. Key questions include: What partners are included (and excluded) in such frameworks? How are local priorities balanced with market criteria? What capacity and capability is being created? Specific issues which are explored include: people, practices and the ‘performance gaps’ between desired and actual outcomes; disruptive and sustaining technologies and how these are employed at city level; financial and institutional innovation at city level; and, transforming the commercial property regime and engaging with the business sector at city level.

- **Modelling urban transitions and pathways.** This sheds light on tools and principles for guiding policy makers and practitioners from simple ‘what if’ questions, based on a single modelling technique, to more interlinked tools that capture not only the measurable changes but also the spatial and temporal nature of modelled urban transitions.

- **Steering and navigating sustainable urban transitions.** This focuses on the development and implementation of policy approaches, governance-oriented tools, and broader institutional frameworks for steering and navigating sustainable urban transitions. Issues to be addressed here include: complexity and uncertainty; participation and inclusion; integrating appraisal, learning and evaluation; and the challenges and opportunities for reflexive governance.
1.1 The Future (or ‘Tomorrow’s World’) of Cities

Thinking about the future of cities has become an increasingly important part of the wider ‘foresight’ agenda. Over the last 20 years a substantive literature has emerged which has tried to address for example, what a ‘smart city’ or a ‘sustainable city’ or an ‘eco city’ should encompass, in terms of aspirations and tangible end products for citizens and other key stakeholders. After all, cities today are responsible for some 70% of global carbon emissions and 75% of global energy consumption; and, by 2050, 70% of the world’s population will live in cities. As concerns over climate change and resource constraints grow, many cities across the world are trying to achieve a low carbon transition. In this sense ‘foresight’ can also be thought of a conceptual framework involving a range of forward-looking approaches of informed decision-making that include considerations and views of the long term (Kubeczko et al., 2011), and which could help inform current and future decision-making in the urban realm.

As an example of ‘urban foresight’ thinking in the UK, the Future of Cities Project was run from within the Government Office for Science (GO-Science) and was launched in June 2013 by Sir Mark Walport, the chief government scientific officer. This major project developed an evidence base on the future of UK cities to inform decision makers, and used evidence and futures analysis, taking a view towards 2065, and considering how people will live, work and interact in our cities 50 years from now (Government Office of Science, 2016a, 2016b; Ravetz and Miles, 2016). The aim of this project was to provide policy makers with the evidence, tools and capabilities needed to support policy decisions in the short term to lead to positive outcomes for the UK’s cities in the long term. The project was organised around six main themes:

- living in cities;
- urban economies;
- urban metabolism;
- urban form;
- urban infrastructure;
- urban governance.

This perspective on foresight and ‘futures thinking’ is also at the heart of other recent academic research programmes, besides EPSRC Retrofit 2050 (see Chapter 15). For example, the Oxford Flexible Cities (Future of Cities) programme at Oxford University seeks to re-think the city, in theory and practice, as a flexible and evolving space that better responds to contemporary urban challenges (http://www.futureofcities.ox.ac.uk/). In Australia, the Visions and Pathways 2040 (VP2040) was a 4-year research and engagement project funded by the Australian Cooperative Research Centre for Low Carbon Living (CRC LCL), and involved three universities – University of Melbourne, University of NSW and Swinburne – and many government and industry partners (http://www.visionsandpathways.com/about/project-objectives/). The project aimed to develop visions and innovation and policy pathways for transforming Australian cities to achieve rapid decarbonisation and increased resilience in the face of climate change. This is all part of a wider discourse involving the role of urban foresight and the role of universities in contributing to the development of city visions (Tewdwr-Jones and Goddard, 2014; Tewdwr-Jones et al., 2015).
In Europe, the concept of ‘territorial foresight’ has also gained traction in a number of studies which focus on cities and urban areas (Fernández-Guell and Redondo, 2012). Indeed, here and in other contexts, the move to foresight thinking relates to the high degree of complexity and turbulence prevalent in many cities. There is a growing recognition that if we are to confront and tackle ‘black swan’ events and construct valid responses to climate change and resource depletion, we need new methods and tools to understand the future of our cities (Government Office of Science, 2016a, 2016b). This notion of closer alignment between futures thinking/foresight and strategic planning is also a key element in helping drive change in our thinking. The key elements in implementing urban foresight for a more sustainable future are focused on (Fernández-Guell and Redondo, 2012):

- Anticipation – foresight is a structured way to anticipate and project long-term social, economic and technological developments and needs.
- Vision – foresight details a guiding strategic vision, which offers a shared perspective and commitment to an issue(s).
- Action – foresight develops and implements strategic visions through detailed action plans, which enable current actions to tackle the future successfully.
- Participation – foresight incorporates participatory methods that enable debate and analysis with a wide variety of stakeholders.
- Networking – foresight enables the production and development of new networks and exchange of ideas, experiences and knowledge.

Therefore, urban foresight offers us key advantages for thinking about the future of cities (Fernández-Guell and Redondo, 2012; Dixon and Eames, 2013; Eames et al., 2013). Firstly, a variety of plausible and coherent future visions can be developed through participatory processes. Secondly, a wide range of stakeholder engagement can produce tangible strategies to cope with anticipated future environmental and socio-economic change. Thirdly, the development of expert networks can exchange and disseminate knowledge and outputs to a variety of stakeholders and decision makers. As the UK Future of Cities Foresight programme points out (Government Office of Science, 2016b: 7):

City foresight is the science of thinking about the future of cities. It draws on diverse methods to give decision makers comprehensive evidence about anticipated and possible future change. With ever increasing volumes of available data and emerging new analytical approaches, cities need to be equipped for complex decision-making about the future in a way that engages the appropriate partners and communities. Currently the UK rarely looks very far into the future of its cities, or considers the full richness of possibilities. Working together, national and local governments can change this by strengthening the mechanisms and processes available for cities to examine the long term and take evidence-based action to shape their own futures.

As part of developing our thinking about the future of cities, understanding the processes of urban retrofitting at a city scale itself requires the development of an integrated perspective on long-term systems innovation; in other words, an accompanying
Introduction

Theoretical perspective in which to link with urban foresight techniques. This perspective is commonly referred to within the literature as ‘socio-technological transitions’ (Eames et al., 2013). In this sense the defining characteristics of urban retrofitting are: (i) its comprehensive nature and large scale; (ii) its integrated nature, requiring a high degree of private–public partnership arrangements; (iii) the sustainable nature of its funding; and (iv) a clearly defined set of goals and metrics for monitoring (Living Cities, 2010).

Responding to these challenges in a purposive and managed way also requires cities to bring together two disconnected issues: ‘what’ is to be done to the city (e.g. technical knowledge, targets, technological options, costs) and ‘how’ will it be implemented (e.g. institutions, capacity, public engagement, 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 (May et al., 2010; Dixon et al., 2014; Hodson and Marvin, 2016).

Bridging these gaps and undertaking urban transitions will therefore require new forms of interdisciplinary working: bringing together, amongst others, engineers, architects, planners, natural and social scientists, and incorporating elements of horizon scanning, technology foresight, multi-scale modelling, master planning, deliberative appraisal and knowledge exchange. Drawing upon concepts and ideas from evolutionary, systems and complexity theory such transitions are understood as complex, co-evolutionary, and characterised by non-linear processes which span multiple actors, levels and dimensions over long-term timescales (Elzen et al., 2004; Geels, 2005a, 2005b; Kemp et al., 2006; Geels et al., 2008).

Building upon such theoretical insights, together with case studies of historical innovations in systems ranging from energy, transport, food and sanitation to entertainment and popular music, the multi-level perspective (MLP) has therefore emerged as the dominant conceptual model (or broad heuristic) seeking to explain the dynamics of large-scale socio-technical systems change in terms of the interplay between niche, regime and landscape (‘micro’, ‘meso’, and ‘macro’) processes (Smith et al., 2010; Truffer and Coenen, 2012; Eames et al., 2013).

The EPSRC Retrofit project essentially viewed a city as a ‘complex adaptive system’ and drew on critiques of traditional planning processes (Eames et al., 2014). Urban retrofitting is therefore seen as an interlocking system of innovation challenges, with a primary emphasis on:

- Multi-scale transitions: for example, building, neighbourhood, community, and city scales (i.e. ‘integration across scales’).
- Integrative perspectives on longer term systems innovation, which are multi-sectoral and multi-level. Here the concept of socio-technical regime is adapted to identify particular urban retrofit ‘regimes’ (e.g. housing, urban infrastructure and land-use regimes; Eames et al., 2013).
- Identifying sustaining and disruptive retrofit technologies (Dixon et al., 2013).
- Understanding retrofit as a ‘co-evolutionary’ and ‘socio-technical’ change process (Hodson and Marvin, 2012; Eames et al., 2013).

The MLP was therefore used in the EPSRC Retrofit 2050 research as a way of conceptualising a more systemic approach, in contrast to what might be termed a ‘building

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1 See McGrail and Gaziulusoy (2014) for an interesting comparison of EPSRC Retrofit 2050 and other urban transition research projects.
scale’ approach, or indeed, more ‘piecemeal’ and fragmented approaches to the problem. To do this, the research drew on ‘transition management’ frameworks, and theorisation of the performative roles of visions and expectations (see e.g. Eames et al., 2013; Dixon et al., 2014), and some of the chapters in this book (e.g. by Dixon, and by Loorbach) shed further light on the MLP.

Visioning and backcasting are also useful tools in exploring potential futures, and were a crucial element of the work of EPSRC Retrofit 2050. The process of backcasting is one of defining a vision of a desirable future and then articulating a pathway to that future from the present day. In fact, backcasting is a fairly broad term, with key factors including who develops the future vision, whether one or multiple visions are considered, and theoretical grounding with respect to models of innovation (Eames, 2011). Rather than imposing a single normative vision, the EPSRC Retrofit 2050 approach sought to acknowledge the contested and inherently political nature of sustainability through exploring a broad range of visions. These visions were then interrogated by relevant experts in order to create ‘scenarios’: so that an end vision combined with a specific ‘pathway’ described the journey from the present day for the future city-region. Visioning, generating a picture of desirable futures, is therefore a key step in any backcasting process, and is a useful tool in dealing with uncertainty by developing a shared set of expectations. These shared expectations shape both the speed and direction of social and technical change: they have a performative role in providing legitimacy; mobilising investment; promoting network formation; and reducing risk by aligning research and development and production activities (Eames et al., 2013). Essentially, they bring together information, resources and actors to rally around a set of shared visions to underpin action. Indeed, the recent proposals to develop a national retrofit programme for housing in the UK (Arup, 2016) partially drew on the EPSRC Retrofit 2050 research and its work, by emphasising the importance of scaling up action; adopting a holistic perspective; and creating viable funding mechanisms for retrofit.

Foresight methods and theoretical perspectives (such as the MLP) therefore potentially offer us a rich way of gaining insights into how cities could, and should, evolve to a sustainable future. This acknowledgement that new ways of thinking, analysing and theorising about the transition to a more sustainable future for our cities by 2050 are required, is a fundamental rationale for this book. This book therefore builds on other EPSRC Retrofit 2050 outputs (including Dixon et al., 2014, and Hodson and Marvin, 2016) to highlight important emergent issues around ‘governance and dynamics’; ‘modelling’; and the ‘steering and navigation’ of urban retrofitting. It is effectively the culmination of the 4-year EPSRC Retrofit 2050 research programme, and draws together the main findings of that programme. Through the chapters which follow we hope academic researchers, professional practitioners, and industry experts will therefore be better able to understand not only the challenges of urban retrofitting, but also how a ‘Tomorrow’s World’ of retrofitted cities could be achieved.

1.2 The Structure of the Book

1.2.1 Part One: Governance and Dynamics of Urban Retrofit

This part of the book focuses on the issues involved in the development of wider metropolitan frameworks for retrofitting activities. This includes the development of frameworks for private sector investment; the development of partnerships with market
or non-market interests; and the relationships with existing local community, third sector and low income household retrofit activities. Key questions include: What partners are included (and excluded) in such frameworks? How are local priorities balanced with market criteria? What capacity and capability is being created? The chapters in this part also explore the wider dynamics of both commercial and residential retrofit.

1.2.1.1 Community Housing Retrofit in the UK and the Civics of Energy Consumption

Andrew Karvonen

The existing housing stock in the UK will make a significant contribution to national carbon emissions for many decades to come. Existing houses present a significant challenge to systemic upgrades because they are influenced by a disparate set of regulations, incentives, and stakeholders. Unlike the new build industry, there is no single set of standards to regulate and steer the energy performance of the existing housing stock. To address this challenge, a wide range of government bodies and non-governmental organisations have initiated domestic retrofit programmes based on the notion of ‘community.’ The aim of community retrofit programmes is to create a collective of various actors who influence domestic buildings to make retrofit activities more effective and widespread. This rescaling of domestic housing retrofit from the individual household to the community level counters the fragmented and incremental character of domestic retrofit activities by creating shared networks of inquiry and action. This chapter explores the social and political aspects of community domestic retrofit programmes to understand their implications to sustainable urban transitions. The chapter begins with a summary of the challenges to systemic domestic retrofit in the UK and the deficiencies of the ‘rational choice’ model that is commonly employed by Government and other organisations to reform the existing housing stock. Then, four emerging approaches to collective domestic retrofit are presented to illustrate how the notion of community reframes the relationship between individuals and the state. Finally, the chapter concludes with reflections on the emerging civics of low-carbon transition that are embedded in community housing retrofit programmes.

1.2.1.2 City-wide or City-blind? An Analysis of Retrofit Practices in the UK Commercial Property Sector

Tim Dixon

Commercial property produces about 10% of the UK’s greenhouse gas emissions and consumes 7% of UK energy. It is estimated that UK business is overlooking a potential cost-saving of £1.6b through under-investment in energy efficiency, with the UK’s commercial retrofit market potential estimated at £9.7b (or US$16b). Using the MLP as a conceptual lens this chapter examines the nature and characteristics of the commercial property retrofit regime in the UK. Based on 37 face-to-face interviews conducted during 2012–2013 (as part of the EPSRC Retrofit 2050 programme) the chapter examines the trends in commercial property retrofitting at a ‘regime’ level to address the following key questions: (i) ‘Who?’ by identifying the main stakeholders in the commercial property retrofit regime and its key features; (ii) ‘What?’ by defining what is meant by ‘retrofit’ in the regime and examining the key retrofit technologies being used; (iii) ‘Why?’ by examining the key drivers and barriers for commercial property retrofit; and (iv) ‘How?’ by examining the institutional frameworks, legislation and monitoring/
standards behind commercial property retrofit (including financing, assessment methods, and monitoring and verification systems). The chapter suggests that although there is evidence of niche experiments, the regime is hampered by complexity, fragmentation and conservatism. This is not helped by a lack of consensus over the meaning of the term ‘retrofit’. Moreover, the commercial property sector does not necessarily take a ‘city-wide’ view of retrofit projects: in this sense it is ‘city-blind’ with the focus more likely to be on individual building or property portfolio level. The chapter examines issues of scale, particularly at city level (and also summarises the key challenges to retrofitting at city scale in the regime), and finally sets out insights for the future, including policy and practice implications.

1.2.1.3 Performance Gap in ‘Deep’ Retrofit: Issues at the Design and Construction Interface
Will Swan, Niloufar Bayat and Graeme Sheriff

Deep energy efficient retrofit of hard to treat (HTT) properties is emerging as a major concern in the UK. A number of studies have highlighted the difficulties of effective delivery of this type of retrofit, citing issues of lower than expected performance, known as the ‘performance gap’. The aim of this chapter is to investigate the different factors that drive this performance gap when conducting deep retrofit in the UK’s ageing housing stock. Here, a series of semi-structured interviews was undertaken with recognised retrofit experts in the UK, including architects, energy consultants, contractors and sub-contractors who were actively involved in energy-efficient retrofitting of HTT properties, to identify key performance gap factors. The study reveals that the major issues in such projects associated with the performance gap predominantly present themselves in the design and construction interface. The respondents identified a number of issues including: understanding and skills, working practices, and the physical uncertainty around HTT properties. These issues raises questions as to the position of deep retrofit as a solution to HTT retrofit, as not only a technical problem, but one of construction management, communication and, ultimately, industry culture.

1.2.1.4 Transforming the Commercial Property Market in Australian Cities: Contemporary Practices and the Future Potential in Green Roof Retrofit
Sara J. Wilkinson, Paul van der Kallen, Allan Teale and Hera Antoniades

Australia needs to increase the adaptation of the existing commercial property stock to reduce building related greenhouse gas emissions. Some of these emission reductions could be achieved by retrofitting green roofs. Given that Germany had over 10 million square metres of green roofs by 1996, have we been missing an opportunity in Australia? Green roofs offer many benefits such as stormwater management, improve water run-off quality, reduce the urban heat island effect, extend the lifecycle of the roof membrane, and improve thermal performance. There are social sustainability benefits through the provision of spaces for people to enjoy. Roofs can account for 40–50% of impermeable surfaces, and typically around 15% of office stock in Australian city centres has the potential for green roof retrofit. This chapter defines green roofs and examines issues facing Australia in respect of retrofit, climate adaptation and sustainability. The transformation of the commercial property stock is examined in respect of the barriers, incentives, legislation and opportunities, which exist currently. A series of illustrative case studies demonstrate how roofs have been retrofitted for bio-diversity,
urban food production, stormwater attenuation and thermal performance. An examination of policy and incentives at city and building scale reveals the future potential for green roof retrofit in Australian cities. The conclusions summarise the current position and posit an agenda for the future.

1.2.2 Part Two: Modelling Urban Transitions and Pathways

The chapters in this part shed light on tools and principles for guiding policy makers and practitioners from simple ‘what if’ questions, based on a single modelling technique, to more interlinked tools that capture not only the measurable changes, but also the spatial and temporal nature of modelled urban transitions. The development of foresight techniques and scenarios is also explored to bring an integrated sense of purpose to developing transitions and pathways for urban futures.

1.2.2.1 Modelling Residential Retrofit: Insights on the Effect of Regional Characteristics for the Cardiff City Region
Malcolm Eames, Simon Lannon, Miriam Hunt and Aliki Georgakaki

Using Cardiff City Region as a case study this work investigates the potential for cost effective energy and carbon saving measures at the city region scale, taking into account characteristics and constraints in each locality. Results indicate that compositional downscale using statistical information at the local authority level can provide useful insights about the retrofit needs and potential at this level. Assumptions regarding the residential fuel mix and future electricity supply have a considerable impact on determining the cost effectiveness of measures and the potential CO₂ savings, especially for local authorities with a residential housing stock and fuel mix markedly different from the assumed average. Around a quarter of the CO₂ saving target for the domestic sector (if applied uniformly at all sectors) can be achieved by the measures examined in this study, but significant investment, and swift action is needed to achieve this potential. The approach has sought to reconcile the need to incorporate regional characteristics in broad top-down scenario work, with the reality of data and resource scarcity which hampers the implementation of detailed bottom-up models at a large scale. Using elements from both top-down and bottom-up models may be the best approach to address the needs of users at the regional and local authority level.

1.2.2.2 Weatherproofing Urban Social Housing for a Changing Climate Through Retrofitting: A Holistic Approach
Anna Mavrogianni, Jonathon Taylor, Michael Davies and John Kolm-Murray

Among the many major challenges to the implementation of large-scale housing retrofit in the UK is combining climate change mitigation through energy efficiency upgrades with climate adaptation. Whilst the specification of increasingly airtight and insulated building envelopes is necessary to reduce carbon emissions from the domestic building sector, new and existing homes will also need to be prepared for a warmer climate. This chapter explores the interrelationship between these often contradictory requirements in the context of social housing, using South Islington, in central London, as a case study. Overheating risks are likely to be amplified in social housing due to the increased propensity to overheating of certain dwelling types that are common in this sector.
(e.g. purpose-built flats) and the high levels of individual vulnerability, in particular among the elderly. The chapter suggests that although social housing residents are often sceptical about climate change, they may be already facing thermal discomfort under the current climate, which is expected to be exacerbated under future climate scenarios. This research also found that air pollution, noise and security concerns may limit the potential of occupant-controlled natural ventilation.

1.2.2.3 What is Hindering Adaptation to Climate Change in English Suburbs, and What Would Help Facilitate Action?
Ian Smith, Katie Williams and Rajat Gupta

Climate change makes many challenges on suburban areas. This chapter focuses on one of the multiple problematics of climate change: the challenge of overheating. Reporting on evidence from the EPSRC-funded SNACC project (EP/G061289/1), the chapter presents results from neighbourhood modelling of potential overheating in six English neighbourhoods using the DECoRuM model. It then explores how residents in these neighbourhoods thought through and thought about their response to the threat of overheating, calling on Ostrom’s notion of the ‘collective action problem’ and on social practice theory. Whereas there is a clear demonstrable technical problem for the 2050s and beyond, residents are unable to both resolve their collective action problem and move beyond how their current lifestyle preferences make many adaptive responses to overheating ‘inconvenient’. However, residents are prepared to implement low cost technical fixes and options that have current benefits (such as shade planting). Thus any strategic plan for retrofitting the English housing stock needs to be realistic about the degree to which current owner occupiers are prepared to invest their household resources in the housing infrastructure of 2050.

1.2.2.4 The Value of Foresight and Scenarios in Engineering
Liveable Future Cities
Chris Rogers

Engineering of future UK cities typically involves starting with an urban context shaped over hundreds of years and, whether adding new developments or regenerating existing areas, the essential process is one of retrofitting in this wider city context. In supporting citizens and city systems, civil engineers create artefacts that often function decades into the future. Consequently, they take cognisance of the concepts of sustainability, resilience, adaptability and liveability, ideas that need to be examined so that they can be embedded in processes of future visioning while acknowledging likely (possibly radical) contextual change. Drawing on the Foresight Future of Cities project, which focused on the UK’s city systems and the UK’s system of cities, the efficacy of alternative ways of using scenarios to enrich, empower and future-proof today’s engineering interventions in cities is explored in this chapter.

1.2.3 Part Three: Steering and Navigating Sustainable Urban Transitions

In this part of the book the chapters focus on the development and implementation of policy approaches, governance-oriented tools, and broader institutional frameworks for steering and navigating sustainable urban transitions. The issues addressed here
include: complexity and uncertainty; participation and inclusion; integrating appraisal, learning and evaluation; and challenges and opportunities for reflexive governance; and practical insights from emerging research and practice in ‘eco cities’.

1.2.3.1 Urban Sustainability Transition: Retrofitting the City
Derk Loorbach

The transition of the built environment from energy consuming and unsustainable towards energy producing and sustainable is a complex, long-term challenge. One might assume that this transition will happen just because it is (increasingly) possible, affordable, desirable and just, but the speed of changes and the likely outcomes of the transition are far from certain. Incumbent regime actors, routines and rules complicate this transition, and many of the alternatives are not competitive enough given existing regulations and economic conditions. However, the combination of demographic changes, economic pressures, resource issues and new (information) technologies is increasingly leading to an existential problem in a building sector that focuses primarily on new houses in high quantities against low financial margins and on incrementally improving existing building stock. The effects of these pressures create space for acceleration of alternative transition pathways. It stimulates investments in new and so far, marginal alternatives such as energy producing houses through new retrofitting concepts. This chapter reflects upon the transitional challenge taking into account both the complexities and resistance to changes but focuses on the governance challenges of this transition. It will present some of the novel ideas on the tensions and paradoxes that arise in the acceleration or breakthrough phase of transitions and describes an example of a transition programme underway in the Netherlands to combine home owners, banks and private equity, the building sector, real estate agents and government to transform more than 100,000 homes from the 1970s and 1980s into energy producing before 2020. This programme, Energy Leap (Energiesprong), is gaining traction and helping to transform the built environment. It is drawing international attention and spreading to countries such as France and the UK, but is also in these countries facing the complex challenges of transition.

1.2.3.2 Presenting Futures: London 2062
Sarah Bell

Universities have an important role to play in supporting cities through transitions to sustainability, amongst many other issues facing citizens and decision makers. The London 2062 project invited academics and students of University College London (UCL), a multi-faculty university located in central London, and partners from across London to consider the key issues shaping the future of the city. Through a series of seminars, workshops and publications contributors were encouraged to draw on their expertise to identify the forces shaping London and to consider how these might play out over the next five decades. The outcomes reflect the diverse methods and contributors, ranging from design principles for climate change adaptation to a vision of London run by mega-football clubs. Unconstrained deliberation about the future by well-informed people helps to clarify the key issues that are currently at stake in the city, as well as pointing out what these might mean in 50 years.
1.2.3.3 Framing New Retrofit Models for Regenerating Australia’s Fast Growing Cities

Peter W. Newton

Forecasts of continued high rates of population growth for Australia’s major cities are placing increased pressure on metropolitan planning strategies for more innovative urban infill solutions. To slow sprawl, infill targets of 70% or more designed to accommodate new dwelling development over the next 25 years in the established middle suburbs are falling well short of requirements. This chapter will provide a perspective on why this is not occurring and will update progress on research directed towards the framing of a new model for greyfield precinct redevelopment – akin to what was created for brownfields under the Building Better Cities Programme of the early 1990s. Greyfields constitute those predominantly residential areas in Australian cities where the stock is ageing, physically deteriorating, technologically obsolescent and environmentally poor performing and where the value of the property lies in the land – an economically underperforming asset, but occupied, unlike brownfields and greenfields. Greyfields, however, are extremely well located in the established low density middle suburbs of Australian cities, with good access to public transport, jobs and higher level education and health services. They represent untapped potential for more intensive, regenerative retrofitting – at precinct scale. Unlocking this potential requires innovation in multiple arenas such as urban governance and urban planning and design – the focus for this chapter, using the city of Melbourne, Australia as the case study.

1.2.3.4 City-regional Futures in Context: Insights from the Retrofit 2050 Project

Carla De Laurentis, Malcolm Eames, Miriam Hunt and Tim Dixon

Research findings from the EPSRC funded Retrofit 2050 project, aim to advance and explore the theoretical and practical understandings that underpin a shift to sustainability of the UK’s core city regions in 2050. Utilising a participatory backcasting and scenario building process at national and regional levels, the Retrofit 2050 project has sought to envisage what a sustainable urban environment could look like based upon the systemic urban retrofitting of an existing UK city-region to 2050.

First, it is argued that the construction of normative sustainability oriented future scenarios and vision(s) of a desirable future(s), is fruitful in understanding and managing processes of transition and meeting the goals of environmental sustainability. Secondly, the regional level visioning process described here intends to reflect the observations that retrofitting, by its very nature, does not occur on a blank state and will rather occur in existing social, governance and physical structures.

Utilising the Retrofit City Futures, developed during the Retrofit 2050 project, as guiding visions it is argued that city regional futures need to be grounded in a rich understanding of the (economic, political, social and ecological) transformation processes that shape development at regional level. The research reflects on the example of the Cardiff city region and highlights how these transformation processes play out across the variegated (rural, post-industrial and urban) geographies of the Cardiff city-region shaping, influencing and rendering distinctive the visions and city futures of Cardiff.
1.2.3.5 National Policies for Local Urban Sustainability: A New Governance Approach?

Simon Joss and Robert Cowley

Cities have become a focal point for efforts to transition towards a more sustainable, low-carbon society, with many municipal agencies championing ‘eco city’ initiatives of one kind or another. And yet, national policy initiatives frequently play an important – if sometimes overlooked – role, too. This chapter provides comparative perspectives on four recent national sustainable city programmes from France, India, Japan, and the UK. The analysis reveals two key insights: first, national policy is found to exercise a strong shaping role in what sustainable development for future cities is understood to be, which helps explain the considerable differences in priorities and approaches across countries. Secondly, beyond articulating strategic priorities, national policy may exercise a ‘soft’ governance function by incentivising and facilitating wider, voluntary governance networks in the effort to implement sustainable city projects locally. This innovative role, however, depends on the ability of national policy to produce resonance among societal actors and on its effective interaction with formal planning processes.

1.2.4 Part Four: Overview of Key Themes from the Book

1.2.4.1 Conclusions and Reflections: Retrofitting Cities for Tomorrow’s World

Malcolm Eames, Tim Dixon, Miriam Hunt and Simon Lannon

In this chapter we reflect on the main findings of the EPSRC Retrofit 2050 programme, setting this in the context of the themes which constituted this book, and the wider policy and practice debate surrounding the future of cities, both in the UK, and internationally.

References


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Part I

Governance and Dynamics of Urban Retrofit
Community Housing Retrofit in the UK and the Civics of Energy Consumption
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Overview

The housing stock in the UK comprises an estimated 25% of national carbon emissions. New houses replace existing houses at a very low rate, less than 0.5% per year (Jones et al. 2013), meaning that between two-thirds and three-quarters of the current housing stock will still exist in 2050 (Sustainable Development Commission 2006, Roberts 2008, UK Green Building Council 2008, Gupta & Chandiwala 2010, Eames et al. 2013). Thus, there is a pressing need to upgrade the existing housing stock to reduce its carbon emissions. Systemic retrofit of housing is a significant challenge because, unlike the new build housing industry, there is no clear set of guidelines to govern the retrofit process. As the UK Green Building Council (2008: 1) states, the existing housing sector is 'hugely fragmented, with a plethora of industry sectors and other stakeholders, different groups of actors and decision-makers and various inter-related policies'. Implementing a comprehensive strategy for retrofit requires novel approaches to organise and direct this fragmented landscape.

To address the fragmented character of the existing housing stock, stakeholders ranging from the UK government and local authorities to social housing providers and charity organisations are developing approaches of 'community' retrofit. The aim is to approach retrofit in a more joined up way to influence the carbon performance of domestic buildings on a broad scale. The notion of community provides an opportunity to foster new relationships amongst the actors who influence the built environment, including designers, building owners, financiers, local authorities, and occupants. By linking up these actors through shared networks of inquiry and action, it is hoped that a low-carbon building stock can be realised.

This chapter contributes to a growing body of literature on 'community retrofit’ (e.g. Brown & Vergragt 2012, Vergragt & Brown 2012, Gee & Chiappetta 2013, Karvonen 2013, Swan 2013, Gupta et al. 2014) by comparing and contrasting the dominant ways that community is leveraged in the housing sector. The chapter begins with an overview of some of the most significant challenges to domestic retrofit in the UK and a critique of the 'rational choice' and individualist model that is commonly applied to upgrade the
existing housing stock. This is followed by a summary of four community retrofit approaches that provide innovative routes to transform the built environment. The chapter concludes by reflecting on the implications of community housing retrofit to the politics and governance of low-carbon transitions.

2.1 Challenges to Systemic Housing Retrofit

The UK’s housing stock is constantly being retrofitted to meet contemporary norms and standards as well as prepare for future conditions. The notion of ‘retrofit’ is often used interchangeably with renovation, modernisation, restoration, and rehabilitation. All of these terms describe activities undertaken (often by homeowners) that go beyond routine maintenance and repair (Meijer et al. 2009, Dixon & Eames 2013). This includes modernisation of kitchens and bathrooms, installation of insulation and energy efficient boilers, replacement of roofs and windows, construction of extensions and conservatories, and so on. These interventions are periodic, occurring anywhere from 5 to 30 years (or longer), and are often done in a piecemeal fashion. Realising systemic change to the housing stock involves coordinating these discrete interventions into a directed strategy of upgrade.

The housing stock comprises a wide range of ages and construction methods so there is no ‘one-size-fits-all’ approach to upgrade. Further, there is a lack of incentive for homeowners to undertake retrofit of their properties because these activities are often disruptive, costly, and require effort to coordinate product designers, manufacturers, installers, rebate programmes, and so on. All of these factors contribute to the fragmented character of retrofit activities and this has hindered widespread change (Clarke 2006, Oreszczyn & Lowe 2010, Swan 2013). Oreszczyn and Lowe (2010: 110) summarise the retrofit challenge succinctly: ‘Empirical evidence and experience suggest that it will be neither particularly easy nor particularly cheap to reduce energy use in buildings. However, there is a perception in government that energy efficiency in buildings is straightforward and requires minimal investment.’

Government has traditionally approached housing energy performance and carbon reduction by introducing a range of regulations and incentives. Regulations such as the Building Standards, the Decent Homes Standard, and the Scottish Housing Quality Standard have been supplemented with incentive programmes such as the Feed-in-Tariffs Scheme and the Renewable Heat Incentive to compel or encourage homeowners to upgrade their properties. These approaches use legal and financial levers to optimise energy performance while improving the quality of life and health of occupants and enhancing property values. As a whole, regulations and incentive programmes have produced a patchwork of upgrades to the housing stock but have failed to realise widespread change (Eames et al. 2013). Maller and colleagues (2012: 257) argue that: ‘market mechanisms, easy retrofits, and economic rationalist understandings of human actions are unlikely to achieve widespread systemic changes needed to address the environmental and social challenges of climate change, largely because they do not challenge the status quo and overlook the routines of everyday life.’ Thus, regulations and incentive programmes are a necessary but insufficient approach to reduce the carbon emissions of housing.
Beyond regulations and incentive programmes, there is a wealth of information available on domestic retrofit. Information provision rests on the assumption that the energy performance of the existing housing stock is hindered by a lack of knowledge either with homeowners or building professionals. Thus, there is a need to fill the ‘information gap’ to realise systemic retrofit. For example, the Centre for Refurbishment Excellence (2016) in Stoke-on-Trent is a one-stop shop for best practices, case studies, and training for construction industry professionals. The SuperHomes Network (2016) is a consortium of over 200 houses that have achieved at least a 60% saving in carbon through retrofit and provides free tours to the public twice a year. And the Low Energy Building Database (LEBD 2016) is a free online resource managed by the Association for Environment Conscious Building with detailed case studies on 230 domestic retrofit projects for industry professionals and the public. Like regulations and incentives, information provision is a useful first step in catalysing change in the built environment. However, ‘information alone is unlikely to motivate changes as a matter of course’ (Moloney et al. 2010: 7616).

The problem with regulations, incentive programmes, and information provision is that they focus on the individual as the agent of change. This epitomises the ‘rational choice’ model where it is assumed that a person has the motivation and capacity to review and select from a range of options (Gram-Hanssen 2009, 2010, Heiskanen et al. 2010, Spaargaren 2011, McMeekin & Southerton 2012, Berry et al. 2014, Karvonen 2016). The result has been an overemphasis on the individual, particularly homeowners, to realise systemic change to the housing stock while neglecting the various stakeholders that can either facilitate or hinder change. This is particularly the case with energy upgrades to housing. As Heiskanen and colleagues (2010: 7586) note: ‘For decades, attempts to change energy-related behaviour were targeted at individuals as consumers of energy.’ Alternatively, the housing stock can be understood as ‘a cultural asset that is embedded in the fabric of everyday lifestyles, communities, and livelihoods’ (Ravetz 2008: 4463). This shifts the emphasis of retrofit from the individual consumer or property owner to recognise that domestic life is linked to larger social, cultural, and political drivers. This serves as the basis for understanding the emergence of community approaches to housing retrofit.

2.2 Community and Low-Carbon Futures

The idea of ‘community’ serves as a useful alternative to individualist understandings of society. A wide range of social scientists have examined the notion of community in environmental politics and sustainable development in current debates including grassroots innovation (e.g. Seyfang & Smith 2007, Seyfang et al. 2010, Seyfang & Haxeltine 2012), civic environmentalism (e.g. Agyeman & Angus 2003, Karvonen 2011, Karvonen & Yocom 2011), environmental governance (Bäckstrand 2003, Bulkeley 2005, Walker 2011), social movements (Shutkin 2000, Hess 2007), and political theory (Little 2002, Barber 2003, DeFillipis et al. 2006). Community is recognised as a progressive, collective, and mobilising force (Aiken 2014) motivated by the assumption that ‘groups of individuals are better placed to create new institutions and schemes for resolving social dilemmas’ (Heiskanen et al. 2010: 7587).
Communities are a strong presence in energy and carbon debates but often through protest activities (Walker 1995, Van der Horst 2007, Cass & Walker 2009, Wolsink 2010). To a lesser extent, communities participate in locally owned and managed energy infrastructure projects (Muruyama et al. 2007, Walker et al. 2007, 2010, Rogers et al. 2008, Walker 2008). Walker (2011: 777) argues that: ‘The involvement of communities has become an increasingly recurrent feature of carbon-related discourse, viewed as positive, productive and contributing to the successful implementation and social embedding of various forms of carbon reduction activity.’ Likewise, Aiken (2014: 765) notes that community ‘emerges as a key site in the transition to low carbon futures partly because of its ability to encompass both the global and local, and also to internalise and governmentalize the behavioural changes that transition to low carbon futures requires.’ Thus, community serves as a critical link between the individual consumer that is creating carbon emissions and the government that is charged with reducing those emissions.

2.3 Community Housing Retrofit

Multiple housing retrofit programmes have emerged over the last decade based on notions of community (Karvonen 2013, 2016, Swan 2013). These programmes go beyond the individualist emphasis of regulations, incentive programmes, and information provision to recognise the housing stock as a shared asset with multiple stakeholders. This shifts the focus of retrofit from the individual house to a collection of houses with similar issues or to a collection of actors with shared interests.

Community housing retrofit programmes have several commonalities. First and foremost, occupants are at the centre of decision-making processes. This recognises that for retrofit measures to be effective in the long term, they need to be understood not only as a reconfiguration of how a house is physically configured but how it is inhabited and managed on a daily basis. This reflects a sociotechnical perspective where the house is comprised of a combination of social and material relations (Guy 2006, Guy & Karvonen 2011, Day & Walker 2013). A second similarity of these programmes is that domestic retrofit is a complex process. This complexity includes technical and economic issues but also social issues related to comfort, health, well-being, and happiness. Thus, the process of retrofit is about bringing the physical and social, the house and the home, into new sociotechnical alignments (Vergragt & Brown 2012, Walker et al. 2015).

Community is interpreted in various ways through these programmes. It may comprise stakeholders such as design and construction professionals, government officials, neighbours, and third sector organisations, or it may occupy a particular geographic location consisting of a dominant housing type. As Walker (2011: 778) argues: ‘The different meanings of community that are drawn on by policy and non-governmental actors link to a set of expectations about what community can productively bring to carbon mitigation initiatives.’ In the following subsections, four different interpretations of community retrofit are presented to understand how community is being used to promote knowledge creation and action and how this influences the retrofit process.
2.3 Community Housing Retrofit

2.3.1 Community as Local Governance Strategy

For over a decade, the UK Government has recognised community as an important strategy for climate change mitigation. The 2005 *Securing the Future* report states: ‘Community groups can help tackle climate change, develop community energy and transport projects, help minimise waste, improve the quality of the local environment, and promote fair trade and sustainable consumption and production (HM Government 2005: 27). This agenda recognises that ‘community level initiatives hold the potential to ground climate change policy in a much more visible way to the everyday practicalities of energy use than more “top-down” measures have been able to achieve’ (Peters et al. 2010: 7596). Community here represents a novel form of local governance to address the multiple challenges of climate change. Hauxwell-Baldwin (2013: 9) argues that: ‘community is conflated with civil society as part of a new social architecture through which the “search for sustainability” may be governed, and new social movements form around “the complex area of climate change and energy efficiency”.

An example of the local governance of retrofit is the Carbon Coop, a member-owned community benefit society in Manchester that represents over 100 households (Carbon Coop 2016). The organisation received £500 000 in funding from the Department of Energy and Climate Change’s Community Green Deal programme to retrofit 12 houses across Greater Manchester. The Carbon Coop practices whole house retrofit by strategizing with homeowners on multiple measures to reduce carbon emissions by 80% or more while also being affordable. As such, each house received a whole house assessment, zero interest loan, access to subsidy programmes, procurement of contractors, and design and specification services. While the programme continues to use traditional government incentives, it manages these funds at the local scale where they can target a particular housing stock.

In 2015, National Energy Action presented the Carbon Coop with an Energy Efficiency Best Practice Award from National Energy Action (2015), stating: ‘The programme has successfully leveraged the high levels of householder involvement and trust that the Green Deal has failed to, informing a new, ambitious, community-led approach to retrofit.’ Organisations such as the Carbon Coop go beyond conventional regulations and incentive programmes by operating at an in-between scale to bridge national government targets and a particular housing stock. There is an understanding that local organisations have a better understanding of the opportunities and barriers of domestic retrofit and can align what is happening on the ground with broader government ambitions. While there is a continued reliance on traditional financial mechanisms to incentivise retrofit among homeowners, there is an acknowledgement that low-carbon interventions are most effectively managed and executed at the local scale. This embodies an ‘ecolocalisation’ agenda for transitioning to a low-carbon society (Shutkin 2000, North 2010, Aiken 2014).

2.3.2 Community as Identity

At the opposite end of the spectrum are those retrofit programmes that counter the UK government’s dominance in low-carbon governance. Bottom-up initiatives recognise that the housing stock is embedded in particular places. They take advantage of a shared geography to bring together a community of neighbours and are often tied to other
low-carbon initiatives such as local food growing, local currency, transport, energy generation, and so on. Transition Towns are the most prominent example of this approach that links domestic living, consumption practices, and local governance (Smith 2011a, 2011b, Aiken 2012, 2014, Feola & Nunes 2014). These types of retrofit programmes rely on social capital as the currency of retrofit strategy and action. There is an assumption that the shared values amongst a particular population can lead to shared action to upgrade their houses.

An example of grassroots domestic retrofit that is about local identity is the Community Action for Retrofit Delivery (CARD) project, a part of Transition Town Totnes (2016). CARD was launched in 2013 with support from the Energy Saving Trust and includes five organisations in South West Devon that deliver workshops and home energy assessments with the goal of upgrading 250 houses. The project is unique because it uses community organisations to stimulate retrofit in the private housing sector in a particular geography where residents have embraced the Transition Town agenda. Rather than scaling environmental governance to a local organisation, community is engendered through an emphasis on place and identity. By situating retrofit in a particular locale with a robust social fabric, networks of retrofit knowledge can be developed and applied to a familiar housing stock.

Low-carbon culture is achieved by developing a shared local identity and common values about energy consumption. This approach suggests a very different mode of community that is founded on ‘social innovation’ to challenge and disrupt existing institutional frameworks (Aiken 2014). A retrofitted housing stock in Totnes sets it apart from other UK towns while also aligning the performance of the houses with the Transition Town ethos of the residents. These place-based approaches to community tend to be more radical because they challenge and disrupt existing institutional frameworks (Aiken 2014). This emphasises the connection between the housing stock and social networks. They are a contemporary manifestation of 1970s environmental politics of the Back-to-the-Land and Appropriate Technology social movements.

2.3.3 Community as Learning Network

Another interpretation of community focuses on developing a learning network to address the complexities of domestic retrofit. Here, there is a recognition that a significant challenge of housing retrofit is to join up the appropriate actors to create a chain of knowledgeable stakeholders that can execute upgrade activities effectively. Aligning the various financial, modelling, building, and manufacturing actors with homeowners creates a learning network. Here, it is not so much scale or place that is important as effective circuits of knowledge sharing that can facilitate coordination and action.

An example of community as a learning network is Retrofit for the Future, a £17m programme launched in 2009 by the Technology Strategy Board (since renamed Innovate UK). The project lowered the carbon emissions of 86 houses by 50–80% through the purposeful coordination of housing providers, designers, contractors, and researchers. They identified four keys to successful retrofit: project planning; site management; understanding the supply chain; and working closely with residents (Technology Strategy Board 2013: 3). A report on the results of the programme states that: ‘Well-delivered projects have clear lines of responsibility across teams who are committed to the retrofit’s objectives. When all parties understand what is required and
why, it leads to better results’ (Technology Strategy Board 2014: 5). The programme also provided a platform to collect data for comparison across the case studies. There is an emphasis here on learning as the key to realising systemic retrofit (Hertin et al. 2003, Vergragt & Brown 2007, 2012, Evans & Karvonen 2011, Ross 2011, Gupta et al. 2014, Grandclément et al. 2015).

The learning network also emphasised the process of retrofit and the need to harmonise the various actors through intermediation. Intermediaries ‘work in-between, make connections, and enable a relationship between different persons or things’ (Moss et al. 2010: 5). The intermediary could be a government agency (as in this case), a non-profit or community organisation, or even a private company. The overarching aim is to optimise the chain of retrofit stakeholders to realise the greatest carbon savings. Like the place-based approach to community retrofit, it suggests the need for societal learning as key to realising a low-carbon future. However, the learning network approach is not focused on a particular ethos but instead centres on the material process of retrofit as its driving force.

2.3.4 Community as Ethical Commitment

Another distinctive form of community retrofit involves social housing providers who are addressing fuel poverty to promote better health and well-being while saving energy and reducing carbon emissions (Gee & Chiappetta 2013, Swan 2013). Social housing providers own and manage large housing estates and retrofit is one of the services that they provide to their low-income tenants. Retrofit activities here are not simply aimed at energy and financial savings but also embody a moral activity to provide adequate accommodation to populations in need (Gee & Chiappetta 2013).

Salix Homes, a social housing provider in Greater Manchester, provides an example of community as a moral agenda with its refurbishment of the New Barracks Estate in Salford (Arup & Salix Homes 2011, 2012a, 2012b, Arup 2012). The project involved the retrofit of 79 Edwardian terraced houses to simultaneously reduce energy consumption, combat fuel poverty, and improve occupant comfort and health. The retrofit team did not perceive the occupants as receivers of housing upgrades but instead recognised that they needed to be included in the process to reduce conflicts and ensure long-term benefits. This counters the common approach in social housing where ‘the most common logic has been retrofitting as part of social policy “done” to low-income and poor households, who are often seen as compliant and unable to resist’ (May et al. 2013: 11). Community here is used to realise a more inclusive retrofit process by including low-income renters, a group that is often left out of retrofit decisions. In describing the project, a team member (Arup 2012) notes: ‘Rather than focusing solely on physical improvement, Salix has looked at how this will help improve energy consumption and the environmental impact of its properties, as well as the experience of tenants living in its homes.’ Thus, the retrofit process recognises the social as well as the physical aspects of housing.

Community here emerges as a collaborative mode of retrofit that allows social housing providers to develop improved relations with their tenants while creating a shared sense of identity and greater cohesion amongst social housing tenants. The social housing provider serves as an intermediary to facilitate retrofit activities and moreover, to foster longer term carbon savings as the houses are inhabited. Retrofit is understood
not as a one-off event but as a long-term dialogue on how people and energy are connected (Fawcett 2014). This provides an intriguing opportunity for social housing providers to serve as leaders in environmental governance by fostering a low-carbon culture among their tenants.

### 2.4 Community Housing Retrofit and the Civics of Low-carbon Transitions

The emergence of community housing retrofit has important implications on the governing of low-carbon transitions. There is an explicit effort to recognise how social and material factors are intertwined in the housing stock and how these socio-technical systems can be harmonised (Vergragt & Brown 2012). In all cases, there is an emphasis on ensuring that the occupants are part of the retrofit process. Occupants are not simply receivers of housing upgrades but instead, they are understood as being crucial to realising the long-term benefits of retrofit. There is also an emphasis on the chain of actors who produce the retrofitted house. This assembly of stakeholders suggests that low-carbon governance can take multiple forms with different implications. Community has the potential to provide a new mode of low-carbon governance whereby the lived aspects of housing are aligned with the financial and material aspects, shifting the emphasis of retrofit away from technical and economic considerations towards the sociotechnical configurations of occupants and systems of provision (Guy 2006, Rohracher 2008). This suggests a more nuanced and complex approach to carbon mitigation activities, one that recognises the lived experience of housing as equally important to its physical configuration.

Community housing retrofit activities are an intriguing development because they provide promise for alternatives to the business-as-usual approach to upgrading the housing stock, cutting across the individual ownership of houses to identify commonalities and shared interests. In effect, the emphasis on community has the potential to transform occupants from consumers into citizens and from homeowners into neighbours and colleagues. These activities hold promise for engendering a new civics of energy consumption that can address the complexities of high carbon lifestyles through collective action. Community can bridge the gulf between the state and the individual, between the global need to reduce carbon emissions and the daily activities of individuals. As Peters and colleagues (2010: 7596) argue: ‘Community level initiatives hold the potential to ground climate change policy in a much more visible way to the everyday practicalities of energy use than more ‘top-down’ measures have been able to achieve.’

At their best, these projects and programmes represent a new form of civic politics and new modes of ecological citizenship (Karvonen 2010, 2011, 2015). They comprise coalitions of progressive actors that can realise opportunities, make connections, and instigate actions. Walker (2011: 779) argues that ‘community is seen as an integral part of wider innovation, learning, education, and diffusion processes, acting as a conduit, a lubricant and an exemplar for change.’ In this way, they provide intriguing connections between innovation and community action (Seyfang et al. 2010). Moreover, they hold promise for recasting the citizen relationship with political institutions by re-energizing civic culture (Hoffman & High-Pippert 2005).
From a pessimistic perspective, the rise of community organisations can be seen as filling the gap left by the rollback of the state as the principal arbiter of environmental governance (Karvonen 2010). Governance through community can result in unrealistic expectations for civil society groups to drive low-carbon transitions (Amin 2005) and could potentially push ‘agency and responsibility on individuals at a local level, in everyday lives, taking a specific governmentalised tone’ (Aiken 2014: 765). From this point of view, the rise of community is symptomatic of the post-political condition (Swyngedouw 2009) where carbon mitigation activities are simply left to civil society rather than being the remit of elected bodies. This raises important questions about how systemic change can be realised without any real power to act (DeFillipis et al. 2006).

It remains to be seen if community approaches to domestic retrofit and related activities can produce a new form of civic politics. The various community retrofit programmes that have emerged in the UK are relatively new and while they have reported early successes, it is unclear if they will have a sustained influence on carbon emissions. They may represent a new form of low-carbon politics that is situated and empowers the connections between people and the built environment. Alternatively, they may represent the only alternative as governments increasingly retreat from any substantive role in reducing carbon emissions.

2.5 Conclusions

This chapter has provided insights on the emergence of community and its potential to contribute to the systemic retrofit of the existing housing stock in the UK. As Eames and colleagues (2013: 506) note: ‘Large-scale urban retrofitting requires systemic change in the organisation of built environment and infrastructure, and the integration of socio-technical knowledge, capacity and responses.’ The community retrofit programmes summarised above provide alternatives to the conventional approach of targeting the individual consumer through a ‘rational choice’ mode of change. Instead, they aim to enhance the various relationships among retrofit actors as well as their specific contexts in new and generative ways. The Carbon Coop brings distant carbon targets of the UK Government to a local level while the CARD programme in South Devon focuses on a familiar geographic context to foster a new form of place-based progressive politics. Meanwhile, Retrofit for the Future sees community as a way to bring together the network of stakeholders that can more easily facilitate the process of domestic retrofit while the New Barracks Estate demonstrates a strong moral commitment to reducing carbon footprints while also providing affordable and liveable housing to low-income residents. These approaches are not mutually exclusive and there are multiple overlaps including intermediation, recursive learning, and the complex interactions between people and the built environment. As Berry and colleagues (2014: 2) note: ‘Community-led approaches have the potential to stimulate and enable local action on energy through giving meaning to information and experience.’

At their best, community retrofit programmes provide hope for an improved, low-carbon future by introducing civil society to the process of retrofit. It recognises the governance of carbon and the improvement of the built environment requires greater involvement by civil society (Seyfang & Smith 2007, Peters et al. 2010). Like other forms of community energy, ‘individuals take the role of citizens rather than consumers, and
gain the capacity to work together to transform their energy infrastructure on the local level’ (Heiskanen et al. 2010: 7586). At the same time, these initiatives can be used to develop stronger local identity and civic pride while feeding into related initiatives that can foster community cohesion. As Seyfang and colleagues (2013: 979) write: ‘By bringing together groups of people with common purpose, they overcome the structural limitations of individualistic measures, by empowering and enabling communities to collectively change their social, economic and technical contexts to encourage more sustainable lives and practice their ideological commitment to sustainability.’ If nothing else, these community retrofit programmes bring visibility to changes in the built environment, translate distant carbon targets into tangible actions and outputs on the ground, and raise the potential for low-carbon cultures to take root.

References


Overview

Commercial property produces about 10% of the UK’s greenhouse gas emissions and consumes 7% of UK energy. It is estimated that UK business is overlooking a potential cost-saving of £1.6b through under-investment in energy efficiency, with the UK’s commercial retrofit market potential estimated at £9.7b (or US$16b). Using the multi-level perspective (MLP) as a conceptual lens this chapter examines the nature and characteristics of the commercial property retrofit regime in the UK. Based on 37 face-to-face interviews conducted during 2012–2013 (as part of the EPSRC Retrofit 2050 programme) the chapter examines the trends in commercial property retrofitting at a ‘regime’ level to address the following key questions: (i) ‘Who’? by identifying the main stakeholders in the commercial property retrofit regime and its key features; (ii) ‘What’? by defining what is meant by ‘retrofit’ in the regime and examining the key retrofit technologies being used; (iii) ‘Why’? by examining the key drivers and barriers for commercial property retrofit; and (iv) ‘How’? by examining the institutional frameworks, legislation and monitoring/standards behind commercial property retrofit (including financing, assessment methods, and monitoring and verification systems).

The chapter suggests that although there is evidence of niche experiments, the regime is hampered by complexity, fragmentation and conservatism. This is not helped by a lack of consensus over the meaning of the term ‘retrofit’. Moreover, the commercial property sector does not necessarily take a ‘city-wide’ view of retrofit projects: in this sense it is ‘city-blind’ with the focus more likely to be on individual building or property portfolio level. The summary report examines issues of scale, particularly at city level (and also summarises the key challenges to retrofitting at city scale in the regime), and finally sets out insights for the future, including policy and practice implications.
3.1 Introduction

In comparison with the domestic property sector the commercial property sector is perhaps relatively under-researched when it comes to examining energy efficiency and other wider ‘retrofit’ measures such as water and waste. Yet commercial property produces about 10% of the UK’s greenhouse gas emissions and consumes about 7% of UK energy (Committee on Climate Change, 2013), and it is estimated that UK business is overlooking a potential cost-saving of £1.6b through under-investment in energy efficiency (Westminster Sustainable Business Forum/Carbon Connect, 2013). The UK’s commercial retrofit market potential is estimated at £9.7b (or US$16b) (World Economic Forum, 2011).

Often the research focus in commercial property (which includes retail, offices and industrial space) has been on ‘new build’ as the growth in ‘green’ and ‘sustainable’ buildings has taken root (Dixon et al., 2009; Della Croce et al., 2011; Leishman et al., 2012). However, there is an increasing concern that the rate of progress in tackling energy inefficiency in existing commercial stock is too slow. This is challenging because it is estimated that by 2050 some 70% of today’s buildings will still be standing, with 40% built prior to 1985 (when Part L of the Building Regulations was first introduced; Better Buildings Partnership, 2010), and 60% built prior to 2010 (Mackenzie et al., 2010).

The importance of existing stock is also brought home when it is appreciated that the rate of turnover of the building stock in the UK is very slow: less than 1–2% of total building stock each year is new build (Dixon, 2009; Stafford et al., 2011). Current renovation and refurbishment rates are somewhat higher, with between 2.9% and 5% of existing stock for domestic buildings and 2–8% for commercial stock, depending on the sector (Stafford et al., 2011), but still present a very significant challenge in meeting the UK’s carbon reduction targets.

Retrofitting therefore takes on an important significance in the context of commercial property. Previous work has discussed the definition of retrofit (Dixon and Eames, 2013). Essentially the term originated in the USA in the late 1940s and early 1950s and is essentially a blend of the words ‘retroactive’ (applying or referring to the past) and ‘fit’ (to equip). The term ‘retrofit’ has subsequently been used to imply substantive physical changes to a building or buildings (e.g. mitigation activities to improve energy efficiency). It has also often been linked to the concept of ‘adaptation’ (i.e. intervention to adjust, reuse, or upgrade a building to suit new conditions or requirements) (Douglas, 2006; Wilkinson, 2012) and often used interchangeably with other terms such as ‘refurbishment’, ‘conversion’, ‘renovation’ and ‘refit’.

However, at a city level it can be argued that the term retrofit is distinguishable from these terms, because the defining characteristics of urban retrofitting are: (i) its comprehensive nature and large scale; (ii) its integrated nature, requiring a high degree of private–public partnership arrangements; (iii) the sustainable nature of its funding; and (iv) a clearly defined set of goals and metrics for monitoring (Living Cities, 2010). In the EPSRC Retrofit 2050 project we define urban retrofit as the:

Directed alteration of the fabric, form or systems which comprise the built environment in order to improve energy, water and waste efficiencies (Eames, 2011: 2).

Moreover, understanding processes of sustainable urban retrofit at a city scale, and within the context of city visions, also requires the development of an integrated
perspective on long-term socio-technological systems innovation, commonly referred to within the literature as ‘transitions’ (Geels et al., 2004). This is because the defining characteristics of urban retrofitting are seen as being its comprehensive nature and large scale, and its integrated nature, both of which require a high degree of private–public partnership arrangements and strong governance frameworks (Living Cities, 2010).

Responding to these ‘scale’ challenges in a purposive and managed way also requires us to bring together four important questions which have often been treated in a ‘disconnected way’ (Dixon and Eames, 2013; Dixon et al., 2014b):

- ‘Who’ is involved in this process? (i.e. key actors and networks).
- ‘What’ is to be done? (i.e. technical knowledge, targets, technological options, costs).
- ‘Why’ is it important? (i.e. individual, organisational and cultural drivers and expectations).
- ‘How’ will it be implemented? (i.e. institutions, capacity, publics, governance).

Currently, in policy and disciplinary terms, there is still too large a separation between these important questions, characterised by disciplinary fragmentation; an absence of appropriate governance frameworks; and a failure to learn from projects and experiments and incorporate these into systemic transitions (Bai et al., 2010; May et al., 2010). This is true not only at the scale of the city but also within the commercial property retrofit regime itself.

In this research therefore we seek to address these questions using a Multi-Level Perspective (MLP), which draws on the work of Rip and Kemp (1998), Geels (2010) and Eames et al. (2013).

The overall aim of the research which is examined in this chapter is to examine the trends in commercial property retrofitting at a ‘regime’ level and to examine the following key questions:

- **Who?** – identifying the main stakeholders in the commercial property retrofit regime and the main characteristics of the regime.
- **What?** – defining what is meant by ‘retrofit’ in the regime and examining the key retrofit technologies being used.
- **Why?** – examining the key drivers and barriers for commercial property retrofit.
- **How?** – examining the institutional frameworks, legislation and monitoring/standards behind commercial property retrofit (including financing, assessment methods and monitoring and verification systems).

The chapter also examines issues of scale, particularly at city level (and summarises the key challenges to retrofitting at city scale in the regime), before setting the research findings in the context of applied policy and practice.

In doing so the research employs the following definitions:

- **Commercial property**: comprises retail, offices and industrial space (excluding public buildings and other ‘non‐domestic’ property).
- **Regime**: the socio-technical regime, as defined by Geels (2002) includes a web of inter-linking actor networks across different social groups and communities following a set of rules. These rules comprise the established practices of a system and relate to: technology; user practices and application; the symbolic meaning of technology; infrastructure; policy; and techno-scientific knowledge. Change can, and does, occur at the regime level but it is normally slow and incremental in contrast to the radical
changes at the niche level. The actors who constitute the existing regime are set to gain from perpetuating the incumbent technology at the expense of the new. This is known as ‘lock-in’.

3.2 UK Commercial Property: Nature and Characteristics of Commercial Property

Understanding how the commercial property sector approaches retrofit activity also requires an understanding of the characteristics of the sector.

First, there is a higher level of tenanted property in the commercial property sector than in the domestic sector. Over half of commercial property is rented (51%), compared with only a third of housing (Property Industry Alliance, 2013). This is because many businesses have become increasingly reluctant to commit the capital and management time required in owner occupation, and owner occupiers took advantage of high prices in the mid-2000s to participate in ‘sale and leaseback’ deals.

Secondly, the sector is an important part of the UK economy. In value terms the sector is worth about £717b, with retail, at £227b, the largest commercial property sector. Offices are, however, catching up with retail, with greater capital value growth seen in 2011 (Property Industry Alliance, 2013).

Thirdly, we also know that average lease lengths in the sector are falling. The average length of a new lease in 2011 fell to below 5 years, compared with 8.7 years in 1999. Over 75% of new leases now have durations of 5 years or less. Larger tenants, occupying bigger units, tend to have relatively long leases. Many tenants benefit from rent free periods at the beginning of a lease. Retail warehouses, where demand from tenants is relatively strong, have the longest leases and industrials, the shortest (Property Industry Alliance, 2013).

Fourthly, we know that the sector is complex. The Carbon Trust report, Building the Future (Carbon Trust, 2010), highlighted the complexity of the sector in terms of its diversity, building types, and its range of stakeholders. But the report also spoke about the conservatism of the sector and its risk-averse nature.

There have been a number of previous research reports which have focused on energy use and energy efficiency projects in the commercial property sector. These reports have tended to focus on the following main areas.

- **Energy use**: energy is used in different ways across the sector but generally space heating makes up the largest proportion of service sector energy use, except in retail and communications/transport, where lighting is the most important (e.g. retail uses about 35% of all lighting in the services sector) (DECC, 2013).

- **Levels and type of retrofit activity**: previous research has pointed out that company size is an important factor in the decision to invest in energy efficiency projects. Often large companies lead the way, and offices tend to be the primary focus for retrofit activity (EEVS/Bloomberg, 2013; Westminster Sustainable Business Forum/Carbon Connect, 2013). Retrofit projects tend to be predominantly focused on lighting, with much less emphasis on renewables.

- **‘Barriers’**: previous research has highlighted key barriers in energy efficiency investment (see e.g. Better Buildings Partnership, 2010; World Economic Forum, 2011; Buildings Performance Institute Europe, 2012; CBI, 2013; Westminster Sustainable
3.3 What Conceptual Frameworks Can We Use to Understand Commercial Property Retrofitting?

There have been a number of conceptual frameworks which have attempted to provide insights into how we should analyse decision-making contexts at an individual firm level or a wider, sector level (Dixon, 2014a). Table 3.1 provides examples of these from the non-domestic and domestic sectors. Indeed, the ‘Communities of Practice’ framework enables us to look across the scales of building, company and beyond, and is perhaps inspired by other kinds of multi-level research including transition theory (Janda, 2014).

1 Although data are patchy it is estimated that in a typical city commercial offices can use 10% of a city’s water supply (European Commission, 2009).
However, if we are to understand sector change we also need to understand temporal change and how the landscape of policy and regulations may or may not influence change in the sector. In this research therefore whilst we test out sector models we utilise the MLP because it offers the opportunity to assess changes over time and across scales.

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Table 3.1 Examples of conceptual frameworks used in energy efficiency research.

<table>
<thead>
<tr>
<th>Level</th>
<th>Conceptual framework</th>
<th>Authors</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Organisation’</td>
<td>Pro-environmental Policy Adoption</td>
<td>Pellegrini-Masini <em>et al.</em> (2011)</td>
<td>An office based study which uses investment decision-making based on cost–benefit analysis to understand occupier decision-making</td>
</tr>
<tr>
<td></td>
<td>PTEM-based</td>
<td>DECC (2012)</td>
<td>A modified framework which recognises the critique of PTEM and places organisational behaviour in a context that recognises: social cultural domain; regulation and policy domain; material domain and market domain</td>
</tr>
<tr>
<td>Investment Decision</td>
<td></td>
<td>Cooremans (2012)</td>
<td>Recognises decision-making as a process within the organisation based on systemic steps from idea through to solutions, evaluation and choice and implementation</td>
</tr>
<tr>
<td>Communities of Practice</td>
<td></td>
<td>Axon <em>et al.</em> (2012)</td>
<td>Communities can act across scales and synthesise legal/property; policy context; and technology adoption/environmental performance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Janda (2014)</td>
<td></td>
</tr>
<tr>
<td>‘Sector’</td>
<td>Technology Diffusion</td>
<td>Rogers (2000)</td>
<td>Based on the concept of S-shaped diffusion curve with early adopters driving change</td>
</tr>
<tr>
<td></td>
<td>Technology Pull-Push</td>
<td>Gallagher <em>et al.</em> (2012)</td>
<td>Based on (i) push which implies that technology is pushed through R&amp;D, production and sales functions onto the market without proper consideration of whether or not it satisfies a user need; or (ii) market pull in which technology is developed by the R&amp;D in response to an identified market need</td>
</tr>
<tr>
<td></td>
<td>Market Transformation</td>
<td>Killip* (2013)</td>
<td>A strategic process of market intervention which aims to alter market behaviour by removing identified barriers and creating opportunities to extend cost-effective energy efficiency as a matter of ‘standard practice’*</td>
</tr>
<tr>
<td></td>
<td>Multi-Level Perspective (MLP)</td>
<td>Thakore <em>et al.</em> (2013)</td>
<td>Uses a perspective which is based on a socio-technical framework which links landscape, regime and niche and is connected to transition theory and focuses on the UK Green Deal</td>
</tr>
</tbody>
</table>

* Killip's work also drew parallels between market transformation and transition management.
Essentially the last decade has seen the emergence of the new interdisciplinary field of sustainability transitions research. Indeed, transitions theory, and the MLP in particular, has played a substantial role in helping understand the complex and multi-dimensional shifts needed to move societies to more sustainable modes of production and consumption in areas such as transport, energy, housing, agriculture and food (Coenen et al., 2011). Informed by insights from evolutionary economics, innovation studies, ecology, systems thinking and complexity theory, transitions theory assumes that large scale societal changes occur in a quasi-evolutionary fashion, and that patterns in the dynamics of ‘systems innovations’, or ‘transitions’, occur as a result of processes of variation and selection driving the co-evolution of social and technological change. Transitions are understood as complex processes resulting from mutually reinforcing changes involving multiple societal actors, operating across multiple domains (science, technology, economy, ecology, institutions, culture, user-behaviours and expectations). Moreover, from historical studies we know that transitions are long-term processes, with system-wide change typically taking decades (20–50 years) to occur (Dixon et al., 2014b).

Transitions theory postulates that successful systems (or ‘socio-technical regimes’) comprising networks of artefacts, actors and institutions, become stabilised over time through the accumulation of processes promoting ‘lock in’ and path dependency (e.g. sunk investments in skills, capital equipment and infrastructures, vested interests, organisational capital, shared belief systems, legal frameworks that create uneven playing fields, consumer norms and lifestyles). In this MLP (Figure 3.1), ‘lock-in’ to existing systems is overcome and transitions occur as a result of experimentation and the emergence of new socio-technical configurations (innovations) within protected niches. These factors, combined with landscape pressures, destabilise and transform or replace the existing ‘regime’ (Rip and Kemp, 1998; Geels et al., 2004; Kemp and Loorbach, 2006).

Given their inherent complexity and uncertainty, it is argued that, socio-technical transitions cannot be ‘planned’ or ‘managed’ in the traditional sense. Instead, proponents of transition theory suggest that new reflexive, networked governance practices

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**Figure 3.1** Multi-level perspectives on transitions. *Source: Geels et al., 2004. Reproduced with permission of Elsevier.*
are required to align both the speed and direction of system change towards the goals of sustainable development (Geels et al., 2004; Rotmans, 2006).

MLP also connects with the concept of emergence, which is defined as the arising of novel and coherent structures, patterns, and properties during the process of self-organisation in complex systems (Goldstein, 1999). The common characteristics of emergence include radical novelty, integrated wholeness, dynamic evolvement and ostensibility (i.e. it can be perceived). In this chapter the concept of niche experiments practices is therefore a recurring theme.

Finally, we also need to understand that if niches are to become mainstreamed in regime terms that transition management is needed to influence the existing structure in a more sustainable direction; in this sense a ‘transition’ is understood as a fundamental change in structure, culture and practices (Kemp and Loorbach, 2006).

### 3.4 Research Findings

In our research, *commercial property* comprises retail, offices and industrial space (excluding public buildings and other ‘non-domestic’ property).

As well as using the lens of MLP to analyse the regime, we also examined the extent to which other conceptualisations of organisation-level technology deployment can offer a coherent view of the commercial property sector. These include technology diffusion models and technology push-pull models.

The research is based on 37 semi-structured interviews with key actors in the commercial property retrofit regime which were carried out between November 2012 and May 2013. All interviewees were senior decision-makers in their organisations. All interviews were transcribed and coded. Table 3.2 summarises the groups.

#### 3.4.1 ‘Who’? – The Main Stakeholders in the Commercial Property Retrofit Regime and the Nature of the Regime

The commercial property retrofit ‘regime’ is made up of a complex array of stakeholders who interact in a variety of ways when a retrofit project is undertaken. In the

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultant (includes 3 architects and engineers)</td>
<td>10</td>
</tr>
<tr>
<td>Influencer</td>
<td>8</td>
</tr>
<tr>
<td>Investor/developer</td>
<td>5</td>
</tr>
<tr>
<td>Financier</td>
<td>4</td>
</tr>
<tr>
<td>Occupier (including retail)</td>
<td>3</td>
</tr>
<tr>
<td>Technology company</td>
<td>3</td>
</tr>
<tr>
<td>Corporate owner</td>
<td>2</td>
</tr>
<tr>
<td>Government</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
</tr>
</tbody>
</table>
3.4 Research Findings

interviews that we conducted the commercial retrofit projects were generally carried out at building level, and organised from within the company undertaking the project, although this can also occur at a wider, portfolio level if the organisation holds a number of property assets. These projects therefore were primarily 'driven' and 'led' by owner occupiers, or in the case of tenanted property, by landlord investors or tenants (Figure 3.2).

The commercial property retrofit regime is characterised by complexity, fragmentation and conservatism despite niche experiments.

3.4.2 ‘What’? – Retrofit Defined and the Key Technologies Being Used

Based on the interviews with key players, the research found that in many instances a distinction was indeed made between retrofit, where a building(s) could be refitted with relatively 'light touch' energy efficiency measures, for example, whilst a tenant was still in occupation, as opposed to the case of 'refurbishment' which entails a much 'deeper' level of refit with changes to the internal and external fabric of the building, with the latter frequently occurring at lease renewal. However, in other cases refurbishment was used rather than retrofit.

There needs to be a much clearer consensus over what the term retrofit means therefore (Table 3.3) as this is hampering progress because of a lack of common language and understanding. For example, although the RICS provides guidance on sustainability and valuation the current edition of the guide does not define ‘retrofit’ and ‘refurbishment’ explicitly.
Key retrofit technologies include energy efficient lighting and controls, building services, and management systems and controls (Figure 3.3). These types of measure are frequently referred to as the ‘easy wins’ or ‘low hanging fruit’, and include ‘commercially proven’ technology measures that are lower risk, create less disruption, and have a shorter payback time (usually 2–3 years or less). The ‘other’ category included measures such as interior fabric, water efficiency and behavioural change measures. Typically, these measures can achieve energy savings of 20–40% per annum. Where retrofit projects were carried out, the primary focus was on energy, with a relatively lower degree of emphasis on water and waste, and with the latter tackled mainly through recycling measures.

There are examples of niche experiments in commercial property retrofit at company and pan–industry influencer level (e.g. through Better Buildings Partnership, UK Green Building Council). These relate to company practices, property portfolio approaches, and policy and practice guidance, as well as the use of ‘test bed’ technologies.

3.4.3 ‘Why’? – The Key Drivers and Barriers

Interviewees were asked to identify the key drivers which influenced the decision to undertake commercial property retrofit projects. Figure 3.4 shows that policy-related
drivers were seen as being the most important for all stakeholders. This included the Carbon Reduction Commitment (CRC) Energy Efficiency Scheme, which is a mandatory carbon emissions reporting and pricing scheme to cover all organisations in the UK (excluding state funded schools in England from April 2013), using more than 6000 MWh per year of electricity. Other important legislation mentioned, included the Energy Act 2011, which from April 2018 will, under current proposals, make it unlawful to let residential or commercial properties with an Energy Performance Certificate (EPC) Rating of F or G; Building Regulations under Part L; and renewable grants, including the Renewable Heat Incentive (RHI). Intriguingly, some interviewees felt that making Display Energy Certificates (DECs) mandatory in the sector would help drive further changes, as they provided a measure of actual energy performance rather than theoretical energy performance (in contrast to an EPC). The most important drivers in commercial property retrofit therefore relate to policy, economic factors (e.g. rising energy costs) and marketing/reputation (Figure 3.4).

The most important barriers relate to economic factors (overall cost and value impact), organisational issues and lease structures (Figure 3.4). The significance of organisational barriers should not be underestimated. For some commentators the term ‘barriers’ carries the sense that in some way if these were removed then energy efficiency would automatically act as a precursor to ‘rational’ behaviour in the marketplace, but this ignores the organisational context for decisions, and also ignores the interrelationship between the barriers themselves, and the fact that they should best be seen in the context of the socio-technical landscape and regime.

2 The ‘Other’ category includes contractual drivers and technology drivers.
3 Other relevant emerging policies include the Energy Savings Opportunity Scheme (ESOS), which under Article 8 of the EU Energy Efficiency Directive states that non-SMEs are subject to an energy audit.
4 The Energy Act also introduced the legislation underpinning the Green Deal.
Figure 3.4 Drivers and barriers for commercial property retrofit.
3.4.4 ‘How’? – Institutional Frameworks, Legislation and Monitoring/Standards

Despite the inherent conservatism in the incumbent regime, there is clear evidence of emerging niches in what might be termed ‘deep retrofit’, in contrast to the ‘light retrofit’ of the regime. The adjectives are chosen for two reasons: first, this conveys the idea that actors in the niche are more deeply embedded in a ‘sustainable’ or ‘green’ retrofit agenda; and secondly, that the types of projects they undertake involve more complexity and strategic planning around retrofit than the incumbent regime. It is clear that the regime focuses predominantly on low risk, low cost retrofit projects with a relatively short payback period, whereas niches are emerging where risks are higher, costs may be higher and payback longer. In the regime, the tendency is for technologies (such as LED and Building Management systems) to be used, whilst in the niche there is evidence of emerging experiments around innovative and higher risk technologies (e.g. phase change materials).

The regime also tends to be characterised by passive and conservative end users (owners and occupiers), in contrast to highly active end users, and this is underpinned by an idealistic culture and a unique understanding of how to drive retrofit programmes at company and portfolio level.

The key challenges for emerging niches in commercial property retrofit were related to the types of technology being used, and revolved around collaboration; alignment of the technology and development lifecycle; improving the evidence base; and issues around technology innovation.

There is a range of financing models used in commercial property retrofit. The majority of projects are self-financed or paid through a service charge. There are a number of niche financing models in the sector, including Energy Performance Contracting, alongside the emergence of specialist investment funds.

These include:5

- Service charge: where a landlord can claim the costs of retrofit back through the ‘hard services’ part of the service charge payable by a tenant.
- Energy Performance Contracting: where retrofitting is financed through projected future energy savings. Typically, an Energy Supply Company (ESCO) provides customised engineering, installation and maintenance with the guarantee of reduced energy consumption as a result of their work.
- Managed Energy Service Agreements: where the contractor takes over responsibility for the energy bill and manages the relationship with the utility provider(s) (ESCO). The building owner then pays the contractor the historical energy bills corrected for weather and other factors (or what they would have paid) (e.g. SciEnergy).
- Investment Funds: where specialist funders provide capital for retrofit. An example here is the Green Investment Bank’s underwriting of the partnership between Sustainable Development Capital and BRE.

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5 Other models have also emerged such as City Deals, Green or Climate Bonds and Tax Increment Financing, some of which attempt to engage with commercial property players. The UK’s Green Deal, which came into operation in October 2012 and was enshrined in the Energy Act 2011, but was ultimately scrapped, proved unsuccessful for a variety of reasons (e.g. relatively high costs of loans, and complexity of the scheme; see Chapter 15). A recent report (Westminster Sustainable Business Forum/Carbon Connect, 2013) also highlights the importance of Enhanced Capital Allowances and the Carbon Trust/Siemens Energy Efficiency Schemes as further examples of finance to tackle the upfront capital costs of energy efficiency retrofits.
- UK Green Investment Bank (UKGIB): UKGIB became operational in October 2012, with £3 billion in UK taxpayer capital dedicated to its mission of ‘accelerating the UK’s transition to a more green economy, and creating an enduring institution, operating independently of government’ (UKGIB, 2016). The bank has so far backed 21 green projects and committed over £700m, mobilising a further £2b in private finance. However, on 3 March 2016 the UK Government launched the process to move the Green Investment Bank into the private sector and details were set out in statements from the UK Government and the Green Investment Bank (see Chapter 15).

The diversity and heterogeneity of commercial property presents challenges in large-scale retrofit. Investors and landlords did not necessarily take a city scale view of the world. As one investor/developer suggested (Dixon et al., 2014a: 8):

We are kind of city blind. We do look at our portfolio, from a retrofit point of view we’ll look at our portfolio and say, OK, where can we get best bang for buck, if you like? We’re trying to reduce our carbon emissions; there’s no point in us concentrating on the lowest carbon emitting building in our portfolio. We’ll go and concentrate on the biggest one, and ... can we actually do to it? The only time that cities come into it is through either the legal requirements of that particular city, if we’re doing developments in that city or something like that.

As a result, the commercial property sector does not necessarily take a city scale view of retrofit projects. The focus is more likely to be on individual building or property portfolio level. ‘Sticky’ infrastructure projects such as district heating schemes could, if accompanied by mandatory measures and incentives, provide opportunities for the sector to take a different view.

We can therefore see niche experiments operating at a range of scales but with the greatest levels of activity in the regime occurring at building scale and portfolio scale. Further research (e.g. Dixon et al., 2014b) suggests that city level experiments have, in some instances, started to engage more directly with the commercial property sector and vice versa, but these niche experiments remain patchy at best.

### 3.5 Conclusions and Discussion

The MLP offers a helpful perspective through which to view emerging practices in the commercial property retrofit regime. It is clear that a number of niche experiments have been emerging at company level (e.g. through the producer network and the user network) and these relate to company-level practices through, for example, the development of sustainable development briefs; company-wide sustainability plans; and asset management strategies (Figure 3.5).

We are also seeing further development of emerging practices at pan-industry influencer level with best practice guides, toolkits and other guidance (e.g ‘low carbon retrofit,’ ‘green leases’ and ‘green building management groups’). Finally, a further set of niche experiments relate to the development of specialist funds and financing models for commercial property retrofit.
We need to understand these experiments within the context of a complex set of relationships between key actors/stakeholders in the regime, founded on cultural values, market and user practices and regulations and policies.

Despite the emergence of these experiments and the importance of UK policy as a key driver (e.g. the Climate Change Act, Energy Act and the Energy Efficiency Carbon Reduction Commitment), the sector remains one which is conservative and risk-averse in nature. This is hampering whole-scale transformation of the sector and the roll-out of retrofit in the sector at city level. Stronger legislation is needed to drive change and better integration of the public and private sectors around the retrofit agenda at city scale.

Achieving a consensus on what we mean by retrofit is essential, but for large scale commercial property retrofit to succeed at all scales there also needs to be urgent action in both policy and practice. This is founded on four key principles (Dixon, 2014b):

- **Financing is crucial to success.** There should be further financial strengthening of the UK Green Investment Bank, which could then offer financial support at city level to retrofit projects and also to SMEs.
- **Actual energy performance should be transparent.** Display Energy Certificates (DECs) should be mandatory in the sector, perhaps incentivised through business rates and stamp duty reductions for more energy efficient properties. Other suggestions include increasing financial penalties for those failing to fulfil both EPC and DEC requirements.
- **Better integrated leadership at city level is needed.** Local authorities have a role to play in helping drive the retrofit agenda, but they face funding constraints. Local Economic Partnerships and the wider business community also both have a key role to play through partnerships and innovative financing models. ‘Sticky’ infrastructure projects, such as district heating schemes supported by improved incentives, could also provide further opportunities for city-wide retrofit to attract commercial property stakeholders.

**Figure 3.5** Emerging niches in the commercial property retrofit regime: a multi-level perspective.
• **Consistency in standards is needed at a number of levels.** There needs to be a clearer consistency in commercial retrofit assessment standards around BREEAM, Ska Rating and other related standards. An approved products and suppliers list is also needed for commercial property retrofit, with more transparent performance in use data, and better support for emerging technologies, so that companies have more certainty over technology choice. There should also be better consistency in monitoring and verification standards, perhaps based around the International Performance Measurement and Verification Protocol (IPMVP®). This could also be underpinned by a comprehensive database of UK commercial buildings which could create a performance benchmark and help foster competition.

As one interviewee in the EPSRC research put it:

> I don't think that we need to wait and hang around for the next big thing. I think it’s there... it’s about people collaborating together, whether that’s developer, tenants or whether that’s whole neighbourhoods or ... retailers joining hands. We need to get together to put some scale into it but I don't think we can do that without some mandatory action, primarily by the government.

### Acknowledgements

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### References


Overview

Deep energy efficient retrofit of hard to treat (HTT) properties is emerging as a major concern in the UK. A number of studies have highlighted the difficulties of effective delivery of this type of retrofit, citing issues of lower than expected performance, known as the ‘performance gap.’ The aim of this chapter is to investigate the different factors that drive this performance gap when conducting deep retrofit in the UK’s ageing housing stock. Here, a series of semi-structured interviews was undertaken with recognised retrofit experts in the UK, including architects, energy consultants, contractors and sub-contractors who were actively involved in energy-efficient retrofitting of HTT properties, to identify key performance gap factors. The study reveals that the major issues in such projects associated with the performance gap predominantly present themselves in the design and construction interface. The respondents identified a number of issues including: understanding and skills, working practices, and the physical uncertainty around HTT properties. These issues raise questions as to the position of deep retrofit as a solution to HTT retrofit, as not only a technical problem, but one of construction management, communication and, ultimately, industry culture.

4.1 Introduction

Retrofit has been identified as a major approach for the delivery of the UK government’s climate and energy objectives. HTT make up a significant number of the UK’s housing stock; the UK has some of the oldest housing stock in the European Union. Due to low replacement rates of the domestic stock, this existing housing must be addressed to deliver the UK’s carbon dioxide emissions reduction targets (Kelly 2009), with a projected 75% - 87% of current stock in use in 2050 (Boardman 2007, Power 2008, Ravetz 2008, Kelly 2009). Power (2008) identifies the residential sector as an area that is cost effective to address in terms of carbon abatement. The potential role of an energy efficient domestic building stock to address the three energy challenges – fuel poverty,
energy security and climate change mitigation – is well established. However, the implementation of a UK retrofit strategy remains a challenge (Dowson et al. 2012).

The UK housing sector accounts for approximately 29% of total UK energy demand (Palmer and Cooper 2011). Carbon emissions from the existing housing stock totalled 77 Mt in 2012 (DECC 2015a), nearly double the consumption of the non-domestic stock (Palmer and Cooper 2011). According to the Building Research Establishment (BRE 2008), 9.2 million properties in England are recognised as HTT, being built prior to the introduction of any formal energy standards or regulation.

HTT properties are defined as houses built with one or more of the following characteristics: solid walls, single glazing, no loft space or being off the gas grid (CLG 2006). These are generally considered to be pre-1919 properties, which emit more than double the CO₂ of post-1990 properties (CLG 2012). HTT properties make up 43% of the total housing stock in England, and suffer from significant heat loss when compared with other housing types (DEFRA 2006), with heating making up some 55–66% of total domestic energy consumption (Palmer and Cooper 2011). As such, these properties are generally the worst performing properties in terms of energy efficiency (Killip 2008). The EU and the UK Government have introduced a number of policies and related initiatives to address the problem of domestic energy consumption, such as the Energy Performance of Buildings Directive, the EU Renewable Energy Strategy, the Climate Change Act 2008, and the UK Low Carbon Transition Plan (DECC 2009a, 2009b). UK energy policies have also attempted to support the practice of retrofitting to facilitate higher energy performance in the ageing stock, through the Green Deal, the Energy Act 2011 and supplier obligations such as the Carbon Emissions Reduction Target, the Community Energy Savings Programme and, their replacement, the Energy Company Obligation, in order to achieve the Government’s target to reduce carbon emissions by 80% by 2050 (BRE 2008). However, the lack of success of some of these policies, particularly the Green Deal which was suspended in 2015, has led to a major policy review, the Bonfield Review or Each Home Counts. The terms of reference for this review clearly identify technical failure, standards compliance and consumer protection as key issues (DECC 2015b).

All of this points to addressing the existing stock through retrofit. ‘Retrofit’ includes upgrades to the fabric or systems of a property that may reduce energy use or generate renewable energy (Roberts 2008). Sustainable or energy efficient retrofit can be defined as the physical changes to the fabric, systems or controls of property (Swan et al. 2013), and is used interchangeably with refurbishment, renovation and modernisation (Bell and Lowe 2000, (Hong et al. 2006, Kelly 2009, Reeves et al. 2009, Jenkins 2010). However, TSB (2014) stress that the terminology of retrofit in particular is not to be confused with refurbishment or renovation, which includes repairs, maintenance and improvement, which makes good or aesthetically enhances a building, as opposed to reducing its energy use. Here we will use the term ‘energy-efficient retrofit’. It should also be considered, particularly when addressing deep retrofit, that retrofit is generally positioned as a systemic concept, where a whole house rather than individual measures are considered (Lowe 2007, Baker et al. 2013, TSB 2014). The focus on the retrofit delivery process, rather than solely considering the technical changes to the property, shares some characteristics with work done by Janda and Parag (2013), who investigated the process of construction of retrofit, however the focus here is around the implications for the performance gap, rather than the process itself.
Energy-efficient retrofit in the context of this study refers to building projects in which the targets for reduction in energy consumption are 60–80%, sometimes known as ‘deep’ retrofit (Jones et al. 2013). Boardman (2007), Power (2008) and Ravetz (2008) all identify that deep energy-efficient retrofitting of HTT properties could lead to major carbon reductions.

However, there is emerging evidence that energy-efficient retrofitting frequently fails to perform as intended as highlighted by Gupta and Gregg (2015). While Gupta and Gregg highlighted wider issues of deep retrofit in use, here we focus on ‘performance gap’ issues that present themselves at the design and construction stages, preventing the delivery of the predicted energy savings in such projects (EcoTech 2012).

4.2 Defining the Performance Gap

The term ‘performance gap’ is the gap between as designed, the performance intended in design, and as-built or in-use performance. This gap is established by physically measuring performance in a variety of ways, ranging from simple tests such as air pressurisation tests, which are a matter of regulatory compliance for new build housing (ATTMA 2010), measurement of the conductivity of building elements (Baker 2008), or whole house methods such as co-heating (Sutton et al. 2012). All of these methods, and others, are combined to test the data used in models such as the Standard Assessment Procedure (SAP) or the Reduced Data Standard Assessment Procedure (RdSAP) that are used in the UK to predict the in use performance of buildings (Hong et al. 2006, Wetherell and Hawkes 2011). The gap is established between what is predicted in the model and the data collected from these types of tests to identify the nature of the performance gap.

The extent of the performance gap between designed and measured buildings is a long standing discussion in both domestic and non-domestic buildings, with buildings rarely performing as measured in the field (Jaffe and Stavins 1994, ZCH 2014), and a wide number of reasons for this have been identified (Bordass et al. 2001, Wingfield et al. 2008, Wingfield 2011, ZCH 2014), ranging from build quality to issues of the modelling process itself. It should also be considered that the measurement of buildings is not without its own discrepancies, driven by a number of technical, methodological and analytical issues (Swan et al. 2015). The Zero Carbon Hub (ZCH) Performance Gap Study (ZCH 2014), which focused on new-build housing, regarded specifically technical issues rather than occupant issues. It is important to acknowledge the significant impact of issues related to occupancy and that such issues are an equally important subject area (Summerfield et al. 2010), particularly around the issues of the adoption and use of new retrofit installations (Brown et al. 2014). However, here we focus specifically on the process factors to deliver the physical product, considering where the potential performance gap issues arise during the interface between the design and construction phase. The ZCH Performance Gap Report (ZCH, 2014) also approached the problem from a process perspective, highlighting phases in the process of constructing new build houses where the intended design might not be delivered.

The performance gap factors identified in the study included a wide variety of issues such as design changes post-modelling, to problems around construction and installation. While the focus of the ZCH study was new build housing, it becomes apparent
that many of these process issues that lead to gaps between design intent and the delivered product can play out in an almost identical way during retrofit projects. A number of other studies also recognise how these process issues, in the context of retrofit, create performance gap issues. Prasad (2014) touched on current energy-efficient retrofit processes in non-domestic buildings, stressing the need to restructure current processes due to issues of fragmentation. Given such discontinuity, it is inevitable that performance gaps will open up, targets will be missed, innovations will not work as anticipated, and lessons will not be learned from unintended outcomes (Prasad 2014). Similarly, Shah (2012) identifies that the inherent nature of such projects means that they change constantly, potentially due to issues such as hidden defects and unknown factors in the building quality; and therefore the initial design might not be the final chosen design and this could produce a different level of performance. In specific reference to the Retrofit for the Future Programme, Gupta et al. (2015) recognise the applicability of performance gap thinking to energy efficient retrofit. Davies and Osmani (2011) conducted a survey among architects, many of who identified retrofit technology as unreliable. Swan et al. (2013) conducted a large-scale survey of social housing asset managers assessing the perceived effectiveness of retrofit measures, which further identified issues with the performance of a number of technologies. Dowson et al. (2012) share this view, suggesting that retrofit measures ‘may only be half as effective as anticipated’ Davies and Osmani (2011) identified a ‘lack of unified solution’, mainly due to diversity in typology of English housing as an additional major constraint.

The problem of the process of delivery for energy-efficient retrofit raises two key questions. How can we close the performance gap in energy-efficient retrofit projects to ensure higher energy performance, particularly in HTT properties? How can we approach this phenomenon to develop a deeper understanding of the nature of retrofit processes?

### 4.3 Methodology – Expert Interviews

Interviewees were selected from a sample of retrofit experts with specific reference to HTT properties. The study participants consisted of architects, energy consultants, contractors, and sub-contractors, with extensive retrofit expertise, which were selected from experts who had worked on the UK Retrofit for the Future project (TSB 2014), funded by Innovate UK, formerly the Technology Strategy Board.

The Retrofit for the Future Programme was a major study conducted to assess the potential of reducing carbon dioxide emissions of a range of domestic property types by 80%, using deep retrofit approaches. The core aim of this programme was to gain a deeper understanding of the issues around retrofit, and to learn and to share that learning within the peer group. Many, although not all of these properties, fell into the HTT category, generally pre-1919 domestic properties. As the projects were targeted with achieving 80% emissions reductions, all projects were identified as deep retrofit. It should be noted that of a sample of 37 properties, only 8% exceeded the 80% target, with 27% achieving 70–80% reductions. Thirty per cent of the properties achieved less than 50% reduction, which should be taken in the context of £100 000 budgets for many of these properties (TSB 2013). While it is not clear from the sample the exact proportion of HTT, it does indicate issues with delivering expectations against HTT properties.
Here we look specifically at an intersection of HTT and deep retrofit. The interviewees were enrolled by attending events related to the Retrofit for the Future programme, with further interviewees enrolled using a snowballing technique (Robson 2002), with a specific goal of identifying those who had worked on HTT properties. In total 19 experts were interviewed, as shown in Table 4.1.

Based on the nature of the research design, an exploratory research approach was adopted, asking open questions to explore processes of deep retrofit in detail and investigate the performance gap issues that presented themselves. Each interview was conducted with specific reference to the retrofit project from the Retrofit for the Future scheme that involved the participants. All interviews were conducted in person, recorded and transcribed verbatim. The interview questions were designed to develop a deeper understanding to the nature of the processes of energy-efficient retrofitting as well as identifying major performance gap issues across these processes from perspectives of both design and construction teams. The main question themes were:

- Underlying principle of retrofit
- Decision making in assessment of property and design of retrofit
- Project planning and installation issues
- Difficulties in delivering the project and underlying causes
- Identification of lessons learned and their wider implications

Table 4.1 List of interviewees.

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Job role</th>
<th>Years of experience</th>
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<tbody>
<tr>
<td>1</td>
<td>Architect/Energy consultant</td>
<td>33</td>
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<tr>
<td>2</td>
<td>Architect/Energy consultant</td>
<td>20</td>
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<tr>
<td>3</td>
<td>Energy consultant</td>
<td>10</td>
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<tr>
<td>4</td>
<td>Contractor/Designer</td>
<td>17</td>
</tr>
<tr>
<td>5</td>
<td>Architect/Energy consultant</td>
<td>33</td>
</tr>
<tr>
<td>6</td>
<td>Contractor</td>
<td>25</td>
</tr>
<tr>
<td>7</td>
<td>Architect/Energy consultant</td>
<td>20</td>
</tr>
<tr>
<td>8</td>
<td>Contractor</td>
<td>19</td>
</tr>
<tr>
<td>9</td>
<td>Architect/Housing Association</td>
<td>40</td>
</tr>
<tr>
<td>10</td>
<td>Senior energy consultant</td>
<td>30</td>
</tr>
<tr>
<td>11</td>
<td>Energy consultant</td>
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<tr>
<td>12</td>
<td>Supplier</td>
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</tr>
<tr>
<td>13</td>
<td>Architect/Energy consultant</td>
<td>38</td>
</tr>
<tr>
<td>14</td>
<td>Architect technician manager</td>
<td>41</td>
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<tr>
<td>15</td>
<td>Energy consultant</td>
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<tr>
<td>16</td>
<td>Architect/Energy consultant</td>
<td>20</td>
</tr>
<tr>
<td>17</td>
<td>Architect/Energy consultant</td>
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<tr>
<td>18</td>
<td>Sub-contractor</td>
<td>25</td>
</tr>
<tr>
<td>19</td>
<td>Architect</td>
<td>18</td>
</tr>
</tbody>
</table>
The data from interviews and case study were analysed using transcribing, coding, categorising, thematic analysis (Patton 2002) and prioritisation. This chapter presents an overview of detailed results emerging from the analysis outlining retrofit process and major issues to the performance gap and effective solutions.

The structure of the analysis was set to illustrate the retrofit experts’ different perspectives on how and where the performance gap presents itself across the current energy efficient retrofit processes.

### 4.4 Findings

The analytical approach used in this study helped to identify major issues that drove the performance gap and examine where such issues present themselves across retrofit process. A standardised framework was developed to illustrate major stages of the retrofit delivery processes. Figure 4.1 gives a summary of the developed framework and outlines seven stages of the retrofit delivery process. These identified stages to the retrofit delivery process include ‘briefing and planning’ (BP), ‘assessment’ (A), ‘schematic design’ (SD), ‘technical design’ (TD), ‘programming and procurement’ (PR), ‘construction and commissioning’ (CC), and ‘completion and handover’ (CH).

Figure 4.1 illustrates where the major issues causing the performance gap tend to present themselves across the retrofit process. A total of 27 major performance gap issues were identified and categorised into six interrelated themes, using thematic analysis, of ‘understanding and skills’, ‘working practices’, ‘HTT’, ‘occupant’, ‘supply chain’, and ‘budgetary’. The results from the first phase of analysis indicate that the major issues related to the performance gap have a complex and interrelated nature. The major issues tend to overlap with one another, meaning that each major issue is not completely independent. It is therefore important to examine some of the interactions of these major issues in order to understand their level of impact on the performance gap. An overview of the results is given from the analysis for three of the most cited themes. The following subsections discuss these three identified contributors to the performance gap in detail.

#### 4.4.1 Theme 1 – Understanding and Skills

The concept of ‘understanding and skills’ refers to the level of construction knowledge, practical training and qualification on issues specifically related to energy efficient retrofit. The results of the analysis indicate that the majority of the identified major issues relating to the performance gap are generated from deficiencies in understanding and skills across both the design and construction team.

When considering the skills and knowledge within the design team, this might include lack of understanding of the implications of early stage retrofit decisions on the performance gap. Such decisions might include: buildability of the retrofit design; specifications of the appropriate renewable energy solutions; and the compatibility of energy efficiency systems including building services. This issue was particularly evidenced at the briefing and planning stages of the retrofit process. The interviewees collectively stressed the importance of retrofit design decision-making at this stage of the process due to the significant impact on performance gap. Inadequate levels of early involvement of the project delivery team during the early stages of the design phase were also
highlighted as an issue. This reflected the linkage between design decisions and buildability, or constructability (Jergeas and Put 2001) on site. One of the architect/energy consultants noted:

...having everyone involved from the initial stages of the project is very important and I think energy consultants and especially architects have a more critical role in retrofit using their skills to design and specify properly integrated packages of energy efficiency measures and to quality-assure work on site (Interviewee 7, Architect/Energy consultant).

Figure 4.1 Process map with performance gap issues located in process.
An additional interrelated issue is construction decisions made by site teams, which will also be addressed in the following theme of working practices. Instances of an inadequate understanding of retrofit design implications were particularly stressed by one of the retrofit experts when indicating major issues to performance gap. Inappropriate proposals included an air-source heat pump, which was also rejected due to not being economic as well as producing higher carbon emissions than an A-rated boiler. This issue was prevented when the energy consultant experienced in the field was instructed and the retrofit design proposals were changed to suit the project’s objectives. The energy consultant made the following statement as one of the key considerations for good practice:

Initial involvement of both the design and site teams is key in retrofit projects. It can prevent complications and issues like at the early stage these and save a lot of time (Interviewee 3, Energy consultant).

A retrofit design integration, later developed by the design team, was specifically developed and tailored individually to suit each project.

Each house is different and having good knowledge of integrated retrofit design between building fabric, services and renewables is essential to the success level of retrofit projects (Interviewee 17, Architect/Energy consultant).

Ali et al. (2008) indicate that major performance gap issues in energy efficient retrofitting are related to a lack of initial involvement of the project team, including both design and construction teams and lack of construction knowledge of energy performance and retrofit design integration (TSB 2014). In addition, Davies and Osmani (2011) looked solely at the architects’ perspectives in relation to low-carbon housing retrofit challenges; they share the view on the major challenge of design and technical issues. Their evaluation showed that the major factors affecting the design and technical challenges are directly linked to lack of initial involvement of all the project team and the lack of a standardised strategy package solution replicable for all housing types. Other studies have also identified these factors as the major challenge in housing retrofit design and construction phases (Plimmer et al. 2008, Stafford et al. 2011). The question appears not just about knowledge itself. It is about applying the correct knowledge at the correct point in the process – this is not only design led, but also about integrated design and construction driven by practices such as early contractor involvement (Song et al. 2009).

4.4.2 Theme 2 – Working Practices

This theme is concerned with the practices and expectations that predominate in the construction industry. Together these represent ‘how it has always been done’ and the findings indicate that it is important not to underestimate the influence these norms have on the delivery of retrofit. To an extent there is a clash, or shortfall, between the practices demanded by deep retrofit and the embedded practices of site personnel. Such practices relate to workmanship, communication and on-site problem solving. Notions of precision are also important: in retrofit, for example solid wall installations,
tolerances and expectations of quality may be higher than those that might traditionally be expected in a standard housing new build or refurbishment, where stringent energy performance targets are not a key consideration.

Two major issues were repeatedly evident in construction and commissioning stage of retrofit delivery processes: the interrelated issues of competency and training deficiencies within site teams and communication issues were highlighted by almost all participants as factors that have a significant impact on the performance gap.

Site teams were viewed as often lacking the understanding and skills of issues that are considered major contributors to performance gap in retrofit delivery processes, and these were associated with industry culture around as-built performance and, in particular, the relatively low priority attributed to energy performance. In turn, energy efficiency measures suffer from poor installation and commissioning. All participants collectively agreed that lack of communication and feedback between the design and site teams at any stages of retrofit delivery process could significantly impact the performance gap. The interviewees also identified a series of examples in relation to the major issue of competency and training within site teams.

In one example, the retrofit design proposals were amended by the energy consultant to install a solar thermal panel to the top half of the roof for maximum efficiency particularly during the summer. In addition, the energy consultant advised the installation of the solar photovoltaic (PV) panels on the lower half of the roof and this was clearly illustrated on detailed design drawings issued on site. The energy consultants reasoning for this was that the overshadowing from the chimney would have a greater impact on the performance of the PV panels. However, sub-contractors installed the PV panels to the top of the roof and the solar thermal panel on the lower part of the roof, therefore going against the design details.

So that’s, for whatever reason, the understanding from the energy experts in terms of energy performance to the site manager and then from them, from a logistical perspective in terms of what gets delivered when and when they schedule in different jobs, there was a breakdown in communication there and we got it installed the wrong way round. From their perspective as a site manager it was just it goes on the roof, it fits, let’s put this on the roof it fits, that’s fine. They had the drawings. They may have checked, they may tell you they’ve checked. But no-one came all the way back to the energy consultants on this project. So we’re changing it because of this, is this okay? That’s what I mean when I say a breakdown of communication (Interviewee 3, Energy consultant).

This issue was not communicated with the energy consultant or the architects and was only identified by the energy consultant on site at the completion stage. The energy consultant believed that placing greater priority on communication with the design team for clarification within working practice could have prevented this issue. In addition, frequent involvement of the design team during the construction phase would be a beneficial development of working practices:

It would be beneficial for retrofit project to allow frequent site visits by the design team during the process to flag up these issues in good timing for either prevention or making corrections (Interviewee 3, Energy consultant).
Another participant identified similar issues associated with a lack of communication from the construction team and limited time for site visits conducted by the design team. After conducting a site visit of one of the projects it became clear that a different material to that specified by the design team had been ordered and installed on site. That is, certain design specifications were ignored and not ordered. The construction team did not communicate the change in ordering and installation of a different and cheaper material, and did not take into account the different energy performance and durability of the substituted product. Consequently, due these important differences, the actual delivered energy performance delivered on site was negatively affected. Agreeing with the view of Interviewee 3, the design team believed that a stronger understanding of the energy goals of retrofit and more interactions between designers and constructions workers would be beneficial:

There is a need for deeper understanding of the aim of retrofit projects within our construction team but also to increase the number of site visits to prevent these issues early (Interviewee 17, Architect/Energy consultant).

These examples highlight the predominance of the ‘way it has always been done’ in the retrofit process and indicate that this is not sufficient when expanding the parameters of a project to encompass the energy performance of the building. This is problematic, since construction is an industry where innovation and problem solving are often focused on site at construction stage. Where such endeavours are innovative and add value they can be viewed positively as ‘hidden innovation’ (Barrett et al. 2007). However, these examples illustrate the potential for workplace practices, particularly when energy factors are not taken into account, to contribute to the performance gap and hinder progress. In many respects there is also a question of perception: what might be perceived as tacit practice by construction personnel, may be perceived as poor quality of communication by energy professionals. This issue of integration and communication is far from uncommon (Baiden et al. 2006) and can be viewed as a persistent problem within construction projects of all types.

### 4.4.3 Theme 3 – Hard to Treat

The theme of HTT is concerned with the physical uncertainty around HTT properties. The participants confirmed that major issues associated with the theme of HTT are generally results of the ‘secret’ and ‘concealed’ nature of the existing HTT properties. The nature of HTT properties increases the complexity level of the delivery processes, which can lead to uncertainties and risk and retrofit design change in the deep retrofit projects. All participants recognised uncertainties that stem from the hidden structure and elements of the existing HTT properties. In addition, the experts shared a similar view on the good practice of invasive assessment at the early phases of the delivery process. A large number of examples associated with this theme emerged. In one example in particular a series of interrelated issues to the theme of HTT was explained:

...two, three or four things were uncovered as part of the strip out of the property. So as you’re doing a whole house retrofit, what you’re doing is you’re pulling away the plasterboard, everything from the walls, from the floors, from the ceiling so
that you can then put in the insulation and then make good in a first fix, second fix and so on. As we did that with the property we found numerous structural or other issues with the underlying fabric. The roof joists, which have notches in them – the notches, are perhaps a third of the width of the joist and that’s because someone at some point did an illegal loft conversion, or a room in a roof, but didn’t think to ask building control. So you have these, which make it a very unsafe unstable room in a roof…the retrofit design changed pretty considerably from the architects’ suggestion. So we changed quite a bit from the original brief (Interviewee, 3, Energy consultant).

The interviewees were all recognised retrofit experts in the industry; nevertheless, the complex delivery process of deep retrofit was still seen as a learning curve even for these experts:

As we do more and more we’ll build up a bank of knowledge so that there are less surprises, but I think at the moment it’s definitely true that each building you never really know until you’ve stripped it all out (Interviewee 2, Architect/Energy consultant).

This issue of learning was also highlighted by one of the architect/energy consultants:

I’ve learned tonnes of stuff from these two projects of Retrofit for the Future but a lot of it’s about how little we still know. You know I mean I thought with 30 years’ experience in energy consultancy I knew how to do retrofit and I kind of did at technical level, I know how to do one offs very well but you ask me to do one a minute or you know however many a week you need, that’s a whole different ball game and how do you specify that in a robust way when you can’t control every detail yourself and how do you roll it out with probably multiple contractors and lots of tenants with lots of interests, you know we’ve got loads of learning to do (Interviewee 1, Architect/Energy consultant).

This issue of risk and uncertainty in retrofit is well understood in the non‐domestic sector (Egbu 1995). It is also likely that smaller domestic builders are familiar with the uncertainty around older properties that may exhibit these types of issues. Every house will present its own issues, with both standard and non-standard building elements having to be addressed. The experts indicated that this is a learning curve for the industry as a whole, which in many respects can only be addressed by learning by experience. However, serious thought should be given to how to capture this learning in tools, processes or, potentially, products.

4.5 Conclusions

In many respects we are left with a not entirely new picture of the construction industry. While energy efficient retrofit, and particularly deep retrofit of domestic properties may be viewed as a new problem given an emerging policy context around energy security and climate change specifically, the issues that have been highlighted at the design
and construction interface represent old problems of fragmentation of the supply chain, industry culture and quality that have been highlighted repeatedly in both government reports and the construction management literature. These problems were a particular focus of the Rethinking Construction Report (Egan 1998), and many of them are directly referenced in the TSB’s Retrofit Revealed Report (TSB 2013). A second issue that raises its head is that retrofit is difficult. Old houses are complex, have hidden ‘secrets’ that may mean responses are made on site at the expense of the design. While recognised experts in the field oversaw these projects, when we consider scaling up to the kinds of scale demanded by the problem, the skill base required to respond to this level of complexity might not currently be widely available. This is a question of imperfect information, which directly translates to risk. Perhaps, some of the difficulty of wider implementation of deep retrofit in the HTT sector is driven by this risk.

As well as these old problems are new ones that demand new ways of working. Working practices are embedded within the industry and they can be difficult to change; they are part of the culture of the industry. Some deeply seated approaches to the way things are done are not sufficient to ensure that predicted performance is achieved. Deep retrofit demands a stronger link between the design team and the construction team to ensure that issues that impact performance such as thermal bridging or thermal by-pass, often caused by poorly installed or non-specified details in insulation, are not built into properties. This can be caused by designers specifying things that are hard to implement on site, but also by a lack of understanding of the implications of making build choices at the expense of the design. While it is unlikely that site operatives will have a full working knowledge of the building physics implications of their choices, it may be possible to attempt to establish new ‘rules of thumb’ or heuristics that are alluded to by the expert interviewees.

The purpose of this study is to consider the wider problems of the performance gap during the construction process. The focus of the study has been to consider not only what technical solutions we offer up for retrofit, but look more closely at how we do it. Individual projects can show us what is technically feasible, but many of the risks are associated with wider practical and cultural issues. They are around issues of site communications, team integration and process. If we are to scale up, it is perhaps time to focus more on the ‘how’ of deep retrofit.

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5

Transforming the Commercial Property Market in Australians Cities: Contemporary Practices and the Future Potential in Green Roof Retrofit

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Overview

Australia needs to increase the adaptation of the existing commercial property stock to reduce building related greenhouse gas emissions (Snow and Prasad, 2011). Some of these emission reductions could be achieved by retrofitting green roofs. Given that Germany had over 10 million square metres of green roofs by 1996, have we been missing an opportunity in Australia?

Green roofs offer many benefits such as stormwater management, improve water run-off quality (Mentens et al., 2006; Hilten et al., 2008), reduce the urban heat island effect (Susca et al., 2011), extend the lifecycle of the roof membrane (Kohler, 2008: 91), and improve thermal performance (Castleton, 2010: 62). There are social sustainability benefits through the provision of spaces for people to enjoy. Roofs can account for 40–50% of impermeable surfaces according to Stovin (2010) and typically around 15% of office stock in Australian city centres has the potential for green roof retrofit without structural alterations (Wilkinson & Reed, 2009).

This chapter defines green roofs and examines issues facing Australia in respect of retrofit, climate adaptation and sustainability. The transformation of the commercial property stock is examined in respect of the barriers, incentives, legislation and opportunities, which exist currently. A series of illustrative case studies demonstrate how roofs have been retrofitted for bio-diversity, urban food production, stormwater attenuation and thermal performance. An examination of policy and incentives at city and building scale reveals the future potential for green roof retrofit in Australian cities. The conclusions summarise the current position and posit an agenda for the future.

5.1 Introduction

Australia, like many other developed countries, needs to increase the adaptation of the existing commercial property stock to reduce building related greenhouse gas emissions (Snow and Prasad, 2011). For example, Melbourne aims to be carbon neutral by 2020.
(Arup, 2008) with a target of 1200 building adaptations to deliver 24% greenhouse gas emission reductions through sustainability measures retrofitted to the existing stock. Some of these emission reductions could be achieved by retrofitting green roofs. Given that by 1996 Germany had over 10 million square metres of green roofs, have we been missing an increasingly important opportunity in Australia?

A green roof offers a building and its surrounding environment many potential benefits. These include: stormwater management; improved water run-off quality (Mentens et al., 2006; Hilten et al., 2008); improved air quality in the urban canyon (Yang et al., 2008); a reduction of the urban heat island effect (Takebayashi & Moriyama, 2007; Susca et al., 2011); longer durability of a roof membrane (Kohler, 2008: 91); and improved thermal performance (Castleton, 2010: 62). Other benefits also include enhanced architectural interest and bio-diversity (Castleton, 2010: 62), re-introducing the natural world into the anthropogenic environment and the associated social sustainability benefits through the provision of spaces for people to enjoy.

Roofs can account for up to 32% of horizontal surfaces in built-up areas (Frazer, 2005), or 40–50% of impermeable surfaces according to Stovin (2010), and typically around 15% of office stock in Australian city centres has the potential to be retrofitted with green roofs (Wilkinson & Reed, 2009). That is, the roof slope is below 32° and also meets other criteria in respect of access, safety, structural capacity, orientation and overshadowing.

This chapter defines green roofs and examines the specific issues facing Australia in respect of retrofit, climate issues and sustainability. The next section explores the barriers, incentives, legislation and opportunities which exist in this market currently. A series of illustrative case studies from major Australia cities then demonstrate how roofs have been retrofitted for bio-diversity, urban food production, stormwater attenuation and thermal performance. The penultimate section describes the future potential for green roof retrofit in Australian cities, through the examination of policy and incentives at city and building scale, as well as through best practice guidance for practitioners. The conclusions summarise the current position and where we need to go forward.

5.2 Green Roofs Defined

A green roof is defined as a roof that uses plants including moss, lichen, sedum, trees, shrubs, flowers and bushes. Green roofs are referred to by a number of different labels, such as eco-roofs, nature roofs or roof greening systems. In short, green roofs are a living vegetated roofing alternative to traditional impervious roofing materials. A green roof comprises:

- a roof structure;
- a waterproof membrane or vapour control layer;
- insulation (if the building is heated or cooled);
- a root barrier to protect the membrane [i.e. made of gravel, impervious concrete, polyvinylchloride (PVC), thermoplastic polyolefin (TPO), high-density polyethylene (HDPE), or copper];
- a drainage system;
- a filter cloth (non-biodegradable fabric);
5.2 Green Roofs Defined

- a growing medium (soil) consisting of inorganic matter, organic material (straw, peat, wood, grass, sawdust), air;
- plants.

Figure 5.1 illustrates a typical green roof section.

Green roofs can be extensive or intensive. Table 5.1 summarises the characteristics of extensive and intensive green roofs. Extensive green roofs are essentially roof gardens, which typically provide space for people, and the depth of soil or substrate layer provided varies between 50 mm and 200 mm and requires artificial irrigation. Intensive roofs, on the other hand, often require a deeper planting medium (greater than 150 mm). There is a third type, a semi intensive green roof that is a hybrid of the intensive and extensive roofs. It is vital to keep the plants alive in the long term, and this is a challenge because it requires an active and ongoing commitment to a maintenance and irrigation regime (Skyring, 2007). Standard soils are not used because they are too heavy for roof structures and a calculated ratio of aggregate (e.g. shale, vermiculite, etc.), organic materials, air and water is used. The correct growing medium is critical and may be challenging in some Australian cities due to climatic conditions, particularly excessive seasonal rainfall (e.g. as in the Northern Territory) or minimal rainfall (e.g. as in Victoria).

![Typical green roof section](image)

**Figure 5.1** Typical green roof section.

**Table 5.1** Characteristics of extensive and intensive green roofs.

<table>
<thead>
<tr>
<th>Extensive green roof</th>
<th>Intensive green roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow growing medium (50–200 mm)</td>
<td>Deeper growing medium (&gt;150 mm)</td>
</tr>
<tr>
<td>Lightweight structure to support roof</td>
<td>Heavier roof structure required to support roof</td>
</tr>
<tr>
<td>Cover large expanses of rooftop</td>
<td>Small trees and shrubs feature</td>
</tr>
<tr>
<td>Requires minimum maintenance</td>
<td>More maintenance required</td>
</tr>
<tr>
<td>Lower capital cost</td>
<td>More expensive</td>
</tr>
<tr>
<td>Not usually recreational</td>
<td>More common in tropical climates</td>
</tr>
<tr>
<td>Accessible or inaccessible</td>
<td>Accessible or inaccessible</td>
</tr>
<tr>
<td>Does not usually require irrigation</td>
<td></td>
</tr>
<tr>
<td>Minimum structural implications for existing buildings</td>
<td></td>
</tr>
</tbody>
</table>
5.3 Retrofit Issues in Commercial Stock in Australian Cities

Suitability for a green roof retrofit is dependent on factors such as the roof type, size and slope. Extensive and intensive roofs require a minimum slope of 2% and roofs with less than 2% slope require additional drainage measures to avoid water logging (University of Florida, 2008). Additional requirements are good drainage, lightweight growth media, waterproofing, additional structural support, rainwater harvesting and the use of drought or heat tolerant plants. Longevity of the structure, drainage and waterproofing system is essential because replacement costs are high. Green roofs are designed to last a minimum of 50 years which is approximately twice the life cycle of a roof covering such as bituminous felt. Overall the following criteria are taken into account when determining whether a roof is suitable for retrofitting: position of the building, location, orientation of the roof, height above ground, pitch, weight limitations or load bearing capacity of the building, preferred planting, sustainability of components and levels of maintenance. The first six criteria are purely physical attributes of buildings and the last three are related to building owner/client desires and the ability to maintain (Wilkinson & Dixon, 2016).

Other factors such as climate influence the potential to retrofit a green roof, and the type of green roof it is possible to provide. Australia has eight climate zones and is one of the most climatically diverse nations. For Australia, major flooding occurred over the densely populated east coast area for two consecutive years from 2010. On the west coast, the State Emergency Service responded to over 100 requests for flood related damage when 29 mm of rain fell in half an hour at Perth Airport (Bureau of Meteorology, 2012). In March 2012 the Bureau of Meteorology issued Flood Warnings and broadscale Severe Weather Warnings for heavy rain and flash flooding over much of northern and eastern Queensland. The estimated cost of remediating flood damaged buildings was A$18 billion (Reserve Bank of Australia, 2017). Another example is excessive heat which can cause heat to become trapped under the tree canopy in urban canyons formed between high-rise commercial property; and a consequence is increased mortality in Australian cities caused by heat stress (ABC, 2014). Thus some cities benefit more from green roof retrofit to reduce UHI whereas others would benefit more from stormwater attenuation retrofit.

Commercial stock in the city centres is varied, dating from the early to mid 1800s onwards. Institutionally owned stock tends to be more contemporary, medium to high-rise, detached and concrete framed. This stock also is more likely to have environmental ratings either for energy and water use (NABERS), a requirement of the 2010 Commercial Building Energy Efficiency Disclosure legislation (Warren and Huston, 2011) or the voluntary Green Star rating. This stock has the most potential, physically and financially, to be retrofitted (Wilkinson, 2012). Privately owned commercial stock tends to be smaller in scale and is more likely to have pitched roof structures. In commercial stock, owners and/or property/facility managers need to consider maintenance requirements. With green roofs long-term maintenance is essential, and the building owner is recommended to enter into a minimum 5-year maintenance contract to ensure the correct processes are undertaken and that planting is properly established. Finally, there are budget considerations, which include how much the owner is willing to pay for a green roof. And here, a whole life cycle costing approach may be useful to determine the overall costs and may offset the higher initial construction and installation costs.
5.4 Drivers for Green Roofs

There are many benefits of green roofs, one of which is the reduction of external noise for occupants, as the substrates and vegetation absorb airborne noise. In addition, water harvesting is possible from green roof systems. It is possible to design the system to collect rainwater, which can irrigate the planting systems or, in some climates, be used within the building to reduce overall water usage from the mains systems. With regards to stormwater management it may be possible to reduce the volume of stormwater between 50% and 85% (Wilkinson et al., 2014). In addition, the percolation and filtering of stormwater improves the quality of stormwater entering the main drainage systems (Wilkinson and Reed, 2009).

Energy conservation of between 15% and 30% has been recorded in buildings with green roofs (Niachou et al., 2001). As a result of less energy use, greenhouse gas emissions are reduced. The amount of energy conserved varies due to variations in climates, variation in the depth of green roof substrates and also differences in base building construction and performance (Niachou et al., 2001). Green roofs can lower surface roof temperatures by 10–15.5 °C, which means less heat gain occurs inside the building and less cooling is required as a result. Lower temperatures are recorded where darker vegetation is used (Niachou et al., 2001). On a larger scale, the reductions in energy usage and external surface temperatures of roofs can lessen the UHI effect of city centres. The city of Toronto in Canada estimated that a city wide application of green roof technology could reduce the UHI by 0.5–2.0 °C (City of Melbourne, 2014). UHI is caused when the heat from the sun is absorbed into buildings by the roof and then released back into the air leaving city centres up to five degrees hotter than outer suburbs and rural areas. The UHI is exacerbated in high-density, high-rise city centres where hot air is trapped at lower levels under tree canopies creating even hotter temperatures; this phenomenon is known as the urban heat canyon. Pollution abatement is another benefit, where airborne particulates are caught within the vegetation and pollutants are filtered naturally through the planting systems. Furthermore, air quality is improved as the plants reduce the levels of nitrous oxides and volatile organic compounds (Peck et al., 1999). A London study of green walls found a reduction of 15–40% in nitrogen dioxide and 23–60% reduction in particulate matter (Pugh et al., 2012). A final environmental advantage is the contribution to bio-diversity within the city with the creation of habitats for birds and invertebrates.

For owners seeking to promote sustainability, and to offset the impact of environmental obsolescence as well as gaining accreditation through the green rating tools, there are ratings such as Green Star award innovation points for green roofs (Green Roof Technology, 2017).

Advocates of green roofs posit that green roofs have high aesthetic values, and add colour and vibrancy to colourless rooflines. Humans derive enjoyment from being able to view natural environments and the provision of green roofs allows occupants in dense urban centres the chance to enjoy the visual amenity of green roofs and gardens. This phenomenon is known as the biophilia effect (Kellert and Wilson, 1993). Other social and community benefits are increased worker health, productivity and creativity (Peck et al., 1999).

On a practical level, green roofs extend the useful life of the base roofing material because it is covered and protected from the aging effects of exposure to the
Transforming the Commercial Property Market in Australians Cities

atmosphere, weather and pollutants (Wilkinson et al., 2015). Furthermore, financial savings are made because less maintenance of roof coverings is required. Other economic benefits are employment opportunities created for a wide range of professionals including suppliers and manufacturers of green roofing materials as well as engineering professionals.

Costs were noted as a barrier above, however some incentives now exist to encourage owners to retrofit sustainability. In Melbourne and Sydney, these are known as Environmental Upgrade Agreements or EUAs (City of Sydney, 2015). In an EUA building owners can access capital for commercial building improvement projects, allowing owners and tenants to benefit from a more sustainable and efficient building. EUA loans are provided by a lender at favourable rates of interest to fund works that improve the environmental performance of an existing building. The repayments are collected through rates paid by tenants. To date there has been a disappointing uptake of EUAs within the sector, however it has coincided with the global financial crisis and activity across the sector as a whole is much weaker (Van der Heijden, 2014). A Green Roof Policy was published in Sydney in 2012, a first in an Australian city, and a Green Roof Technical Officer was employed to document, promote and encourage the uptake of green roofs in the city. The officer was supported by a Technical Advisory Panel (TAP), which comprised State and Local Government officials, professional consultants and academics. The officer and TAP were supported for a 2-year period only, and a longer period would have enabled green roofs to become more embedded within the Sydney practice. Similarly, a green roof policy exists in Melbourne. However, no other Australian city has yet to formally adopt any policy or appoint a dedicated officer for the technology. As noted, some cities such as Toronto in Canada and Basel in Switzerland have mandated green roofs in certain circumstances and this may be a viable solution elsewhere and for retrofit (City of Melbourne, 2014).

One barrier, a lack of legislation around sustainability, is gradually being overcome although it is quite possible that legislation will be repealed. The innovative and world leading Carbon Tax is one such victim of the current Australian government’s attitude towards sustainability legislation: it was repealed shortly after their election victory in 2012.

A question that frequently arises is: do mandatory or voluntary approaches work best with regards to sustainability measures in buildings? In 2010 a Commercial Building Energy Efficiency (CBEED) Mandatory Disclosure Act (Commonwealth) was passed, requiring all owners of premises over 2000 m² to disclose in public a certificate relating to the building’s energy rating under the NABERS rating tool. The certificates are known as Building Energy Efficiency Certificates or BEECs and are very similar to the European Energy Performance Certificates (EPCs) (Warren and Huston, 2011). A 2012 study of commercial office building adaptation in Melbourne from 2009 to 2012 showed that NABERS was more important than Green Star when it came to drivers to adaptation (Wilkinson, 2014a). This shows that mandatory approaches appear to work more effectively than voluntary ones in Australian commercial building adaptation or retrofit. On this basis, it is posited that a mandatory approach to green roof retrofit could work.

Opportunities for greater take up of green roof retrofit include the increasing importance of Corporate Social Responsibility (CSR), which encourages private companies to adopt measures that enhance social and environmental sustainability. Green roofs have environmental and social benefits and tick two boxes at once. In summary, the drivers
How can we transform the commercial property stock? A series of barriers and drivers to the adoption of green roof retrofit are explored in this section. The barriers to green roof uptake rest with a number of stakeholders. For example, there is a perceived lack of awareness within the development industry and built environment professionals, as well as a poor appreciation by government officials in some cities and the general public regarding the benefits of green roofs. Furthermore, there have been few Australian incentives supporting green roof diffusion and little debate as to whether mandatory or voluntary approaches work best (Skyring, 2007; Wilkinson, 2014a). In Basel and Toronto, planning policy requires that all new flat roofs meeting certain criteria, above 350 m² in Toronto, are green roofs and thereby presents a pro-active approach to encouraging green roof technology (Doug et al., 2005).

Another perceived barrier is that green roofs have higher construction costs. Skyring (2007) estimated that costs are double those of a standard roof. For new construction on a small green roof, costs are estimated to be A$150–450/m² plus costs of building and planning permits, lifts and cranes and consultants’ fees (City of Melbourne, 2014).
The costs of strengthening works to concrete roofs vary between A$450/m² and A$650/m² and for steel roofs around A$250/m², with additional columns to support roofs being A$2500–6500 each (City of Melbourne, 2014). Historically the market does not recognise or appropriately account for the benefits of green roofs, and rather than adopting a life cycle assessment which includes accounting for the environmental and social benefits, typically the economic case is the only one considered (Peck et al., 1999).

One of the biggest barriers to adopting new methods and techniques in property and construction is a risk aversion to, or a fear of, the unknown. There are no long-term documented examples of green roof technology for stakeholders to use as evidence (Wilkinson & Reed, 2009). For example, whilst claims of lower maintenance costs appear reasonable and sound, there is no historic evidence to conclusively support this claim and the notion that green roofs are a maintenance liability prevails. When green roof technologies are adopted within building codes and technical standards are produced, it is envisaged that confidence will be enhanced in the sector. Another issue is related to the technical data limitations for calculating the benefits associated with green roofs. The benefits noted above achieved through the installation of green roofs vary according to a building’s location, climate and construction type. However, the anticipated savings may not be fully realised in practice and concern over this factor may deter some from adopting the measure.

### 5.6 Valuation Issues

A further perceived barrier is the issue of value in respect of green roofs. The commercial property market is primarily motivated to act by economic factors. When evidence exists that measures add rental and so capital value to a property, there is a greater incentive for uptake and adoption. Rooftop space is generally considered to add value to a building when there is an associated income stream such as rental income for telecommunications installations, signage rights or perhaps as a childcare playground (M. Willers, personal communication, 2015). The relationship between any such income and additional capital value is dependent upon the certainty and stability of the income stream. Naturally, the rental level that can be economically paid by the tenant is a reflection of the underlying profitability in the relevant ‘rooftop’ enterprise.

On this basis, attributing value to a ‘green roof’ would require a third party to take a lease or licence agreement over the space and then, at their own costs, fit the roof for their intended use (RICS, 2016). The underlying rental would be a reflection of the economics relative to the agricultural/horticultural enterprise and the supply and demand of rooftop space fit for purpose. At face value, it seems unlikely that this would be a viable proposition in terms of food production, particularly given the likely maximum scale of any proposed enterprise, the direct set up costs involved and overlaid with other complexities such as the legal issues involved with sharing roof space with existing users, access restrictions and building security.

Possibly, uses such as for resting/circulating indoor plants may be viable at a low rental level. In the future, medical marihuana may be suitable given inherent access, location and security related benefits present in commercial buildings. Based on retail product pricing across the USA, medical marihuana would seem a highly viable proposition.
A second, and less directly quantifiable, approach to assessing any rental or capital value increase is the positive impact green roofs may have on the overall appeal of a building within the tenancy market: the so-called ‘non-tangible’ benefits. This could be simply from the additional aesthetic appeal or by incorporating associated recreational/entertainment facilities, or perhaps by allowing building occupants to take a more active role. Green roofs positively impact sustainability ratings available to tenants and owners in the Green Star rating system as an innovation point (Green Roof Technology, 2017).

Financial benefits under this approach are difficult to measure in terms of any additional rental income or capital value attributable specifically to green roofs. Nevertheless, within a basket of sustainable or other building attributes, they may make a building more desirable to tenants, leading to reduced vacancy periods and energy costs in comparison with competing buildings. The difficulty in measuring the rental and capital value impact of a single building attribute reflects the multiple attribute differences that generally exist between comparable buildings and the fact that rental negotiations do not apportion the rental agreed against individual building attributes. As such, identifying the rental value of one attribute from the basket of attributes provided by reasonably comparable buildings is often an impossible task. Some attributes, such as a panoramic view, are more identifiable, however others, for example the nature of the building foyer, are more difficult.

A large data set is required, wherein the particular attribute being tested can be distinguished from buildings without that attribute. This approach is reflected in research, which originally identified the value benefit of incorporating energy efficiency measures within commercial buildings (Newell et al., 2011; Eichholtz et al., 2013). These studies were undertaken in the US and Australia and contributed towards the establishment of the Investment Property Databank (IPD)’s ‘Green Property Investment Index’ in 2011 which now informs owners and investors in the commercial property sector. Traditional valuation approaches involve using historical transactions as an evidence base and experience has shown that this makes it harder to initially establish value in innovative building technologies (Warren-Myers, 2013).

A factor presently attracting industry and academic attention is attempting to quantify productivity benefits attributed to high Indoor Environmental Quality (IEQ) performance in commercial buildings (Bordass et al., 2001). Productivity can be measured in dimensions such as staff turnover, absenteeism, and how occupants physically and mentally feel at various times of the day relative to local environmental conditions prevailing within the building at those times. Logically, an improvement in the physical environment such as access to, or views over, green roofs may add something towards the same agenda. The underpinning rental/capital value argument is based on taking a more holistic view of how IEQ related building performance impacts on operational costs of building users and attempts to attribute measurable business cost savings to the same. This approach may possibly be a more accurate way of measuring the true benefits of physical building attributes and involves factors such as IEQ, building responsiveness to external climatic conditions and user comfort.

Demonstrable productivity benefits attributed to a specific building attribute are likely to have a far greater impact on tenancy decisions and rental/capital values in the long term as labour costs are much higher than rental costs in the productive use of a commercial premises. To illustrate the point, typical labour costs are likely to be upwards of A$5000/m² in a commercial building where gross rental costs for the same
may be $500/m² (say, 10% of labour costs). Accordingly, a 10% increase in productivity attributed to a high IEQ may equate with a 100% increase in arguing the underlying rental value. On the basis that high IEQ performance is shown to lead to increases in user productivity, the financial case for using this performance as a dimension of rental value and so capital value will be established. Nevertheless, isolating IEQ performance (and building attributes such as a green roof) from other variables in measuring employee performance is a complex task.

Some pioneering work exists in Canada with regards to ascribing a monetary value to green roofs (Tomsky and Koromowski, 2010), which sets out techniques for valuing sound attenuation, stormwater attenuation, air quality and associated health improvements, as well as greenhouse gas sequestration. Tomsky and Koromowski (2010) take the view that non-market or indirect valuation techniques must be adopted. Whilst a non-market approach may be useful in informing policy makers, it is unlikely to form part of developer/investor/tenant decision making processes or stimulate voluntary investment in green roofs in the sector. The value in this work lies in establishing costs and benefits of potential policy measures.

5.7 Retrofitting Investment to Date

Commercial property market practices are primarily motivated by relatively short-term market economics. A parallel may be drawn with market experience in regards the uptake of energy and water efficiency retrofitting in Australia. Recent experience points to the following factors as the likely drivers for sustainable retrofitting of commercial buildings:

- Nature of building owner (e.g. institutional investor versus private investor).
- Tenancy profile/likely tenant profile for a specific building.
- CSR branding by fund managers, listed ownership entities and tenants.
- Introduction of mandatory disclosure legislation and BEECs.
- Physical attributes of a specific building and likely economic life.
- Length of tenure under existing leases (how long until vacancy becomes a risk).

In reality, adoption of energy efficiency and other sustainability measures in the Australian commercial sector has been largely limited to buildings which are likely to remain desirable to publically listed and government tenants and fall within the Premium, A and B grade sectors of the office market (Wilkinson, 2014a). These buildings tend to have floor plates in excess of 1000 m², be located in Central Business District (CBD) locations and date from the 1980s onwards (Wilkinson, 2014a). Whilst energy and water efficient retrofitting of commercial buildings in this sector has now been widely adopted, the economic case in regards to energy and water cost savings, even here, is marginal. The primary motivation appears to stem from:

- Corporate branding benefits for owners and tenants.
- Mitigation of vacancy risk by owners (where sustainability ratings are a ‘must have’ part of tenancy market location decisions).
- Risk management by owners and tenants against rapidly escalating energy costs (particularly under a carbon tax regime).
5.8 Taxation Considerations

Annexed to the uptake for green rooftop space providing added value to a building, there is also another aspect to consider for the commercial property market. In particular, this is the potential to introduce tax incentive benefits for green roofs. These tax incentives can be at both federal level, where there is a benefit available for taxable income derived from the building; and also at state level with incentives for property developers to receive the opportunity for additional floor space ratio or similar. For instance, in the USA, the Energy Policy Act 2005 (Federal), provides Federal tax credits of US$1.80 per square foot if certain conditions and standards are met. Additionally, at a state level, there are varying bonuses such as in Texas, USA, green roof density will provide the developers with the opportunity to acquire an additional 8 ft² of floor space for each square foot of green roof space installed. Similarly, Toronto (Canada), Tokyo (Japan) and Switzerland have developed and introduced tax incentive schemes for building owners and developers. In contrast, Australia is relatively inexperienced with embracing green rooftops for the commercial property market.

In part, this could be attributed to the complexity of the Australian taxation laws, with differing applications for the stakeholders, namely the building owner, the tenant, and the developer. Issues such as retrofitting compliance, ongoing maintenance and upkeep, and commercial leasing considerations would need to be measured and introduced into the relevant taxation aspects of the legal system. For instance, the costs associated with
the retrofit of a green roof are borne either by the building owner or the tenant who has taken out a lease or licence agreement. Under the current taxation laws in Australia, either party is able to claim some portion of these costs against their relevant taxable income. However, there are some technical restrictions such as the intention of undertaking the green roof retrofit, that is, are either of the parties entering into a lease or licence agreement for profit-making purposes?

Other aspects of taxation law include the decline in value of selected assets, the building write off for parts of the structural requirements for the roof top space, and costs associated with the installation and drainage of the irrigation system necessary for the green rooftops. Therefore, clear policies and guidelines to maximise these deductions would be ideal for all stakeholders involved. Indeed, clarifying the tax application and the introduction of tax incentives within the green roof regime is a worthy theme for the future transformation of Australian cities.

5.9 Contemporary Practices

Four illustrative case studies demonstrate the application of green roof technology in practice for bio-diversity, food production, stormwater and thermal performance. Unfortunately, there are few examples of retrofitted green roofs in Australia currently, and where no retrofit examples exist new buildings are shown.

5.9.1 Green Roof Retrofit in Commercial Stock – Case Studies from Melbourne and Sydney

5.9.1.1 Bio-diversity Green Roof Retrofit – University of Melbourne Burnley Campus, Victoria

The building was originally constructed between 1946 and 1949 and is used for teaching purposes. It is listed on the Victorian Heritage register. The roof is concrete with a 1° slope. The roof is accessible to staff and students who have a working at height certification, and is visible from the first floor hallway window. Horticulture is taught within the building and the roof is used in teaching and research. This bio-diversity roof comprises Victorian grassland plant species in a shallow scoria substrate, a range of landscaping materials and features to provide habitats for lizards, birds, insects and other small invertebrates (Figure 5.2). The retrofit was completed in February 2013 at a cost of A$13 930 and covers 49 m². The existing concrete roof has a load bearing capacity of 150 kg/m².

The existing waterproofing was patch repaired saving A$2000. The green roof components include ZinCo SSM45 protection mat and HDPE root barrier, a ZinCo FD40 drainage layer and ZinCo Filter Sheet SF. A scoria-based growing substrate 100 mm deep was installed. The roof receives run-off from two downpipes that drain a roof area above. One is directed into the pond and ephemeral stream, the other enters a buried drain pipe that travels along the long axis of the roof. This allows lateral seepage of water into the substrate, and supports plant species with higher water needs, such as Kangaroo Grass (*Themeda triandra*). Drainage off the roof is achieved through two drains on the northern perimeter of the building. As there is no irrigation system, the roof is watered by hand-held hose during hot weather or prolonged dry periods. The design and preliminaries costs were A$3000, patch repairs were A$1500, green roof
costs were A$5150, labour costs were A$1650, and the remaining A$2630 was spent on
plants and planting.
University staff maintain the roof, which takes about an hour per month, and a
photographic record of weed species is maintained to monitor those that germinate on
the roof. Timely removal of these plants before they set seed prevents them from
becoming more widespread. Plant nutrition is provided with an 8- to 9-month low
phosphorus controlled-release fertiliser, applied at half the recommended rate.
Nine months after planting the vegetation was still sparse, although this is likely to fill
in as the grasses self-sow over time. Possums living in two Italian Cypress trees that
grew adjacent to the building grazed on the plants, although the trees were removed in
2013 as possum nesting and grazing had caused irreparable damage to the trees’ canopies.
The rooftop plants recovered well in spring and Australian ravens and magpies visited
the roof to use the pond and to bring food to consume on the roof. Spiders colonised the
tree debris, and an ant colony moved into the rocky substrate near the end of the stream.
Building occupants have commented on their enjoyment of the colourful grassland
species planted outside the first floor window.

5.9.1.2 Food Producing Green Roof Retrofit – University of Technology Sydney (UTS)
Housing, Ultimo, Sydney, New South Wales
This nine-storey student residence, called Gumul Ngurang, which means ‘friendly place’
in the local indigenous language, was built in 2003 with a roof designed for public access.
This accessibility made it relatively straightforward for adaptation to food production.
Perimeter garden beds were part of the original design. In 2013, following the award of a City of Sydney environmental grant, two large raised beds were designed and installed on the rooftop, following negotiation with the University building Property Manager. In order to address concerns about potential damage to the roof membrane and to accommodate the possible need to remove the beds at some future stage, raised beds were provided. These beds drained into water containers, which was reused on the beds. Herbs and vegetables are grown all year round (Figure 5.3) and the garden beds are maintained by the UTS Staff and Student Garden Club. The raised beds provide no thermal benefit to the roof, a limited impact on stormwater attenuation but have attracted local bio-diversity to the roof and there is considerable social engagement for staff and students.

5.9.1.3 Stormwater Roof – UTS Alumni Green Roof, Ultimo, Sydney, New South Wales
This building was completed in October 2014 as part of a major redevelopment of the UTS campus. Alumni Green is a green roof of 6500 m² overall, with a sports hall and a library retrieval system located directly below. There is easy access to the green roof for staff, students and the public. Native and drought tolerant plants occupy the eastern part of the roof, and an open space covered with turf comprises the western part of the roof. Sydney Local Government Area has only 4% of the native flora and fauna left from
the date of settlement in 1788 (Bradshaw, 2012), and sites that reintroduce native species are highly desirable as they also encourage native insects to return. Some deciduous trees provide much needed shade in summer months but allow sunlight to penetrate the space in winter periods. Stormwater is captured, stored in 60 000 l tanks, treated and re-used to supply approximately 87% of the Alumni Green water requirements. A 32 000 l tank provides on-site detention and is used to manage stormwater during excessive rainfall.

UTS Executive Project Manager, Marc Treble, and Sustainability Officer, Danielle McCartney, specified the green roof for a number of reasons including improvements to air quality and bio-diversity, as the site is located in the city centre on the fringe of the CBD. Other environmental benefits are increased quality of stormwater run-off and mitigation of the urban heat island. Water economy is managed through a system of irrigation, which is controlled to ensure efficient watering of the plants and turf. A key driver was the opportunity to create a green space on campus for UTS staff and students in which to socialise and relax. Being a city centre campus, many students tend not to remain on site after classes. The Alumni Green roof is part of a policy to encourage students to remain on campus for longer periods. Figure 5.4 shows that the social space is well used and the area has been transformed by the green roof.

Figure 5.4 Alumni Green roof – UTS, Sydney.
5.9.1.4 Thermal Roof and Urban Heat Island – Minifie Park, Melbourne, Victoria
This one storey, early learning centre building has a green roof of 440 m², is located in a city park, and was completed in December 2012 at a total building cost of A$306 000. Of this sum, A$180 000 went on design and preliminaries and A$126 000 on the green roof installation and plants. The roof has a 2–3° slope. The roof was intended to provide thermal insulation primarily, but also to blend into the park location and to add to biodiversity by using local flora and providing habitats for local fauna (Figure 5.5 and Figure 5.6). The roof comprises an aluminium roof deck supported by a steel framed portal structure: a load bearing capacity of 170 kg/m² was provided. The green roof is
irrigated and water is collected and stored in six tanks with a total capacity of 24,000 l. Monitoring of the energy and water consumption will reveal performance levels. Anecdotally the builders used the building during winter time as it was warmer than the site office.

5.10 Future Potential in Green Roof Retrofit

The chapter has shown that green roof retrofit for many commercial properties is technically possible and economically, environmentally and socially desirable, yet it remains the case in Australia that wide scale adoption has not occurred yet. This section discusses the future potential for green roof retrofit at a city and building scale, and also at policy level. Finally, the chapter examines the availability of best practice guidance to professional practitioners in the built environment, which aims to up-skill consultants with the latest advice and knowledge with regards to best practices regarding valuation, licenses and technical advice.

With predicted climate change, Australia is said to be facing areas where increased frequency and intensity of rainfall will be experienced and other areas which will become hotter and drier. On this basis, some cities and regions will be looking at adaptation of the existing stock with stormwater green roofs whereas others will see green roofs as a means of reducing energy usage and cooling demand. With regards to stormwater management, Lamond et al.’s (2014) Melbourne study of office building green roof retrofit found it may be possible to reduce the volume of stormwater between 50% and 85%.

The City of Melbourne experiences intense heat in summer periods. In January 2014 a 4-day period of temperature exceeding 42 °C saw an extra 250 people die in Melbourne through heat related illness, some of which was experienced in the CBD (ABC, 2014). Heat was trapped in between high-rise CBD buildings and under tree canopies exacerbating the heat further. Toronto in Canada estimated that a city wide adoption of green technology would deliver reduction of 0.5–2 °C to their urban heat island, and with 15% of roofs retrofitted the temperature of the CBD could be reduced by 2 °C (City of Melbourne, 2014). If this were to happen, the heatwave conditions as experienced in Melbourne during January 2014 may not have caused so many fatalities.

Furthermore, the continuing expansion of our cities will require some to use green roofs to improve air quality and attract bio-diversity into the area. The City of Sydney has lost 96% of the original flora and species that existed when the city was settled in 1788 – this loss is quite astonishing (Bradshaw, 2012). Such catastrophic loss demands action on a city-wide scale. The mandated approach adopted by Toronto could see a fair amount of re-introduction of native species into the city, on the basis that 15% of roofs can be retrofitted; an area of 168.75 ha would be available to plant out (Ghosh and Wilkinson, 2015).

Evidence exists that:

- Native species could be protected and reintroduced on a scale never before seen in Sydney.
- The urban heat island of Melbourne could be reduced by 2 °C and save lives during heatwaves.
- Stormwater surges could be reduced by 50–85% in Melbourne.
To date no mandatory legislation exists in Australia with respect to green roofs in new construction or retrofit works. This surely must be revisited if our cities are to adapt to predicted climate change conditions. A combination of mandatory measures and changes in practices in our commercial property market will be required to bring about the necessary transformation. Currently what we have are guides and policies to encourage the uptake of green roof technology in new build and retrofit (City of Melbourne, 2014; City of Sydney, 2015). Whilst there has been an increase in the specification of green roofs in Melbourne and Sydney over the last 3- to 5-year period, many more green roofs are required for the changes in temperature, reductions in stormwater flow and increases in bio-diversity to be apparent.

This chapter has shown that private building owners can benefit from installing green roofs from enhanced values and from improved occupant and building user satisfaction. Initiatives where green roofs are used to grow food to be donated to charity can be featured in Corporate Social Responsibility reporting and enhance a company’s reputation and standing in the community. Peck’s work (Tomsky and Koromowski, 2010) shows us it is possible to ascertain the added value in green roof retrofit, though these are of most use to policy makers. With greater uptake of green roofs in commercial property, valuers will be able to discern added value, though isolating the green roof contribution is challenging. As with sustainability and value more broadly, there is a need to educate the valuation profession. Other opportunities could exist in exploring the potential to write off leasing or licensing of roof space used for food production and donation as a tax write-off.

Best practice guides have been produced by the City of Melbourne and Sydney, respectively, and in mid 2016 a RICS Best Practice Guidance Note was published to communicate to practitioners how green roof retrofit can enhance building value, improve occupant comfort, reduce operating costs, extend roof covering lifecycles as well as mitigate the urban heat island, improve air quality and water run-off quality through filtration and reduce building related greenhouse gas emissions (RICS, 2016). The guide was written by a transdisciplinary professional and academic team, comprising valuers, property managers, building surveyors, engineering and green roof installers, based in Australia but having international experience across UK, Europe, Oceania and Asia. With regards to enhancing building value, it is necessary to tie into income or risk if the building is an investment property. Good quality information on design, costings and management and maintenance of the roof is needed also. The RICS Guidance Note is a good step forward, however guides on valuation are also needed if the case for green roof retrofit is to become stronger.

5.11 Conclusions

The benefits of green roof retrofit are manifold and evident to many, however key stakeholders remain largely unconvinced on a wide enough scale to make them a common specification in any adaptation. The reasons for this reticence to adopt green roof retrofit have been outlined and range from technical to social judgements, to knowledge and to awareness levels. In particular, valuers do not know how to value a green roof and to date, no widely accepted license or lease document has been accepted to formalise arrangements between parties. This is changing however and should provide
reassurance to all parties in respect of responsibilities and liabilities. Research shows the potential impact of green roof retrofit is significant – the temperature of city centres can be reduced by 2 °C if 15% of roofs were retrofitted (City of Melbourne, 2014). This is likely to increase in importance as time goes by. The transformation of the commercial property market comes in a number of forms, for example one would be the added value in buildings which have green roofs. Eventually it will be possible to distinguish more accurately the value of the aesthetic social green roof space from the bio-diverse, stormwater or thermal green roof. More importantly, green roofs provide a link to nature and to the seasons; they remind us when it is too wet, too hot, too dry or too cold. Food producing green roofs remind us where our food comes from and what we can grow locally, connecting us again to the seasons. This relationship should be revived for all our sakes. There is a strong correlation between observing, knowing and caring – we should encourage this relationship wherever possible from our built environment to the natural environment.

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References


References


Part II

Modelling Urban Transitions and Pathways
6

Modelling Residential Retrofit: Insights on the Effect of Regional Characteristics for the Cardiff City Region

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Overview

Using Cardiff City Region as a case study this work investigates the potential for cost effective energy and carbon saving measures at the city region scale, taking into account characteristics and constraints in each locality. Results indicate that compositional downscale using statistical information at the local authority level can provide useful insights about the retrofit needs and potential at this level. Assumptions regarding the residential fuel mix and future electricity supply have a considerable impact on determining the cost effectiveness of measures and the potential CO₂ savings, especially for local authorities with a residential housing stock and fuel mix markedly different from the assumed average. Around a quarter of the CO₂ saving target for the domestic sector (if applied uniformly at all sectors) can be achieved by the measures examined in this study but significant investment and swift action is needed to achieve this potential. The approach has sought to reconcile the need to incorporate regional characteristics in broad top-down scenario work, with the reality of data and resource scarcity which hampers the implementation of detailed bottom-up models at a large scale. Using elements from both top-down and bottom-up models may be the best approach to address the needs of users at the regional and local authority level.

6.1 Introduction

The aim of this chapter is to present modelling work carried out under the auspices of the Retrofit 2050 project, building on the work of the Centre for Low Carbon Futures (CLCF) (spanning the Universities of Birmingham, Hull, Leeds, Sheffield and York), which explores the impact of regional variation on the effectiveness of retrofit investment for cost and carbon savings. In particular, it will show that, in the Welsh context,
variations in fuel mix across local authorities (LAs) are substantive enough to warrant different investment opportunities for different LAs.

As the CLCF’s report ‘The Economics of Low Carbon Cities’ (Gouldson et al., 2012) notes, despite the range of opportunities available to reduce energy bills and carbon footprints through retrofitting activity, a lack of reliable information on their performance and reliability is a major barrier to action. High levels of risk and uncertainty deter investment, and prevent retrofit from moving from a niche activity undertaken by interested parties to a widespread form of building maintenance. The CLCF’s work sought to fill this gap by forecasting benefits at the city-region level, detailing the financial and emission gains to be had from different retrofit interventions. Building on models created as part of this work, modelling work at Cardiff University has sought to address this lack of information by creating reliable, informative model for decision makers to use while directing resources in planning retrofit, focusing on the local level in the case study areas of Greater Manchester and the Cardiff City Region, and this work is presented here.

Indeed, government policy and academic literature have suggested that regional and local governments may be in a stronger position to promote sustainable development than their national counterparts. However, this transfer of responsibility must be supported by policy makers at an appropriate level, where necessary resources and competencies can support policy change. However, what has been seen in many cases is that responsibility has been transferred without coordination or appropriate resource in terms of knowledge and human capital with the capacity to act on these issues. Within the residential sector, there has been limited research into the disaggregated potential for energy, carbon and cost savings achievable by readily available energy efficiency and low carbon measures in the individual LAs. As such, LAs are faced with a challenge when trying to draw insights into the best options available to them. This can result either in missing ‘best practice’ lessons from elsewhere or LAs hesitating to take decisions on cutting edge or contentious projects (Stevenson and Richardson, 2003).

This chapter is structured as follows: Section 6.2 considers the context in which the LAs of the Cardiff City Region, as defined by the Retrofit 2050 project as incorporating the LAs of Cardiff, Newport, Rhondda Cynon Taf, Blaenau Gwent, Bridgend, Caerphilly, the Vale of Glamorgan, Torfaen, Monmouthshire, Merthyr Tydfil, Swansea and Neath Port Talbot make decisions about retrofitting activities, including the shifting role of local government in the UK and the existing housing stock, both in the past and present. Section 6.3 presents the methodology employed by the model, its requirements and its potential outputs. Section 6.4 discusses some results from the model’s application under the auspices of the Retrofit 2050 project, including implications for different types of retrofitting activity by locality and the importance of fuel mix. Finally, Section 6.5 makes some concluding remarks.

6.2 Context

6.2.1 Role of Local Government

As has been noted above, LAs are increasingly taking a role in guiding sustainable development in their jurisdictions. This idea is not a new one: the importance of
local action for sustainability was discussed at length in the 1992 United Nation Conference on Environment and Development, leading to the formation of the Agenda 21 partnership for the promotion of sustainable development (Schreurs, 2008). Yet, despite this early interest in the role that local government (and governance) can play in sustainability policy and transition, relatively little has been written on the matter.

The literature does highlight that the relationship between central and local government is a complex one. Wilson and Game (2002: 27) note that local governments are ‘are able to do what they are statutorily allowed to do’: that is, their ability to act is not general but specific to their fields of devolved responsibility. Nonetheless, they do have some financial independence, along with these specific areas of responsibility and discretion, giving them ‘partial autonomy’ to act (Bulkeley and Kern, 2006).

LAs in the UK do not have an explicit duty to combat climate change, but they are responsible for a number of duties related to it (Bulkeley and Kern, 2006), for example the maintenance of social housing, waste and travel policy. As such, they are in a position to take action on levels of water and energy use and carbon emissions at the local level.

Moreover, while the economic, ecological, population and institutional challenges of climate change are widely recognised as being globally felt, they are not felt the same in all places. As well as varying across countries, these pressures are felt differently across and even within cities (Hodson and Marvin, 2010). As such, local governments are in an arguably unique position to recognise and respond to these challenges as they are felt in their localities.

6.2.2 Cardiff Domestic Stock: History and Legacy

Wales was largely left behind by the first Industrial Revolution, associated with water power and the textile industries, and it was not until the iron boom of 1760 that the economy began to expand, with South Wales driving the Welsh economy forwards (Wang and Eames, 2010).

As of 1801, Cardiff and its hinterland were home to about 40 000 people, eclipsed by the nearby towns of Merthyr and Swansea. From the mid nineteenth century onwards, however, the region experienced rapid population growth, from 208 145 in 1861 to 485 000 in 1891 and up to 885 000 by World War I (Hooper, 2006). For the latter part of the nineteenth century, South Wales was a boom economy built on the export of raw materials, at once a major centre for iron production and the greatest coal exporting region in the world (Minchinton, 1969). While the volume of raw materials exported from the region grew significantly, this was not based in improvements in productivity; rather, mass immigration saw the South Wales Valleys lined with rows of houses to accommodate its swelling population (Minchinton, 1969).

By 1913, the landscape of South East Wales had changed. The coalfields had been populated with industry and housing for the labour force; Cardiff, for its part, had developed new residential areas to meet the growth in population (Hooper, 2006). However, the changing wider economic climate began to impact on the local economy. The region was highly specialised and export-orientated in its activities, both of which left it open to changes in the global market. As international competition rose, South Wales lost its competitive advantage and the region began to decline.
Post-war regeneration was necessarily concerned with physical renewal issues such as housing. During the 1950s and 1960s, policy included the building of extensive housing estates which would, ironically, become something of a problem to be addressed by future regeneration efforts (CAG Consultants, 2005).

Housing is an area of devolved responsibility, with the Welsh Government and 22 Welsh LAs being jointly active in retrofitting the housing stock. Local councils are responsible for upgrading the stock that fails, maintaining the standard over the following years (Welsh Assembly Government, 2008) and ensuring sustainable development within their boundaries by identifying and supporting sustainable and viable renewable energy schemes (Welsh Assembly Government, 2010). The Welsh Government have declared a strong commitment to achieve annual carbon equivalent emissions reductions of 3% per year in areas of devolved competence, relating to all direct greenhouse gas (GHG) emissions in Wales not covered by the European Union emissions trading system (EU ETS), including power generation emissions (for the most part covered by the EU ETS) assigned to the end-user in each of the non-traded sectors (Welsh Assembly Government, 2008). By this definition, the residential sector represents 30% of the emissions within Welsh Government competence and becomes one of the key areas of intervention where potential large savings could be achieved towards the policy targets within devolved competence by 2020 (Forster and Levy, 2008: Welsh Assembly Government, 2008).

The Welsh residential sector has a larger share of hard to treat properties compared with the rest of the UK – for example, 15% of properties in Wales are off the gas network, compared with 10% in England (DECC, 2014) and 31% of Welsh properties are solid walled, compared with 22% in England (Valuation Office Agency, 2014) – which indicates large scope for improvement in energy efficiency but potentially also larger associated marginal costs. Whilst a wide range of potential retrofit measures are available, the main technical means of reducing energy consumption and CO2 emissions from existing dwellings in Wales fall into three broad categories: (i) changing the energy source for space and water heating to more carbon and energy efficient alternatives; (ii) insulation and improvements to air tightness; and (iii) the use of small scale renewable energy systems at the local level.

### 6.3 Methodology

Residential energy consumption is influenced by many parameters, and thus the evaluation of the effectiveness of policies and intervention scenarios is not a simple task. Previous work on policy options for the reduction of GHG emissions has concluded that it is difficult to predict the impacts of policy measures in the long term, because of the uncertainty over many of the variables involved.

The majority of literature divides modelling methods in two categories: top-down models; and bottom-up models. Top-down models are based on regression analysis in order to examine the relationship between energy consumption and demographic, financial and technological factors (Swan and Ugursal, 2009). Bottom-up models are based on the examination of a sample of individual houses and then extrapolate the result to a regional or a national level (Jones et al., 2007). One of the most important limitations of models is the lack of appropriate input data or absence of data in general, as well as the level of disaggregation of input data. Both types of model can provide...
6.3 Methodology

relatively robust results given the right configuration; bottom-up approaches examine scenarios providing a great level of disaggregation and detail, including new technological features, but require significant input; top-down models usually rely on historical data in order to derive robust results.

A number of residential models have been developed as policy support tools, providing projections at the national level. The majority of these are based on the BREDEM tool, which has a great level of complexity and, consequently, requires a lot of input from several data sources for its application. Despite a number of studies at UK level (Kavgic et al., 2010), there is limited research into the disaggregated potential for energy, carbon and cost savings achievable by readily available energy efficiency and low carbon measures in the Welsh local authorities. Examining the application of these models in the context of the Welsh local authorities reveals a number of issues with lack of data; the interpolation and substitution of data based on other regions; and the aggregated nature of results limiting the potential for regional insights. At the time of writing there is no representative residential stock model for Wales.

The work is based on the methodology used to model the domestic sector in the CLCF’s report ‘The Economics of Low Carbon Cities’ (Gouldson et al., 2012). This is a top-down model, using data from the UK Committee on Climate Change (CCC), at the same time considering changes in the fuel costs and energy mix. The CCC data assess the potential energy, cost and carbon savings for a variety of low carbon measures in the residential sector, over and above a baseline scenario, which are theoretically possible at the UK level, and subsequent reduces that potential to what can realistically be achieved under certain conditions (BRE, 2008; elementenergy, 2009; Weiner, 2009). In essence, the sector specific data are still derived through the application of BREDEM through the use of a single ‘average’ type of home (BRE, 2008; Weiner, 2009).

The model has the ability to offer the potential energy, cost and carbon savings from a range of low carbon measures downscaled at local authority level by taking into consideration region-specific housing stock information. The present amount of households and future projections for each of the LAs have been employed (Ricardo-AEA, 2013) to transform the data available at UK level. Subsequently, the Home Energy Efficiency Database (HEED; Energy Saving Trust, 2010) was used to obtain a location-specific picture of existing measure implementation, and concurrently the potential for each measure that remains (Figure 6.1).

Figure 6.2 shows the share of different fuel mix in residential energy consumption in the region, with a notably high variation across LAs. This reflects differences in levels of urbanisation, historical context of building stock and geographical topology. Indeed, while Figure 6.2a shows that variation is marked across the Cardiff City Region, which is the area of study here, Figure 6.2b shows that variation is even greater across Wales as a whole. Additional modelling work was carried out to translate the energy savings assigned to each measure to fuel and cost savings that reflect the fuel mix in each LA. This work explored the link between measures and fuel costs, where financial savings can be higher if the fuel type is electricity.

As has been noted above, this variation in fuel mix has implications for the cost effectiveness of certain measures, especially for solid wall insulation as the fuel costs have a major impact on its viability in the longer term. An additional piece of modelling work aims to translate the energy savings assigned to each energy efficiency measure to fuel and cost savings that reflect the fuel mix in each LA.
This was achieved by correlating historical data on the contribution of each type of fuel to different domestic uses with the share of the respective fuel in overall domestic consumption (DECC, 2012a, 2013a) and the information contained in HEED. The correlation revealed strong relationships between the two datasets and additional correlations between the use of specific types of fuel for space and water heating through time, which also related well with the HEED data expressing the geographical context. Examples are presented in Figure 6.3, Figure 6.4 and Figure 6.5.

These correlations were combined with the trends observed in the domestic energy demand projections to estimate the progression of the fuel mix within each of the LAs. The same trajectory has been assumed, in terms of change in percentage per year, as given in the UK level projections, to be taking place at LA level as well, albeit from a different starting point.

While the methodology provides a way to attribute energy used for space and water heating to different fuels and come up with projections, it should be noted that fuel switch trajectories may differ depending on the starting point, the availability of technologies, resources and other parameters that cannot be accounted for in this study. Similarly in terms of the relationship between the fuel type used for space and water heating, the historical correlation may not be maintained going forward due to changes in technology. Renewables have been ignored as they only projected to account for 2.3% maximum of the mix by 2030 according to domestic energy fuel mix projections used in this model. Clearly this will change depending on uptake of renewable technologies in the future.

Having attributed the energy savings for each use to a particular mix of fuels the cost and emission savings are calculated from the fuel price projections (DECC, 2012a) and the carbon intensity associated with each energy source through the use of established emission factors (DECC, 2012b) (Table 6.1) These remain constant through the time frame of the study with the exception of electricity emission factors which are discussed in the following section.
The analysis uses the values published by DECC towards the end of 2012 (DECC, 2012c). These forecasts are available in three fuel cost scenarios; low, central and high, with and without tax. Private investment rates range between 8% and 25% while social rates are usually assumed to be at 3.5% (Pye, et al., 2008). The change in fuel type usage that was used to

Figure 6.2 Share of different fuels in the residential energy consumption of Welsh local authorities and Wales in (a) Cardiff City Region and (b) Wales as a whole. Data source: DECC 2013a.
Figure 6.3 Correlation between oil share in HEED main heating fuel data and total domestic energy consumption. Each point represents a local authority. *Data source:* Energy Saving Trust, 2010 and DECC, 2013a.

Figure 6.4 Historical correlation between the use of oil fuel in space heating against the share in total domestic energy at UK level. Each point represents a year. *Data source:* DECC 2013a.

Figure 6.5 Historical correlation between oil (and other petroleum products) use for space and water heating at UK level. Each point represents a year. *Data source:* DECC 2013a.
work out the carbon saving was also applied to work out the cost savings. The carbon intensity of electricity from the relevant fuels follows DECC forecasts (DECC, 2013b) and reflects the projected fall in the carbon intensity of electricity in the period to 2022.

### 6.4 Results

First, and most importantly, the analysis of each of the 12 LAs in the Cardiff City Region (as defined by the Retrofit 2050 project, adapting the definition employed in the Wales Spatial Development Plan 2008) revealed that the potential savings from the same retrofitting measure is different in each LA.

Figure 6.6 and Figure 6.7 show the potential for CO₂ savings by building fabric measures and the investment needed based on the fuel mix for each of the LAs, respectively. The interventions are grouped by type into: increasing wall or loft insulation; better glazing; or a number of other measures. Wall insulation has by far the most potential for emission reductions but also the highest associated cost accounting for just over 60% of the potential savings and 65% of the investment needed. Various levels of loft insulation and changes in glazing follow in terms of the carbon reduction potential, while a number of other measures such as DIY floor insulation and improvements in air tightness also make a small cost effective contribution.

Note that the trend in both the emission reduction potential and the necessary investment does not always correlate with the relative size of the LA. This is due to the differences in the residential stock in each location as recorded in the HEED, and the difference in fuel mix, which is reflected in the calculations.

Figure 6.8 gives an indication of the number of cost-effective building fabric interventions. In the high fuel cost scenario over 186 000 properties in the Cardiff City Region could benefit from cost-effective improvements in loft insulation by 2017. This is reduced to fewer than 109 000 interventions if low fuel costs are assumed. Solid wall insulation does not feature in a low fuel cost scenario and glazing measures are also substantially reduced. Conversely, cavity wall insulation and the remaining building fabric measures examined are not affected by the magnitude of change in fuel cost between the two scenarios.

Combining all the above information it is possible to present emission savings relative to the share of investment and instances of retrofit measures in each category of measures (Figure 6.9). Loft and wall insulation have the most instances, but when it comes to

<table>
<thead>
<tr>
<th>Fuels</th>
<th>Emission factor kgCO₂/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal and solids</td>
<td>0.31</td>
</tr>
<tr>
<td>Gas</td>
<td>0.18</td>
</tr>
<tr>
<td>Electricity</td>
<td>0.55</td>
</tr>
<tr>
<td>Oil</td>
<td>0.25</td>
</tr>
</tbody>
</table>
Modelling Residential Retrofit: Insights on the Effect of Regional Characteristics for the Cardiff City Region

Figure 6.6 CO\textsubscript{2} emission savings broken down by type of building fabric measure for each local authority.

Figure 6.7 Investment needed by 2022 in each area of building fabric measures per local authority.
6.4 Results

Figure 6.8 Scale of cost effective building fabric interventions for the Cardiff City Region domestic sector in the high (a) and low (b) fuel cost scenarios.

Figure 6.9 Split of cost effective instances, investment and carbon emission savings potential between different types of building fabric measures for the Cardiff City Region.
investment and CO₂ savings, it is wall insulation that requires most of the funding but also delivers emission cuts. Similar comparative graphs can be produced in more detail for each category, or including just a selection of measures to aid (along with other factors) decisions on the allocation of funds and priority of measures in each area.

### 6.4.1 Wall Insulation

Wall insulation measures are divided into solid and cavity wall based on the type of wall; cavity wall insulation is split further based on the age of the property to pre 1976, 1976–1983, and post 1983 construction. The first thing to note is that solid wall insulation is not cost effective across the Cardiff City Region, but only in certain LAs, namely Cardiff, Monmouthshire, Newport and the Vale of Glamorgan. These are not LAs with larger proportion of solid wall dwellings in the housing stock, but rather areas where the fuel mix for space heating is such that it makes solid wall insulation cost effective for the given fuel cost scenario. As shown in Figure 6.10, in the period 2012–2017, when solid wall insulation measures start to feature in the results, these four LAs have the highest fuel costs for space heating, while there seems to be a marginal cost around 6.3 p/kWh where the measure becomes cost effective.

Figure 6.11 shows that these particular LAs also have higher emission factors for space heating relative to the rest of the region. If low fossil fuel costs are assumed solid wall insulation is not cost effective across the board.

Pre 1976 cavity wall insulation accounts for 69% of the potential for CO₂ savings from wall insulation in the Cardiff City Region and has 34% of the cost effective investment modelled. Solid wall insulation contributes a further 23% of CO₂ savings but requires 60% of the funding for the implementation of wall insulation measures to 2022. According to these figures, the greatest initial gain could be obtained by targeting older (pre 1976) properties with cavity walls.

### 6.4.2 Loft Insulation

The potential for CO₂ emission reductions by installing loft insulation is split between introducing insulation to uninsulated or poorly insulated properties and upgrading the
insulation of moderately insulated properties to a high standard. Uninsulated properties account for 34% of the potential for reductions from this measure at about 10% of the total necessary investment. At the other end of the scale, upgrading insulation from 100 to 270 mm would cut annual CO2 emissions a further 26% of the potential, requiring 55% of the estimated investment.

Up to 5% of the surveyed stock in the Vale of Glamorgan has no loft insulation, and in total up to 28% of the stock in LAs such as Monmouthshire and the Vale of Glamorgan is considered for the loft insulation measures presented here. Taking into account both stock condition and size, Swansea is the LA that could achieve the greatest savings from this measure.

### 6.4.3 Glazing

Double glazing is a popular measure; the implementation of double glazing often happens for reasons unrelated to energy efficiency. The change from single to E rated double glazing is mandatory for extension and/or renovation work and for that reason it is considered unaffected by the modelled policies and no costs are assigned to the measure. It is estimated that the stock will be fully replaced by 2035.

In the case of glazing measures, potential savings are shared between replacing single and old double glazing in most cases, except for LAs where the share of single glazing is high, such as Merthyr Tydfil, and Swansea (12–13% of the stock). Replacing single glazing to double would bring about 42% of the potential savings; a further 28% of the potential reduction in CO2 emissions could be achieved by replacing old double glazing. The remaining 30% of CO2 savings is the most expensive to achieve, requiring glazing to best practice. Note that glazing to best practice has not been adjusted through the use of HEED data and consequently the potential for this measure is only dependent on the size of the LA. Glazing to best practice is not cost effective if low fossil fuel costs are assumed.
6.5 Conclusions

The aim of the methodology applied in this work, was to look into the potential for cost effective energy and carbon saving measures at the city region scale, taking into account characteristics and constraints in each locality. First results indicate that modelling residential retrofit at the LA level can provide useful insights about the retrofit needs and potential at this level.

Assumptions regarding the residential fuel mix and electricity emission factors have a considerable impact on determining the cost effectiveness of retrofit measures and the potential CO$_2$ savings particularly for expensive measure such as solid wall insulation. The effect is exaggerated for LAs that have a fuel mix markedly different from the assumed average, and becomes more pronounced in general for long term projections, as the uncertainty over the emission factors and costs of power generation increases for future years. Although a first attempt has been made to tackle these issues, providing valuable insights at the regional level, it is clear that they should be subject to further research.

The present work has sought to reconcile the need to incorporate regional characteristics in broad top-down scenario work, with the reality of data and resource scarcity which does not allow detailed bottom-up models to be implemented for most areas. It is essential to reconcile these approaches and work towards an accurate portrayal of the sector in order to address residential stock-specific constraints and opportunities. In doing so, a mid-way approach using elements from both top-down and bottom-up models may have to be devised to address the needs of users at the regional and LA level.

Despite the limitations mentioned above, what the present work has shown is that there are useful insights to be gained from taking a middle-level approach to consider the best way to invest in retrofit, and that these decisions need to be decentralised to more local levels of government. Even with the geographically small Cardiff City Region, different LAs are subject to different housing stocks and differing fuel mixes: we have shown above that these differences have a sufficient impact upon cost and carbon saving outcomes as to be considered significant. There is, then, a role for local government in managing data in order to best maximise retrofitting of the housing stock. This role, however, must go alongside a cooperative, synergistic approach from higher levels of government with greater access to data and funding resources.

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References

References


DECC (2012a) Energy Consumption in the UK Domestic Data Tables 2012 Update. Table 3.6 and Table 3.7.


7

Weatherproofing Urban Social Housing for a Changing Climate Through Retrofitting: A Holistic Approach

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4 Energy Strategy & Advice Manager, Energy Service Islington Council, 1 Cottage Road, London, N7 8TP

Overview

Among the many major challenges to the implementation of large-scale housing retrofit in the UK is combining climate change mitigation through energy efficiency upgrades with climate adaptation. Whilst the specification of increasingly airtight and insulated building envelopes is necessary to reduce carbon emissions from the domestic building sector, new and existing homes will also need to be prepared for a warmer climate. This chapter explores the interrelationship between these often contradictory requirements in the context of social housing, using South Islington, in central London, as a case study. Overheating risks are likely to be amplified in social housing due to the increased propensity to overheating of certain dwelling types that are common in this sector (e.g. purpose-built flats) and the high levels of individual vulnerability, in particular among the elderly. It was indicated that although social housing residents are often sceptical about climate change, they may be already facing thermal discomfort under the current climate, which is expected to be exacerbated under future climate scenarios. It was also found that air pollution, noise and security concerns may limit the potential of occupant-controlled natural ventilation.

7.1 Scope

This chapter explores optimal pathways to futureproofing the climate resilience of social housing through retrofitting. Climate adaptation challenges and opportunities for the social housing sector in the UK are assessed through a case study: a climate awareness survey of vulnerable residents in council homes in South Islington, central
London that was carried out in 2012–2013 as part of the Climate Resilience Islington South Project (CRISP) (Kolm-Murray et al. 2013) funded by the Department for Environment, Food & Rural Affairs (DEFRA), and a follow-up detailed indoor thermal monitoring and modelling study in a number of selected properties (Mavrogianni et al. 2015).

7.2 The UK Housing Retrofit Challenge and Potential Unintended Consequences

Sustainable urban retrofitting is defined as the ‘directed alteration of the fabric, form or systems which comprise the built environment in order to improve energy, water and waste efficiencies’ (Dixon et al. 2014). The UK faces the unprecedented engineering challenge of retrofitting its existing housing stock with the aim to reduce carbon emissions attributable to the residential sector. Such interventions would also help alleviate fuel poverty, which currently affects more than 8 million individuals in the UK and is defined as the condition of being left with a residual income below the official poverty line after paying for required fuel costs above the median level (Hills 2013).

However, unless a holistic approach towards retrofit is adopted that combines climate change mitigation and adaptation strategies, retrofit interventions may lead to unintended consequences (Shrubsole et al. 2014). Mitigation, in the context of climate change, is defined as ‘a human intervention to reduce the sources or enhance the sinks of greenhouse gases’. Adaptation, on the other hand, is defined as ‘the process of adjustment to actual or expected climate and its effects’ (IPCC 2014). The interactions between retrofit policies, building physics and human behaviour can be convoluted and their outcome is often difficult to predict.

Retrofitting, if done inappropriately, may increase the risk of a building overheating during warm summer weather (Mavrogianni et al. 2012). Although excess cold will remain the predominant weather-related health risk factor, with heat waves expected to become more common in the future due to climate change (Murphy et al. 2010), heat-related mortality is expected to increase. Core urban areas, in particular, are expected to experience aggravated risks in the future due to the combined effect of the urban heat island phenomenon, outdoor air pollution and climate change. Low income groups are likely to be affected by such risks the most (LCCP 2013). Active cooling adaptations, such as air conditioning are currently rare in UK dwellings, but by 2030 it is estimated that one quarter of English homes will have air conditioning in order to cope with the warming climate (Collins et al. 2010). Due to the energy demand and CO2 emissions of such systems, active systems should be discouraged in favour of passive cooling methods.

7.3 Challenges and Opportunities for Social Housing Retrofit

Around one fifth of the UK domestic building stock (approximately 4.7 million dwellings) is classified as social housing. Social housing can be the home to some of the more vulnerable segments of the UK population. The 2011 Census (ONS 2016a) indicates that 13.2% of the households residing in social housing are long-term unemployed (versus
4.5% in the total population), and that 18.7% of those over 65 live in social housing. In Islington, these values raise to 16.2% long-term unemployed and 20.5% of those over 65.

Energy efficient retrofit is particularly needed in social housing as occupants may be less likely to be able to afford heating costs, and may be more vulnerable to negative health consequences from cold due to age or health concerns. In addition, social housing benefits from public ownership and regulation with Registered Social Landlords (RSL) are already required to ensure that they provide and maintain homes to an acceptable standard (Reeves et al. 2010). Social housing could, thus, function as a starting point that could help accelerate large-scale sustainable retrofit in the UK. Indeed, research has shown that local councils in the UK have been proactive in retrofitting the existing stock to be more energy efficient (Hamilton et al. 2014).

Occupants of social housing may be at particular risk from high indoor temperatures, as they are less likely to be able to adapt their homes to a changing climate themselves, and they are likely to be elderly or have a pre-existing health condition that increases their susceptibility to heat (Kolm-Murray et al. 2013; LCCP 2013); they may be home during the hottest time of the day; they may be unable to take action to help reduce the indoor temperatures, such as opening windows; and they may be resident in one of the building types that is of particular vulnerability to overheating, such as top-floor flats in multi-occupancy buildings. The 2010–2011 English Housing Survey (DCLG 2015) indicates that a high percentage (around 71%, Table 7.1) of those over 60 years old in social housing living in London are housed in purpose-built flats, which can have a high overheating risk.

### Table 7.1 Dwelling types and population percentages for those in social or private housing in London, from the 2010–2011 EHS.

<table>
<thead>
<tr>
<th>Dwelling type</th>
<th>Social housing</th>
<th>Rented or owned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Under 60</td>
<td>60 or over</td>
</tr>
<tr>
<td>End terrace</td>
<td>7.2%</td>
<td>3.2%</td>
</tr>
<tr>
<td>Mid terrace</td>
<td>16.9%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Semi detached</td>
<td>4.6%</td>
<td>6.9%</td>
</tr>
<tr>
<td>Detached</td>
<td>0.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Bungalow</td>
<td>1.2%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Converted flat</td>
<td>7.1%</td>
<td>9.9%</td>
</tr>
<tr>
<td>Purpose built flat, low-rise</td>
<td>45.3%</td>
<td>63.9%</td>
</tr>
<tr>
<td>Purpose built flat, high-rise</td>
<td>17.6%</td>
<td>6.9%</td>
</tr>
</tbody>
</table>

7.4 The Building Envelope as a Climate Modifier

The geometric characteristics and physical properties of a building can markedly modify the indoor climate and levels of exposure to excess temperature and air pollutants. There is a wide range of evidence demonstrating that there is a large variation in
indoor environmental quality and associated exposure risks, including indoor temperature monitoring studies (Beizaee et al. 2013), building physics modelling studies (Gupta & Gregg 2013; Mavrogiani et al. 2012; Oikonomou et al. 2012; Porritt et al. 2012), and epidemiological studies of heat wave mortality (Vandentorren et al. 2006).

This large body of research on the overheating risks of different building variants in the UK could potentially be used to support retrofit and design decisions. Previous research has indicated that external shading (Porritt et al. 2012; Gupta & Gregg 2013), external solid wall insulation (Porritt et al. 2012), increased passive ventilation with trickle vents, and roof insulation (Taylor et al. 2015a) may help to reduce the risk of overheating. Porritt et al. (2013) have produced a retrofit toolkit and ranking of different interventions to reduce overheating risk in dwellings. With an eye to futureproofing social housing, it is essential that future retrofit guidance and designs of social housing take into account the outcomes of this body of research in their recommendations.

Increasing ventilation through opening windows is one of the primary means for reducing indoor temperatures in naturally ventilated buildings. However, this is not always possible: in some areas, high levels of crime, noise or air pollution may make occupants reluctant to open their windows. Noise pollution is often cited as a key reason behind the decision of occupants not to open windows, which is crucial taking into account that noise exposure has been found to correlate with low socioeconomic status (Dale et al. 2015). The ingress of harmful pollutants from outdoor sources, such as PM$_{2.5}$ from traffic and industry, will increase when windows are opened, leading to a potential increase in future exposure levels as occupants are forced to ventilate further to cope with hotter temperatures (Taylor et al. 2015a). Research suggests that social housing in England has lower levels of outdoor pollution indoors than other housing types due to their relatively high airtightness due to retrofit and reduced number of exposed facades (Shrubsole et al. 2016). However, a correlation between low income and high outdoor pollution levels has also been observed (Pye et al. 2001) meaning that the advantages conferred by social housing may be offset by the higher external pollution concentrations and the need to open windows more often to offset high internal temperatures.

7.5 The Role of Seasonal Health Policy

The vulnerability of the social housing population, combined with characteristics common to dwellings with overheating problems, means that a number of risks exist that may be mitigated by an effective seasonal health and housing development policy. It is, therefore, critical that modifications to the building fabric in social housing account for both current and future climate scenarios when undergoing retrofit.

One such example of current policy is Public Health England’s Heatwave Plan for England (PHE & NHS 2015), which recommends a number of actions to be taken during warm weather to cool indoor temperatures, for example opening windows when indoor air is warmer than outdoor air, using outdoor sun awnings and shading, and reducing the use of electrical equipment and lighting. While the role of occupant behaviour is significant for indoor temperatures (Mavrogiani et al. 2014), the existing guidance does not account for the influence of buildings on exposure risk, and is reliant on General Practitioners (GPs) to disseminate to vulnerable individuals.
The modifications of existing buildings, or the design of future buildings, to cope with hot summers and a warming climate is likely to be a key component of any drive to reduce heat-related mortality risks, and there is currently no requirement to assess overheating risk when retrofitting dwellings. As current UK policy is encouraging the energy-efficient construction or retrofit of dwellings, it is important that these changes to the building fabric are done in a manner which does not increase overheating risks in the future.

Public health and local government have influential roles in mitigating heat risk to the most vulnerable individuals. At the local council level, this can include financing appropriate retrofits that provide energy efficiency and indoor temperature benefits, and by prioritising low heat risk housing for the most vulnerable individuals. The reduction of neighbourhood overheating risks through urban heat island mitigation will also help reduce overheating; this may be done, for example, through increasing green spaces, street canyon design, green roofs and cool pavements (Gago et al. 2013).

### 7.6 South Islington: A Case Study

#### 7.6.1 Climate Risk Awareness and Behaviour

The *Climate Resilience South Islington Project* (CRISP) was carried out in 2012–2013 to assess the factors influencing the behaviour and attitudes of older social housing tenants to extreme weather. The south of Islington, and specifically the two wards of Bunhill and Clerkenwell, was chosen due to:

- Its population density: 129.4 people per hectare, compared with 4.1 per hectare for England (ONS 2016a).
- Low levels of green space: Islington as a whole has the second lowest ratio of green space to population of any local authority area in England (London Borough of Islington 2011).
- Concentration of high rise housing, meaning lots of unshaded, single-aspect dwellings: 17.3% of households in the study area lived on the fifth floor or above, compared with 0.7% for England (ONS 2016b).
- Air quality: There are significant concentrations of ozone, PM$_{2.5}$ and PM$_{10}$ in parts of the study area, particularly around the King’s Cross, Old Street and City edge areas (King’s College London 2016).
- Location within London’s urban heat island: Islington is located in an area characterised by increased urban temperatures as demonstrated in the map in Figure 7.1.

A quantitative study of 450 residents over the age of 60 was conducted, alongside three focus groups, 10 in-depth case studies and 22 surveys of organisations working with older people in the area. Key findings were as follows (Kolm-Murray et al. 2013):

- Residents surveyed did not take the health risks of hot weather as seriously as those posed by cold weather, with many seeing heat waves as an uncontrollable act of ‘Mother Nature’. Many were philosophical to the point of fatalist about the risk associated with high temperatures.
- There was a certain amount of scepticism about climate change and scientific explanations.
On average, study participants viewed anything above 28 °C as a heat wave, 4 °C below the daytime temperature designated by the Met Office to trigger a heat wave alert in the London region (Figure 7.2). (An average threshold temperature of 32 °C by day and 15 °C overnight for at least two consecutive days needs to be exceeded for a heat wave alert to be issued; PHE & NHS 2015.)

There was a small but significant minority of individuals who appeared to be genuinely isolated and these were often those who were not taking necessary steps for heat wave resilience, such as adequate hydration.

Whilst most individuals followed general advice about hot weather, there were widespread misconceptions about window management and a lack of clarity over the use of fans.

Fear of crime and animal entry, and to some extent noise and pollution, prevented effective window management for night time ventilation. As illustrated in Figure 7.3, the majority of residents tend to open windows during the day and close them during the night.

Whilst there is some evidence for the benefit of community cooling centres there was widespread scepticism about such facilities with only those reporting low social contact being somewhat open to the idea.

### 7.6.2 Indoor Summer Thermal Comfort and Environmental Quality

As a follow-up to the CRISP study, participants were contacted and asked to participate in an indoor temperature monitoring study in order to assess the levels of exposure to
indoor overheating of vulnerable residents in the case study estates. The study also investigated synergistic effects between window opening patterns, indoor thermal conditions and indoor air quality under different energy retrofit and climate change scenarios. It focused on three social housing typologies (1900s low-rise, 1950s mid-rise and 1960s high-rise). Hourly indoor temperature and relative humidity were monitored in eight flats during the summer of 2013 using Onset HOBO U12-012 data loggers (Onset Corporation 2016).

Figure 7.2 What CRISP survey respondents considered constitutes a heat wave (size of bubble indicates number of respondents who chose this temperature). Source: Kolm-Murray et al. 2013. Reproduced with permission of Kolm-Murray.

Figure 7.3 Comparison of how many windows CRISP survey respondents open in the daytime and at night. Source: Kolm-Murray et al. 2013. Reproduced with permission of Kolm-Murray.
The key findings of this study are summarised below and in Mavrogianni et al. (2015):

- In the case study flats examined, the indoor temperatures closely followed the outdoor temperatures, potentially as a result of poor insulation (high thermal transmittance) and/or frequent window opening during this period.
It was shown that, according to the indoor monitoring results, residents in the case study flats already experience a number of hours of overheating even during a mild summer, such as that of 2013. This is particularly important, taking into account that the adaptive capacity of residents, that is the actions an individual can take to improve their thermal comfort during hot weather (e.g. adjust clothing, consume cold beverages, have cold showers, etc.) may be limited in these properties, especially among the elderly and chronically ill individuals.

Flats located in the 1960s high-rise building appeared to be more vulnerable to heat, with excess indoor temperatures recorded there more frequently compared with the other monitored flats, which corroborates the results of previous studies.

Taking this into account, dynamic thermal modelling using the physics based EnergyPlus software package version 8.0.0.007 (US DoE 2015) was employed to simulate the thermal and airflow performance of the 1960s 17-storey tower block (Figure 7.4 and Figure 7.5). The case study building is representative of high-rise residential developments constructed under the Social Housing Schemes in the 1960s and 1970s. A series of alternative scenarios were modelled:

- building fabric energy efficiency levels (summarised in Table 7.2)
  - existing state
  - following retrofit including external wall insulation, windows upgrade and improvement of building fabric airtightness
- window and shading operation modes
  - all-day ‘rapid’ ventilation
  - night time ‘purge’ cooling and daytime shading, in line with existing recommendations

Some of the main observations of the modelling analysis are:

- The simulation results of a mid-floor south-oriented flat in the block (labelled ‘CW’ in Figure 7.5) were consistent with the monitored data and demonstrated that

### Table 7.2 Building fabric modelling input data for the modelling case study building (1960s high-rise).

<table>
<thead>
<tr>
<th></th>
<th>Existing</th>
<th>Retrofitted</th>
</tr>
</thead>
<tbody>
<tr>
<td>External walls</td>
<td>Precast concrete parts with no</td>
<td>Precast concrete parts with internal</td>
</tr>
<tr>
<td></td>
<td>insulation</td>
<td>insulation</td>
</tr>
<tr>
<td></td>
<td>U-value = 2.00 W/m²K</td>
<td>U-value = 0.60 W/m²K</td>
</tr>
<tr>
<td>Ground floor</td>
<td>Solid concrete slab</td>
<td>Solid concrete slab</td>
</tr>
<tr>
<td></td>
<td>U-value = 1.60 W/m²K</td>
<td>U-value = 1.60 W/m²K</td>
</tr>
<tr>
<td>Roof</td>
<td>Solid concrete slab</td>
<td>Solid concrete slab</td>
</tr>
<tr>
<td></td>
<td>U-value = 2.30 W/m²K</td>
<td>U-value = 2.30 W/m²K</td>
</tr>
<tr>
<td>Windows</td>
<td>Post-2002 double-glazed with a uPVC</td>
<td>Triple-glazed with a uPVC frame</td>
</tr>
<tr>
<td></td>
<td>frame</td>
<td></td>
</tr>
<tr>
<td></td>
<td>U-value = 2.00 W/m²K</td>
<td>U-value = 1.80 W/m²K</td>
</tr>
<tr>
<td>Air infiltration</td>
<td>11.5 m³/m²·h at 50 Pa</td>
<td>5.0 m³/m²·h at 50 Pa</td>
</tr>
</tbody>
</table>

*Source: Mavrogianni et al. 2015. Reproduced with permission from Taylor and Francis.*
overheating thresholds are also likely to be exceeded under future climate scenarios. As illustrated in Figure 7.6, under the 2050s Medium (a1b) emissions scenario (UKCIP 2009), the living room of the case study flat faces more than 70% of occupied hours above 25 °C for all iterations.

- It appears that an unintended consequence of the assumed retrofit measures is that summertime indoor overheating appears to increase compared with the baseline condition. For the retrofit scenario with night only cooling and shading, internal temperatures lie above 25 °C for the majority of the time that occupants are indoors.
- According to the simulation results, under both the current and future climate, natural ventilation could potentially reduce indoor temperatures but only to a certain degree. The increase of external temperatures in the future, according to climate change projections, is expected to decrease the effectiveness of natural ventilation as a cooling strategy.
- Interestingly, as shown in Figure 7.6, the all-day ‘rapid’ ventilation strategy was found to be more effective in terms of lowering temperatures in the living room compared with the combined night ‘purge’ ventilation and daytime shading strategy.
- However, the opposite was observed for the night time temperatures in the bedroom. In this case, an intelligent natural ventilation strategy, such as the combination of night ‘purge’ ventilation combined with (internal) shading of windows receiving

**Figure 7.6** Exceedance of overheating thresholds in the living room of the mid floor flat of the CRISP follow-up case study modelled building during the summer period under the 2050s Medium emissions 50th percentile UKCP09 scenario. Source: Mavrogianni et al. 2015. Reproduced with permission from Taylor and Francis.
direct solar radiation during the day was proved to be more effective than daytime ‘rapid’ ventilation.
• In line with the findings of the CRISP questionnaire survey and other studies, indoor air pollution concerns could further limit the applicability of such strategies in an urban context. As shown in Figure 7.7, when bedrooms warm up windows will stay open during the night (according to the assumptions on occupant behaviour). As a result, outdoor air will enter the room and PM$_{2.5}$ indoor/outdoor ratios will approach 1.0. Overheating may therefore be a problem in heavily polluted urban areas that deter occupants from opening their windows.
• According to the CRISP survey, noise was the second most important reason for reluctance to open windows in the area, which could further limit the potential for natural ventilation.

Although these findings need to be treated with caution given the small sample of dwellings that were surveyed, they do highlight the emergent need to develop combined strategies for year-round indoor thermal comfort and air quality in an urban environment. Advanced city-wide multifactor heat risk mapping based on building physics housing stock models, such as the one developed by Taylor et al. (2015b), could

![Figure 7.7](image)

**Figure 7.7** Temperature and PM$_{2.5}$ indoor/outdoor (I/O) ratios in the bedroom of the mid floor flat of the CRISP follow-up case study modelled building during the three hottest consecutive days of the 2050s Medium emissions 50th percentile UKCP09 scenario. Source: Mavrogianni et al. 2015. Reproduced with permission from Taylor and Francis.
potentially aid the identification of heat vulnerability 'hotspots' and prioritisation of proactive heat wave prevention measures (Figure 7.8).

### 7.7 Conclusions

Social housing in urban areas is often home to individuals who, due to age, illness, or social isolation, are most vulnerable to the effects of hot weather. Often the location of the housing within the urban heat island and the fabric and construction of the dwellings may act to increase the temperature exposures inside the dwellings, and thus exacerbate the problem. Policies should account for the nature of the building before implementing large-scale retrofit programmes, while housing officers should seek housing at low-risk of overheating for the most vulnerable individuals.

Evidence generated by studies such as CRISP and other attitude questionnaire surveys when combined with indoor temperature monitoring studies is essential to understand the variation in heat risks across the building stock. It can be used in order to validate modelling studies, while modelling studies can be used to understand the complexities of building performance, as well as model dwellings under future climate scenarios. Furthermore, such studies can offer valuable insights and contribute to seasonal health policy development. It is essential that trade-offs between summer indoor thermal comfort and air quality are taken into consideration when developing recommendations for individual behaviours that could combat overheating, such as the ones included in the Heatwave Plan for England (PHE & NHS 2015).

### Acknowledgements

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WEather-related Health Impacts: Methodological Study based On Spatio-temporally Disaggregated Multi-pollutant Models for Present Day and FuturE (AWESOME; grant number NE/I007849/1) and by the National Institute for Health Research (NIHR) Health Protection Research Unit (HPRU) in Environmental Change and Health, Theme 2: Sustainable Cities at the London School of Hygiene and Tropical Medicine (LSHTM) in partnership with Public Health England (PHE). The views expressed are those of the authors and not necessarily those of the DEFRA, NERC, NHS, NIHR, Department of Health or PHE.

References


8

What is Hindering Adaptation to Climate Change in English Suburbs, and What Would Help Facilitate Action?

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Overview

Climate change makes many challenges on suburban areas. This chapter focuses on one of the multiple problematics of climate change: the challenge of overheating. Reporting on evidence from the EPSRC-funded SNACC project (EP/G061289/1), the chapter presents results from neighbourhood modelling of potential overheating in six English neighbourhoods using the DECoRuM model. It then explores how residents in these neighbourhoods thought through and thought about their response to the threat of overheating, calling on Ostrom’s notion of the ‘collective action problem’ and on social practice theory. Whereas there is a clear demonstrable technical problem for the 2050s and beyond, residents are unable to both resolve their collective action problem and move beyond how their current lifestyle preferences make many adaptive responses to overheating ‘inconvenient’. However, residents are prepared to implement low cost technical fixes and options that have current benefits (such as shade planting). Thus any strategic plan for retrofitting the English housing stock needs to be realistic about the degree to which current owner occupiers are prepared to invest their current household resources in the housing infrastructure of 2050.

8.1 Introduction

Suburbs have been the setting for environmental and social change for over a century (Baldassare 1992; McManus and Ethington 2007). Facing up to the environmental threat that is likely to be wrought by climate change is only the latest challenge to these areas where a majority of the population live both in the Developed North and the Developing South (Leichenko and Solecki 2013). Climate change projections suggest
that the suburban built environments that currently shelter us from the elements will struggle to protect us from extreme weather events and gradual changes in temperature and precipitation in the future. Suburbs will also prove to be a challenge in developing low carbon lifestyles (in order to reduce the scope of climate change) and in sheltering us from hotter and wetter weather.

This chapter explores what might need to be done to, and with, the suburban built environment in England in order to make it more capable of sheltering suburban communities from a hotter climate. There are other climate change impacts that are likely to affect English suburbs, such as increased precipitation in winter, but this chapter concentrates solely on increased summer temperatures to illustrate a generalised problem in adapting suburbs, namely: what can residents do (as the main group of owners of suburban assets) to adapt to a problem that will emerge at some point in the future? We explore the general problem of overheating, with specific reference to adapting the English suburban built environment, to 2050.

The 'Suburban Neighbourhood Adaptation for a Changing Climate' (SNACC) research project set out to explore how suburban communities and suburban neighbourhoods in England might adapt to climate change (Williams et al. 2012). This chapter uses evidence drawn from this major study. It explores the issue in two parts: first, it sets out the likely scenarios for the experience of overheating during the period from 2030 to 2050. This looks at the physical characteristics of the housing stock and the urban form of neighbourhoods and how these influence the likely experience of overheating in this period for suburban residents (particularly in their homes). Secondly, it explores the views of suburban residents and a wider group of stakeholders responsible for the physical environment in suburbs to the potential threat of overheating (and associated issues of water stress) in order to tease out what they are prepared to do in order to adapt homes, gardens and neighbourhoods. How residents talk about adapting in the face of potential overheating is interpreted through the lenses of the collective action problem (outlined by Ostrom 1990) and through the heuristics of social practice theory (after e.g. Shove and Walker 2010).

8.2 What is the Suburban Retrofitting Problem?

The general trajectory of climate change and its implications for environmental conditions are well known (Gupta and Gregg 2013). Within England climate change is likely to lead to warmer winters and hotter summers (on average) with changes in the distribution of ‘rainfall events’. In other words, it is likely to be hotter and drier in summer, and warmer and wetter in winter, with rain in more intense bursts. These changes place additional requirements on the built environment of suburbs, such as the need to keep us cool in summer and to permit increasing volumes and flow rates of storm water to permeate the ground, be held safely, or flow into drainage systems.

In England environmental pressure on the suburban built environment is worsened because so much of the housing stock and the infrastructure, landscaping and layouts are very old, and because they change relatively slowly, thus reducing opportunities to provide more climate ready homes and environments. For example, it is estimated that around 18% of the English housing stock (and the neighbourhoods in which they are located) date from before 1914 (Department for Communities and Local Government 2011) and the UK has the oldest housing stock in the European Union. Rates of house building are between 100 000 and 170 000 new houses per year – or between only 0.3% and 0.7% new stock per annum.
Thus the English suburban housing stock is not renewed frequently and there may be
a need for it to be retrofitted to meet new environmental challenges, such as overheating.
The stock of neighbourhoods and housing that currently is in use will continue to form
the majority (75–85%) of the built environment in 2050, based on the current dynamics
of the house building industry. On top of this, the retrofitting task will need to confront
older building technologies more often in the UK than in the rest of Europe.

As stated above, one of the main challenges for English suburbs in the future will be
increased temperatures in summer, and the risk of overheating for people in their homes.
In modelling work for the SNACC project, relating to suburban England, Williams et al.
(2012: 33) reported that the summer mean temperature in southern English cities is
likely to rise by 2–5 °C by 2030 depending on which projected greenhouse gas emission
scenario is adopted (medium to high risk here – based on UKCIP projections). However,
the heating effect is not just a result of changes in the climate. Stone and Rodgers (2001)
outline some of the ways in which urban form tends to accentuate environmental heating
effects as an urban ‘heat island’ (even if the climate were not to change). Although the
‘heat island effect’ is most prominent in the centres of cities (and urban agglomerations)
where the ‘mass’ of the built environment is at its greatest, suburban areas are also be
affected, due to their location within built up settlements, and their thermal properties.
A rising average temperature will both increase the frequency of heatwaves (periods of
sustained hot weather) and increase the average length of a heatwave. Thus overheating
is probable in any current summer but due to climate change we are likely to experience
heatwaves in combinations of greater intensity, greater length and greater frequency in
the future than we do now. In our probabilistic future, future suburban Bristol will
become (in climate terms) like current suburban Bordeaux.

So why might this be a problem? In a review of the literature on environmental heating,
Anderson et al. (2013) clearly make the link between average summer temperature
increases and increases in the rates of morbidity and mortality, although the relationship
between hot weather and poor health is not a simple one. Kalkstein and Davis (1989) point
to a strong effect of acclimatisation when they considered the relationship between sum-
mer temperatures and mortality across 48 US cities. This work suggests that heat-related
mortality in the summer was greatest where hot summers were rare and that heat-related
mortality was difficult to identify statistically in cities that have the hottest summer tem-
peratures. So, some of the impact of higher summer temperatures and longer, more
frequent heatwaves might be mitigated by our capacity to ‘get used to’ the heat. However,
some members of society are more at risk of increased mortality through hot summer
temperatures than others. Anderson et al. (2013) identified particular groups ‘at risk’ as
those more likely to have a pre-existing medical condition or to be either over 65 years of
age or less than 10 (infant children). Individuals were more likely to be vulnerable if they
live in a flat (either south facing or top floor), or have a condition that limits their options
to adapt their behaviour (e.g. if they are confined to bed or living with a disability). Thus the
poor health outcomes of increased summer heat are unlikely to be evenly spread in society.

### 8.3 Hot in the Suburbs?

English suburbs have a diverse range of urban forms. Williams et al. (2012) identified six
generic types of English suburban form, though they accept that some ‘real’ suburbs are
often a mix of these types. In order to explore what might be done to adapt the
suburban built environment to make it more liveable in the future, six neighbourhoods were identified which matched, to a reasonable degree, these ideal types both in terms of dominant housing type and dominant urban design. The suburbs were in Bristol, Oxford and Stockport. In order to assess the risks of overheating, a model of each of the six suburban neighbourhoods was constructed to test likely scenarios of heating within suburban housing using a range of climate change projections, using the DECoRuM model, developed by Gupta (2008, 2009). The DECoRuM model can produce results at the level of the individual dwelling but also at the scale of a street, district or complete city (Gupta 2008, 2009). These modelled projections were then used in subsequent workshops with residents in the neighbourhoods.

Table 8.1 outlines the results of the models working with two time horizons (2030 and 2050) and two combinations of probability-based climate scenario defined by two dimensions. The first dimension was the likely trajectory of global greenhouse gas emissions over the period 2010–2050; and the second dimension plotted a range of likelihood in terms of outcomes of each emissions pathway. In this way the modelling team worked with a benign outcome of a medium level trajectory for greenhouse emissions and a median level climate outcome (50:50 chance under the emissions scenario for the given year) and a harsher, less likely outcome (1 in 10 chance of occurring under the emissions scenario for the given year). These two scenario combinations give a range of possible climate futures. In addition to the urban form of the neighbourhood the modelling also took into consideration whether the neighbourhood was located in southern or northern England. Table 8.1 then gives the percentage of properties in the modelled neighbourhoods that were likely to experience overheating under the given scenarios for the given years.

**Table 8.1** Likelihood of overheating in six neighbourhoods in England under different climate change scenarios (based on average summer temperatures).

<table>
<thead>
<tr>
<th>Inner historic (pre-1914)</th>
<th>Pre-1939 ‘garden suburb’</th>
<th>Inter-war suburb</th>
<th>Post-1945 social housing</th>
<th>Car-based suburb</th>
<th>Medium-high density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current climate</td>
<td>South</td>
<td>South</td>
<td>South</td>
<td>North</td>
<td>North</td>
</tr>
<tr>
<td>2030 medium emissions 50:50 scenario</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>2030 high emissions 1 in 10 scenario</td>
<td>96%</td>
<td>100%</td>
<td>100%</td>
<td>70%</td>
<td>57%</td>
</tr>
<tr>
<td>2050 medium emissions 50:50 scenario</td>
<td>71%</td>
<td>100%</td>
<td>98%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>2050 high emissions 1 in 10 scenario</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Data derived from DECoRuM model (Gupta and Gregg 2013).
It is noticeable that none of the properties in these six neighbourhoods is projected to experience overheating in a ‘standard year’ currently. However, this modelling suggests that overheating will become an increasingly prevalent issue when average temperatures increase. The 1 in 10 chance climate outcome of the high level emissions scenario suggests that all properties will be overheating by 2030 in the South of England and, even in the neighbourhood in northern England, all properties would experience overheating by 2050 under the pessimistic scenario. Under the most benign scenario only the neighbourhoods in southern England (southern-central) would experience overheating. These properties were most likely to be built in the early part of the 20th century. In northern England overheating only becomes a serious problem if greenhouse emissions follow a high level pathway.

So, what can residents and landlords do to tackle overheating in their homes and neighbourhoods? The SNACC project defined a retrofit action as something that a property owner/manager can do to change the property fabric or the property services in response to a given stimulus (in this case overheating or anticipated overheating). Nine plausible retrofit actions for property owners/managers were identified (Williams et al. 2012). These nine retrofit actions were: the fitting of external solar shading (such as awnings) to the outside of homes; fitting internal shutters to windows; putting solar film on windows; growing plants and bushes on the walls of homes; modifying the roof of the property to be a ‘green roof’ (a roof covered by plants and vegetation); painting external walls (and roofs) white to reflect sunlight; extending the eaves of the roof to increase shading; changing the thermal properties of the building to react more slowly to temperature changes (building ‘thermal mass’); and, finally, building shaded outdoor spaces in gardens. Many of the retrofit installations are currently standard in climatic zones that are similar to the future conditions in England (such as external shutters in the Mediterranean area or finishing buildings in white in Australia). However, retrofitting these measures would have a range of different implications with regards to cost and disruption for the residents of the property. Thus placing solar film on windows is a cheap, simple DIY task whilst fitting a green roof would be costly, and need professional help, and planning permission. We return to this list of potential retrofit actions later in the chapter.

As stated above, the existing housing stock will still constitute the bulk of English housing in 2050. Modelling work on the thermal characteristics of this existing housing suggests that increasing summer temperatures are likely to lead to homes that are uncomfortable to live in (see Gupta et al. 2015 for more detail), in turn, in some cases leading to increasing mortality. The problem of overheating is most accentuated in the housing stock and neighbourhoods in inter-war suburbs and pre-1939 garden suburbs (from the period 1919 to 1945) which account for around 20% of the English housing stock (English Housing Conditions Survey estimate for 2007; Department for Communities and Local Government 2011). The next most problematic set of neighbourhoods were the medium-density neighbourhoods built more recently that account for a further 15% of the housing stock. This is particularly true for neighbourhoods in the south of England. However, by 2050, if emissions have followed the high end of the climate outcome, these areas could be experiencing severe overheating issues.

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1 These refer to average standard years. Clearly heatwaves can be experienced under current climatic conditions (e.g. the summers of 1976, 2003 and 2006) in exceptional years.
range (the A1FI scenario for the IPCC), then there is a high chance of most English suburban homes experiencing overheating in an average year.

The problems not only lie with the housing stock but also with choices about how gardens are planted (with little shading). However, the SNACC research found that suburban residents are very unlikely to have undertaken any measures to adapt their homes to make them cooler. A key element of the research was to find out why no action was being taken, and what might motivate change.

8.4 How Does the Current Literature Explain Why Retrofitting Might Happen?

There is not space in this chapter to explore the different ways in which social science research explains the choices that might be made by suburban dwellers and the institutions that manage public space in neighbourhoods on retrofitting and adaptation in the light of climate change (see Adger et al. 2005 for a review of ‘systems’-related work or Geels 2011 for a socio-technical transition perspective). In this chapter we interpret what suburban residents said about what they are prepared to do to retrofit their homes, gardens and neighbourhoods. We will outline the views of residents in the light of two bodies of work related to socio-economic explanations of climate change adaptation:

- The notion of the collective action problem and rational choice is where residents will choose to adapt to a particular ‘problem’ if the benefits of adaptation outweigh the costs. Following the work of Ostrom (1990), the collective logic of investing in retrofit action in order to produce a climate-adapted built environment depends upon the balance of individual cost, collective benefits, the composition of the ‘collectivity’ pushing adaptation and the degree of coercion keeping the collectivity together.

- Social practice theory (after e.g. Gabriel and Watson 2013) sees the issue of adaptation as one where the new technology (such as those suggested for retrofitting) enhances and gives value to an existing social practice (involving the home or garden). Actions that challenge or diminish existing practices (such as roof insulation making attic storage problematic) are not taken up. Under this literature the likelihood of adaptation is a social dance between the ‘folk knowledge’ of what residents expect from their homes and gardens (in terms of usability) and the technical expertise of the builders and tradespeople they come into contact with.

In order for residents to retrofit a home to make it comfortable in a hot summer (without air conditioning) through physical changes to the building either requires residents to have direct control over that property or to enable their landlord to make changes. Under the notion of rational choice, for a suburban resident to retrofit their home for overheating, they would need to believe that the benefit of this (experienced by them) would outweigh the costs of implementing the change (either directly paid for or paid for through rents). This is likely to be enhanced when residents have the potential for living in their home for longer (thus benefitting over a longer period). We can consider this context for the six neighbourhoods in the SNACC project using Census of Population data from 2011 (the time period in which the workshops were carried out).

Figure 8.1 presents the six case study neighbourhoods, plotting the proportion of households that are owner-occupied (both with and without a mortgage) relative to
England as a whole (100 = same as national average) as the indicator of ‘control’; and
the proportion of household reference persons (HRPs) who are aged under 35 years
old relative to England as a whole (100 = same as national average) as an indicator of
whether the household might possibly benefit from avoiding overheating in 2050.
This reveals a spread of likelihood of future benefit versus tenure control. It is
notable that there are no neighbourhoods in the category of having residents that
are both relatively youthful and who are dominated by owner occupiers. This reflects
the process by which households acquire and pay for owner occupier housing over a
housing career. It would not be clear from this plot alone where the aggregate trade
off lies between having control over the housing versus being young enough to expe-
rience the likely benefits. On the face of it, it is probable that the least likely neigh-
bourhood to adapt to overheating would be the car-based suburb (older residents
who are likely to own) whilst the medium-density neighbourhood (younger residents
who are more likely to rent but are likely to benefit over a longer length of time)
might be most likely to adapt, all other factors being equal if the rational choice
model holds.

As part of the SNACC project, six problem-focused workshops were carried out with
residents from the six neighbourhoods, whilst three parallel workshops were run with
representatives from the institutional stakeholders who frame and shape the built envi-
ronment and the technical characteristics of the housing stock in suburbs (planners,
infrastructure managers, campaign groups, etc.). These neighbourhoods not only have
a different balance of tenure and average age but also a range of different urban forms
(and building technologies). These neighbourhoods also span the range of ‘uncertainty
of effect on overheating’ as illustrated in Table 8.1. The northern neighbourhoods are
markedly less likely to experience regular overheating under the more optimistic climate
change scenarios. During the workshops residents and the professionals representing
the institutions/organisations that frame suburban development were asked to think
about what they were prepared to do to adapt their neighbourhoods conceived as
houses, gardens and the public spaces in between. The aim of the exercise was not to be

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**Figure 8.1** Plotting control over housing versus likelihood to directly benefit from adaptation to
overheating for 2011 (derived from Census of Population). HRPs, household reference persons.
representative of the whole suburban population but to better understand the constraints and opportunities for retrofitting in English suburbs. One section of the workshop was dedicated to a theme labelled ‘summer house’ where issues of overheating retrofitting options were discussed with residents.

Thus it might be expected that focus groups in these neighbourhoods might take different views on adapting their homes for overheating depending upon:

- What needs to be done/what can be done (a function of the construction of the house and its urban form setting).
- Whether the neighbourhood is in the south or north of England (making overheating more/less likely).
- Whether the household owns the property (and has resources to adapt it).
- Whether the householder feels they are likely to perceive the benefits of adapting it.

Analysing the logic of residents to a range of different retrofit actions for their homes and gardens for overheating, a number of themes emerged from the workshop participants. These themes are grouped under two headings in Table 8.2: cost-related themes and lifestyle-related themes. These themes themselves relate to the main explanatory frameworks outlined above: the universal rationalisation of maximising utility for the household; and a social practice related theme of lifestyle (with all other contextual issues being equal).

These rationalities for action and inaction mix up the general themes of utility maximisation (with a time dimension) and the theme of social framing (through lifestyle framing). The general arguments for adoption become important when either the direct cost to the householder is low (or subsidised via grants) or the marginal cost is low when adaptation can take place in the context of other maintenance/upgrading work. On the downside adoption becomes problematic when the costs of implementation are high, either in direct terms or in terms of time and effort required to achieve implementation.

**Table 8.2  Rationalities for adopting/not adopting retrofit actions.**

<table>
<thead>
<tr>
<th>Reasons for being likely to choose retrofit action</th>
<th>Reasons for being less likely to choose retrofit action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost-related themes</strong></td>
<td><strong>Lifestyle-related themes</strong></td>
</tr>
<tr>
<td>Cheap, convenient (i.e. DIY)</td>
<td>Attractive</td>
</tr>
<tr>
<td>Could be done easily with other home renovations</td>
<td>Lifestyle benefits (enjoyable, reduces noise)</td>
</tr>
<tr>
<td>Potential for financial support (grants and subsidies)</td>
<td>Environmentally friendly (reduces carbon emissions)</td>
</tr>
<tr>
<td>Energy cost-savings</td>
<td>Improves current climate comfort</td>
</tr>
<tr>
<td>More efficient</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Too expensive as initial cost</td>
</tr>
<tr>
<td></td>
<td>Major building works required</td>
</tr>
<tr>
<td></td>
<td>Potential damage to property from measure</td>
</tr>
<tr>
<td></td>
<td>Requiring external approval (e.g. from housing association)</td>
</tr>
<tr>
<td></td>
<td>Bulky and unattractive</td>
</tr>
<tr>
<td></td>
<td>Loss of house space</td>
</tr>
<tr>
<td></td>
<td>Inappropriate housing orientation for measure</td>
</tr>
<tr>
<td></td>
<td>Lack of space or sunlight required for measure</td>
</tr>
<tr>
<td></td>
<td>Simpler behavioural alternative</td>
</tr>
</tbody>
</table>
The second row of explanations focuses on ‘lifestyle’ issues that social practice theorists (e.g. Gabriel and Watson 2013) would relate to what residents consider to be ‘appropriate’ or ‘acceptable’ for their life in the suburbs (these frames are conceptualised as ‘scripts’ by Shove and Walker 2010). Thus for a retrofit action to be thought of as acceptable, it needs to be thought of as attractive or offering lifestyle benefits now (such as an increase in environmental comfort). Actions that are more likely to be considered unacceptable are those that either do not offer clear benefits or those for which there are simple behavioural alternatives (such as drawing curtains and opening existing windows for ventilation).

In discussing overheating with residents it is clear that in order to consider retrofit action they need to perceive the existence of a problem. In the case of overheating residents did not necessarily believe a problem existed. One resident noted:

I think [overheating] wouldn’t be relevant as at the moment there isn’t really a great need for it because we haven’t got high temperatures.

Residents in the northern English neighbourhoods could recall having the heating turned on in the summer and were inclined to view climate change scenarios of having warmer summers to be an attractive prospect.

However, residents in the neighbourhoods in southern England could recall uncomfortable heat in their neighbourhoods, stating, for example:

We need to put the green back into the district, we really do because the last couple of years if you walked down [local medium-high suburban street] on a hot day it is like walking through the Gobi Desert. It is boiling.

Thus residents demonstrated some ambivalence as to whether overheating constituted a ‘problem’ and whether it constituted a priority for them in maintaining or adapting their home and garden. Table 8.3 outlines the consensus of acceptability for a range of retrofit actions on homes and gardens that will reduce either the experience or the effects of overheating to varying degrees. These retrofit actions are set out in relation to the typology of the urban form and to the location within England. Drawing on Figure 8.1 we might also draw conclusions in relation to the dominant types of tenure and average age of residents. In Table 8.3 the retrofit actions discussed with residents have been ordered in terms of their likely disruption (during implementation) from the fitting of solar film to windows and fitting lock-open window casements (that can be done by the householder) to the retrofitting of a green roof at the opposite end of the disruption scale (requiring builders, planning permission and building regulations approval). Table 8.3 outlines group attitudes towards each of the possible actions marking group consensus as one of: ‘yes’ indicates the majority of the focus group participants were likely to implement the retrofit; ‘no’ indicates the majority of the group participants were not likely to implement the retrofit; ‘mixed’ indicates that the group was split on their likelihood of implementing the retrofit action; and ‘n/a’ indicates that the action was not discussed in the group generally because it was unsuitable for the housing type in that neighbourhood. In addition to the nine retrofit actions outlined above, Table 8.3 also includes attitudes of the groups to fitting lock-open windows that would have multiple benefits of general security as well as being a response to overheating issues.
Table 8.3 Retrofit actions related to overheating and acceptability by residents in focus groups.

<table>
<thead>
<tr>
<th>Action related to preventing overheating in increasing order of disruption/inconvenience</th>
<th>Inner historic (pre-1914)</th>
<th>Pre-1939 ‘garden suburb’</th>
<th>Inter-war suburb</th>
<th>Post-1945 social housing</th>
<th>Car-based suburb</th>
<th>Medium–high density</th>
<th>No. of ‘yes’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar film on windows (glazing)</td>
<td>Yes</td>
<td>Mixed</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>3</td>
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<tr>
<td>Lock open windows</td>
<td>Yes</td>
<td>Yes</td>
<td>n/a</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Wall greenery</td>
<td>Yes</td>
<td>n/a</td>
<td>Yes</td>
<td>Mixed</td>
<td>No</td>
<td>n/a</td>
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<td>Shaded outdoor space</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Mixed</td>
<td>Mixed</td>
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<td>External solar shading</td>
<td>No</td>
<td>Mixed</td>
<td>Mixed</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>1</td>
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<td>Internal shutters</td>
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<td>No</td>
<td>No</td>
<td>Mixed</td>
<td>No</td>
<td>Mixed</td>
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<td>White roof and walls</td>
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<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>n/a</td>
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<td>Extended eaves</td>
<td>n/a</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>n/a</td>
<td>n/a</td>
<td>0</td>
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<td>Increasing the thermal mass</td>
<td>n/a</td>
<td>No</td>
<td>n/a</td>
<td>Mixed</td>
<td>No</td>
<td>Mixed</td>
<td>0</td>
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<td>Retrofitting a green roof</td>
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<td>No</td>
<td>Mixed</td>
<td>No</td>
<td>No</td>
<td>Mixed</td>
<td>0</td>
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<td>No. of ‘yes’/no. of ‘no’</td>
<td>3/4</td>
<td>3/4</td>
<td>2/4</td>
<td>3/3</td>
<td>1/7</td>
<td>3/0</td>
<td></td>
</tr>
</tbody>
</table>

n/a, not applicable.
In terms of the aggregate social characteristics of the neighbourhood there was a
difference in attitudes depending on the average age of residents in the neighbourhood.
Thus in the north of England, it was the car-based neighbourhood with the older aver-
age residents where the focus group was least accepting of the technical options for
overheating. In this case only the implementation of lock-open windows was thought to
be likely. In the post-1945 social housing neighbourhood focus group, participants were
more likely to want simple measures to be implemented. In the southern group of
neighbourhoods, all the neighbourhood focus groups were positive in relation to two to
three of the technical options (the simplest and least expensive options). However, it
was the medium-density neighbourhood where focus group participants found three
retrofit actions to be acceptable, and the group did not reject any of the options outright.
In the medium–high density suburb the residents (on aggregate) had less control over
their housing (fewer owner occupiers and more renters) but were generally younger and
thus more likely to perceive the benefits from dealing with future overheating.

Thus from a rational choice perspective, neighbourhoods with residents who are
generally younger (and thus more likely to perceive the benefits) were more likely to be
the places where focus groups found adapting to overheating to be acceptable. Equally,
neighbourhoods located in climatic zones where overheating appears to be more certain
(i.e. southern England) were more likely to have focus groups that found adapting to
overheating to be acceptable. The keenest neighbourhood focus group was also in an
area where the capital costs of adaptation were less likely to fall upon the residents
because of high levels of renting households.

This pattern of acceptance and rejection can also be seen through the lens of cost-
related and lifestyle-framed rationalities. Thus clearly the retrofit actions that were
lower cost, less dependent on technical expertise and had multiple benefits (such as
shaded garden areas or window opening locks) were the ones that were most readily
deemed to be acceptable. The options that were the most expensive and the most dis-
ruptive (such as green roofs) were most likely to be rejected. Given that the groups all
expressed some scepticism as to the likelihood of persistent and regular overheating,
this also demonstrates the collective action problem where the costs are clear, high and
immediate and the benefits are uncertain and at a vague point in the future. At the time
when the focus group work was carried out (Summer 2011) there had been a consistent
and real drop in household incomes for the preceding two to three years.

Based on the discussions in six neighbourhood workshops and three local authority
level workshops, Table 8.4 sets out how the respondents saw the likelihood of retrofit
action in their neighbourhoods. This summary of participants’ views is organised in
terms of a multi-level schema of national government, local agency stakeholders and
individual households. Table 8.4 also distinguishes between actions (both collective and
individual) that are considered acceptable (but not necessarily likely) and actions that
are considered likely and acceptable. Residents might be willing to do simple things to
their homes and gardens where these adaptations offer clear benefits now (more sum-
mer shade in the garden or a pleasant green garden), but few residents were prepared to
significantly upgrade their homes and gardens given the timescales and likelihoods of
overheating scenarios. Within a broader local ‘regime’ for adapting to overheating, local
agencies were prepared to maintain green spaces to enhance shade and would make
plans for heatwave emergencies. The wider ‘landscape’ for overheating was less clear.
There is no explicit regulation or framing of domestic overheating at the time of the
focus groups. In addition, there were no grant or subsidy arrangements in place in the early 2010s in order to make adaptation to overheating more attractive.

### 8.5 Conclusions

There is a clear rational and technical argument that overheating is likely to become a serious problem in southern suburban England at least – and in all likelihood a problem in northern suburban England as well. However, the current conditions and framing of overheating in the minds of suburban residents are not propitious for a campaign to adapt the stock of English suburban properties (homes and gardens) and neighbourhoods to this upcoming problem. Residents are sceptical and only willing to invest in retrofit actions for which they can clearly see current benefits, and that can be scripted into their current lifestyles. The socio-technical landscape for retrofit action for overheating does not provide opportunities for suburban residents to change this way of thinking (i.e. no current subsidies, and regulations which are actually likely to accentuate the problem at a future date). Local authorities (as part of the localised socio-technical regime) can ensure that new buildings and the maintenance of existing greenspaces will contribute to reducing neighbourhood heat islands since residents are generally favourable towards tree planting and enhancing outdoor spaces. However, English local government does not have the resources to do much more than this, especially during a period of austerity.

These explanations of inaction are not however surprising in and of themselves. We would argue that the focus for working out the most likely means of retrofitting suburban housing needs to focus less on the technical characteristics of any given retrofit product or service. This work (and others such as Shove and Walker 2010) might push built environment research to consider the interaction of suburban residents and their housing, their gardens and their neighbourhoods. Retrofitting needs to meet both a technical criterion of maintaining comfort in the built environment but it also has to facilitate the lifestyle choices of suburbanites. Given that the technical solutions for

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**Table 8.4** Plausible socio-technical response to overheating issue in suburban England.

<table>
<thead>
<tr>
<th>Level of socio-technical framing on the technical fix for overheating</th>
<th>Activities envisaged in response to the prevention of overheating and mitigation of the effects of overheating that are considered acceptable</th>
<th>Considered likely (and acceptable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central government</td>
<td>Source of grant/subsidy ‘funding’</td>
<td>Regulating and providing information on technical fixes</td>
</tr>
<tr>
<td>Local agencies</td>
<td>Community cool rooms</td>
<td>Development control (of new homes and urban design), planting/maintenance of street trees/greenspace, health and social care/emergency response during heatwaves</td>
</tr>
<tr>
<td>Individual householder/community</td>
<td>Install reflective glazing and external garden shading, changing garden planting, fitting window-opening locks</td>
<td></td>
</tr>
</tbody>
</table>
retrofitting are reasonably well practised, the urgency resides in identifying how built environment professionals understand the needs, practicalities and aspirations of the suburban lifeworld. Although identified as a technical problem, the evidence from the English suburbs suggests that overheating is a suburban problem for which the time is not right. Perhaps only continued exposure to heat stress may prompt suburban residents and those responsible for managing or maintaining suburbs to take retrofitting action.

References


What is Hindering Adaptation to Climate Change in English Suburbs, and What Would Help Facilitate Action?


9

The Value of Foresight and Scenarios in Engineering Liveable Future Cities

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Overview

Engineering of future UK cities typically involves starting with an urban context shaped over hundreds of years and, whether adding new developments or regenerating existing areas, the essential process is one of retrofitting in this wider city context. In supporting citizens and city systems, civil engineers create artefacts that often function decades into the future. Consequently, they take cognisance of the concepts of sustainability, resilience, adaptability and liveability, ideas that need to be examined so that they can be embedded in processes of future visioning while acknowledging likely (possibly radical) contextual change. Drawing on the Foresight Future of Cities (FFoC) project, which focused on the UK’s city systems and the UK’s system of cities, the efficacy of alternative ways of using scenarios to enrich, empower and future-proof today’s engineering interventions in cities is explored.

9.1 Introduction

The concept of ‘retrofitting’ existing cities is routine in terms of engineering thinking, although the terminology is perhaps unusual in routine practice. We do, however, talk routinely about urban regeneration to bring about more sustainable, resilient, adaptable and liveable cities – that is, we seek to design with sustainability, resilience, adaptability and liveability in mind. It is worthwhile exploring these concepts in relation to the dynamic urban research landscape that has emerged in the early 21st century since they constitute the principles on which any future visioning must be founded. By doing this, we are then in a position to bring our disciplinary expertise to bear on the problems of engineering cities of the future in the sure knowledge that we are not thinking and working within ‘disciplinary silos’ and thereby adversely constraining the vision. In the author’s case, it is as a geotechnical engineer – working with and within the ground while embracing the ideals of the civil engineering profession and seeking to shape (far) better cities of the future. Under this remit falls buried infrastructure, exploitation of
underground space and sensitive engineering within the ground to meet the needs of today and protect this broadly conceived ‘sub-surface resource’ for future generations of engineers to exploit. Colloquially termed ‘the underworld’, this chapter will seek to apply future city visioning principles to this unseen, and often overlooked, space in cities.

In the later years of the 20th century, there was much discussion of the need to engineer our cities according to the principles of sustainability. Sustainability, as defined in Bruntland’s (1987) oft-cited report, is ‘the ability of the current generation to meet the needs of the present, without compromising the ability of future generations to meet their own needs’. This coincided with the adoption of the argument of three pillars of sustainability – social, economic and environmental – as a means of categorising and assessing, or measuring, the sustainability of a system. Almost as soon as the three-pillar model was proposed, it was suggested that a fourth pillar might be added to cover aspects of policy or governance or, in some countries where the issue dominates, culture. Moreover, the relationship between the three pillars was suggested initially to take the form of a Venn diagram of three interlocking rings, thus putting sustainability at the intersection of all three. This implied that each pillar has, to some degree, an independent entity and thus supported an argument for reliance on technological fixes to address sustainability concerns, since the environment is considered to be separate from citizens and their communities. More recently, the three pillars have been portrayed as three nested rings (e.g. Giddings et al. 2002), with economy at the centre as a societal construct and environment as the outermost ring providing the ecosystem and other services that support society. The concept of sustainability has been discussed extensively in the literature, and this is healthy since it is via such discussion that the idea becomes enriched and arguments become nuanced (Lombardi et al. 2011b).

In the early years of the 21st century, there was much discussion of resilience as supplementing, and in some cases even supplanting, sustainability, as the goal. As with all such categorisations, the appropriateness of the term relates to its definition and the perceptions that the user brings to its use – the context in which the user operates, perhaps. Resilience has strong environmental, and especially climate change, connotations, although if used in the sense of an urban intervention ‘continuing to function, and deliver its intended benefits, in the face of change’ (whether this change represents a shock to the system or incremental change), then it has considerable relevance to engineering in cities (Rogers et al. 2012a). Adaptability leads on naturally as the urban professionals’ response to the need to design in resilience, that is it deals with the consequences of a lack of resilience – it builds flexibility into designs, whether the design is related to an artefact, a practice, a process or a policy. A more recent concept, which perhaps emerged in an attempt to emphasise citizens and society in city thinking, is liveability (e.g. Leach et al. 2013). As with the other concepts, the term requires a definition – in the Liveable Cities programme grant, the term is used to embrace individual and societal wellbeing alongside planetary wellbeing (reducing greenhouse gas emissions and other forms of pollution, and improving resource security).

Unsurprisingly, the UK’s research landscape has mirrored this conceptual development, starting with the UK Science and Engineering Research Council’s (EPSRC’s) £65m pioneering Sustainable Urban Environments (SUE) programme. SUE was visionary, not least in its recognition of the need to fund social and environmental scientists, of all types of disciplinary hue, alongside physical scientists and engineers. SUE has
achieved many positive outcomes, via extensive and diverse programmes of research, and yet one of its greatest successes must be the creation of a cohort of early-career researchers able to work seamlessly and effectively across the disciplines that must combine to deliver the cities to which we aspire in the future.

In SUE’s early research, there was much emphasis on establishing methods for assessing the sustainability of city interventions, clustered along broad disciplinary lines yet reaching out beyond the disciplines. One of the first programmes to adopt a holistic, integrative approach was the case study of the Birmingham Eastside regeneration project, which sought to examine whether the city’s aspiration for it to be ‘an exemplar of sustainable urban regeneration’ was being met in practice. As with other aspects of SUE’s research, this research involved the specification of sustainability indicators with which to assess the movement towards sustainability (Hunt et al. 2008b), a balancing of the tensions and trade-offs that are an inevitable part of the design of urban regeneration schemes (Lombardi et al. 2011a) and the creation of a framework that enables all the voices that should help shape city interventions (all relevant disciplines and stakeholders) to be heard and accounted for in a timely manner (Hunt et al. 2008a).

This thinking flowed into a second programme, Urban Futures, in which the associated need for benchmarking was highlighted (Boyko et al. 2012) and continued into a subsequent programme, Liveable Cities, which is researching a means of measuring the performance of cities with respect to liveability criteria (Leach et al. 2016). In all of this endeavour to provide guidance and methodologies to assist those responsible for devising and designing city interventions, the notion that the adoption of a framework of sustainability indicators and checklist might constrain, rather than enrich, design creativity remained untested. Although superficially counterintuitive, the analogy to design codes of practice, in which expertise, distilled into guidance, becomes codified to the extent that it cannot be gainsaid, suggests that it remains a danger for those implementing research into sustainability and resilience unless specifically addressed (Boyko et al. 2014).

One further goal that has emerged alongside the above aspirations for future cities is ‘smart’; that is, embracing technologies and ‘big data’. Again, a common understanding of terminology is important, noting the truism that ‘smart’ is not ‘truly smart’ if all it does is replicate what we do now more efficiently (Cavada et al. 2014). In the FFoC project, the term ‘smart and smarter’ is being used to get across this deeper meaning. This chapter aims to explore the above and other aspirations that city leaders and citizens have for their cities alongside an understanding of how cities might be configured and operate in the far future. This latter objective, which can be achieved using a number of foresighting and scenario-based methodologies, forms the primary focus of the chapter once the concept of retrofitting is extended to city infrastructure systems, and in particular those that are buried beneath our cities.

9.2 Retrofitting the Underworld

The mission of civil engineers, in supporting citizens and civilised life in cities, in large part involves the installation, maintenance, repair and upgrading of infrastructure systems. Some are visible and help to shape the urban landscape, while most utility infrastructure systems are buried out of practicality and convenience.
This brings its own particular problems: knowing precisely where the utility pipeline or cable in question lies beneath the surface (records often being incomplete and inaccurate), just as important knowing what else is buried in the vicinity, and knowing where the space exists in between the buried infrastructure (pipes, cables, culverts, tunnels, etc.) and the components of the sub-surface built environment (basements, foundations, ground source heat pump pipes, barrier walls, etc.). These challenges form a separate stream of research under the broad umbrella of Mapping the Underworld (www.mappingtheunderworld.ac.uk/). However, there are several challenges of specific relevance to the retrofitting agenda.

The retrofitting agenda is predicated on bringing about change to an existing context, thus requiring the context to be fully understood prior to implementation of designs. For buried infrastructure work, this would traditionally involve some form of site investigation – combining records with invasive or non-invasive testing to prove the competence of the ground and the location of adjacent buried objectives. When integrating the concepts of sustainability, resilience and adaptability into the design of such works, there are complications – additional barriers (Hunt and Rogers 2005) and considerations (Sterling et al. 2012), for which a different planning mindset is required (Hunt et al. 2009). Much of this ‘additionality’ in terms of planning and design results from the fact that it is far from routine to consider the underground space in cities as a potential resource to exploit responsibly, yet in some countries where climate or topography force the issue, there is a wealth of positive engineering experience on which to draw – for example Norway exploits its underground space in cities in many novel ways (Rogers 2009), while Helsinki has developed extensive future plans and planning processes for the exploitation of underground space (Sterling et al. 2012).

Extending the thinking on sustainability assessment frameworks to the responsible exploitation of underground space requires no radical change in methodology, but a different set of sustainability indicators (Zargarian et al. 2013, 2014) and a subtly different perception of resilience (Bobylev et al. 2013). As with the more traditional view of retrofitting, there is a need to integrate new or supplementary systems with existing systems, and these might use both above ground and underground space, such as in the case of incorporation of a rainwater harvesting system for a building (Hunt and Rogers 2014) or a number of buildings via a shared system (Zadeh et al. 2014). A more ambitious form of retrofitting concerns the idea of multi-utility tunnels – a new shared underground space in cities in which pipes and cables are co-located (Hunt et al. 2014). The concept of multi-utility tunnels presents considerable challenges around ownership and governance, quite apart from meshing an existing system at both the supply and delivery points of the service in question. It does, however, reveal a new concept of how to exploit abandoned pipelines in cities for alternative uses, perhaps ones in which the benefits of co-location with other utilities are unimportant and yet one in which the additional protection afforded by the existing pipeline is a benefit.

9.3 The Foresight Future of Cities Project

The FFoC project was commissioned by Sir Mark Walport, Government Chief Scientific Adviser, and was active between September 2013 and December 2015. Comprising a multi-disciplinary Lead Expert Group and a Government Office for Science project
team, its objective was both to commission new work and to review the evidence base on future cities in order to support both central and local government when developing policy and making decisions with long-term impacts. In addition, by working directly with many UK cities, it aimed to develop capability and capacity for long-term policy making for cities, both by making the evidence base accessible and by providing a range of methodologies that allow cities to explore their own future scenarios. Importantly, this recognises that each UK city operates in a unique context and has developed as a result of its own history, reflecting one of the core principles for sustainability (Table 9.1) – when looking forward, it is important also to look back.

Moreover, much recent debate around the potential benefits of some degree of devolution of power and responsibility from central to local government, both in the UK and internationally, has suggested that cities exist at the right scale for bringing about change that is not only sensitive to the local context (see below), but effective in delivering on the agendas associated with sustainability, resilience, adaptability and liveability. This aligns with the thinking of a UK research initiative – Infrastructure BUSiness models, valuation and Innovation for Local Delivery (iBUILD) – that seeks to explore novel business models to take advantage of the opportunities offered by the fact that there are multiple interdependencies between a city’s infrastructure systems (Dawson et al. 2014). iBUILD’s philosophy is that all infrastructure systems ultimately come together in the users of the services, and these necessarily combine at a local scale, ranging from the individual/household/community to the sub-city/city/city-region scale. iBUILD, and its companion research programme ICIF (the International Centre for Infrastructure Futures; www.icif.ac.uk/) which is studying similar opportunities at national and global scales, like FFoC, have adopted systems thinking to explore where value arises from infrastructure systems, whether economic, social, environmental or other forms of value, and how it can be captured in investment models that align those benefitting with those paying. Consequently, iBUILD has explored how novel models of interdependency and value capture that are evidently viable in certain local contexts and operational at local scales might be scaled up (Dawson et al. 2014).

The FFoC project started from the viewpoint that cities are highly complex, dynamic, multi-scalar, multi-dimensional and open, and they all act and function at multiple temporal and spatial scales. To guide its work, it looked out to both 2040 and 2065, the former being a time when projections from today might be used with some degree of confidence while the longer timescale required future scenario approaches to help understand the possible consequences of policies and decisions. It adopted a systems thinking approach for its work with two primary points of focus – the UK’s city systems and the UK’s system of cities – while recognising that policies and decisions play out across a range of scales from neighbourhood, sub-city, city, city region, region of cities and national to global.

It recognised that cities, or city-regions, will often be best placed to shape and implement policies, and thereby make some of the changes necessary, to enable them to function more effectively, since they are uniquely well-placed to understand their own contexts. Equally, policies and actions at the national level may also be necessary to remove barriers to allow this to happen, though the implications of how national policies play out in different local contexts was recognised as important in policy development.
What is ‘sustainable’ is determined locally: local conditions set local priorities
As difficult as the idea of sustainability is to define, defining its implementation is even more of a challenge. What is sustainable is determined in part by the local conditions: for example, water will always be a part of a sustainability agenda but must be a higher priority in drought-prone areas. As with energy, managing water sustainably means reducing demand and tapping more sustainable, locally sourced supplies. Each area will lend itself to different supplies for water and energy – and an assessment of the local conditions will enable the development to identify the solution that makes the most sense for the area. The social and economic fabric of a place also shape its ‘local conditions’. The gritty industrial character and heritage evident in Eastside create a unique sense of place. Its vibrancy and identity have been singled out in Birmingham’s Masterplan Visioning exercise as important aspects to preserve and enhance through the regeneration process

The past and the present must be incorporated to achieve more sustainable regeneration
The existing cultural richness of an urban regeneration area can play an important role in its regeneration. The arts and creative sector has been an important catalyst for regeneration in Eastside – but there is a risk that the local artists may be displaced in the regeneration process. Existing businesses can also help integrate the new community to the existing community, but they may need support (information, financial, training) to survive the regeneration period. As with people in a regeneration area, other species in Birmingham Eastside may not thrive in the new environment if proper plans are not incorporated into the process: most of Eastside's biodiversity is found within brownfield sites and fragments of semi-natural habitat. Replacing brownfield sites with highly managed green spaces delivers less biodiversity, just as losing the existing small independent retailers reduces the economic and social diversity

Early involvement in the development process is central to advancing the sustainability agenda
Design specifications are determined iteratively throughout the development process: as the design advances, more and more options are ‘locked in’ or ‘locked out’. If the sustainability objectives are set at the beginning, for example through the incorporation of sustainability indicators and benchmarks, there is a higher probability of their informing the process going forward. Certain (but by no means all) sustainability solutions can be incorporated later, for example in response to planning conditions, but retrofitting sustainability solutions is usually substantially more expensive than incorporating them from the start

Individual design decisions influence the ability to meet very different sustainability objectives
The three pillars of sustainability – economic, social, and environment – may seem unrelated at first glance. However, design specifications such as roof pitch can impact on whether a project meets sustainability objectives as disparate as: conserving water (rainwater harvesting is more efficient with a pitched roof); conserving biodiversity (some species require a flat rubble roof); developing a sense of place (what do the other roofs in the area look like); and cultural heritage (historically what roof shape would have been found here). Sometimes different objectives work together: designing for optimum solar light can reduce energy consumption and improve health and well-being. Until all development professionals are fully trained in sustainability, the incorporation of a sustainability advisor can help to make the connections for the development team – someone who has access to the latest research, and knowledge of the interrelationships between various design specifications and sustainability requirements

Sequencing activities correctly in the development process keeps sustainability-related options open
Best practice guidance for delivering a particular sustainability outcome often specifies that a list of actions should be undertaken in sequence. However, it is rarely specified precisely when these activities should take place in relation to key development process decisions. For example, to deliver ecological enhancement it is necessary to: survey, conduct an impact assessment, then develop and specify the required mitigations and enhancements. If this sequence of activities is completed after the outline proposals have been approved, the design may have evolved to a point where the desired enhancements cannot be incorporated. The Development Timeline Framework (Hunt et al. 2008a) is a tool developed by the research team to make these timing issues explicit
From its very inception, the FFoC project addressed the problem of defining a ‘city’. It acknowledged that there are various ways of defining cities according to the functions they serve, and that it is often unhelpful to attempt to divorce cities from their hinterlands, and thus functional city regions will often provide the most appropriate scale to understand city systems. However, for convenience and economy – and to provide a common and easily accessible baseline for evidence gathering – the FFoC project decided to collect much of its statistical material on the basis of Primary Urban Areas (PUAs). These are single or groupings of local authorities with a population of over 125,000.

The FFoC project collected evidence in a variety of ways: it commissioned working papers, thought pieces and essays on topics that it identified as being of central importance, and drew on the huge amount of work of many organisations – think tanks, universities, research centres and lobby groups. It visited more than 20 cities to understand their current contexts and explore their aspirations for the far future. Coordinated through a City Visions Network, it encouraged and enabled the development of a number of local Foresight projects. It held meetings with UK Government Departments and organised workshops with a variety of experts, for example planners and designers, utility companies, water professionals and those involved in private finance. All of this has helped in the compilation of an evidence base, which is available on the FFoC project’s website (www.gov.uk/government/collections/future-of-cities).

At the heart of the FFoC project was a debate over the contribution we might make to the science of cities, or more accurately: what can ‘science’ offer? Science, in this context, was interpreted broadly, that is ‘knowledge’ from all sources. This included evidence that could help cities, and those for whom cities provide a focus of their activities, make sense of the interdependent systems and subsystems, and embraced both quantitative and qualitative information. This fed a process combining four distinct but inter-related elements of analysis (understanding the context and evaluating potential future scenarios), policy (defining what we are trying to achieve), design (creating means of achieving it, i.e. inventing ‘solutions’ to ‘problems’) and implementation (making ‘change’ happen).

The inherent complexity and diversity of actors in cities means that the topic of future cities is occupied by many disciplines, sub-disciplines, professions and sub-professions, and each has its own perspectives on and definitions of ‘the city’ as an object of study. Moreover, many of the challenges presented by cities are interdisciplinary, meaning that strategic thinking has to be drawn from across the disciplines and professions, and effective design and action requires effective collaboration between these disciplines and professions. This concurs with the findings of the Birmingham Eastside project (Table 9.1).

The FFoC project adopted six core headings to form the basis for its analysis:

- How people live in cities in the context of population growth and demographic change.
- The future of urban economies.
- Understanding urban metabolism, and the sustainability and resilience of UK cities in the context of resource security and climate change.
- Future urban forms, including opportunities for restructuring cities and growing new places.
The evolution of urban infrastructure systems, including transport and connectivity (both physical and digital).

Effective governance structures and the impact of policy, with a focus on both local and national governance and particular reference to planning.

However, in choosing these broad themes, the FFoC project remained acutely aware of the interdependencies between these themes, and that other cross-cutting themes, such as ‘technology’, are equally pervasive, while there are many influences that could act as ‘disruptors’ to the normal evolution of city systems. This all combined to paint the complex picture in which the FFoC project sought to provide an evidence base from which policies could be formulated to take into consideration the potential consequences for the UK’s city systems, and the UK’s system of cities, in the far future.

9.4 Scenarios

Engineering to support retrofitting of cities necessarily starts with an understanding of the context that the engineering seeks to change, and given that engineering interventions in cities usually involve a combination of changes to physical artefacts, operational processes and user behaviours, the context needs to be viewed from multiple dimensions and in the widest possible sense. Moreover, this context is changing, and in some dimensions the changes are remarkably rapid. Given that engineering interventions put in place today must operate and deliver their intended benefits into the future – and for many infrastructure systems their future efficacy is expected to extend to several decades – then an understanding of how the context might change in the (far) future is an essential input to the design process.

One way to help look forward is to look back, and in terms of changing context this exercise reveals a sobering picture in terms of the rate of change – looking back from 2015 at the changes that have taken place over 5 years (Internet Of Things, ‘Big Data’, the Green Deal, ISO standard for sustainable cities, BSI standard for future cities, a shift in discourse from resilience to liveability, the devolution agenda in practice) or 10 years (financial crash and the age of austerity, the rise and fall of the ‘Big Society’, a plethora of city bodies, networks and initiatives emerging, a shift in discourse from sustainability to resilience, the devolution agenda proposed) emphasises the problems associated with engineering for the far future. From this derives the adage: ‘predictions and projections will be wrong, it is simply a question of how wrong’ – hardly encouraging for engineers whose discipline is based on making use of well-honed experience in design. The primary alternative to projections is scenario-based analysis, which can take many forms (Hunt et al. 2012).

Notwithstanding the challenges of formulating predictions and projections, there is a need to engage in forward looking – using predictions and projections, while attempting to take cognisance of context change – whilst acknowledging that when looking to the far future, the use of scenarios can prove an invaluable additional aid to engineering thinking. Scenarios get around the problem of the constraints of today’s changing context by allowing engineers to describe alternative futures, ‘parachute into these futures’, explore how their engineering interventions might work, and then cast back to the present to explore the barriers that might compromise their efficacy. Put another
way, they can be used to explore the vulnerability of an engineering intervention, or more helpfully the vulnerabilities of a set of alternative interventions designed to bring about a set of intended benefits. Combining forward looking with backcasting from alternative futures yields a more robust way of testing the design of engineering interventions.

This was the approach adopted by the FFoC project, which used two time horizons to aid its thinking: projections based on alternative assumptions of context change were used when looking out to 2040, while alternative far-future scenario approaches gained more attention when looking out to 2065. Both were then used to explore urban transitions and pathways. As an example of forward looking, it was assumed, on the basis of projections by the UK Office for National Statistics, that the UK population is expected to grow by around 9 million by 2040 and 15 million by 2065. Four alternative projections were used to anticipate the consequences for the UK’s cities and the UK’s system of cities depending on where this increase of population was accommodated:

- concentrated in London and the Greater South-East, making the UK’s only megacity even more powerful;
- distributed uniformly amongst the major cities (i.e. Glasgow, Edinburgh, Newcastle, Manchester, Leeds, Bristol, Cardiff and equivalent large cities);
- distributed uniformly in smaller cities and towns throughout the UK;
- concentrated in a single new northern conurbation centred around Manchester, Leeds and Sheffield (the so-called Northern Powerhouse), which might then grow to become the UK’s second megacity; this was only fleetingly considered as an option.

None of these were in any way considered favoured, or desirable, but all had very different implications for the maintenance/development of the UK’s city systems and the infrastructures that would be needed to link them together. In short, they enabled different ways of thinking about the policies that might be adopted.

Looking beyond FFoC’s medium-term staging post of 2040, for which scenarios based upon projections can provide valuable insights, to 2065 the development and use of scenarios can serve three specific purposes:

- Extreme-yet-plausible scenarios can be used to determine the likely efficacy of policies, designs, changes in behaviour or other interventions in the governance or activity of cities (i.e. whether the intervention is likely to deliver its intended benefits). This follows the Designing Resilient Cities (DRC) methodology created by the Urban Futures project (Lombardi et al. 2012, Rogers et al. 2012b). In brief, the intervention is tested in today’s context and also explored in four scenarios at the extremes of plausibility in very different directions of travel from today’s world. In the case of an urban intervention (e.g. adaptation by retrofitting, although the same principles apply to new build, maintenance, refurbishment, a new policy or other type of change to the current system), the DRC method first defines the full extent of the intervention and identifies all of the intended benefits that the intervention aims to provide. For each of the intended benefits in turn, it establishes the conditions necessary for that benefit to be delivered and then determines whether the conditions are in place today, that is: were the intervention put in place today, would it deliver its intended benefits? The likelihood of the necessary conditions extending into the future is then assessed against the four UK-based scenarios. Taken together, the scenarios describe points on
The outer boundary of the space within which the range of likely plausible futures lies. Each of the scenarios is described by detailed sets of characteristics produced from extensive research based on robust data sets (Rogers et al. 2012b).

- **Aspirational scenarios** are visions of the future that meet a set of criteria which are considered essential and/or desirable in cities of the future. This requires the articulation of a set of aspirations of those who live, work and play in, and govern, cities, and might include, for example: responses to climate change, social disparities, resource use and resource security, citizen health and wellbeing. This set of city aspirations should be generated by the city in combination with its citizens via some form of foresighting process or consultation exercise. An alternative approach is to take a national view, such as that revealed by the University of Birmingham Policy Commission on Future Urban Living (Rogers et al. 2014). In this exercise, evidence was taken from a wide range of those governing cities and those for whom cities provide the focus of their activities, and then distilled into a combined set of aspirations for UK future cities and recommendations for how they might be realised. A more city-specific approach, being adopted in the Liveable Cities programme, is to ascertain individual and societal aspirations (distilled from interviews of a cross-section of citizens in the city in question; Joffe and Elsey 2014). Liveable Cities is also determining the aspirations of different sectoral groups via bespoke workshops. However they are formulated, it is common to create a small number of alternative scenarios in which certain of the core aspirations are prioritised (alongside a ‘business as usual scenario’), create narratives to explain them, and then test whether the interventions are likely to achieve the aspirations. This approach aligns with that used in the Retrofit 2050 project, which resulted in three future scenarios being formulated to deliver urban sustainability benefits (Smart – Networked City, Compact City, and Self Reliant – Green City).

- **Morphological analysis**, or the ‘two-axis’ technique, provides a further alternative approach. In this analysis, the problem is analysed for the primary influences on it and the two most dominant are selected as the axes across which thinking is prompted. Placing these axes orthogonally yields four quadrants, and thus four scenarios – one in which movement is positive with regard to both influences, one in which both influences are suppressed, and two in which only one influence operates. An example of this is provided by Hunt et al. (2013) in which the two primary influences on whether an intervention might prove sustainable and resilient were suggested to be adoption of technology and alteration of user behaviour. In this particular example, the scenario analysis was employed to determine whether urban interventions were likely to result in an achievement of an 80% reduction in carbon dioxide emissions, and, unsurprisingly, demonstrated that a combination of enabling technological and positive changes in user behaviour provided the most assured means of achieving the goal. A more specific example relating to retrofitting concerns the balance between technology and user behaviour in regulating water demands (Zadeh et al. 2013).

There are several observations to be made on the use of scenarios. The first, and often most helpful, is that the process of creating the scenarios itself directly aids in developing thinking on the proposed intervention, creates new ideas and assists in shaping its implementation. Of equal importance is the recognition that scenarios are in no way a means of providing a solution to a problem, that is they should not be used in the expectation that the designer of the intervention – the policy-maker, the engineer, the
architect, the psychologist, or whoever is responsible for proposing, shaping and bringing about the change – is relieved of any responsibility. Scenarios are enablers of improved design, not a substitute for any action on the part of the designer. If the scenarios are being created for use by others, once they have been created they need to be tested and refined via an iterative process to ensure that they are accessible by those that need to use them; that is, that the language is unambiguous and that the dimensions of the scenario are fully covered. One way to help in this is to create a narrative to describe the scenarios. In the case of the DRC method, for example, each of the scenarios was accompanied by ‘a day in the life’ of people living in the four future worlds (Lombardi et al. 2012). A similar outcome can be achieved via visualisations of the alternative futures. An example from the FFoC project of where visualisations help thinking, although not directly related to scenarios, is provided by Dunn et al. (2014). Finally, scenarios for use by others need to be accompanied by some form of methodology to create what is commonly referred to as a ‘toolkit’ (e.g. Hunt and Rogers 2015).

9.5 Conclusions

The role of civil engineers in engineering cities of the future, being the topic of most concern for the author, who has unashamedly drawn heavily on his portfolio of research over the past 15 years, is ultimately to support citizens and city systems. By the nature of their profession, they typically do so by creating artefacts that are often required to function decades into the future, and in so doing they have a responsibility to take cognisance of the concepts of sustainability, resilience, adaptability and liveability. They equally need to take cognisance of how cities operate today and the current context in which they are operating, as well as future (possibly radical) contextual change. In this endeavour, future visioning, both via projections and scenarios, can be used to enrich, empower and future-proof today’s engineering interventions in cities, and various examples of how they might be deployed have been given. Moreover, in developing the FFoC project, which focused on the UK’s city systems and the UK’s system of cities, both likely and potential contextual changes have been considered at length, and approaches based on both projections and scenarios have been used to assist policy-makers engaged in local and national governance in formulating policies that will likely have far future benefits. Foresighting using alternative futures based on projections and scenarios has a relevance to each of the aspects of retrofitting covered in this book, as the Retrofit 2050 project has ably demonstrated. One challenge that now remains is to synthesise all of this activity on foresighting such that it becomes second nature to those who shape cities of the future.

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References


Part III

Steering and Navigating Sustainable Urban Transitions
Overview

The transition of the built environment from energy consuming and unsustainable towards energy producing and sustainable is a complex, long-term challenge. One might assume that this transition will happen just because it is (increasingly) possible, affordable, desirable and just, but the speed of changes and the likely outcomes of the transition are far from certain. Incumbent regime actors, routines and rules complicate this transition, and many of the alternatives are not competitive enough given existing regulations and economic conditions. However, the combination of demographic changes, economic pressures, resource issues and new (information) technologies is increasingly leading to an existential problem in a building sector that focuses primarily on new houses in high quantities against low financial margins and on incrementally improving existing building stock. The effects of these pressures create space for acceleration of alternative transition pathways. It stimulates investments in new and so far, marginal alternatives such as energy producing houses through new retrofitting concepts. This chapter reflects upon the transitional challenge taking into account both the complexities and resistance to changes but focuses on the governance challenges of this transition. It will present some of the novel ideas on the tensions and paradoxes that arise in the acceleration or breakthrough phase of transitions and describes an example of a transition programme underway in the Netherlands to combine home owners, banks and private equity, the building sector, real estate agents and government to transform more than 100 000 homes from the 1970s and 1980s into energy producing before 2020. This programme, Energy Leap (Energiesprong), is gaining traction and helping to transform the built environment. It is drawing international attention and spreading to countries such as France and the UK, but is also in these countries facing the complex challenges of transition.
10.1 Introduction

It is increasingly argued that cities are at the frontline of sustainability: not only are cities most vulnerable to ecological, socio-economic and political crises but they are also the hotbeds of innovation and experimentation. Cities are entities in transition themselves as much as that they are the spaces within which novelties emerge. Cities themselves however do not constitute monolithic agency: rather they are composed of various actors: the organisations and the networks that build and make cities by continuously reshaping, redefining and re-enacting the urban. The vast majority of daily actions, innovations and decisions, policy measures and business strategies aim to improve existing urban fabrics, economies and (infra)structures. However, the collective impact of urban life is persistently unsustainable, creating negative ecological impacts, social tensions and economic crises. In spite of decades of attention to sustainability, human development is locked into an inherently unsustainable pathway. Taking the perspective of sustainability transitions (Grin et al., 2010) a deeper and more fundamental shift is required towards fundamentally different cultures, structures and practices that are inherently sustainable rather than less unsustainable (Loorbach, 2014).

This shift of paradigm is quite visible in the attempt to radically transform the built environment from an energy consumer into a zero energy or even energy producing built environment. For decades, the built environment has been handled by policymakers and the building sector, focusing on quantitative and efficient production. Energy and materials were hardly a concern during the first post war decades, but have slowly come on to the agenda. Across developed countries energy efficiency measures were introduced, waste separation schemes and all sorts of labels and codes stimulating sustainable development of the built environment. In the Netherlands, the country this chapter focuses upon, efforts to push the building sector for sustainability started in the 1990s, targeting both construction and resident behaviour. Successful examples such as the ‘Ecoteams’, going door to door providing tips for reducing environmental impact, have led to all sorts of improvements.

But in spite of the relative success – for example the CO₂ emissions per square metre in the built environment were reduced by 50% compared with 1990 levels in major Dutch cities – there has not been a substantial change in the overall trend. Rebound effects, growth, increase in use of appliances and a slow uptake of innovations in the building sector in general lead to a very slow process of change. While this can partly be explained by the inherent slowness of change in the building stock, my argument is that it is also largely caused by a locked-in regime around the built environment: historically developed routines, practices and paradigms centre around growth, quantitative production and efficiency. This regime is increasingly challenged by alternative views, practices and structures that are better able to cater to the needs of our time: sustainable energy and healthy living environments. From a transition perspective, we can understand these current dynamics as the interplay between a changing societal context, internal tensions within the regime, and competing alternatives, creating a period of chaotic and disruptive systemic change.

There are increasingly strong signals of such deeper changes across society. Sustainable technologies are maturing after decades of experimentation. Across the globe ‘translocal’ networks of transformation are emerging, developing inherently sustainable alternative systems such as complementary currencies, energy and food collectives, and transition
towns. Driven by the possibilities of the internet, availability of open access data and knowledge, and transformative entrepreneurial capacities individuals all over the world are linking up in transformative networks. This emerging network society is changing the world collectively in a fragmented, decentralized and self-organizing way, not with global negotiations, Local Agendas or top-down planning but through dedication, creativity, persistence, patience, hard work, failure and recovery. We argue that this transformative human energy could be the most promising development to accelerate toward sustainability; but also that modern cities with their top-down institutions, hard infrastructures, unsustainable energy system, dependence on external resources and unsustainable levels of consumption will not fade away easily. This is what we call transforming cities: the uncoordinated yet globally emerging movement in cities where innovative new sustainable solutions are being experimented with, shared and translated at increasing speed.

Dealing with this new reality also requires new approaches to governance and change, to help accelerate and guide these emerging sustainability transitions. As we have now known for decades, our current pathway of development is not sustainable, and regular policy so far seems unable to shift course. Developed countries are increasingly crossing the ecological, social and economic boundaries within which production and consumption patterns can be sustained, leading to a variety of problems, crises and tensions. Rather than dealing with these tensions through efficiency increases, technological innovation and regulatory interventions, transition studies suggest that inevitably more structurally unpredictable and chaotic changes will take place. As much as such transitions could lead to less desirable futures and collapse, such transitions also offer the possibilities for the relatively rapid breakthroughs that are deemed necessary to achieve global sustainability goals. Actively anticipating and adapting to the dynamics of transitions, transition management (Loorbach, 2007) is therefore considered as a way to increase the chances for sustainability transitions.

10.2 Transitions as the Analytical Starting Point for Addressing Urban Transitions

In essence, transition management studies complex adaptive societal systems (such as societal sectors, regions, cities or ports) that go through fundamental non-linear changes in cultures, structures and practices. Transitions are defined as the result of co-evolving processes in economy, society, ecology and technology that progressively build up toward a revolutionary systemic change in the very long term. Because of this complexity, transitions are impossible to predict, fully comprehend, or steer directly, but they are seen as a pattern of change that can be anticipated. These processes can be adapted to in such a way that the inevitable non-linear shifts and associated crises provide massive windows of opportunity for accelerated reorientation toward sustainability.

The multi-level model (Geels, 2002), originating from innovation and technology studies, is taken as point of departure (Figure 10.1). The central level is the meso-level at which the so-called regime is located. The term ‘regime’ refers to the dominant culture, structure and practice embodied by physical and immaterial infrastructures (e.g. roads, power grids, but also routines, actor-networks, power relationships, regulations). These institutionalized structures give a societal system stability and guide decision-making and individual behaviour of actors. At the same time, the regime has a certain level of
rigidity that normally prevents innovations from altering the structure fundamentally. The second level is the micro-level of innovations: inside so-called ‘niches’ novelties are created, tested and diffused. Such novelties can be new technologies, new rules and legislation, new organizations or even new projects, concepts or ideas. The third level is the landscape, the overall societal setting in which processes of change occurs. The landscape consists of the social values, political cultures, built environment (factories, etc.) and economic development and trends. The landscape level typically develops autonomously but directly influences the regime level as well as the niches by defining the room and direction for change.

Although transitions are characterized by non-linear behaviour, the process itself is a gradual one. Transitions can be described in terms of ‘degradation’ and ‘breakdown’ versus ‘build up’ and ‘innovation’ or in terms of ‘creative destruction.’ The central assumption is that societal structures go through long periods of relative stability and optimization, followed by relatively short periods of structural change. In this process, existing structures (values, institutions, regulations, markets, etc.) fade away while new ones emerge. Historical analyses of societal transitions suggest that transitions go through different stages. Four phases are distinguished, originally represented by an S-shaped-curve (Rotmans et al., 2001) but more recently visualized as an ‘X-curve’ (based upon Loorbach, 2014) (Figure 10.2). The nature and speed of change differ in each of the transition stages:

- In the early predevelopment, a regime optimises and thereby enhances lock-in while gradually societal pressures increase and niche experiments start to develop.
- In the later predevelopment regimes start to destabilise and enter disruptions while alternatives start to accelerate and develop into alternative structures.
- In the actual transitional phase structural changes take place in a visible way through shock-wise, disruptive recombination of old and new elements, accompanied by a phase-out and breakdown of other parts of the old regime.
- In the stabilisation phase, a new regime settles and moves toward path-dependent optimisation again.
The X-shaped curve is a highly simplified model to represent such a complex process as a transition. Behind the smooth curve, multiple and interrelated innovations and disruptions take place at a different speed and level. The dynamics at the levels of regimes and niches are co-evolutionary: the emergence of alternatives over time co-evolves with the increasingly evident lock-in at the level of a regime and vice versa. In practice, it is often individuals and specific organisations that, especially in the later stages of the predevelopment, create interlinkages. For example, more proactive incumbent actors start to collaborate with start-ups and disruptors or bottom-up initiatives create a representative body to take part in policy processes. In the actual phase of transition, the interests and strategies of regime actors diverge through which they create the necessary conditions for a new regime to emerge. A central message of the transition perspective is that structural systemic change is not a gradual, linear process but a disruptive, shock-wise and chaotic one. Also, in the longer term such transitional changes are inevitably part of progress. The transition perspective provides a way to analyse complex societal change processes and to develop strategies to guide and accelerate such transitions towards sustainability.

10.3 Sustainability Transitions in Urban Areas

Cities are a key locus in these sustainability transitions: they are as much the sites where unsustainability issues converge, manifest themselves and have severest impact, as they are the places where innovations develop, diffuse and scale-up (Ernstson et al., 2010; Nevens et al., 2013). Cities themselves are subject to transitions: they go through continuous processes of change and many cities have adopted explicit and ambitious sustainable development goals. Simultaneously, cities play a crucial role in broader sustainability transitions, as here new practices, technologies, institutions and cultures are developed. In this chapter this perspective is used to address the question of retrofitting
the built environment: it both requires a fundamental change in how the built environment is developed and the need to facilitate the ‘landing’ of transitions in domains such as energy, food, mobility and finance at the level of buildings.

This millennium, the global urban population exceeded the rural population for the first time in history (Seto et al., 2010); at present, more than half of the world’s total population lives in cities. As a consequence of the global urbanisation trend, most demand for energy, food, water, buildings, waste management, healthcare, education, and other basic goods, is concentrated in and around cities. Along with the problem of satisfying increasing demand comes the fact that through the unwanted by-products of the unsustainable socio-technological systems in place, cities are responsible for the largest proportion of environmental impacts. Worldwide, cities are responsible for almost 75% of total resource consumption (Madlener & Sunak, 2011), and the primary source of greenhouse gas (GHG) emissions. Overall, cities account for at least 70% of energy-related GHG emissions. Sustainability problems can be found in almost all socio-technological systems needed to ‘run cities’. As such, cities are the locations where most of the (un)sustainability issues find their origin. In contrast, cities are also locations for sustainability innovation and societal progress; cities can even be considered as potential ‘drivers’ for sustainable development or ‘hubs’ for radical sustainability innovation (Bulkeley et al., 2010; Vergragt & Brown, 2010). Instead of seeing cities as centralised bureaucracies or static entities we follow the more recent conceptualisation of cities as multi-faceted ‘municipalities’ behaving as self-governing actors on sustainability issues. In this view, cities take the lead in sustainability solutions. While they might not be the exclusive locations to advance sustainability transitions, cities can at least play an important role on two levels: as ‘actors’ with regard to (re)developing socio-technological systems; and as facilitators to sustainability innovations (Frantzeskaki et al., 2014). Actors, in general, can ‘push policy’ towards promoting sustainability on the street level, along (re)structuring the city’s infrastructure, and facilitating larger scale environmental, social and economic innovations throughout the world.

This insight that cities are ‘actors and locations’ of sustainability transition is not new. Many ambitious sustainability initiatives have already emerged at the level of cities and metropolitan regions, such as the C40 Climate Coalition. From a transition perspective, we argue that while the potential for accelerating towards sustainability is there as facilitator or location, cities do not automatically make this shift as actors. More important, when cities do take up their role as actors, the available ‘development’ policies so far seem insufficient to guide an accelerated change towards sustainability. While development policies have added to economic and technological improvements in many cities around the world, simultaneously global consumption and waste levels stemming from these improvements have continued to increase. In this view, regular urban policies and cities’ governance structures focus too much on ‘straightforward’ economic development and standard technological solutions, whereby adaptive and transformative strategies for sustainability are needed. Sustainability is too often considered as a separate domain of secondary policy concern, mainly because it is dominantly perceived in the realm of short-term economic calculus. Thus, its advance is perceived as very costly and uncertain. Clearly, it takes massive investments to (re)structure cities’ socio-technological systems towards sustainable functioning. Still, the transition perspective suggests that no matter how high the costs and level of uncertainty, the cost of inaction in the long
run is always higher. Because socio-technological systems are embedded in societies, which in turn are embedded in their environment (Giddings et al., 2002), the persistent unsustainability inevitably will lead to a deep crisis in and possible collapse of the current systems. The primacy of short-term economic concerns in policy making is short-sighted, as the functioning of economic systems is dependent on sustainable functioning of socio-technological systems, as well as their societal and environmental surroundings.

The awareness about the unsustainability of our current development pathways found a global stage with the introduction of the notion of sustainable development by the so called Brundtland Commission in the 1980s. It was defined as: ‘Meeting the needs of the present without compromising the ability of future generations to meet their own needs’ (WCED, 1987). The report concluded in line with studies like the ‘Limits to Growth’ report: an inherent unsustainability in the dominant development pattern, an unsustainability pathway we are still locked into, even after three decades of research, policy and debate seeking to define, operationalise and implement sustainable development. It can therefore be argued that sustainable development in its current institutionalised forms has become part of sustaining unsustainability (Loorbach, 2014) and that we need to fundamentally reconsider this notion and how it should be operationalised in practice. To do so, we start from identifying common ground as well as seek to identify seeds of transformative social change towards inherent sustainability rather than incremental change leading to reduced unsustainability.

A common ground is found in that it encompasses social, environmental and economic prosperity, here and in other places, now and in the future. What this exactly means differs from situation to situation, as the needs of people vary, depending amongst others on historical, political, economic, social and ecological circumstances and developments. The many forms of unsustainability in Western societies are visible in the form of what we call persistent problems. Examples of such problems at different scale levels are: climate change at a global level; the agricultural problem at continental scale, with animal diseases as symptoms such as bird flu, mad cow disease and foot-and-mouth disease; and the mobility problem at a national level with traffic congestion and air pollution due to increased mobility (Rotmans & Loorbach, 2007). These problems are complex, as they are deeply embedded in societal structures and institutions. They have multiple causes and consequences and their reach stretches beyond a wide range of societal domains, actors and scale levels.

A clear example of this is the unsustainability of our current energy systems and how this impacts the urban environment. Most modern cities which historically had their own energy supply now depend on national energy grids and power plants running on fossil fuels in a liberalised market. Cities experience the effects of pollution, price volatility and dependence upon foreign supply, but often do not have the position or instruments to change this. Alternatives have long been considered as politically contested or too small scale to replace current options. The interests, investments and stakes in the current fossil fuel based regime are high, so that structural change cannot be expected to be initiated by the vested parties, also called regime, which is defined as the dominant constellation of structures, culture and practices in a certain societal system. However, many cities are putting substantial efforts into developing new urban energy solutions. These range from stimulating energy efficiency, to diffusing renewable technologies, to developing waste-heat systems or smart grids. Cities are thus providing
the spaces for radical alternatives to the dominant fossil fuel based and centralised
energy system thereby becoming important change agents in transitions. It is however
in practice a rather chaotic and uncoordinated process in which different cities explore
different strategies, solutions and technologies, depending on their local context,
challenges and potential. In terms of transition governance, developing a sustainable
energy system thus is not a process of planning and control but requires clever organisa-
tion and facilitation through creating room for self-organisation, experimentation and
learning.

10.4 A Transition in the Urban Built Environment?

Following the transition perspective, it is argued that how we have come to think,
organise and practice urban development (the regime) has historically been organised
around accommodating growth and comfort increases. Shifting to a regime that is
based on quality, sustainability and liveability will require a deeper change in how the
urban development and construction regimes are organised. Given the built-up
routines, vested interests and institutional support for the old regime, achieving such
deeper change poses what is called a persistent problem. Such persistent problems
cannot be addressed through single and predictable solutions but require processes of
experimentation, learning and breakdown that move beyond regular policy approaches.
Many policy and market based strategies have been developed to stimulate sustainable
development and innovation, but the efficiency gains (e.g. more efficient industries)
have been curbed by growing levels of consumption. The transition premise is that in
order to achieve the levels of sustainability needed (e.g. an 80% reduction of CO₂ emis-
sions) requires more than improving the existing systems; it requires systemic changes
or transitions. From this perspective, the challenge to move towards sustainability is
thus understood as the need to achieve fundamental systemic change, implying disrup-
tive power shifts.

In terms of urban retrofitting, it has long been realised that there is an evident need
(and possibility) to increase the energy efficiency of the built environment. Historically,
the driving factors behind the development of the building ‘regime’ in the post-war
decades in countries like the Netherlands have been to accommodate a rapidly growing
population, and an increase in demand for space and comfort. This has led, in the
Netherlands, to a building regime consisting of particular cultures, structures and
practices that favour quantity over quality, and are typically focused on either large scale
standardised area development (referred to as VINEX) or individual approaches. In the
dominant individual approach every building is unique in that it is constructed through
a collaboration between consortia of different contractors that each contribute to
specific parts of the construction, maintenance or retrofit process. This implies high
learning costs, small economic margins and large space for error (every new home con-
structed in general contained on average 23 building errors in the Netherlands in 2012).

The economic crisis, combined with a stabilisation of the population growth has since
2008 put an increasing pressure on the building sector. Traditionally this pressure has
been mitigated by increasing efficiency and optimising existing practices and struc-
tures. For example, regarding the energy performance of the built environment in the
Netherlands, energy performance indicators have been developed along with ‘labels’
that make the energy performance of a building visible. Under pressure to improve energy efficiency, targets have been agreed to achieve step changes in the built environment, moving up the efficiency ladder. Typically, such steps can be realised by incremental steps, for example shifting to highly efficient boilers, installing double glazing or insulating roofs. In practice, such incremental steps lead to improvement but also deepen the lock-in: inhabitants tend to only take such measures every 7 years or so, and the individual measures taken often reduce the added value of further steps.

10.5 Transition Project ‘Energiesprong’

So while the dominant strategy is an incremental improvement of the existing building stock, based on the existing small scale complex cooperation between contractors, builders, the installation sector and home owners, an initiative started in 2010 in the Netherlands to achieve a more sustainable solution. Energiesprong¹ (literally: Energy Leap), also called ‘Transition Zero’, is a programme designed to develop and bring together supply and demand for buildings without an energy bill on a large scale. It started from the analysis that the Dutch building sector was too fragmented, energy efficiency policies too incremental and investment opportunities too fragmented and small scale to accelerate to a net-zero energy built environment. It also identified the technological and economic potential and feasibility of making this jump under the conditions that the mentioned barriers were addressed. To do this, Energiesprong developed a number of projects focused on developing industrial scale retrofitting in the building industry, bundling demand via the rental sector and creating investment portfolios.

They identified the persistent problems in achieving net zero energy housing in terms of the wrong financial incentive structure (upfront investment versus long-term revenues), too high costs of net zero retrofit (because of the home-by-home approach), and a lack of large scale cooperation. The vision developed therefore was to work towards a more industrial approach to home retrofit combined with an innovative financing scheme based on energy service contracts. The idea was that through involving large scale funders (banks and pension funds) to guarantee upfront investments, and having home owners commit to a period of paying the amount of their current energy bill to pay back the investments, an ‘energy-mortgage’ could solve the financing problem (Figure 10.3). Additionally, they envisioned a rapid reduction of net zero energy retrofit by upscaling and standardising the production. When they started, the average cost for a standard home in the Netherlands was roughly 130 000 Euros. This would imply a 30-year payback period.

The project started with a few houses, largely subsidised by the Dutch Ministry, providing the context for construction companies to develop experience. Upscaling started from 2013, having now achieved a successful net energy-zero retrofit of a few hundred buildings and a significant lowering of the total cost to already around 45 000 Euros per home in 2014 (Figure 10.4), along with a number of new financial instruments to facilitate this. In 2015 they further standardised the approach to be applied more widely, starting with a signed deal including the retrofitting of 110 000 rental homes.

¹ http://energiesprong.nl/transitionzero/.
The project started by the end of 2015. During 2016 it helped to develop better insight into effects of energy retrofitting on the use of the buildings and the inhabitant behaviour. It also started to impact the broader sector and involved parties like building owners and developers through accelerating the business case and financial mechanisms behind energy zero retrofit. The aim is to further bring down the cost to around 30 000 Euros, which would imply a financing from the energy bill well within a 10-year time frame.

Interestingly enough, while this project was subsidised as an innovation project by the Ministry, it has so far not accelerated with the pace that could be expected, given the potential. The approach could be applied to around 6 million Dutch residential
buildings, effectively achieving net zero-energy for around 80% of the building stock. The Ministry’s focus however is still on incremental optimisation, rather than taking the approach as the basis for a national plan with such an ambition. Meanwhile the Energiesprong has stimulated large scale innovation in the retrofitting sector targeting full scale retrofit to net zero-energy within 10 days maximum, creating as smooth a transition for home owners as possible. By the middle of 2015 efforts were under way to implement the funding scheme and to close contracts with more housing corporations to start the retrofit of thousands of homes in 2016. The ultimate ambition is to move towards the 2 million homes built in the 1950–1980 period and to develop a standardised practice and financing model that will enable rapid diffusion. The approach has helped to mobilise frontrunners in the Dutch building and financial sector and it has successfully lobbied to change regulations so that building owners can charge occupants to pay back the energy investment (the law on energy performance payment or energieprestatievergoeding EPV in Dutch). Their impact has not gone unnoticed and has led to the experimental adoption of it in countries like France and the UK.

10.6 Transition Management and the Built Environment

From a transition perspective it seems obvious that such an initiative fits within a process of more systemic change in which a regime focused on producing quantities in the most cost efficient way can transform into a regime that is based upon effective delivery of quality. Given the relative low commitment of the existing policy and construction regime as well as the struggle of the programme to move forward in the first years, the question can be raised of how such a transition might be better managed. In this section the basic ideas behind transition management will be outlined before formulating some ideas and approaches that might be considered to accelerate and further guide this transition to a retrofitted city.

Since small changes might evoke large scale systemic change when the system itself is close to a threshold (a take-off in transition terminology), transition management focuses on coordination and stimulation of the emerging innovations and alternative futures rather than on the mainstream or regime. Transition management is based upon a number of principles (Rotmans & Loorbach, 2009; Frantzeskaki et al., 2012) that set it apart from regular policy approaches. These principles will be briefly set out before exploring how they could be applied to this case.

The first principle is that of creating space for and empowering of niches through so-called transition arenas and strategic niche management. The notion of arena originates from that part of complexity theory that indicates that a small initial change in the system may have a great impact on the system in the long run. In systems terms we call this an emergent structure: an environment that offers some protection for a small group of agents. The self-organising capacity of the system generates new, dissipative structures in the form of niches. A niche is a new structure, a small core of agents, that emerges within the system and that aligns itself with a new configuration.

With empowering we mean providing with resources, such as knowledge, finances, competences, lobby-mechanisms, exemption of rules and laws and space for experimenting (Avelino & Rotmans, 2009).

A focus on frontrunners is a second key aspect of transition management. In complex system terms frontrunners are agents with the capacity to generate dissipative structures and operate within these deviant structures. They can only do that without being (directly) dependent on the structure, culture and practices of the regime. In the context of transition management, by frontrunners we mean agents with peculiar competencies and qualities: creative minds, strategists and visionaries. In order to effectively create a new regime agents are needed at a certain distance from the dominant regime.

Another principle of transition management is guided variation and selection. This is rooted in the notions of diversity and coherence within complexity theory. Diversity is required to avoid rigidity within the system. Rigidity here means reduced diversity due to selection mechanisms which means that the system cannot respond flexibly to changes in its environment. Coherence refers to the level of interrelatedness among the entities of a complex system. In the equilibrium phase there is continuous variation and selection but when a regime settles this becomes the dominant selection environment and thus decreases the diversity. However, a certain amount of diversity is required to explore a diversity of innovative options instead of looking for the optimal solution. Rather than selecting innovative options in a too early stage, options are kept open in order to learn about the pros and cons of available options before making a selection. Through experimenting we can reduce some aspects of the high level of uncertainty so that it leads to better-informed decisions about variation and selection in the next round.

The principle of radical change in incremental steps is a paradox that is derived from complexity theory. Radical, structural change is needed to erode the existing deep structure (incumbent regime) of a system and ultimately dismantle it. Immediate radical change, however, would lead to maximal resistance from the deep structure, that cannot adjust to a too fast, radical change. Abrupt forcing of the system would disrupt the system and would create a backlash in the system because of its resilience. Incremental change allows the system to adjust to the new circumstances and to build up new structures that align to the new configuration. Radical change in incremental steps implies that the system heads for a new direction towards new attractors, but in small steps.

Anticipating future trends and developments by taking account of weak signals and seeds of change acting as the harbingers of the future is a key element of a pro-active, long-term strategy such as transition management. This future orientation is accompanied by a strategy of adaptation, which means adjusting while the structure of the system is changing. This requires adequate insight into the dynamics of a complex system but not in the sense that the future state of such a system is predictable, but that there are periods when the system behaves in a relatively orderly manner and, to a limited extent, is predictable. However, there are also periods in which the behaviour of the system is quite unpredictable. So although the degree of predictability is rather small, transitions do imply generic patterns that indicate the future pathway. Path dependency is an example of such a pattern.

These principles were translated into a framework (also referred to as the transition management cycle) focused on the predevelopment phase and creating space for radical
visions, experiments and transformative networks. In later phases of transitions, where the dynamics become more chaotic as regimes destabilise and partly fall apart while alternatives emerge and start to institutionalise, attention needs to shift towards processes of (de)institutionalisation, phase out and development of new market structures. The panarchy governance framework developed in this context (Loorbach, 2014) distinguishes between empowering transformative innovation, establishing new structures and institutions, guiding phase-out and breakdown, and reflexive transitioning.

Applied to our case of a leap from optimising existing building stock to a radical system retrofit, we could argue that the Energy Leap initiative is following the transition management principles in that it starts from a deeper analysis of the transitional dynamics in their domain, focuses on involving frontrunners, actively experiments with different models and organises systematic reflection and learning. The initiative has all the characteristics of a transition experiment. It plays into the persistent problem associated with the dominant regime of building and retrofit, which is an incremental and fragmented approach towards energy efficiency. The initiative focuses on a superior alternative which offers benefits in terms of long-term cost, comfort, employment as well as sustainability. It is being propelled forward by a changing societal context: in the Netherlands the dependence on natural gas for heating homes is increasingly problematic. The national reserves are not only running out over the next 15 years, but are also causing earthquakes in the extraction areas, leading to public protests. The dependence on Russia for the natural gas supply is leading to public and political debate, favouring alternative solutions like net zero energy housing.

However, the initiative, while supported by a Ministry fund, has encountered a lot of scepticism and resistance from the existing regime in many ways. Not only does the government seek to prolong our dependence on gas, partly based on existing long-term contracts with Russia, but they also favour more centralised solutions like waste-heat systems and geothermal solutions. The construction sector itself has not fully embraced the approach yet, questioning the business model, the feasibility and the envisaged centralised industrial approach. In many ways one could explain such resistance as a typical regime reflex: the way of thinking, organising and practising behind the Energiesprong is fundamentally different from the dominant regime. Like in all transitions however, time favours the niche alternatives as the learning curves of these are steep, prices will drop further and the positive dynamics will reinforce themselves. At the same time the so far still dominant paradigms, structures and practices are increasingly complex, expensive and ineffective. The question now becomes how this process of regime decline and niche emergence can be coordinated or governed in such a way that a smooth and swift transition is realised.

By now the Energiesprong has developed a critical mass of change agents, a working and economically interesting model and a compelling narrative. Their network now includes increasingly skilled builders, financing institutions like banks and pension funds, housing cooperations, researchers and local governments. However, to make the shift to the next phase they also need to start to think about new types of structures and institutions, for which they obviously will also need institutional support and a larger scale operation. In this context it is therefore logical that the initiative seeks to develop shared agreements amongst the more institutional partners in the programme (housing corporations, financial institutes and the Ministry) as well as to codify and standardise procedures and practices within the net zero energy retrofit.
From a transition perspective this process will inevitably also come with conflicts and more resistance. However, promising and superior the developed retrofit model, it is a direct threat to the business model of the existing regime. The Dutch government not only is partly dependent on income from the sale of natural gas for heating (which could fall to near zero in households) but is also mentally and institutionally locked in into the regime of efficiency and optimisation. This is similar for the innovative builders now able to produce the retrofitted homes but the majority lack the skills, knowledge and cooperative organisation needed. Such actors therefore understandably (and perhaps deliberately) slow down this transition, which in the end is inevitable given the steep learning curves and the inherent benefits. The process of scaling up the model and industrialising the approach over the coming years from this perspective could make for a fascinating case study into the acceleration phase of transitions.

10.7 Outlook: Transitioning the City?

In this chapter I introduced the perspective of transitions in urban contexts, highlighting both the persistent unsustainability associated with ongoing urban development as well as the potential of cities to be the birthplaces of sustainability transitions. I also reflected upon the inherent tensions and ambiguities involved in such sustainability transitions. As these imply a fundamental change in dominate cultures, structures and practices, they are in practice often complicated by vested routines, interests and disbelief. The emphasis on improving the existing is often outweighing the promise of the radical alternative, unless under the condition of a severe systemic crisis. My argument is that in a number of critical sectors and domains for cities such crises are increasingly surfacing, for example in energy, mobility and housing. But simultaneously a more systematic and strategic focus on the radical alternatives offers a perspective to turn these crises into transformations.

I also introduced the example of the zero energy retrofit programme Energiesprong in the Netherlands as an example. It clearly illustrates both the potential of radical niches as well as the inherent difficulties of shifting the dominant regime into this direction. The completely different type of approach pursued by the initiative is based on a novel way to organise the retrofit process, to finance it, to combine technologies and to regulate it. In all these aspects it conflicts with the dominant practices, structures and ways of thinking. Nevertheless, the initiative is gradually accelerating as the prices drop as predicted, experience is being built up and more and more organisations are getting involved. At the same time the dominant approach is increasingly complex, expensive and not delivering the necessary changes quickly enough. This is the typical pattern of transitions, in which over time the inevitable development of the new starts to co-evolve with the inevitable decline of the old, leading to more chaotic and disruptive changes at the level of regimes.

This is only one example of the transition dynamics occurring in an urban context. Similar dynamics between optimisation and transformation can be observed in energy (efficient coal plants versus local renewable collectives), waste (efficient collection and separation versus circular economy and reversed recycling), mobility (emission standards and congestion policies versus automated electric mobility), care (efficient healthcare homes versus community care) or food (efficient industrial food production versus
urban farming and food collectives). In many cases the alternatives seem small scale, vulnerable and expensive but as time goes on the externalities associated with the unsustainable regimes will become more and more visible and the cost of the alternative will continue to go down.

This brings us to the question of governance. As outlined in this chapter, the approach of transition management focuses on empowering more radical alternatives and ushering them to a phase of maturity and competition with destabilising regimes. My argument is that we are now entering this more chaotic phase of systemic change in which it is inevitable that urban governments need to get seriously involved. This involvement is not in the sense of subsidising innovation projects or small scale initiatives, but in terms of rethinking the basic conditions, regulations and ambitions within which urban development takes place. Even though many of such conditions are set by national government, the trend of decentralisation, combined with the role of the local authority when it comes to planning, taxation and local regulation, provides the tools for actually accelerating sustainability transitions.

Looking to the potential of radical alternatives, it is possible to envision cities which provide their own energy; are based on zero emissions and automated mobility; in which citizens are involved in producing food, clean water, energy and services; in which resource cycles are closed within the region; in which the cost of living is substantially lower and the quality of life and health substantially higher. Not only the technologies, but also the concepts, business models, institutional solutions, knowledge and examples to do it are already there on a small scale. What is needed, however, for an acceleration and timely transitions are the types of strategic transformative initiatives like the Energiesprong as well as political and societal leadership in cities. This means leadership that is not characterised by its ability to play the regular policy game and get appointed within the existing regime but leadership that is able to politicise issues along the fault lines of transitions, able to reveal the underlying tensions and vested interests and routines that prevent acceleration, and able to empower and mobilise agency for transformation.

References


11

Presenting Futures: London 2062

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Overview

Universities have an important role to play in supporting cities through transitions to sustainability, amongst many other issues facing citizens and decision makers. The London 2062 project invited academics and students of University College London (UCL), a multi-faculty university located in central London, and partners from across London to consider the key issues shaping the future of the city. Through a series of seminars, workshops and publications contributors were encouraged to draw on their expertise to identify the forces shaping London and to consider how these might play out over the next five decades. The outcomes reflect the diverse methods and contributors, ranging from design principles for climate change adaptation to a vision of London run by mega-football clubs. Unconstrained deliberation about the future by well-informed people helps to clarify the key issues that are currently at stake in the city, as well as pointing out what these might mean in 50 years.

11.1 Introduction

Retrofitting cities to improve sustainability and resilience requires discernment of possible, likely and desirable futures, and the capacity to identify factors that are within and beyond control. Discernment in turn requires wisdom and humility, as well as confidence and courage. Retrofitting may be framed as a technical challenge, based on forecasts of variables such as emissions, demographics, resource use and climate change but cities provide a complex context for delivering projects and policies. Urban dynamics, culture and politics may prove more favourable to retrofitting some classes of infrastructure, such as installing high-speed broadband, than others, such as public transport networks. Drivers for retrofitting a particular technology or infrastructure may also require multiple policies and approaches. For instance, to improve insulation of homes in social rental, private rental or private ownership, with different insulation of
building and financial circumstances of owners and investors, requires a range of targeted measures. Even if the dynamics and diversity of urban systems can be well characterised, their responses to environmental, economic and social change, and the ways in which they interact with each other mean that urban systems are highly complex and difficult to predict. And yet it is the job of city planners and politicians to make decisions in the present about the future. Such decisions, particularly those pertaining to infrastructure or large scale technical transformation are inevitably taken under conditions of high uncertainty, relying on vision, leadership and judgement as well as technical analysis and forecasting.

Universities have important roles to play in urban transformation (Perry 2011; Stachowiak et al. 2013). Most decisions about urban futures are taken by people with university qualifications, and universities are key centres for educating planners, architects, economists, engineers and other urban professionals. University research provides valuable knowledge, data and methods for urban professionals and decision makers to use in formulating and implementing policies and projects. Universities are important in the ecosystems of urban innovation that give rise to new technologies, systems and practices that are important in urban retrofitting, adaptation and economic growth (Clarke & Williams 2014). Universities are important stakeholders in cities as owners and managers of land, buildings and infrastructure, and as centres for economic activity, income, expenditure and investment in the built environment (Goddard & Valance 2013).

Navigating urban transitions is a complex, multi-faceted problem, requiring wisdom as well as specialist and interdisciplinary knowledge. In addition to their role as stakeholders and knowledge providers, universities are uniquely positioned to support city leaders and professionals in formulating visions for urban transitions (Hambleton 2015). Through what Nicholas Maxwell (2014) has termed ‘wisdom inquiry’ universities are able to help cities to define problems and formulate potential solutions, as well as providing specific technical or scientific knowledge and analysis. This presents a challenge to traditional universities, which have been structured to enable specialist disciplines to produce knowledge independent of external influences. The challenge of integrating different disciplinary knowledge is well known in universities and professions, but the co-definition of problems and co-production of solutions to complex societal problems, such as retrofitting cities for the future, is less well articulated.

The London 2062 project at University College London (UCL) was an experiment in how a university might contribute wisdom as well as knowledge to inform the future of the city. The project invited UCL staff and students, together with policy makers, professionals and civil society, to imagine London 50 years into the future. It aimed to draw on the wide expertise and perspectives of academic specialists and to promote interdisciplinary dialogue, within the university and with the city. The project scope was broadly ‘the future of London’, but focusing on topics and themes such as sustainability, wellbeing, energy and housing, it delivered outcomes of relevance to the challenge of steering urban retrofitting. The broader scope also identified potential outlying factors contributing to urban complexity in London that might not otherwise be considered in framing urban retrofitting and transitions.

This chapter tells the story of the London 2062 project and summarises its main methods, outputs and findings. The project demonstrated the value of a drawing on a variety of disciplinary and methodological approaches, including allowing academics and key partners to contribute independent visions of the future of the city based on their particular expertise, experience and values. The project did not aim at a consensus
vision or prescriptive policy advice, but served to highlight key issues facing London today that have potentially significant impacts on the future of the city. The chapter concludes with reflections on the value of universities instigating such initiatives in the city, and opportunities for supporting greater wisdom as well as providing better evidence for city leaders who are navigating urban transitions.

11.2 UCL’s Grand Challenges

Established in 1826, UCL is a multi-disciplinary university located in central London, with nearly 36 000 students and more than 6000 research and academic staff. UCL has a strong history of research and scholarship relating to urban planning and the built environment, including London. Sir Peter Hall, the eminent planning scholar and author of London 2000 (Hall 1963), worked at UCL from 1992 until his death in 2014. Ruth Glass coined the term ‘gentrification’ in the introduction to the book London: Aspects of Change (Centre for Urban Studies 1964). Staff and students in many faculties at UCL continue world leading urban research engaged with local London issues, including interdisciplinary work undertaken through the UCL Urban Laboratory and the Grand Challenge of Sustainable Cities.

Since 2008 UCL’s Grand Challenges programme has focused interdisciplinary research efforts around key themes, which were defined as complex global problem areas in which UCL has world leading research expertise. The programme is underpinned by UCL’s ‘Wisdom Agenda’, which outlines key activities to support the ‘judicious application of knowledge for the good of humanity’, with a particular emphasis on working across disciplines and in partnership with external organisations and the public (UCL 2011). The first generation of the Grand Challenges were: Global Health, Intercultural Interaction, Human Wellbeing and Sustainable Cities. In 2016 a review of the programme Intercultural Interaction was reformulated as Cultural Understanding and two new Grand Challenges were added: Transformative Technology and Justice and Equality. The Grand Challenge of Sustainable Cities has supported projects and events addressing interdisciplinary urban research on topics including urban water poverty, graffiti, housing, food, megacities, sustainable sanitation, transport and the future of London through the London 2062 project (UCL 2016).

11.3 London 2062

London 2062 aimed to bring academics at UCL from different departments together to explore key themes and trends shaping London over the next 50 years. The scope of the project was intentionally broad, and the method allowed for a wide range of styles of contribution to the discussion, with varying levels of commitment required. With very little funding or opportunities for formal recognition for participating in the project, academic colleagues were motivated to participate as an opportunity to contribute to a challenging, interesting, impactful and enjoyable project. The project included consideration of formal scenario methods and previous scenario based work relating to London, but due to funding constraints these methods were not adopted (Semertzidis & Paskins 2013). Instead, the project pursued a method based on the familiar format of the academic seminar and workshop, structured to allow for new interdisciplinary
perspectives to emerge. Two series of workshops were supplemented with academic, polemic and creative writing, drawings and photographs to provide a rich diversity of voices and perspectives in contemplating the complexity of the future of London. Consistent with the ‘wisdom agenda’ the project was also grounded in recognition that consensus about major issues was unlikely and undesirable from within a diverse academic community and its partners, and humility in that although universities have a valuable role to play in provoking intelligent and wise debate, it is ultimately the role of citizens, city leaders and politicians to make decisions about London’s future.

An initial series of workshops was convened in 2010 based on four cross-cutting themes – the thriving city, the healthy city, the sustainable city and the global city. These themes were chosen specifically to encourage cross-disciplinary interaction, avoiding conventional sectoral divisions. Each workshop involved UCL staff and their invited guests, from external partner organisations. Presenters were asked to structure their contribution around key questions:

- Where are we now?
- How did we get here?
- What might happen?
- What can we do about it?
- What would London look like?

Researchers were understandably most comfortable with the first two questions, and many were reluctant to speculate how things might change so far into the future. As the workshops and conversations developed over the course of several months key issues emerged as being important in shaping the long-term future of London, even where experts were reticent to make particular predictions about specific variables in 2060. A final workshop of all participants clarified major cross-cutting themes for further exploration, which were then developed into a pamphlet and briefing note.

A second series of workshops was held in 2011 and 2012 in partnership with the policy network Future of London to address more specific issues – Housing, Energy, Transport and the Economy. Each workshop consisted of presentations from a panel of two UCL researchers and two external experts from partners including Transport for London, engineering and research consultancies, local authorities and the Greater London Authority. The workshops were aligned with Future of London’s Future Leaders training scheme, bringing participants from local authorities and housing providers from across the city. A final panel session was held as part of UCL’s series of events to coincide with the 2012 Olympics, titled ‘London 2062: the long legacy’, which was open to the public, including all participants in previous workshops. Most workshops were filmed and available for public viewing on the London 2062 project website, along with other project outputs.

The final output of the project was an edited collection of contributions from staff, students and workshop contributors – *Imagining the Future City: London 2062* (Bell and Paskins 2013). The book included longer academic analysis of key trends including water, energy, buildings, food and demographics, shorter opinion pieces and creative visions, drawings, designs and photographs. The book was published under open access creative commons licence with Ubiquity Press, available for free download, and structured under the headings ‘connections’, ‘things’, ‘power’ and ‘dreams’.
11.3 London 2062

11.3.1 Connections

London is defined in part by relationships within the city and to the rest of the UK, Europe and the world. This includes flows of food, water, energy and data, and connections to local, national and international markets and politics. Of central importance to the future of London are flows of people. Demographic forecasts for London typically do not go beyond 30 years. Key factors in London's demographics, such as rates and reasons for migration into and out of the city, shape its profile as a city for young adults, rather than families or older people, who tend to leave London, partly as a result of the high cost of housing compared with the rest of the UK (Mateos 2013). London is also characterised by ethnic diversity, a trend that is likely to continue, leading to conclusions that by 2062, London's population is likely to be 10 million or more, older and more diverse.

London's future is related to the future of other cities, in the UK and in other countries. Decisions taken in London, particularly in relation to finance and capital, have repercussions for the global economy and influence cities around the world (Robinson 2013). London, like other cities, is increasingly 'smart' as sensors and computers become ubiquitous, allowing more information and potentially more control over the functioning of the city and behaviour of its citizens in coming decades, as well as increasing capacity to model and visualise how the city and its systems work (Batty et al. 2013).

New technologies, climate change and other environmental constraints provide increasingly complex opportunities and challenges for London's infrastructure, highlighting the importance of specific attention to issues of retrofit for sustainable and resilient transitions (Venables 2013; Watson 2013).

11.3.2 Things

Retrofitting London's infrastructure to meet the Mayor's target of a 60% reduction on 1990 levels by 2025 will require comprehensive social and technical change. Modelling of different options for the transport sector shows that practically every policy option will need to be implemented to reduce emissions to the target level. This is likely to require significant increases in journeys taken by public transport, walking and cycling, improved efficiency of vehicles, greater use of electric vehicles, and changes in land use and planning to reduce the number and length of journeys (Hickman 2013).

Decentralised and decarbonised energy are also likely to be required to achieve reductions associated with electricity and heating in London, as well as improvements in energy efficiency by retrofitting London's building stock (Fiddick 2013; North 2013).

Achieving these targets is likely to require transformation of the policy frameworks that govern decisions about transport in London, to enable stronger regulation and intervention by government into markets that shape transport requirements and form.

Retrofitting London's buildings to adapt to climate change by 2062 will also require significant policy, social and technical intervention, on a scale that has not yet been evident. In 2062 it is likely that London's summer air temperatures will resemble those now experienced in the south of France, and without appropriate adaptation overheating of buildings will present significant problems (Pelsmakers 2013). Addressing overheating of buildings using conventional air conditioning would intensify overheating of the city as a whole, highlighting the need for low carbon design measures such as shading and natural ventilation. Climate change is likely to exacerbate the urban heat island effect, which could be ameliorated by increasing green space in the city, including
green roofs and walls on buildings. Increased risk of flooding can be mitigated at building scale using sacrificial basements, floating buildings, building on stilts or ‘wet-proofing’, most of which are difficult to retrofit, highlighting the importance of urban or catchment scale measures to manage increased flood risks.

Wetter winters and drier summers in London by the second half of the 21st century, together with a bigger population and smaller households with higher per capita consumption, will have important implications for how water is managed in the city (Bell 2013). By 2062 it is likely that London’s water supply will involve much higher levels of reuse, for potable and non-potable water uses, and a diversity of sources of supply. Continuing to reduce per capita demand for water will be an important element of managing the deficit between supply and demand that is forecast by 2040, facilitated by smart metering and other advanced information technologies to be used in homes and in managing the water supply network. By 2062 the Thames Tideway Tunnel, the solution to the current problem of combined sewer overflows, will have been constructed and the decision about the replacement of the Thames Barrier will have been made, following long-term monitoring of changes in tidal and pluvial flood risk. These large infrastructure retrofits will need to be supplemented by development of distributed green infrastructure – green roofs, permeable pavement, rainwater harvesting, rain gardens, bio-detention ponds and biological filters – to achieve sustainable management of London’s surface water, urban heat island and biodiversity under conditions of climate change and increased population density.

London has a strong heritage of food production, within the city and in surrounding counties. As climate change impacts the availability and affordability of food imported from other parts of the world, food production within the city may be increasingly important. Allotments, urban farms, community gardens and food production systems integrated into buildings and green infrastructure will provide opportunities for improving access to quality food, community development and sustainability in London (Biel 2013). This will require changes in urban planning, design and regulation, and integrated with waste and water recycling, could result in significant changes to the urban metabolism of London.

11.3.3 Power

The extent to which buildings, infrastructure and urban spaces are retrofitted to adapt to and mitigate against climate change depends largely on economics, finance, legislation and regulation. These measures may also have different costs and benefits for different socio-economic groups within a city, depending on how they are implemented and funded. Poverty, inequality, and the nature of the economy are all part of the context of a city into which retrofitting schemes are placed.

Financial services have always played an important role in London’s economy, and this sector has become more prominent since the 1980s. As the London 2062 project was underway in the aftermath of the 2008 financial crisis, the role of finance and the nature of London’s economy were of key concern to participants. An overemphasis on London’s role in global financial markets to the detriment of local economic activity has contributed to widening inequality in the city, particularly in relation to employment and housing opportunities (Taylor 2013). This raises important questions of governance, not just of financial institutions but of the city itself. In the next 50 years, scenarios for London’s governance include continuation of current neo-liberal approaches, a shift
towards a greater role for government, or the emergence of a new form of consensus capitalism, based on shared and common values (Pearce and Raco 2013). A reconsideration of the role of the financial sector in London and the global economy could facilitate retrofitting the city with renewable and zero-carbon technologies, with London in 2062 being celebrated as a leader in demonstrating and financing the global transition to a low-carbon economy (Dalgleish 2013).

London's housing stock will be a key site of retrofit programmes, particularly as part of major urban regeneration programmes. However, housing affordability, particularly home ownership, is likely to continue to decline in London (Hegarty 2013). With the private rental market most difficult to reach for retrofitting policies and programmes, this trend will have impacts not only on the affordability and security of homes for residents, but also the delivery of programmes to reduce London's carbon emissions. Housing affordability, education and economic rebalancing are likely to be important to achieve a sustainable future for London, boosting creative industries, innovation and manufacturing (Cavanagh 2013). Large scale retrofitting industries could play an important economic and social role, as well as achieving emissions targets.

11.3.4 Dreams

In addition to developing academically rigorous analysis of trends and scenarios, London 2062 provided some contributors with ‘free rein’ to think and write about the future of the city in ways that are not normally permissible in their professional or scholarly lives. Some of them wrote editorial style opinion pieces about key issues, while others used the opportunity to create ‘fictional’ accounts or visions of London in 50 years. Such creativity allowed contributors to be more specific and concrete in how they thought the city might change, and also highlighted key trends and issues that are evident though not explicit in more restrained academic contributions.

London imagined in ‘fiction’ shows the importance of relationships to national and international political and ecological events, strange dynamics within the city, and the importance of governance, technology and nature. Stories included London as a city state, resulting from Scottish independence, the UK leaving the European Union, and the designation of Manchester as the capital of England (Gandy 2013; Morphet 2013). Dystopian visions of London in ruins, leading to the return of nature, has a long history in literary fiction and inspires ideas about how London might be retrofitted to allow for a more balanced relationship with nature following on from economic decline and collapse (Beaumont 2013). The reminiscences of a police officer retiring from the beat in 2062 show the likely impacts of technology change on the nature of crime and security (Sidebottom & Kurland 2013). Most provocatively, London run by major football corporations leads to splintering of the city along team lines, with clubs providing services such as health, housing and education, filling in where local governments have withdrawn. In the future access to services may depend on the success and corporate social responsibility of local football teams as a global entertainment conglomerate, with dramatic consequences for those who currently live south of the Thames (Myerson & Rydin 2013).

11.3.5 Imagining the Future City

Running through the written and other contributions to the London 2062 project were a series of emergent themes. Climate change adaptation will be a major challenge, as will meeting current targets for reducing carbon emissions. Whilst it is important to
appraise options, analysis suggests that in sectors such as transport, all conceivable options for reducing emissions will need to be implemented to address the scale of the challenge. Likewise, water supply, drainage and flooding require multiple responses to be implemented in the next 50 years to achieve a sustainable and resilient future. Investment in major infrastructure and policy change must be economically viable, and London's dominant financial sector could provide financial capital to facilitate large scale retrofitting. Renegotiating the relationship between the city and nature will be part of a transition to sustainability. This is more likely to occur through urban design and retrofitting to reduce the urban heat island effect and flooding, and to improve human wellbeing, than as a result of dystopian abandonment of all or part of the city, but nature is never far away in visions for the future of London. The structure of London's economy and housing market were key issues at the time of the project and are likely to remain so in coming decades. If London is not able to adequately address concerns about growing inequality it risks undermining its key strengths as a young, diverse, creative city. London's ability to retrofit technologies and systems to adapt to and slow down climate change will be highly dependent on the governance of the city, the economy and the country.

A significant outcome of the project was to demonstrate that much of London's future will be determined by policy, investment and management decisions taken now and in the near future. Whilst climate change, the global economy, migration and other factors may not be entirely within the control of city leaders, many decisions about the local economy, infrastructure, housing, education and society are within the remit of local and city government. Maintaining or achieving good governance of institutions within London is a fundamental element to delivering a sustainable and resilient city, and delivering the retrofitting needed to adapt to external changes in the future.

### 11.4 Conclusions

The London 2062 project provided UCL academics and their collaborators and professional partners with a variety of opportunities and formats to consider possible futures for the city. The project methodology was deliberately open-ended, allowing for playful, creative contributions alongside more considered academic analysis and forecasts. The outcomes reflect this freedom and diversity, ranging from design principles for climate change adaptation to a vision of London run by mega-football clubs. The project was intended to provoke debate about the trends shaping London and the decisions facing leaders, citizens and professionals in the present.

Thinking about London in 2062 highlights key issues of concern in the present – the structure of the economy, the diversity and rate of growth of the population, housing affordability, governance, infrastructure and the city's relationship to the rest of the UK and the world. London currently positions itself as a global city and national capital, yet is demographically and economically distinct from the rest of the UK. Housing affordability is a major concern in London, with house prices and rents increasingly unaffordable for those on middle and low incomes. Infrastructure developments in transport, energy and water, must balance environmental concerns, local interests and economic development. This can be seen in debates about recent, ongoing and future projects including Crossrail, the Thames Tideway Tunnel, and airport expansion.
The key themes that appeared across the contributions throughout the project, reflect wider political debate in London and the UK. The diversity of viewpoints and outcomes from the project makes clear that the future is something that Londoners will decide, as much as series of events that are beyond their control.

London 2062 was a modest attempt by a university to engage partners and decision makers in discussion and deliberation about the future of its city. Engagement across and beyond the university was enabled through different opportunities and styles of contribution – from the scholarly to the playful. Aiming to support wisdom, as well as provide knowledge, the project demonstrated the value of open, interdisciplinary inquiry, defining problems, offering options, and drawing on specialist analysis and expertise.

Addressing such a long time frame for analysis across such a wide range of sectors and interest presented challenges and opportunities. The key opportunity was for participants to be able to speculate beyond the bounds of what is usually considered predictable within academic research and professional practice. Free from any reasonable expectations of making a ‘correct prediction’, allowed open and provocative discussion. However, this meant that the project did not formulate specific recommendations for policy or industry. Opening up debate is a conventional strength of the university. Formulating guidance for specific action on the basis of the insights gained was not a goal or an outcome of the project.

Retrofitting London is a complex, uncertain task requiring a diversity of expertise and political viewpoints. Universities, in partnership with other institutions and the public, are uniquely positioned to be able to facilitate dialogue and critically examine trends and issues shaping the future of cities in order to navigate through complex decisions about retrofitting to achieve sustainability and resilience in a changing environment, economy and society.

References


12

Framing New Retrofit Models for Regenerating Australia’s Fast Growing Cities

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Overview

Forecasts of continued high rates of population growth for Australia’s major cities are placing increased pressure on metropolitan planning strategies for more innovative urban infill solutions. To slow sprawl, infill targets of 70% or more designed to accommodate new dwelling development over the next 25 years in the established middle suburbs are falling well short of requirements. This chapter will provide a perspective on why this is not occurring and will update progress on research directed towards the framing of a new model for greyfield precinct redevelopment – akin to what was created for brownfields under the Building Better Cities Programme of the early 1990s. Greyfields constitute those predominantly residential areas in Australian cities where the stock is ageing, physically deteriorating, technologically obsolescent and environmentally poor performing and where the value of the property lies in the land – an economically underperforming asset, but occupied, unlike brownfields and greenfields. Greyfields, however, are extremely well located in the established low density middle suburbs of Australian cities, with good access to public transport, jobs and higher level education and health services. They represent untapped potential for more intensive, regenerative retrofitting – at precinct scale. Unlocking this potential requires innovation in multiple arenas such as urban governance and urban planning and design – the focus for this chapter, using the city of Melbourne, Australia as the case study.

12.1 Introduction

The projected growth of cities internationally is presenting major challenges for planning and policy-making if cities are to sustainably accommodate the additional 2.5 billion increase in urban population forecast by the UN by the middle of the 21st century (UN DESA 2014) – within increasingly well-established planetary boundaries (Rockstrom & Klum 2012) and natural resource capacities (WWF 2014). Rates of growth vary by city and country but irrespective of growth trajectory (Martinez-Fernandez et al. 2012), there
is now increasing recognition that new urban development models are needed to better align a city’s built environment with its future population by better managing the land available for development; especially in established built up areas where pressure for redevelopment is strong (Schilling & Logan 2008; Newton 2010). This is increasingly the case in fast-growing cities, where it is argued that poor land use planning and regulation is creating a scarcity of land in particular locations, inhibiting their capacity to accommodate growth in a manner that is environmentally sustainable, economically efficient and socially equitable (The Economist 2015a).

This chapter examines current attempts at retrofitting Australian cities in two key urban infill arenas: its brownfields (abandoned or economically underutilised industrial or commercial property) and its greyfields (ageing but occupied established inner and middle residential suburbs). Taken together they require planning that attempts to direct property investment and population inwards, rather than continuing to use (typically low density and car dependent) greenfield development as a demographic absorber that continues to feed the sprawling and poorly serviced outer suburban zone.

It also explores the extent to which retrofitting can contribute to a significant reduction in ecological footprint characteristic of Australian and North American cities. The high liveability achieved by cities in these countries has been linked to their world leading consumption of resources and generation of greenhouse gas (GHG) emissions (Newton 2012) – twice that of European cities with similar liveability ratings. Differences in urban form, density of development, size of housing and level of public transport provision are major contributing factors, and are key elements capable of being reshaped to positive effect as cities confront the need to redevelop (Newton et al. 1997). A critical question is whether retrofitting is limited to incremental building level change (primarily in housing yield), or whether retrofitting affords prospect for urban regeneration – at broader, precinct scales. Regeneration encompasses a transformative process with objectives of renewing and restoring the wider ecosystems underpinning urban settlements (Girardet 2015). Regeneration is linked with eco-positive development, involving urban designs that ‘...reverse existing impacts and increase the ecological base...’ (Birkeland 2014: 151). Urban retrofitting that is restorative requires substantial innovation – at multiple scales (building, precinct and metro level), all of which need to be aligned in order to deliver the step change in performance required for Australian cities to be liveable and sustainable.

After briefly outlining the current and likely future trajectories of change in Australia’s largest cities, together with their sustainability challenges, the chapter explores the pathways for transitioning to more regenerative urban retrofitting at precinct scale in the brownfield and greyfield arenas. Establishing viable development models for retrofitting greyfield precincts represents one of the biggest challenges for urban planning at present and constitutes the remainder of the chapter, with particular focus on Melbourne.

12.2 Current State, Future Trajectories and Retrofitting Challenges for Australia’s Largest Cities

There is bipartisan agreement between both of the leading federal political parties for a ‘Big Australia’ – not withstanding several major national inquiries undertaken over the past 40 years that have sought (inconclusively) to identify what would
constitute a ‘sustainable’ population. Given that immigration consistently contributes more than half of Australia’s annual population growth – now the highest of OECD countries after Luxembourg and Israel – and the federal government controls this lever, the likelihood of the nation reaching or exceeding a forecast 40 million population by 2061 is almost certain (ABS 2013; Australia’s population in 2015 was 23.8 million). The capital cities will continue to attract the bulk of this growth, with Melbourne’s population set to become the largest by 2061 at 8.6 million – twice its current population.

The degree to which sustained rapid urban growth exerts positive or negative impacts on the future economic, social and environmental performance of Australia’s cities will depend on how well they are planned for (Krockenberger 2015). There is now clear evidence of ‘planning deficits’ (Gleeson et al. 2012). The current challenges for metropolitan planning are already substantial, and include:

- A shortage of housing supply capable of matching demand (National Housing Supply Council 2013); and a rapid growth in residential property prices to a position where Australian capital cities lead 26 other global housing markets as tracked by The Economist (2015b). Much of the higher priced housing is now concentrated in the inner and middle suburbs of Australia’s largest cities – reflecting processes of economic restructuring, reurbanisation and gentrification associated with a displacement of manufacturing industry and its workforce by information/knowledge/creative industries and their (higher income) workforce.

- An extended period of house price inflation above that of wages and cost of living (CPI) forcing lower income households to cheaper and less accessible and productive locations in the car dependent outer suburbs. Suburbanisation of disadvantage has increased markedly over the past 20 years and is now clearly evident in Sydney (Randolph and Tice 2014) and Melbourne (Hulse and Pinnegar 2015). This socio-spatial disadvantage is multi-faced and combines: concentrations of low income; poor access to jobs, public transport, education and health care services; and a spatial concentration of social problems (Burke 2015). It is weakening the social fabric as well as the productivity of Australian cities.

- Ageing urban infrastructure linked to a national shortfall in infrastructure expenditure estimated at approximately AS$100 billion – a fourfold increase in less than a decade (Watt 2014). Closely linked to this is an indifferent performance rating for a number of key urban infrastructures by Engineers Australia (2013), which revealed little or no real overall progress since the 2005 assessment, except in areas linked to the nation’s resources boom, largely in remote non-metropolitan regions. A key challenge for governments is a programme of long term investment to transition to next generation urban transport, water, waste and energy infrastructures, including the emerging distributed infrastructures.

- Continued dependence on greenfield development to accommodate the majority of new housing constructed in Australian cities (Figure 12.1) despite urban infill targets in all metropolitan planning schemes being in the range 50–70%. Most cities are currently struggling to reach 50% infill, ensuring that there will be continued urban sprawl together with its established negative consequences (Trubka et al., 2010).
The Challenge of Regenerative Urban Transition

A regenerative retrofitting of Australia’s cities requires change that is radical, transformative – and potentially disruptive. Socio-technical transition theory has emerged in recent years in an attempt to provide greater conceptual coherence to the complex set of processes involved in transition to sustainable development (Grin et al. 2010; Geels 2011). The processes are multi-level and interconnected and revolve around three major constructs – applied here in an urban context:

- **Regimes** are the prevailing systems related to urban development and governance, encompassing all the industries involved in property development, government at all levels and local communities, their current practices, established relationships and modes of ‘doing business’. While legislative power rests with government, industry lobbies are powerful influences on city development as are urban communities of Nimbyish residents. They constitute a heady mix of stakeholders in established, occupied residential areas with high redevelopment potential.

- **Innovations** are generally technological or social in origin and have capacity, if adopted widely, to make substantial change to current practice and the performance of cities. Over decades, innovations in transport, communication, energy generation, waste treatment, building, domestic and industrial appliances and so on have transformed industries, jobs and built environments. Their capacity for urban transformational change varies (Newton and Bai 2008 identify three horizons of urban technology innovation) as does level of resistance to their adoption.

- **‘Landscapes’** represent the prevailing conditions in current urban environments, such as those outlined in the previous section. They are the products of existing and prior regimes as well as sets of endogenous and exogenous processes (Newton & Doherty 2014) and represent the context within which niche innovations emerge and attempt to penetrate the market. The challenge for each urban innovation is to understand where and how best it can intervene in a built environment in order to help progress a
transition to more sustainable urban development. In the context of retrofit that has a capacity for being regenerative, intervention needs to be mindful of urban scale, urban fabric and urban arena.

12.3.1 Scale of Built Environment Innovation

For transformational retrofit to take place, built environment innovation needs to occur and be integrated across a number of spatial scales. Whether at building, precinct or metropolitan scale, there are technology and design innovations capable of dramatically reducing the demands on both the direct and indirect resource inputs to cities as well as providing new and more sustainable avenues of supply. These are summarised in Table 12.1 (each cell in the table represents a pointer to innovation capable of significantly advancing sustainable urban development). For this chapter, *precinct scale innovation* is a principal focus since precincts represent the fundamental building blocks of cities and a more effective scale for the physical retrofitting and regeneration of a locality (Sharifi & Murayama 2013). Indeed, it has been argued (Codoban & Kennedy 2008) that the unsustainable nature of today’s cities is due in part to poor planning at the neighbourhood level – albeit from an era (now past) when resource and carbon constraints were least evident.

12.3.2 Urban Form and Fabric

There is clear evidence that indicates that more compact forms of cities with appropriate public transport infrastructure deliver superior environmental performance (Newton *et al.* 1997, 2012; Trubka *et al.* 2010). Urban form represents the ‘envelope of possibilities’ for mobility, living and working within cities and is reflective of significant prior policy and planning decisions related to infrastructure development and land use zoning. Retrofitting cities involves new decision-making about what new infrastructure investments to make and where as well as new land use zoning. With retrofitting of cities it is also clear that different urban fabrics (e.g. urban versus suburban) provide different levels of receptivity to different types of built environment innovation. For example, with regard to the decarbonisation of Australian housing, the rapid uptake of distributed generation in the form of solar photovoltaics over the last 5 years has occurred largely in suburban environments where rooftops provide good solar access. For equivalent decarbonisation to occur in medium-density housing and high-rise apartments requires precinct scale low/zero carbon solutions (Newton & Newman 2013).

12.3.3 Urban Development Arenas

Cities provide three distinctively different development arenas: greenfields, brownfields and greyfields, with the latter two being the focus for retrofitting and infill (Figure 12.2).

*Greenfields* is the arena where most new housing continues to be developed, despite all major capital city strategic plans having urban infill targets and more compact cities as a goal. There are well established models for greenfield precinct development in all states (Growth Areas Authority 2011), although they tend to perpetuate many of the traditional aspects of land conversion on the fringe that will exacerbate the environmental, economic and social disadvantages outlined earlier, remaining well short of any aspiration to eco-positive performance.

*Brownfields* constitute abandoned or under-used industrial or commercial sites associated with an earlier era of economic activity. Typically, they include the docklands
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<thead>
<tr>
<th>Building</th>
<th>Precinct</th>
<th>Metro region</th>
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<tr>
<td><strong>Energy supply</strong>: zero carbon/carbon neutral/zero carbon negative electricity (from limited set of local energy systems applicable to buildings e.g. solar PV on roof; but likely to be integrated with façade materials); building on benefits of highly energy efficient shell and built-in appliances</td>
<td><strong>Energy supply</strong>: zero carbon/carbon neutral/zero carbon negative precinct; part of smart grid/micro-grid; utilising wider range of options for distributed low/zero carbon energy generation applicable to precincts, especially in higher density city neighbourhoods. Community energy networks becoming attractive in greenfield and brownfield precincts</td>
<td><strong>Energy supply</strong>: emerging hybrid energy system for city – i.e. existing centralised electricity systems (commonly fossil fuel or nuclear based, providing electricity into grid) beginning to accommodate rapidly emerging distributed energy generation; emerging large scale solar thermal and wind farms substituting for fossil fuels</td>
</tr>
<tr>
<td>Water &amp; Sewerage: rainwater harvesting (rainwater tanks); greywater recycling; water sensitive design of building and immediate surrounds; negligible blackwater recycling at present</td>
<td>Water &amp; Sewerage: stormwater capture and use (rainwater tanks, creeks, swales, natural retention); precinct greywater recycling; integrated water system; water sensitive design of buildings and landscaping; limited sewer mining at present</td>
<td>Water &amp; Sewerage: existing linear system involving water capture, storage, treatment, distribution, use and discharge via sewerage system to regional recycling plants or discharge to receiving waters will need to be connected with decentralised systems that enable emergence of an integrated urban water system for a metro region</td>
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<tr>
<td>Waste: zero waste to landfill for selected range of items e.g. paper, plastics; currently limited composting of food waste but \textit{in-situ} composting technologies emerging. C&amp;D waste from knock-down rebuild of individual buildings often goes to landfill</td>
<td>Waste: zero waste to landfill for selected range of items e.g. paper, plastics; opportunity for increased locality-based composting of food waste and organic waste; prospect for precinct vacuum waste collection system. C&amp;D waste recycling more likely for precinct scale retrofit projects</td>
<td>Waste: household waste generation increasing at a rate often overtaking pace of recycling, resulting in continuing use of landfill; slow increase in rate of recycling C&amp;D waste; green waste collection and composting growing; limited composting of food waste. Waste-to-resources transition/circular economy eco-industrial development in its infancy</td>
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<tr>
<td>Indoor Environment Quality: established standards and benchmarks for thermal comfort, energy efficiency, air quality, light, noise etc. that can be required to be met or exceeded by building owner; leads to significant health and productivity benefits; older stock likely to be poor environmental performers in many respects</td>
<td>Local Environmental Quality: encompasses critical factors that contribute to quality of life of local residents e.g. ambient air quality, solar access, noise, open green space and blue space etc. but can be difficult to monitor and enforce quality across an entire precinct (unless master planned)</td>
<td>Urban Environmental Quality: Critical to the amenity of cities; represents an aggregate of the local environmental quality of urban precincts, plus the quality of urban waterways and public realm spaces that provide critical connectivity; government monitoring of urban environmental quality is patchy and needs to be augmented by crowdsourcing of data (humans as sensors)</td>
</tr>
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</table>
Occasional Mobility: dependent on building design/layout for disability access, social interaction as well as privacy; space allocated on site for car parking and bicycle storage can affect mode choice; some local governments in inner city jurisdictions beginning to impose parking space restrictions in new buildings as well as parking restrictions on local streets

Food Production: limited at a building level unless associated with a detached house and land for garden; or vertical gardening

Biophilic Buildings: vegetation limited to roofs and some facades for multi-storey buildings; in competition with other building elements e.g. rooftop solar PV

Housing: individual dwellings can range from the small percentage of architect designed ‘bespoke’ products to the mass produced ‘project’ homes and high rise-apartments. Low- to medium-rise medium density is yet to create a positive impact on Australian cities unlike Europe. The only areas where minimum performance is required for new housing is in relation to thermal performance of the shell; and in some jurisdictions rainwater tanks

Resident Mobility: attractive, safe, mixed use, walkable and cycleable neighbourhoods close to public transport are attracting premium prices and rents reflecting their increasing desirability; precinct design can optimise these features as well as minimise the amount of space allocated to the automobile (driveways, parking), roads and traditional footpaths – space that can be allocated to other uses such as open space, precinct furniture and community meeting places; nucleus for more self-contained city of villages/20 minute ‘cities’

Biophilic Precincts: greater scope for range of vegetative plantings that are attractive to native bird species, provide shade, food e.g. raingardens; integrated with water features; significant potential for reducing heat island effect

Food Production: in addition to what is possible at building scale, neighbourhoods offer opportunities for communal/community gardens

Housing: precincts provide opportunity for introducing a variety of dwelling types (especially medium density) and architectural styles, dwelling sizes and price points. In combination with other precinct elements listed above can create distinctive, attractive and more sustainable ‘places’ to live

Population Mobility: a city’s transport and land use planning will dictate the extent to which housing is accessible to employment and other key services; whether residents have access to public transport or are car dependent (the latter characteristic of much post World War II suburban development in Australian and North American cities); increasing penetration of hybrid and electric vehicles will reduce GHG emissions but not congestion unless attractive car rental/sharing schemes emerge; high speed rail capable of underpinning development of more sustainable functional mega-metro regions incorporating provincial cites as part of an agglomeration economy

Biophilic Cities: are those that provide nature in close proximity to where the urban population lives its daily lives and needs to be an intentional feature of a metro plan, but is often traded off in urban development and redevelopment projects

Food Production: many metro areas have important agricultural and horticultural activities in their peri-urban regions; areas that are under threat from urban sprawl and need to be protected

Housing: at metropolitan scale, suburban housing capacities, residential densities, housing mix and housing affordability tend to dominate urban planning agendas for housing; urban ‘infill’ now an important feature of metropolitan development strategies, with associated targets, but lacking effective planning processes for implementation (e.g. zoning and development approval at municipal level) associated with precinct scale greyfield regeneration

(Continued)
**Table 12.1 (Continued)**

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<tr>
<th>Building</th>
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<tr>
<td><strong>Smart House:</strong> broadband access, multiple sensors on white and black appliances, lighting etc. combined with smart meters provides platform for real time monitoring and management of a safer more sustainable home as well as a highly functional small office-home office work environment, paperless office etc. Broadband also enables telepresence and trip substitution for a range of activities</td>
<td><strong>Electronic Village:</strong> prospect of neighbourhood intranets identified in 1990s yet to materialise due to massive functionality of internet and social media; proximity and face-to-face contact remains the 'glue' for local communication</td>
<td>‘<strong>Wired City:</strong> high speed wireless and fibre communications infrastructures are now ubiquitous in global cities and provide platforms for telepresence and telecommuting opportunities as they present themselves into the future; challenge of avoiding a persistent ‘digital divide’</td>
</tr>
<tr>
<td><strong>Virtual Building Design:</strong> BIM has become established as a powerful platform for architects that enables innovative design in 2D and 3D coupled with automated eco-efficiency performance assessment (cost plus environment) and an enabler of more effective co-design and engagement with prospective occupants/owners; 4D design capability now extends over the building life cycle, including construction and facility management; BIM provides basis for electronic lodgement of planning and building permits and more automated assessment (Newton et al. 2009)</td>
<td><strong>Virtual Urban Design:</strong> PIM is an emerging platform for urban designers where the scale of built environment requiring representation is that of a precinct (neighbourhood, district) where the objects involved are those relevant to precinct performance assessment e.g. energy demand, water demand, embodied carbon, waste generation, walkability, water harvesting, precinct energy generation, waste treatment, urban microclimate etc. (requiring seamless data exchange with BIM and CIM systems); also provides a new digital platform for co-design and decision-making in statutory planning and development assessment processes at municipal level (Newton et al., 2013, 2017)</td>
<td><strong>Virtual City Planning:</strong> CIM encompasses a spread of spatial technologies supported by basic GIS functionality and specific analytical and modelling frameworks and tools that enable representation of significant elements of an urban system (e.g. transport sub-system) and their interaction with other inter-dependent elements (e.g. land-use). Provides platform for scenario analyses of possible/probable/desirable metropolitan futures based on alternative population assumptions, infrastructure investments (including issues of centralised vs. decentralised operations), housing densities, job locations, economic growth expectations etc. – all fundamental to strategic metropolitan planning (Newton 2000)</td>
</tr>
</tbody>
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BIM, Building Information Modelling; C&D, construction and demolition; CIM, City Information Modelling; PIM, Precinct Information Modelling; PV, photovoltaics.
Significant innovation required in multiple areas to deliver a new development model and process for greyfield precinct regeneration

**Figure 12.2** Innovation arenas for establishing greyfield precincts.
precincts that served the sea trade prior to containerisation, outdated commercial high-rise buildings, abandoned manufacturing sites, sections of railways, vacant petrol stations, formerly viable retail sites and so on. They are generally owned by a single party, usually government or industry; of a scale which is closer to that provided by greenfield sites for development; contaminated to some degree, depending upon the nature of prior use; and unoccupied, obviating the need for community engagement at a level required of greyfields.

By the early 1980s a number of prominent brownfield sites were apparent in Australia's major cities, but there was no development model available capable of providing a way forward with a level of risk acceptable to the private sector, given the size of the projects, finance required, and available planning, design and property development expertise. A federally funded Building Better Cities (BBC) Programme commenced in 1991 with the objective of involving government agencies and industry in strategic urban development, with a particular emphasis on the redevelopment of brownfield sites. As a nation-building initiative of the federal government between 1991 and 1996 the BBC programme can be credited with being a catalyst for the subsequent revival of Australia's inner cities (Neilson 2008). State governments have continued to identify brownfields areas as strategic urban renewal precincts.

Docklands represents the largest brownfield development yet initiated in Melbourne. It is a 150ha site adjacent to the central business district (CBD) and is expected to accommodate 20 000 residents and provide 80 000 jobs upon completion in 2025 (http://www.places.vic.gov.au/precincts-and-development/docklands). Construction commenced in 1997 after a chequered and still controversial period of planning undertaken by the state government urban renewal agency, VicUrban, which consisted of dividing the large site up into seven land parcels which were then put out to tender to property developers. Initially excluded from the planning, design and development process, the local government (City of Melbourne) are now involved in attempting to ‘retrofit’ the area with those basic elements associated with place-making following the July 2012 transfer of development responsibility from the state government Docklands Authority. While successful in facilitating development of predominantly commercial buildings and high-rise apartment blocks at Docklands, the quality and innovativeness of the outcomes has been the subject of repeated criticism, predominantly for being overly market driven and un-coordinated and especially for omitting public realm provisions such as green space, good pedestrian connections aligned with active uses, community facilities including schools, and cultural activities at the expense of site yield (Dovey 2005). A ‘carve-up’ of territory among major developers in the absence of any plan for introduction of distributed infrastructures capable of operating at precinct scale meant a lost opportunity for creating a more self-sufficient, resilient, low carbon built environment. Lessons learned need to be translated into the planning process for the next major brownfield development adjacent to Docklands: Fisherman’s Bend.

Fishermans Bend is a 260ha site adjacent to both the Melbourne CBD and Docklands (Figure 12.3), where current industrial land use has been rezoned for mixed use redevelopment in order to accommodate a projected 120 000 (and on some estimates 240 000) people and at least 60 000 commercial jobs. The Government of Victoria (2014) has established a strategic framework for its development over the next 40 years that clearly identifies a set of sustainability objectives: low carbon, water sensitive, climate resilient, low waste and liveable (analogous to VicUrban’s attempts at identifying ESD
principles to guide development at Docklands; VicUrban 2006). It is at the initial planning stage of a major brownfield retrofit project that innovative infrastructure and building options need to be identified and modelled in order to realise the life cycle benefits capable of being captured by the built environment. A recent visioning report on future design options for Fishermans Bend (CRC 2015) revealed that by introducing a number of water sensitive design innovations related to stormwater capture, rainwater harvesting and greywater recycling – all of which can be directed to non-potable uses within the precinct and its buildings – then volume of imported water can be almost halved. By mandating that all buildings be designed to world best environmental rating standard (compared with a local regulated minimum), over 40% reduction in annual energy demand and carbon emissions is achievable, and greater if low or zero carbon precinct scale distributed generation systems were also employed. The governance of the Fishermans Bend development will be what proves critical in whether it becomes a showcase for brownfield precinct regeneration or a repeat of business as usual developer-led retrofit.

*Greyfields* lie predominantly between the more vibrant CBD and inner city housing market and the more recently developed greenfield suburbs, providing greater access to employment, public transport and services than the latter zone. Greyfields in the Australian context have been defined as those ageing but occupied tracts of inner and middle ring suburbia that are physically, technologically and environmentally failing, and which represent under-capitalised real estate assets (Newton 2010). Together, the brownfields and the greyfields represent the focus for urban retrofitting and infill.
12.4 Greyfield Infill Redevelopment

To date, greyfield infill redevelopment has been occurring in three urban settings (Figure 12.2):

- **Activity centres**, which range in size from the CBD, and include several principal activity centres characteristic of poly-centred development in large cities, major retail and commercial activity centres located within the 30 or more municipalities in cities such as Melbourne and Sydney, and a myriad of neighbourhood centres. They have been a central plank in Australia’s metropolitan planning schemes for decades and in more recent times have featured in attempts to further intensify growth (via high-rise apartments) around those activity centres where rail-based transit-oriented-development (TOD) is feasible – enabling the ‘20 minute cities within the city’ (Stanley *et al*. 2015). A major urban design study of the redevelopment potential of Melbourne’s activity centres from a TOD perspective can be found in Dovey and Woodcock (2014) and provides the level of visionary thinking that should be taken up in municipal strategic plans (see e.g. Figure 12.4).

- **Transport corridors** are a more recent proposal for greyfield redevelopment, identifying linear transport corridors as an additional focus for medium-rise high-density development. The requirements for this to work are set out by Adams (2009) and include prescriptive controls over key aspects of corridor development, including up-front ‘as of right’ development to levels of between four and eight storeys (Figure 12.5). Key drivers advanced by the proponents of this model, in addition to providing a pathway for delivering a significant volume of net new housing in greyfield areas (as a result of enabling land value for redevelopment to be more easily determined), include the removal of development pressure off the existing interstitial suburbs which enables them to act as the ‘green lungs’ of cities (private open space and food production etc.) at their existing levels of low density. As with all greyfield development...
redevelopment initiatives, a key challenge is achieving public acceptance. The principles outlined will assist in this regard, since they are intended to help assure the wider community that these corridors are fixed and will not spill over into adjacent suburban areas. Decanting residents from their cars in these public transport accessible locations remains a challenge however (McClosky et al. 2009).

- **Fragmented infill** represents the majority of housing redevelopment currently occurring in the greyfields. It typically involves the construction of between one and four new dwellings on an established site where the value of the land accounts for 70–80% or more of the value of the property asset prior to its redevelopment. It represents sub-optimal redevelopment in many respects in that it generates a relatively low yield in terms of net new housing, and represents a slow burn on the local, public urban resource base: there is loss of (private) open/green space with the removal of gardens and lawn typically part of older detached housing; additional population adds to the demands on municipal services; more households means more cars and added road congestion; and the scale of redevelopment usually means that the project does not attract a developer contribution that can assist government in redressing some of the associated negative externalities.

\[\text{Figure 12.5} \quad \text{Transport corridor redevelopment: (a) Maribymong Road, Maribymong study area, currently; and (b) possible future. Source: Adams 2009. Reproduced with permission of John Wiley & Sons.}\]
An extensive assessment and critique of current greyfield infill redevelopment in Australia is found in Newton (2010, 2013), Newton and Glackin (2014, 2017) and Newton et al. (2011, 2012) and is summarised below as a precursor to the discussion of a socio-technical urban transition project (Greening the Greyfields) that is attempting to formulate, test and apply a new model for greyfield residential precinct regeneration. The principal findings to date from Melbourne research are:

- Net new housing infill is failing to reach a 50% target, most new housing supply is coming from greenfields development.
- Patterns and scale of new dwelling development differ significantly between the brownfields and greyfields: close to 80% of greyfield infill projects are 1:1 (27%) or 1:2–4 (50%) – that is, relatively low yield knock-down-rebuild developments adhering to current planning and building guidelines. Brownfields are the focus for higher yield (apartment) projects: 1:50–100 (17%) or 1:100+ (56%). There is a significant infill gap in the intermediate medium density dwelling range (5–50 units) – where greyfield precinct redevelopment is most prospective.
- High public transport access level (PTAL) is not an automatic determinant of level of infill. Percentage of net dwelling infill in Melbourne is evenly spread between high, medium and low PTAL zones (33, 35 and 32%, respectively), reflecting that households remain attached to their cars and property developers are persisting with providing (often dual) car parks in locations well positioned for public transport access.
- Activity centres are not attracting significant levels of infill housing except in the CBD (currently representing 80% of all activity centre infill; reflected in Figure 12.1; high-rise apartment construction fuelled significantly by foreign investment in new apartments).
- The type of infill housing varies by area socio-economic status. Replacement (1:1) infill is occurring at a higher rate in areas of above average economic status. By comparison, small collections of attached infill dwellings (2–4 and 5–9) are what characterises the housing market offerings to those in average-to-lower income greyfield suburbs. High-rise apartment development is concentrated in the (inner city) above average income areas – brownfields for the most part; and supports the findings of Rowley and Phibbs (2012) that it is area socio-economic status rather than area zoning that is directing where higher cost but better access apartment development is occurring in Australia’s cities at present.

In summary, most greyfield infill housing redevelopment is currently occurring as sub-optimal, fragmented development that is largely located outside of local and state government designated redevelopment areas and is not contributing the ‘dividend’ it might to the regeneration of Australia’s cities if a precinct scale retrofitting was pursued as an urban development policy.

### 12.5 Towards a New Model for Residential Precinct Regeneration

Housing in Australian cities is more than 95% privately owned. This is the principal reason, together with the current planning and building regulations governing redevelopment, why assembling a consolidated cluster of land parcels in established suburbs into a redevelopment precinct is seen as high risk in the property sector. Public housing
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(owned and managed by state governments), however, still represents a significant stock of redevelopable property in Australia’s capital cities, a significant proportion of which could be classed as ‘greyfield’ – ageing, of poor quality physically and environmentally and in established suburbs. It has the advantage from a redevelopment perspective of having a single owner.

In both the public and private sectors there is an absence of development models capable of application to precinct scale medium density residential regeneration in the established greyfield suburbs that is capable of creating a dividend that extends beyond the additional (minimal) yield in housing to include neighbourhood social and physical infrastructure and amenities. Recent research provides pathways to development of new precinct regeneration models in both of these arenas.

12.5.1 Public Housing as a Catalyst for Neighbourhood Regeneration

An Australian Housing and Urban Research Institute (AHURI) study undertaken in 2013–2014 trialled a set of innovative engagement and co-design processes for two localities in Melbourne that contained significant clusters of greyfield public housing. The objective was to assess the viability and replicability of public housing redevelopment becoming a catalyst for broader based neighbourhood regeneration and revitalisation as well as more intensive (medium density) housing projects. Two public housing clusters were selected for this project: one in a higher and another in a lower socio-economic status area. Site analyses were followed by design studio studies where concept plans for medium density housing were developed encapsulating innovations related to smaller building setbacks from streets, less on-site parking, reconfiguration of street space as active space, providing an attractive interface to surrounding neighbourhood, new local energy and water infrastructures and area activation (enhanced quality of open space, walkways and cycle paths; Figure 12.6).

A series of community engagements followed involving local residents and Council members whereby the initial concept plans were introduced as part of a co-design process, where information was subsequently sought on the following: the values and priorities of local residents (individually and collectively); the particular issues pertaining to the local area – its strengths and problems, development opportunities and constraints (both site-specific and generally applicable to other areas); and resident reactions to proposals for new/different building types, scales of development, neighbour-relations, public–private interfaces, urban functionality and so on. The goal was to obtain feedback on the ‘tipping points’ for replicable local redevelopment projects and to generate a methodology for obtaining information from local communities regarding what they would consider to be successful housing redevelopment and neighbourhood regeneration schemes.

The methodology and results from this study are described in detail in Murray et al. (2015) and Glackin & Newton (2015). It demonstrated that the prospect of neighbourhood change and medium density intensification that typically evokes community resistance can be overcome if the project can be seen by residents as attractive and providing clear local benefit – a community dividend. It also revealed that the economic viability of regenerative projects was greater in localities with higher land values: an outcome attractive to financially driven neo-liberal governments wishing to capitalise on public stock held in areas of rising prices (strongly mirroring private sector housing and area gentrification trends).
In recent years, Community Housing Corporations have emerged as a new arm of social housing in Australia and were a significant player in the 2009–2012 Social Housing Initiative of the federal government that injected A$5.6 billion as part of a global financial crisis stimulus package credited with creating 17,000 new dwellings for social housing on sites of (failing) existing public housing stock (KPMG 2014). Community Housing Corporation projects that secure stock transfers from public housing can attract private development finance against the value of those properties to undertake more comprehensive housing redevelopment – and have the expertise in property development to extend further into neighbourhood revitalisation. They are well placed to undertake precinct scale public housing regeneration.

12.5.2 Precinct Regeneration in Greyfields Private Property Market: Municipal Housing Strategies as a Catalyst for Neighbourhood Regeneration

In the established suburbs, piecemeal knock-down-rebuild dominates housing redevelopment and represents a sub-optimal mode of urban regeneration for the greyfields. Intensified redevelopment focused around activity centres and transport corridors are necessary but not sufficient planning options for accommodating the level of infill regeneration. Various micro interventions were proposed ranging from planting vegetables on the nature strip to calming traffic, expanded verges, and reclaiming the space of the street as community sports courts. Source: Murray et al. 2015. Reproduced with permission of Australian Housing and Urban Research Institute, Melbourne.

Figure 12.6 Regeneration of public housing and adjoining neighbourhood, Melbourne. Before (a) and after (b). Various micro interventions were proposed ranging from planting vegetables on the nature strip to calming traffic, expanded verges, and reclaiming the space of the street as community sports courts. Source: Murray et al. 2015. Reproduced with permission of Australian Housing and Urban Research Institute, Melbourne.
required to meet future population and housing needs of Australia’s largest cities. Nor do brownfields provide sufficient development capacity for cities projected to double in population within 45 years. The middle suburban residential greyfields, with their relative advantages of good public transport access, job access and access to tertiary education and higher level health services, represent untapped potential for more intensified precinct scale regeneration.

The Australian Housing and Urban Research Institute supported the first study of greyfield precinct regeneration options for Australian cities (Newton et al. 2011), enabling a comprehensive 12-month transition arena exercise designed to frame the requirements of a model of residential precinct regeneration. It identified a number of arenas where significant innovation was required if a new development model and process for greyfield regeneration was to emerge; by addressing the key questions of: Where? What? Who? How? (Figure 12.2). Subsequent Greening the Greyfields projects supported by the Co-operative Research Centre for Spatial Information and The Australian Urban Research Infrastructure Network has enabled significant progress to be made in a number of the innovation arenas (Newton 2013, 2017; Newton and Glackin 2014)– as briefly outlined in the following paragraphs.

Where to focus precinct regeneration? One of the challenges for greyfield residential precinct regeneration involves the identification of prospective precincts – concentrations of residential property where economic value lies predominantly in the land rather than the ageing built asset and where there are prospects of creating additional community dividend by neighbourhood activation. In metropolitan Melbourne there are at least three quarters of a million dwellings where 70% or more of the value of the property is vested in the land. A software tool (ENVISION; Newton and Glackin 2013) has been specifically developed to identify the location of properties with high redevelopment potential, employing multi-criteria analyses that are purely market based or reflect local planning priorities – depending on assessment criteria selected. It also is available as an e-Research tool from the AURIN and CRCSI websites (http://aurin.org.au/projects/lens-sub-projects/envision/).

What to build represents the second arena for innovation in greyfield precinct regeneration. Precincts will be typically situated among extensive tracts of low density detached housing that has come to define the ubiquitous ‘neighbourhood character’ for Australian suburbs that is enshrined in many local government residential zoning schemes and acts as a major barrier to more intensified forms of mid- to low-rise medium-density redevelopment. Poor design of much medium density housing built to date has also been identified as a major barrier to community acceptance of its diffusion more extensively throughout existing suburbs, and is an issue that governments are attempting to address: ‘while there is an undeniable imperative to increase densities... there is a need to ensure that new developments are well designed, are respectful of the environment and contribute positively to the existing built form’ (NSW Planning 2011: 4). The urban design professions have the capacity to address this by injecting the innovative features for buildings and precincts listed in Table 12.1 into the design of new buildings and precincts. The critical neighbourhood engagement process associated with precinct retrofit, however, has found that these designs need to be able to be:

- visualised and manipulated in local forums in real time;
- assessed as to the performance of these designs against benchmarks that can establish the extent to which they improve upon the built environment that is being retrofitted.
Such assessments provide an evidence base for local councils and communities to evaluate the level of dividend (benefit) that can flow from a proposed precinct retrofit – and will be instrumental in the level of support and incentive that local (and state) government can contribute. They will be central to demonstrating that a transition from (traditional) suburban forms to (more compact) urban forms can add value and character critical to the future of Australian cities in the 21st century.

Who will occupy? A significant and identifiable market has been identified for new medium density housing in the established suburbs of Australian cities. Recent surveys (Kelly 2011, 2012; Newton & Glackin 2015) indicate that there are significant markets for ‘urban’ as well as ‘suburban’ living. The supply side of the housing market is also beginning to respond as revealed by recent trends in dwelling approvals, where units (predominantly inner city high-rise apartments) are now accounting for more than half of all approvals in the major capital cities (HIA 2014; Kusher 2015).

How to deliver greyfield precinct regeneration constitutes the most intractable arena for change to date. Primary challenges relate to the land use restrictions that current government planning systems impose, creating barriers to more effective and regenerative urban development – an issue not restricted to Australia (Marshall 2011; The Economist 2015a).

The most recent classes of residential zoning for Melbourne released in mid 2014 as part of the latest metropolitan strategy plan (Plan Melbourne; DTPLI 2014) have been used by a majority of municipalities to lock up any potential for significant intensification of housing by allocating over 90% of existing properties to the zones where redevelopment is restricted either to ‘single dwellings and some dual occupancies’ (Neighbourhood Residential Zone, NRZ) or ‘single dwellings and some medium density’ (General Residential Zone, GRZ). Only two municipalities out of 21 have 10% of residential property in Residential Growth Zones, where a ‘mixture of townhouses and apartments’ are permitted. As illustrated in Figure 12.7 for one of Melbourne’s representative middle ring municipalities, there was less than 2% of existing housing located in the Residential Growth Zone (RGZ) while almost 60% of properties were in the GRZ (50% of which had high redevelopment potential). One third of residential properties were in the NRZ, of which approximately 40% had high redevelopment potential.

There is significant community opposition to residential intensification, which pitches individual rights against what could be considered good for the city. The entrenched advantage of residents in the established suburbs has translated into a sense of entitlement that resists change to their neighbourhoods. An analysis of the geography of planning appeals to the Victorian Civil and Administrative Tribunal clearly illustrates that a majority of the push-back against infill is in the established and higher income suburbs (Newton & Glackin 2014). There is a pressing need for state governments – who have the principal responsibility for metropolitan strategic planning – to develop a narrative related to the challenges that face the future development of the fast growing capital cities and more clearly communicate to the population the nature of changes that will be required to deliver more environmentally sustainable, productive and socially inclusive cities.

Municipal governments are the critical interface in respect of how they interpret metro strategies should operate in their jurisdiction. Many municipalities in Melbourne can be seen to have ‘gamed’ the most recent state government zoning system by restricting opportunities for residential intensification to small pockets of ‘RGZs’. A review of the 2014 zoning scheme is now under way following a recent change in Victorian state government – and continued critical press (The Age, 2014, 2015; Donegan 2015).
Municipal Housing Strategies are now a required response by all local governments to state government Metropolitan Plans. They represent the most appropriate context in which innovative and comprehensive top-down and bottom-up (community) engagement can occur in exploring future housing capacities of neighbourhoods within a municipality (see City of Melbourne 2013 as an example of good practice). To date, virtually all fail to engage with a visioning of the future of their municipality within the context of their metropolitan sub-region and broader metropolitan population, economic and infrastructure trajectories. Municipal Housing Strategies can be central to identifying the need to reshape significant parts of a municipality in order to regenerate and reactivate them by injecting more intensified development. The tools for locating prospective precincts, developing attractive indicative plans and designs and assessing them for the level of dividend they could deliver to current and future residents now exist. They need to be employed in a Council-led community engagement/neighbourhood change process capable of creating development overlays (micro-zones) where well specified and innovative medium-density residential regeneration can be activated with the prospect for successful implementation.

12.6 Conclusion

The growth of cities is one of the most tangible aspects of urbanisation in developing societies as well as in highly urbanised developed societies such as Australia. Urban growth can be expected to continue for the next half century in the context of future...
population projections. There are agglomeration advantages of growing cities that can be economic, environmental and social in nature. But a failure to adequately plan for urban growth and development can lead to mounting sets of problems. A number of these have been catalogued at the outset of this chapter for Australia’s large cities (also see Newton & Doherty 2014). Cities are a human creation, however, which means that there continues to be capacity to intentionally reshape and change them to achieve desirable outcomes – competitive, productive, liveable, environmentally sustainable, socially equitable and inclusive and resilient – notwithstanding the challenges associated with such a task. Urban planning continues to be the principal vehicle for manipulating spaces and places – attempting to articulate what land uses are best undertaken where.

In the 21st century, reshaping cities requires greater focus on retrofitting, to reflect the changing demands of post-industrial urban societies. There is also a recognition that well planned regenerative urban retrofits create more compact cities and deliver superior outcomes compared with their low-density sprawling counterparts. In this regard, there are significant challenges for Australian cities.

Greenfields has been the principal urban arena for the development of new housing precincts in Australia. The level of population growth forecast for the nation’s largest cities over the next 50 years means that greenfields will continue to play a role as a demographic absorber. But it needs to be a much smaller focus for development than has historically been the case; and it needs to reflect more compact, ‘smart’ urban design solutions as well as being more strongly underpinned by public transport infrastructures – reducing the car dependency that is currently characteristic of these areas. This represents a first plank in the transition to green urbanism: identified as a new policy focus for cities that embraces regenerative, compact city and green economy concepts and objectives – policies which need to be articulated and implemented as part of a spatial plan for the future land-use development and redevelopment of metropolitan regions (Newton 2013).

A second plank of green urbanism involves a regenerative retrofitting of brownfields – another arena for precinct scale urban redevelopment. As detailed in this chapter – and akin to greenfield precinct planning – there is a significant inventory of urban innovations awaiting implementation in brownfield precinct settings. Innovations that can deliver eco-positive, regenerative outcomes for energy, water, waste and mobility – more liveable, self-sufficient neighbourhoods with low ecological footprints.

The third plank of green urbanism involves retrofitting the greyfields – beyond activity centres, transit corridors and fragmented knock-down-rebuild urban infill – to include precinct scale renewal in neighbourhoods capable of strategic activation. Without broader based greyfield precinct retrofit, reflecting clear triple bottom line performance specifications (and their associated dividends), the prospect for urban regeneration in 21st Australian cities is poor.

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City-regional Futures in Context: Insights from the Retrofit 2050 Project

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Overview

Research findings from the EPSRC funded Retrofit 2050 project, aim to advance and explore the theoretical and practical understandings that underpin a shift to sustainability of the UK’s core city regions in 2050. Utilising a participatory backcasting and scenario building process at national and regional levels, the Retrofit 2050 project has sought to envisage what a sustainable urban environment could look like based upon the systemic urban retrofitting of an existing UK city-region to 2050.

First, it is argued that the construction of normative sustainability oriented future scenarios and vision(s) of a desirable future(s), is fruitful in understanding and managing processes of transition and meeting the goals of environmental sustainability. Secondly, the regional level visioning process described here intends to reflect the observations that retrofitting, by its very nature, does not occur on a blank state and will rather occur in existing social, governance and physical structures.

Utilising the Retrofit City Futures, developed during the Retrofit 2050 project, as guiding visions it is argued that city regional futures need to be grounded in a rich understanding of the (economic, political, social and ecological) transformation processes that shape development at regional level. The research reflects on the example of the Cardiff city region and highlights how these transformation processes play out across the variegated (rural, post-industrial and urban) geographies of the Cardiff city-region shaping, influencing and rendering distinctive the visions and city futures of Cardiff.

13.1 Introduction

Understanding the role that the built environment can play in achieving ambitious carbon reduction targets and wider sustainability goals (Kelly, 2009; Lomas, 2009; Lowe, 2009) has gained increased attention in recent years. The need to decarbonise the built
environment has often been understood at the level of buildings and neighbourhoods and has been primarily the domain of engineers, architects and construction interests. Although the repair, maintenance and renewal of the built environment and infrastructures as an on-going activity is not a new concept (Graham and Thrift, 2007), the compelling pressures of climate change and demanding environmental and energy priorities have stressed the need to retrofit the built environment and its existing building stock at scale (Hodson and Marvin, 2009).

On a global scale, the concentration of our growing human population within urban centres has focused attention on the role of cities in climate change mitigation and adaptation, and in achieving the broader goals of sustainable development. Although cities are seen as the source of many of our most pressing environmental and resource depletion problems, the creativity and innovative potential of cities may also provide their solutions. In the UK, as with many parts of Europe and the USA, the critical challenge, therefore, becomes not so much how to build new eco-cities, but how best to deal with our ageing building stock and urban infrastructure. In the UK, for example, less than 1–2% of total building stock each year is new build, and some 70% of total 2010 building stock will still be in use in 2050 (Dixon and Eames, 2013).

Retrofitting the built environment constitutes a very significant challenge in meeting the UK's carbon emission reductions targets as emissions from buildings and industry accounts for more than two thirds of total greenhouse gas (GHG) emissions in the UK (Committee on Climate Change, 2010). In this context, in the UK, the Climate Change Act 2008 and the setup of legally binding ambitious targets to reduce GHG emissions by 80% by 2050 and 34% by 2020 has offered a renewed focus to address the impact of the built environment on carbon emissions.

Alongside this, government has sought to develop strategic frameworks for more effective and integrated co-ordination of planning and infrastructure [e.g. the Planning Act 2008, the National Infrastructure Plan (2011), the Low Carbon Transition Plan (2009), Carbon Plan (2011) and the Energy Act 2012]. Together, these strategic documents set out longer term aspirations to develop systemic responses for the management of infrastructure networks. However, the initiative on the ground has been patchy. Much of the UK’s low carbon agenda at city level has been set by the Core Cities programme, which brings together the city-regions such as Manchester, Birmingham and Bristol. Moreover, a survey of the UK’s top 60 cities (by population size) for the RICS (Dixon, 2011) found that only seven have carbon emission reduction targets in place. Similarly, only one in five UK cities has an explicit low carbon plan or strategy. Best practice is the exception rather than the rule in this area.

Over the last decade retrofit has been promoted across a range of national (UK) government bodies, policies and programmes: from the Decent Homes programme, to Building Schools for the Future (BSF), the Community Energy Saving Programme (CESP), the Carbon Emissions Reduction Target (CERT), Feed-in-Tariffs (FITs) for incentivising the uptake of renewable generation, the creation of Low Carbon Economic Areas (LCEA), and more recently the Government’s Green Deal and Energy Company Obligation (ECO). Nevertheless, the government’s Green Deal – created as a flagship policy intended to radically improve the energy efficiency of the nation’s homes and commercial properties – has been heavily criticised. The scheme has proved highly
problematic, requiring significant modifications and additional incentives and due a very low implementation rate, was ended in July 2015 (DECC, 2014; Eames et al., 2014; House of Commons, 2014).

While this shows that retrofit has been promoted across the UK in different ways, the fact remains that up-scaling retrofit from a largely ad-hoc and piecemeal activity into strategic and systemic programmes that transform the built environment requires much more than reductions in carbon. Retrofitting at city scale is a multidimensional problem that requires a strong and integrated focus on energy, water, and waste and resource use, in order to underpin the provision of a healthy and socially sustainable environment within which diverse communities can flourish. What is required therefore, at city level, is a much more coordinated, planned and strategic approach so that cities can be re-engineered (or ‘retrofitted’) for a more sustainable future (Dixon and Eames, 2013).

Large-scale urban retrofitting entails systemic change in the organisation of the built environment and infrastructure, and the integration of socio-technical knowledge, capacity and responses. It also requires new forms of knowledge, expertise and decision support systems that better integrate the technological, economic, and environmental issues and options and societal challenges involved in implementation. These require relevant governance structures and capabilities to develop new social visions and technological expectations not only to enrol and align stakeholders, but also to deliver effective and efficient material change in infrastructure (Eames et al., 2013). To this end, visioning and creating descriptions of sustainable and desirable future have become prominent tools to guide how cities are structured, how they function, and how they are governed (Iwaniec and Wiek, 2014). Cities around the world are increasingly focusing on developing city visions for 2030 and beyond, promoted and underpinned by initiatives such as the C40 cities group (Dixon, 2011; Inayatullah, 2011; Eadson, 2012; Hodson and Marvin, 2012).

It is the aim of this chapter, then, to focus its attention to the way in which the Retrofit 2050 project has sought to envisage what a sustainable urban environment could look like based upon the systemic urban retrofitting of an existing UK city-region to 2050. Adopting a participatory backcasting and scenario building process (Næss and Vogel, 2012; Eames et al., 2013), this chapter aims to:

- stress the role that shared expectations or ‘guiding visions’ can play in shaping both the speed and direction of technological and social change;
- identify the influence that existing social, governance and physical structures play in determining the (economic, political, social and ecological) transformation processes that shape urban sustainable development at city-regional level.

The chapter starts with a brief review of the literature on city futures as a ‘guiding vision’ upon which the Retrofit 2050 team has drawn in identifying the Retrofit City Futures (Eames et al., 2013) to 2050. This is followed by describing the role of the backcasting process and the value of introducing stakeholders engagement in developing city-futures. In exploring the different visions of cities in the Cardiff city-region context, we draw attention to the fact that that retrofitting, by its very nature, does not occur on a blank state and will occur in existing social, governance and physical structures that influence the processes of transformation at city-regional level.
13.2 City Futures as Guiding Visions

The importance of setting targets to drive innovation and environmental improvement has long been recognised within academic and policy circles. However, by themselves, such targets can tell us relatively little about what the future of our urban environments and cities might actually look like. In light of this, the challenge is not simply one of how best to achieve a particular policy target, but more broadly what sort of sustainable future do we want to create. Envisioning such a future(s) clearly requires some degree of creativity and imagination, in order to imagine what cities themselves will be like, how they will operate, what systems will orchestrate them and how they will relate to their stakeholders (citizens, governments, businesses, investors, and others). Nevertheless, there is also a rich and diverse literature that can be drawn upon critically in undertaking this task. This literature encompasses not only academic work from a range of disciplinary perspectives on ‘urban sustainability’ and future cities, but also a rich variety of images and narratives from popular culture, politics, the media and the creative arts (Eames and Dixon, 2012).

Cities have frequently been the focus for utopian visions and imaginations, promoting hopes for a better future, but cities have also been imagined in dystopian and apocalyptic terms as hellish places, where poverty and despair prevail. Within this creative tension, it seems fair to say that ‘utopic’ visions have tended to focus on building new cities (or ‘ideal cities’), whilst, in contrast, ‘dystopic’ visions envisage a world where existing cities reach a point of no return and ultimate social and economic collapse, often realised through literature or film. Re-engineering or large-scale alteration of existing cities has therefore generally not been a feature of utopian visions. From the days of Plato in ancient Greece, the city has played a significant role in utopian thought. This early thinking stems from the idea, particularly in Egypt and Mesopotamia, that the ‘city’ itself was ‘utopia’ (Pinder, 2005), and here the king was a ‘god’, establishing a spiritual heavenly order on earth. However, as Jared Diamond (2005) noted in his study of societal collapse on Easter Island, once the vitality of a belief and cultural system, and the clarity of its future vision collapses, society and culture also collapse.

Societies which create viable images of the future, and help guide a way forward, are therefore more likely to survive, and this explains why city visions have been so important historically, and given the largely urbanised world we live in, why ‘city futures’ and ‘city visions’ have become a dominant feature in urban planning in the 20th and 21st centuries (Frewen Wuellner, 2011; Iwaniec and Wiek, 2014). The evolution of these city visions has been characterised by Kevin Lynch (1981) in terms of ‘city metaphors’. Lynch saw cities in terms of procuring meaning and symbolism for its citizens through the evolution of socio-spatial organisation.

Although ‘futures thinking’ is a distinct area of activity, and should be distinguished from ‘planning’ per se (which is concerned with achieving visions), much of the visionary thinking which evolved from the city vision thinking of Thomas More, Leonardo and others, is also very closely linked with urban planning theory. In the late 20th century, a number of trends challenged some of the visions developed in earlier years. In particular the emergence of an ‘ecological crisis’ and ‘urban crisis’ during the late 1960s and early 1970s, caused by the rapid depletion of resources, environmental degradation and the expansion of cities, with its severe consequences for urban populations, refocused the debate towards ‘sustainable urbanism’ (Whitehead, 2012).
Sustainable urbanism recognised that cities could be key to regulating environmental and ecological impact and social welfare but that unchecked, cities could themselves lead to catastrophic socio-environmental impacts. There was a growing recognition amongst disciplines which included planning, economics, ecology and architecture that understanding and recalibrating the urban form and functioning of cities was essential to developing a more sustainable future. The emergence of cyclical, ‘urban metabolic’ models, which moved away from thinking of cities as consuming resources in a linear fashion, was key to this transformation in thinking. Ideas and concepts which saw cities as compact, mixed use entities with low carbon technologies, driven on by related concepts of ‘smart growth’ and ‘new urbanism’ began to take root (Krueger and Gibbs, 2008; Whitehead, 2012). For example, in the 20th century we have seen the emergence of garden or social cities, which promote the idea of a metropolitan, polycentric region (e.g. the work of Ebenezer Howard); the contemporary or radiant city, which emphasised urban monumentality (Le Corbusier); Broadacre City, which unintentionally led to urban sprawl (Frank Lloyd Wright); and the ecological or spiritual city, which captured the concept of workplace-people (Patrick Geddes).

Daffara (2004), for instance, offers a helpful typology of ‘post-modern’ city futures linked with the concept of sustainability. For example, a ‘techno city’ is a dystopic vision, where urban contradictions remain unresolved, and which is a precursor to ecological and social collapse, and a ‘smart city’ is a place where growth management is being used to try and resolve urban contradictions, but where planetary well-being and biodiversity are still not as important as the well-being of the city and its region. In contrast, an ‘eco-city’ is a place where a sustainable future is being achieved and where urban contradictions are being resolved and a ‘Gaian’ city is where sustainability is a way of life and civilisation is transformed in a utopian future.

Indeed the term ‘eco-city’, as Joss (2009) points out (see also Chapter 14 of this book), has its roots in the 1980s, when it was first coined in the context of the burgeoning environmental movement, notably by Richard Register through his Urban Ecology initiative and the publication of Ecocity Berkeley (Register, 1987). Since then, the term has been ‘mainstreamed’ with a plethora of eco-city developments and plans being mooted in the mid 2000s (Joss, 2009).

More recently the concept of sustainable urbanism has been under scrutiny as some (e.g. While et al., 2010) have pointed to the way in which power and politics are shifted through the exercise of ‘carbon control’ and its ramifications not only for governance structures in cities, but also the way in which some groups may be marginalised through the creation of ‘eco-enclaves’ (Hodson and Marvin, 2010).\footnote{For further discussion of this topic, see Eames and Dixon, 2012.}

What is clear, however, is that many existing cities around the world need to envision and strive for a more sustainable future. Shared visions help people make sense of the future; they can ‘open up’ and make transparent societal choices; they help us to determine what sort of future we want; they promote discussion and debate; and they allow us to see how we can mobilise, deploy, and manage resources to achieve a desired future. Therefore, we argue that exploring alternative expectations and ‘guiding visions’ can not only assist in ‘opening up’ societal dialogue around such questions but also play a performative role in mobilising resources and innovative activity around particular desired outcomes.
More broadly, shared expectations or ‘guiding visions’ are recognized as playing an important role in shaping both the speed and direction of technological and social change as they can play a generative or ‘performative’ role: providing legitimacy, mobilising investment, promoting network formation and reducing risk by aligning research and development (R&D) priorities and production activities (Dierkes et al., 2006; Eames et al., 2006; Van Lente, 1993).

This section has reflected on the extensive and varied history of visions, and how such visions can be performative in shaping the future. The next section considers backcasting as an alternative to traditional planning in urban sustainability and a tool for moving towards alternative futures. This is achieved by describing how the backcasting tool was utilised in developing the Retrofit 2050 city visions.

13.3 How Can We Use City Visions to Understand City Futures of Tomorrow?

Explicit value orientation, systemic and long term considerations, broad stakeholder engagement and social learning have increasingly been considered important elements in crafting desirable future visions (Iwaniec and Wiek, 2014). However, there are a number of challenges arising when trying to apply these principles to developing sustainable urban city visions. Cities can hardly be considered as simple things to comprehend in the present. The processes that underpin the development, change and day-to-day existence of cities are complex, and as such urban environments can best be understood as complex socio-technical systems (Elzen et al., 2004). By this we do not mean simply that cities are complicated, though this is certainly the case, but rather that they exhibit the sort of dynamic non-linear, emergent behaviour we associate with complex systems. Cities are multi-actor in that they are home to a wide variety of actors, each with their own set of concerns and priorities; they are multi-scalar in that they can be imagined at a range of scales from the components that make up a house to the infrastructure that makes up a transport system; and they are multi-purpose in that they fulfil a variety of societal needs. Furthermore, the expertise needed to understand them is scattered across a broad spectrum of academic and professional fields, making them a multi-disciplinary problem.

The complexity of cities, together with the relative inertia of the built environment and strong sunk investment costs presents therefore formidable challenges for a managed transition towards sustainability (Næss and Vogel, 2012).

These challenges are further emphasised when one seeks to identify city futures of tomorrow, due to the inherent uncertainty of the future. We argue that more fluid and performative foresight processes can provide fruitful insights in providing opportunities to identify what can and needs to be done for the development of the building stocks, land use and transport infrastructure in cities and what are the main obstacles to achieving the possible futures. It is therefore important to identify new integrated approaches that can ‘open up’ the strategic navigation of urban sustainability transitions through making explicit competing expectations and framings of both the city and sustainability and can involve a broad range of stakeholders and actors (including government, companies, public interest groups and organisations) both in the definition of the problem, and also when searching for solutions and conditions in developing shared visions.
Backcasting has been proposed as an approach that meets these criteria (Quist and Vergragt, 2006). Backcasting – distinguishable from the vast majority of forecasting approaches and foresighting and scenarios approaches, which focus on likely futures and possible futures, and are projective in nature – is based on the construction of normative sustainability oriented future(s) and the analysis of the conditions, processes and pathways necessary for their realisation. It involves processes of foresight, experimentation, evaluation and social learning built upon stakeholder engagement and participation – in this case it is also referred to as participatory backcasting.

Participatory backcasting has gradually gained acceptance as an important tool for the governance of sustainability-oriented transitions within both research and practice communities (Eames and Egmose, 2011; Robinson et al., 2011; Vergragt and Quist, 2011; Næss and Vogel, 2012; Eames et al., 2013). The process of ‘backcasting’ can be defined as:

> generating a desirable future, and then looking backwards from that future to the present in order to strategize and to plan how it could be achieved (Quist and Vergragt, 2006: 1028).

In other words, vision(s) of a desirable future are first defined and then pathway(s) to that future articulated. Key variables in backcasting include: who develops the future vision; whether one or multiple visions are considered; and theoretical grounding with respect to models of innovation (Eames, 2011). Visioning, generating a picture of desirable futures, is a key step in any backcasting process, and is a useful tool in dealing with uncertainty by developing a shared set of expectations. These shared expectations shape both the speed and direction of social and technical change: they have a performative role in providing legitimacy; mobilising investment; promoting network formation; and reducing risk by aligning research and development and production activities (Eames et al., 2013). Essentially, they bring together information, resources and actors to rally around a set of shared visions to underpin action.

In the case of the Retrofit 2050 project, the backcasting and visioning processes require one to envisage what a sustainable urban environment could look like based upon the systemic urban retrofitting of an existing UK city-region (for the period 2030–2050). In this sense we adopted Grant’s (2004) definition of ‘urban sustainability’ which incorporates survival of the settlement through time, environmental impacts on landscapes, and quality of life for inhabitants. We also treat the term as being synonymous with ‘sustainable urbanism’.

Starting from the twin perspectives that the future is uncertain and that sustainability is an inherently contested and irreducibly political concept, informed both by incomplete and competing knowledge and the diverse values and interests of different social groups (Stirling, 2007), the challenge for the project team was to envisage a range of prospective futures, each encompassing a distinctive understanding of a retrofitted sustainable city-region, which taken together provided a reasonably comprehensive description of the future possibility space. Rather than imposing a single normative vision, our approach sought to acknowledge such contested and inherently political nature of sustainability through exploring a broad range of visions. These visions were then interrogated by relevant experts in order to create ‘scenarios’: an end vision combined with a specific ‘pathway’ describing the journey from the present day to that
future city-region. The Retrofit 2050 scenarios process brought together an expert panel for three participatory workshops to construct a set of prospective visions and pathways for retrofitting a hypothetical UK city-region. Different groups of external participants and stakeholders were involved in different phases of the scenario process. In general terms, however, the role of the external participants was to broaden the range of knowledge and expertise available to the research team, and to provide an element of critical review and societal appraisal. The key outcome, at this stage, was the development of the Retrofit 2050 Visions, a set of three visions of an imaginary city-region in 2050. Each scenario comprises a synopsis, a short narrative outline, and a set of annotated visualisations of the city (Eames et al., 2013). These three futures are represented in Figure 13.1. A brief summary of the key characteristics and indicative indicators for each vision is provided in Table 13.1.

Figure 13.1 Retrofit 2050 national visions: (a) Smart-Networked City; (b) Compact City; and (c) Self-Reliant Green City.
13.3 How Can We Use City Visions to Understand City Futures of Tomorrow?

Table 13.1 Retrofit 2050 national visions.

<table>
<thead>
<tr>
<th></th>
<th>Smart-Networked City</th>
<th>Compact City</th>
<th>Self-Reliant Green City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in land-use and urban form</td>
<td>Low–moderate</td>
<td>Moderate (densification)</td>
<td>High (extensification)</td>
</tr>
<tr>
<td>Social values and institutions</td>
<td>Market oriented values, with emphasis on private consumption. Light touch, networked governance with public sector, local authority and intermediary organisations acting as facilitators for business</td>
<td>Communitarian and localist values expressed at a city and neighbourhood level, coupled with strong local governance and planning systems and an emphasis on social investment</td>
<td>Cooperative and collectivist values underpin new models of participation and shared ownership, in which mutualism and local self-reliance are coupled with strong concerns for social equity and a questioning of materialism</td>
</tr>
<tr>
<td>Economic growth</td>
<td>3.0% p.a.</td>
<td>2.3% p.a.</td>
<td>&lt;1.6% p.a.</td>
</tr>
<tr>
<td>UK population by 2050</td>
<td>86.4 million</td>
<td>76.4 million</td>
<td>66.8 million</td>
</tr>
<tr>
<td>Urban density (2050) (assuming a large city)</td>
<td>No significant change 40 dwellings/ha (or 160 people/ha)</td>
<td>Dense 70 dwellings/ha (or 275 people/ha)</td>
<td>Less dense 30 dwellings/ha (or 120 people/ha)</td>
</tr>
</tbody>
</table>
These visions are not intended to be predictions, or mutually exclusive, but rather to highlight contrasting framings of the contested concept of ‘sustainability’. They draw attention to the competing pressures and dynamics capable of shaping the evolution of our cities in different ways; the visions and scenarios make explicit societal choices, and identify prospective pathways.

Each of these futures is located within a ‘possibility space’ described by two key dimensions of change for systemic urban retrofitting (Figure 13.2):

- The ‘change in land-use and urban form’ dimension that measures the extent of change in patterns of land use and urban form within the city-region. At the low end of this axis changes in the built environment and urban infrastructure are largely overlaid or accommodated within existing patterns of land use and urban forms. At the high end, land use and urban form are radically reconfigured.

- The ‘social values and institutions’ dimension that describes the structure of social relations and patterns of economic activity, including policy styles and consumption behaviour. At one end of this axis market oriented solutions to delivery of public goods predominate, together with individualist values emphasising short term private consumption. At the other end, public goods are delivered through cooperative and collective institutions, with a strong role for civil society. The individual is seen as part of a wider community and mechanisms for the allocation of resources are aligned with long term social goals. Between these two, communitarian values couple with strong local governance institutions to drive social investment at neighbourhood and city scales.

The three visions (and their related ‘possibility space’) have not been developed to be either comprehensive or mutually exclusive. Rather, they are intended to capture distinct aspects in which a hypothetical retrofitted city differs from the current status quo. For example, much of the change in the Self-Reliant Green City is predicated on significant change in the way social values and institutions operate; much of the Smart-Networked City vision is concerned with overlaying new technologies onto existing infrastructures. The goal here therefore is to draw focus towards key aspects of change rather than to generate a set of ‘compartmentalised’ or ‘all-encompassing’ visions. Whilst the visions represent competing, to some extent incompatible, views of urban sustainability, they
are not exclusive. One can certainly imagine how elements of these visions might exist alongside each other, albeit at different scales within a city-region.

The participatory backcasting process utilised in producing the three Retrofit 2050 visions (and their related ‘possibility space’), enabled us to stress that when considering the future of real cities one must consider not just their natural and built environment, but also their particular economic, social, political and demographic structures. How this was taken into account in the Retrofit 2050 project is described next.

13.4 Exploring Visions of Cities in Context: Cardiff 2050

The Retrofit 2050 visions have been developed as a starting point from which to explore the future of core UK cities, although the prospective social and technical changes and accompanying societal choices, they highlight, have, potentially, wider resonance beyond the UK context. Nevertheless, every city is to some extent unique. Such uniqueness reflects not just cities’ natural and built environment but also their particular economic, social, political and demographic structures. Moreover, each city is home to a diversity of values and interests, which can also shape expectations of the future. The starting point of the visioning process at the regional level intended to reflect the observation that retrofitting, by its very nature, does not occur on a blank state and will rather occur in existing social, governance and physical structures.

Methodologically, the grounding of the visions in the Cardiff city-region consisted of a series of separate steps that included: desktop research, a series of interviews with local experts and stakeholders, and a Retrofit City-Regional Futures scenario workshops held in Cardiff that brought together a group of stakeholders from the private, public and voluntary sectors to discuss how the three Retrofit 2050 visions could ‘touch-down’ in context (De Laurentis et al., 2013; De Laurentis and Hunt, 2014).

The three Cardiff 2050 Scenarios produced – Connected Cardiff, Compact Cardiff/Wilderness Valleys and Orchard Cardiff City Region – describe distinctive long term visions of what a sustainable future might look like in the Cardiff City Region and analyse the conditions, processes and pathways necessary for their realisation.

Each was developed using the Retrofit 2050 City Futures as a ‘jumping off’ point and each represents a distinctive articulation of urban sustainability at city-region levels. The Cardiff 2050 City Regional Scenarios therefore represents an exploration of how these different articulations of urban sustainability can be manifested and grounded in the economic, political, social, technological and ecological transformation processes that are shaping the development of Cardiff and South East Wales (Figure 13.3).

This process resulted in the creation of three ‘Retrofit Cardiff’s, each of which embraced a different framing of sustainability in line with the three national visions; yet they were distinctive from their national counterparts in context specific ways. For example, the importance of market forces as a key driver for change in the Smart- Networked City meant that, in the Cardiff context, such a pathway required an intermediary stage of market building with a strong role for local government. Similarly, in the Compact City vision, the historical shape of the region, with scattered settlements across a mountainous region, created a Retrofit Cardiff that comprised compact ‘urban villages’ with green hinterlands. For the Self-Reliant Green City, the Cardiff context again saw a reintroduction of a role for local government, in this case as leader in driving an inclusive and participative
Figure 13.3 Cardiff 2050: city regional scenarios for urban sustainability; (a) Connected Cardiff; (b) Compact Cardiff – Wilderness Valleys; and (c) Orchard Cardiff City-Region.
strategy for change. Figure 13.4 locates each of the Cardiff Visions in relation to our key dimension of change, whereas Table 13.2 provides a scenarios’ summary and indicative indicators.

It is evident from Table 13.2 that diverse drivers and pressures characterised each vision and there are many differences in the way urban sustainability is articulated,
<table>
<thead>
<tr>
<th>Change in land-use and urban form</th>
<th>Connected Cardiff</th>
<th>Compact Cardiff – Wilderness Valleys</th>
<th>Orchard Cardiff City-Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social values and institutions</td>
<td>Low–moderate</td>
<td>High</td>
<td>High 'Extensification' of urban and peri-urban communities</td>
</tr>
<tr>
<td></td>
<td>Continued suburbanisation</td>
<td>Dense urban centres and ‘re-wilding’ of rural hinterland Communitarian and localist values expressed at a city and neighbourhood level, coupled with strong local governance and planning systems and an emphasis on social investment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Market and State play an important role in orienting values, with emphasis on private consumption. Networked governance with regional government, public sector, local authority and intermediary organisations acting as facilitators for business. A culture of inclusiveness is promoted</td>
<td>Cooperative and communitarian values coexist and underpin new models of participation and shared ownership; the regional government provides guidance and promotes a consensus around principle of urban metabolism. Mutualism and local self-reliance are coupled with strong concerns for social equity</td>
<td></td>
</tr>
<tr>
<td>Indicative population and population changes (2050)</td>
<td>2.75 million High population growth Inward migration</td>
<td>2.25 million Moderate population growth Internal redistribution</td>
<td>1.75 million Moderate population decline Outward migration</td>
</tr>
<tr>
<td>Household size (2050)</td>
<td>1.95 persons per house Business as usual trend</td>
<td>2.32 persons per house City centre living</td>
<td>2.60 persons per house Return to 1970 household sizes</td>
</tr>
<tr>
<td>Change in building stock composition (2014–2050)</td>
<td>640 000 New build 770 000 Retrofitted 30 000 Demolished</td>
<td>310 000 New build 660 000 Retrofitted 140 000 Demolished</td>
<td>60 000 New build 610 000 Retrofitted 190 000 Demolished</td>
</tr>
<tr>
<td>Pressures</td>
<td>Economic competition; climate change mitigation and resource constraints</td>
<td>Long term regional trends of post-industrial decline; climate change adaptation and mitigation</td>
<td>Systemic ecological and economic crises; sustainability replaces growth as key driver</td>
</tr>
</tbody>
</table>
| 'Building blocks' of emerging pathways | ICT and broadband networks: 'Super connected city'  
'Smart City' lab  
Growth of existing business clusters  
Electrification of Cardiff and Valleys lines  
Smart metering and smart appliances  
Energy efficiency apps  
Urban energy, waste and water monitored centrally  
Multi-utility super grids  
Metro system  
Modal shift from car to public transport (50:50)  
Passive house is the norm  
Heat pumps in 30% of all homes | Electrified transport system  
Shared car ownership and car free suburbs  
Development of urban heat networks  
Retrofit part of rolling maintenance  
Universal water metering and water management systems  
Renewable energy cooperatives  
Demolition programmes for hard to treat and 'surplus' properties  
Managed retreat from coastal and upland areas  
Metro system  
Tidal lagoons  
Barrages along the coast from Swansea | Integrated Metro system  
Neighbourhood centred infrastructure for urban agriculture  
Electrification of Cardiff and Valleys lines  
Car free suburbs  
Local community owned energy production  
Retrofit uses local carbon neutral/ negative insulation materials  
Private rented property minimum EPC C  
Retrofitting sustainable urban drainage systems  
Public land used for food production  
Hydroponic greenhouse towers  
100% rainwater harvesting  
Pervasive small scale, low capital solutions for waste treatment and recycling  
Bottom-up and grassroots innovations with local and regional government acting as enabler to facilitate social learning and community action |

| Dynamics of change (governance system) | Regional government investment in building innovation capacity allows city-region to become established as node in global technological innovation systems | Institutional and financial innovation allows adoption and deployment of low carbon technologies and infrastructure systems |  

*Regional government investment in building innovation capacity allows city-region to become established as node in global technological innovation systems*
that goes beyond the exemplified Retrofit 2050 Futures. The backcasting process that involved a group of regional stakeholders from the public, private and third sectors made explicit the competing expectations and framings of both the city and sustainability, exploring the sorts of policy, market and technology innovations that are needed to support transition, the societal priorities and the governance settings as well as the challenges that each Cardiff future entails. What is important to stress is that each one of these futures provided an opportunity to identify what can and needs to be done and what the main obstacles are to achieving the possible futures in interpreting and grounding these futures in a deeper understanding of the local historical, socio-economic, geographical and policy context.

13.5 Concluding Remarks

This chapter presented the findings from the EPSRC funded Retrofit 2050 project. Its aims were twofold. First, it stressed the importance of backcasting processes in constructing normative sustainability oriented future scenarios and vision(s) of a desirable future(s). More fluid and performative foresight processes, such as participatory backcasting, have the salient characteristic that can 'open up' the strategic navigation of urban sustainability transitions through making explicit competing expectations and framings of both the city and sustainability. In the case of the Retrofit 2050 project, the backcasting process provided an opportunity to identify what can and needs to be done to attain sustainability goals, as well as identifying the main obstacles to achieving these possible futures. In particular, it allowed the discussion to move beyond the innovation and deployment of individual technologies and to improve our understanding of the processes by which systemic change in urban systems could occur. Our argument reflected that, often, existing visions of sustainable cities have relatively little to tell us about processes of systemic urban retrofit because they frequently overlook important questions. The research has demonstrated the potential contribution that shared expectations or 'guiding visions' can play in shaping both the speed and the direction of technological and social change. It has also highlighted that retrofitting at city level is a multi-sectoral and multi-actor problem that requires an understanding of diversity and conflict in the face of the complexity that is inherent to urban systems.

Secondly, the chapter noted that such complexity includes the uniqueness of the natural and built environment which characterise cities and their particular economic, social, political and demographic structures. Hence, there is a diversity of values and interests that can also shape different expectations of the future within any individual city. Retrofit, by its very nature, does not occur on a blank state and will rather occur in existing social, governance and physical structures. We have argued that these are important aspects to bear in mind in visioning processes. The Retrofit 2050 Futures, therefore, were used as a starting point from which to explore the future possibilities of Cardiff and South East Wales. Using the Retrofit 2050 Futures as ‘jumping off’ points allowed us to stress the importance of the context in shaping and rendering distinctive the three visions for the Cardiff City Region. The point of this is that when the guiding vision touches down in a particular context, processes of selective translation take place in relation to the negotiations of collective expectations. That is to say, different social
interests become active in a work of translation in context. The Cardiff City-Region Scenarios developed highlighted the importance of the city natural and built environment, the particular economic, social, political and demographic structures and the diversity of values and interests that play an important role in crafting different expectations of the future of real cities. In developing the regional scenarios, together with a number of regional stakeholders, a number of key issues were highlighted. These are: the importance of the historical and current socio-economic context of the city-region; the recognition of the role played by the local institutions in influencing the visions and the city-futures; and the important decision points and key priorities for change in the period between the present day and 2050.

While the participatory backcasting approach adopted created a ‘space of communication’ in which imagined futures could be both considered and populated, providing opportunities for cross-sectoral dialogues that are unfortunately rare, it also highlighted some intrinsic challenges that characterise such integrated approaches. Broad stakeholders’ involvement is crucial in addressing complex sustainability problems. This is essential not only because of the fact that they will be affected by change, but because stakeholders have essential knowledge and necessary resources that can inform vision development. As such, a key question in backcasting is: who develops the future vision? One major problem with vision development is the risk of becoming disengaged from the present in light of the irreducible uncertainty of the future; another is the challenge, yet importance, of the diversity and inclusivity of participatory backcasting processes. While the participatory backcasting approach adopted allowed us to engage and explore wide stakeholder interests, it can be said that the group was represented by a homogeneous age group and was very ‘Cardiffian’ oriented. Many critics can then question the inclusivity of such a process, asking ‘whose sustainability’ (see e.g. Meadowcroft, 2009) and ‘whose future’?

While these criticisms certainly highlight important limitations to visioning approaches they also present an opportunity for what Berkhout et al. (2003) deem the ‘real value’ of guiding visions: a focus for deliberation and learning. They argue that it is not often the normative ambitions of a vision that make them useful but rather the process of seeking them. This process opens up reflexive discussions between actors, creating relationships and allowing for legitimate and effective exploration of societal problems.

The exercise highlighted that although there are differences between what is wanted for a sustainable Cardiff city-region future and what can be achieved, visions are certainly a meaningful tool in supporting the elaboration and analysis of a sustainable future for the city-region.

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References


Overview

Cities have become a focal point for efforts to transition towards a more sustainable, low-carbon society, with many municipal agencies championing ‘eco city’ initiatives of one kind or another. And yet, national policy initiatives frequently play an important role, too. This chapter provides comparative perspectives on four recent national sustainable city programmes from France, India, Japan, and the UK. The analysis reveals two key insights: first, national policy is found to exercise a strong shaping role in what sustainable development for future cities is understood to be, which helps explain the considerable differences in priorities and approaches across countries. Secondly, beyond articulating strategic priorities, national policy may exercise a ‘soft’ governance function by incentivising and facilitating wider, voluntary governance networks in the effort to implement sustainable city projects locally. This innovative role, however, depends on the ability of national policy to produce resonance among societal actors and on its effective interaction with formal planning processes.

14.1 Introduction

That towns, cities and urban regions have moved centre stage in global efforts to transition towards a more sustainable, low-carbon society is by now widely recognised. So, too, it is increasingly expected that cities should exercise leadership in championing policies and implementing actions for sustainable development. In short, nationally and internationally, cities are treated more and more as actors in their own right, responsible for deciding and directing their own sustainable urban futures. And yet, national policy programmes frequently play an important role too. They may be less visible than high-profile sustainable city initiatives and iconic urban developments promoted on the local, national and international stages by cities themselves; instead, their influence may...
be more indirect in providing incentives and setting out policy frameworks as the basis for municipal and metropolitan actors to pursue their own agendas and projects. Certainly, our 2011 global survey of ‘eco city’ initiatives showed that national policy programmes have been responsible for a significant number of local urban sustainability schemes, especially ones classified as ‘retrofit’ initiatives (Joss et al. 2011, 2013).

Consequently, in this chapter we aim to take a closer look at the role of national policy programmes in guiding sustainable urban development and related innovation in ‘future cities’. We focus on four notable examples instigated since the millennium: (i) India’s Eco-Cities programme (2002–2010); (ii) Japan’s Eco-Model City programme and related FutureCity initiative (2008–present); (iii) France’s EcoQuartier programme (2008–present); and (iv) Britain’s Future Cities initiatives (2012–present). Together, these four have engaged over 100 hundred towns and cities so far in various ‘eco city’ and ‘future city’ activities. These are all existing rather than newly planned towns and cities – even if, within this remit, the policy programmes do not necessarily differentiate ‘retrofit’, ‘infill’ and ‘urban expansion’ approaches explicitly.

Conceptually, we situate the analysis of these four programmes in the public policy literature (e.g. Hill 1997, 2013; Sørensen & Torfing 2009; Klijn & Koppenjan 2015). This prompts us to consider the following four interrelated policy dimensions (after Hill 1997):

1) The **purposive stance**, or orientation, espoused by policy; this helps reveal underlying values, goals and choices, and explain the prevalence of particular policy discourses.

2) The **dynamic process** of policy-making, from initial policy formulation to eventual implementation, through a series of incremental decisions and adjustments.

3) The enactment of **decision networks** involving a variety of actors, often beyond the initial policy-making process.

4) The deployment of particular **policy tools**, which vary according to the goal of policy and may consist of distributing (benefits), regulating (activities) and constituting (institutions) features.

Applying this conceptual perspective to the analysis of the four national policy programmes leads us to pose two key research questions: (i) how is sustainable urban development normatively and discursively understood and propagated through policy? This relates to the first dimension above, and suggests that definitions of ‘retrofitting cities’ and ‘innovating for future cities’ are informed, and consequently shaped, by underlying norms and paradigms; in turn, this indicates that significant differences might be expected owing to the particular stances that these policies individually espouse. And, (ii) what governance approaches to sustainable urban development are promoted and enacted through these policy programmes? This relates to dimensions 2–4 above, and raises the possibility that national policy may go well beyond articulating ambitious goals and providing broad directives. Indeed, our grounded assumption here is that the four national policies to varying degrees embody a new governance approach, based on a dynamic multi-level policy process which seeks to mobilise and engage multiple actor groups, not least municipal authorities and local communities. If correct, then these policy programmes may represent potentially quite significant governance innovations, deserving closer analysis. Among the implications to consider are whether these national policy programmes, and their underlying governance approach, might offer a way around the frequently noted policy implementation gap by achieving more
14.2 Four National Sustainable City Programmes in Profile

14.2.1 Eco Cities (India)

The earliest of the national initiatives considered here was announced in 2001 as part of the Indian Ministry of Environment and Forest’s (MoEF) 10th 5-year plan (2002/3–2006/7). The Eco-Cities Programme was designed and coordinated by the Central Pollution Control Board (CPCB), a statutory body reporting to MoEF, with technical support provided by the German Agency for Technical Cooperation (GTZ, Gesellschaft für Technische Zusammenarbeit) under the Indo-German programme on Advisory Services for Environmental Management (ASEM). ASEM intended that the programme would catalyse further activity by raising ‘awareness’ and establishing ‘local dynamics for decreasing environmental burden/stress and improving living conditions’ (Surjan & Shaw 2008: 252), thus building the ‘capacities of the stakeholders to prepare and implement projects’ (Kulshrestha 2007: 1). Rather than attempting large-scale, integrated retrofitting, it focused on creating ‘environmental landmarks that show visible environmental improvement’ (Surjan & Shaw 2008: 253). A complementary objective, according to Kulshrestha (2007: 1) was to ‘improve urban management and for this purpose, promote networking of participating cities with similar cities in Europe.’ Essentially, then, the initiative aimed to inspire and enable wider processes of change and knowledge sharing through visible demonstrator projects.

The six cities chosen (Table 14.1) were medium-sized – with populations under 500 000 (CPCB, 2009) – but all had prominent profiles as sites of historical, cultural and spiritual importance.

Table 14.1 Participant cities in the Indian Eco-Cities programme.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Selected cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (2002–2007)</td>
<td>Kottayam (Kerala), Puri (Orissa), Thanjavur (Tamil Nadu), Tirupati (Andhra Pradesh), Ujjain (Madhya Pradesh), Vrindavan (Uttar Pradesh)</td>
</tr>
<tr>
<td>2 (not implemented)</td>
<td>Bharatpur (Rajasthan), Deogarh (Jharkand), Mathura (Uttar Pradesh), Rishikesh (Uttaranchal), Shillong (Meghalaya), Vapi (Gujarat)</td>
</tr>
</tbody>
</table>
significance (Surjan & Shaw 2008: 253; Datta 2011: 5). A total budget of 50m rupees (approximately £500 000) was envisaged for each city, with 50% offered by the CPCB, and 50% to be raised by the local municipality. Six further cities were selected for participation in a second phase, which never took place, but which would have incorporated learnings from the first six (CAG 2010).

Thematically, the programme had a socio-environmental emphasis, focusing on ‘quality of life’ issues: improving public spaces, green areas, and visitor facilities; relieving congestion; upgrading drainage and sewerage; and creating employment for the urban poor (Kulshrestha 2007: 1). Local authorities were invited to prioritise specific projects through design processes in which local stakeholders would participate (Medindia 2007; CPCB 2009: 275); decisions on the technologies to be adopted, and the precise approaches taken, were to be shaped by the problems thus identified in each location.

Locally prepared detailed project reports for each city were reviewed by an expert committee at CPCB against the broad programme objectives. The first set were rejected on the grounds of insufficient public input (Kulshrestha 2007: 2). Following resubmission, the final approved reports all proposed minor interventions to existing land uses. Although some new infrastructure was also planned (e.g. a water pipeline in Tirupati, and a visitors’ ‘eco’ parking and car repair facility in Puri), the general focus was on improving/upgrading existing amenities (e.g. covering stormwater drains in Tirupati, renovating water tanks in Thanjavur, improving public toilets in Puri, renovating a boat jetty canal in Kottayam, cleaning up the lake in Ujjain, and environmental improvements to key pilgrimage routes and sites in Vrindavan).

Collaborative governance methods were encouraged at local level. Local project coordination committees were to operate as partnerships between municipal authorities and other interested local bodies and organisations, and the municipalities were invited to raise funds jointly with other local stakeholder groups. For example, in Vrindavan, contributors included the Banke Behari Temple Trust, three local non-governmental organisations, and the India Heritage Foundation (an international non-profit making spiritual organisation) (Kulshrestha 2007). However, there is no evidence of significant private sector engagement with or investment in the programme, suggesting that the public authorities may have been unwilling, or lacked suitable mechanisms, to secure or manage such involvement. Local authorities were in fact permitted to raise funds with the help of financial institutions, and public–private investment projects had been envisioned (CPCB 2009: 275). In Vrindavan, according to Kulshrestha (2007: 6), private sector actors (including those operating in the tourism industry) had been identified as potential partners in development. The ‘scope for public–private partnerships and private investment’ was one of the criteria for the selection of these six cities (Surjan & Shaw 2008: 253).

In the most optimistic evaluation, the programme did engender small-scale activities in some cases. Three of the six envisaged projects in Tirupati had been completed by 2008; at least one project in Kottayam, the boat jetty canal renovation, was initiated – though CAG (2010) dismissed MoEF’s claim that this had been completed. Kulshrestha (2007), additionally, reports enthusiastic citizen involvement in Vrindavan. Overall, however, the programme was strongly criticised for not delivering on its goals (Datta 2011). The Comptroller and Auditor General of India (CAG) – the national authority
responsible for auditing governmental bodies – observed in its environment audit report for the period ending March 2009 that ‘[w]orks undertaken under the programme remained incomplete in all selected six cities’ (CAG 2010: 65). The processes of plan-making and fundraising had suffered long delays, with work often not beginning even after funds were released. The report suggests that finances were mismanaged by the State Pollution Control Boards (who were managing the funds); and notes that the local authorities in Puri and Vrindavan entirely failed to raise the required funding. CAG concluded that two main factors had led to project failure: (i) the difficulties faced by municipalities in raising funds; and (ii) CPCB/MoEF’s weak implementation and monitoring/control mechanisms. While, then, international ‘best practice’ approaches shaped the programme from its inception, through GTZ’s active involvement, this may have taken insufficient account of both the lack of capacity at local level, and the absence, as Datta (2011: 10) notes, of clear and well enforced national environmental policies.

Although CAG recommended addressing these two problems in the programme’s second phase, there is no evidence of further activity taking place. Neither the more recent urban sustainability initiative (the Ministry of Commerce and Industry’s Delhi–Mumbai Corridor Eco-City Programme, and the Ministry of Urban Development’s Near-Zero Energy Satellite Towns, both announced in 2010) nor the high-profile national Smart Cities competition (launched by the Prime Minister in 2015) are explicitly linked to this earlier programme. Meanwhile, various other new-build ‘eco city’ schemes are being developed by the private sector, and targeted at the Indian middle classes (Datta 2011: 5). The failed Eco-Cities Programme has closer similarities with the more recent Solar Cities scheme (announced in 2008 by the Ministry of New and Renewable Energy): it too is a retrofitting scheme with a socio-environmental focus; and it incorporates international expertise (from the US Department of Energy and Japanese government, among others). However, there is no clear evidence that Solar Cities has attempted to take on board the lessons from the earlier programme.

14.2.2 EcoQuartier (France)

The EcoQuartier programme was launched in 2009 by the Ministry of Ecology, Sustainable Development of Transport and Housing, as part of the national Urban Sustainability Plan. The initiative emerged against the background of two overlapping policy developments at the time: the Grenelle Environnement initiated by the government in 2007 as a national convention aimed at bringing together state and non-governmental actors to facilitate sustainable development action; and the national economic stimulus programme Le Grand Emprunt, launched in response to the global economic crisis of 2008. Consequently, the EcoQuartier programme is guided by the twin overall objectives of encouraging economic investment and facilitating sustainable development, with towns and cities targeted as centres of innovation.

Within this wider policy context, the EcoQuartier programme pursues an avowedly comprehensive approach to urban retrofitting and regeneration. First, with the impetus clearly on investing in existing urban centres as opposed to building new towns, the programme treats urban retrofitting equally alongside urban renewal (especially the re-purposing of brownfield sites) and urban expansion. Hence, the programme concurrently promotes the retrofitting of existing buildings and infrastructure as well as the
construction of a significant number of additional residential units and related infrastructure to meet the demands for urban growth. One evaluation report, of the projects supported up to 2011, categorises 42% as ‘urban expansion’ and 58% as ‘retrofit’ (Ministère de l’Écologie, du Développement durable des Transports et du Logement 2011: 14).

Secondly, the programme is thematically broad, encompassing 20 key areas of engagement along four intersecting strands (Table 14.2). Hence, rather than singling out a particular infrastructure domain or even a particular set of (retrofit) technologies, issues of environmental resource efficiency are closely interrelated with issues of land use planning and concerns about socio-economic health and well-being (‘quality of life’). The programme thus advocates fundamental, integrative and long-term planning and investment efforts. Relatedly, thirdly, the first five key indicators are subsumed under an explicit process heading; this not only foregrounds a comprehensive governance approach to urban retrofitting and regeneration, but also highlights the importance attached to locally co-determined and embedded planning and development processes.

Close co-operation and coordination between national, regional and local actors, from the public and private sectors and wider civil society, are central to the EcoQuartier programme – both in terms of its substantive definition of urban renewal/retrofit (see the thematic strand ‘approach and process’) and of its procedural implementation. Table 14.3 lists the four main implementation phases since 2009. This indicates that the programme has grown quite considerably, with a strong response from local actors (see also Zetlaoui-Léger et al. 2013); and also that it has evolved procedurally, especially through the launch of a national certification (Label EcoQuartier) process. (By 2014, the programme appears to have been transferred from the Ministry of Ecology, Sustainable

Table 14.2 The 20 key areas of engagement in the Grille EcoQuartier.

<table>
<thead>
<tr>
<th>‘Approach and process’</th>
<th>‘Quality of life’</th>
<th>‘Land use planning’</th>
<th>‘Climate change adaptation and resource efficiency’</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Integrative pilot and consultation processes</td>
<td>6) Promoting social cohesion</td>
<td>11) Ensuring mixed land use</td>
<td>16) Greenhouse gas reduction and climate change strategy</td>
</tr>
<tr>
<td>2) Clear project definition</td>
<td>7) Promoting social solidarity and responsible lifestyles</td>
<td>12) Optimising local transport and reducing car dependence</td>
<td>17) Reducing energy needs and diversifying energy sources</td>
</tr>
<tr>
<td>3) Financial, technical and legal feasibility</td>
<td>8) Offering a healthy and pleasant quality of life</td>
<td>13) Promoting alternative and sustainable modes of travel</td>
<td>18) Ensuring high quality, efficient management of water resources</td>
</tr>
<tr>
<td>4) Ability to manage and evaluate project and its effects on district</td>
<td>9) Enhancing local heritage, history and identity</td>
<td>14) Integration into local development processes</td>
<td>19) Avoiding irresponsible use of non-renewable energy and production of waste</td>
</tr>
<tr>
<td>5) Longer term continuity of process</td>
<td>10) Intense, compact and dense district design, in harmony with context</td>
<td>15) Enhancing relationship with agricultural and woodland areas</td>
<td>20) Enhancing biodiversity and urban nature</td>
</tr>
</tbody>
</table>

Source: Adapted from (authors’ translation) Ministère de l’Écologie, du Développement durable des Transports et du Logement 2011: 12.
EcoQuartier displays a multi-level and multi-lateral governance approach functioning chiefly as a voluntary process aimed at encouraging innovation and engendering collective engagement. It has the following five stated characteristics:

1) **Knowledge transfer and policy learning.** Both the ‘Club National EcoQuartier’ and the ‘Label EcoQuartier’ certification process are seen as serving shared learning across organisational and municipal boundaries. This relates both to the contents and forms of urban sustainability, and the various processes, such as planning methods, engineering approaches and investment and financing strategies.

2) **Co-operation.** While the impetus for the initiative comes from the national ministry, the programme is built upon co-operation with local and regional stakeholders as well as various (independent) experts. For example, only around a quarter of the reviewers guiding the national awards, and more recently certification, represent national agencies: approximately one quarter are independent experts, and the remaining half are local experts. Likewise, complementary mechanisms to support preparation and implementation processes are offered at local, regional and national levels.

3) **Local contexts.** While the national guidelines and validation process provide an overarching, unified approach, the emphasis is equally on recognising local specificities. The development of the ‘Label EcoQuartier’ in particular highlights the intention not to impose a uniform state-centric norm, but to promote local context-specific adaptability.

<table>
<thead>
<tr>
<th>Year</th>
<th>Phase</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>First call for proposals</td>
<td><em>160 submissions, of which 14 selected for national award (Palmières national EcoQuartier)</em></td>
</tr>
</tbody>
</table>
| 2010 | **Club National EcoQuartier** launch | *Bidders from first call brought together with aim of shared practice learning*  
  *Grows to over 500 members within first year*  
  *Membership exceeds 600 by 2014* |
| 2011 | Second call for proposals | *393 submissions, of which 24 selected for national award*  
  *Launch of Clubs Regionaux EcoQuartier* |
| 2013 | **Label EcoQuartier** launch | *2013: 13 EcoQuartier certifications, with 32 further projects receiving ‘engagement’ diploma*  
  *2014: 19 certifications (out of 108 projects), and 53 receiving ‘engagement’ diploma*  
  *2015: 7 certifications, and 24 diplomas* |
| 2015 | National evaluation report | *Evaluation of first round of EcoQuartier projects and certification process*  
  *Confirmation of target of 500 projects by 2018* |

*Source: Adapted from (authors’ translation) Ministère de l’Écologie, du Développement durable des Transports et du Logement 2011; Ministère de Logements, de l’Égalité des Territoires, et de la Ruralité 2014.*

Development of Transport and Housing to the Ministry of Housing, Territorial Equality and Rural Development.)

14.2 Four National Sustainable City Programmes in Profile
4) **Policy complementarity.** EcoQuartier is predicated on its coherence with existing statutory planning frameworks and tools. As such, the programme is intended as a collaborative, facilitating mechanism for planning and implementing sustainable urban development.

5) **Accountability.** Given the complementary nature of the programme and its focus on multi-level and multi-actor governance, considerable emphasis is placed on open and transparent guidelines and related evaluation processes. The joint involvement of local and regional actors alongside national representatives, the shared deliberations through the national and regional EcoQuartier clubs, and a commitment to reviewing the progress of the overall programme, together are designed to ensure accountability.

In autumn 2016, the government published a further evaluation report (Ministère du Logement et de l'Habitat Durable, 2016). Calling the initiative, which by then had grown to nearly 110 projects including 50 certifications, “a veritable success” (ibid: 3), the evaluation at the same time highlights several lessons, especially relating to the application of the certification process in local contexts. One general conclusion is that there is a need for more rigorous evaluation; another that follow-up reviews should be carried out once certification has been awarded. The report also reiterates the ambitious objective of growing the initiative to 500 projects by 2018. Meanwhile, a measure of relative success lies in the fact that 38 towns and cities were selected in the first two programme rounds, and 39 EcoQuartier certifications were issued in the subsequent project phase, during which the ministry claims that over 55 000 buildings directly benefitted from certification (Ministère de Logements, de l’Égalité des Territoires, et de la Ruralité 2014). Furthermore, the ‘Club National EcoQuartier’ has reportedly attracted over 600 participating organisations engaged in shared practice learning.

### 14.2.3 Eco-Model City (Japan)

‘The government of Japan will select Eco-Model Cities that will tackle pioneering initiatives and provide substantial support to them, in order to transform Japan into a low-carbon society’ (Prime Minister’s Cabinet Office, quoted in Murakami 2008: 14). This statement reflects the high-level support accorded to the Eco-Model City (EMC) programme and the centrality of the low-carbon agenda. Following the programme’s launch in 2008, 13 towns and cities emerged from the first competitive selection round in 2009, out of a total of 82 applicants (Table 14.4). The selection was from across the

| Table 14.4 Japan’s national Eco-Model City programme, and related FutureCity initiative. |
|----------------------------------|---------------------------------|
| **Programme** | **Phase** | **Cities** |
| Eco-Model City | Phase 1 (2009) | Chiyoda, Iida, Kitakyushu, Kyoto, Minamata, Miyakojima, Obihiro, Sakai, Shimokawa, Tōyama, Toyota, Yokohama, Yusuhara |
| | Phase 2 (2012–2013) | Amagasaki, Ikoma, Kobe, Matsuyama, Mitake, Niigata, Niseko, Nishiawakura, Oguni, Tsukuba |
| FutureCity | Phase 1 (2010) | Higashimatsushima, Iwanuma, Kamaishi, Kashiwa, Keser-city-region (Ofunato, Rikucentakata, Sumita), Kitakyushu¹, Minamisoma, Shimokawa¹, Shinchi, Toyama¹, Yokohama¹ |

¹ Cities selected under both programmes.
country’s eight provinces and included five major cities, four regional core cities, and four smaller cities and towns. An additional 10 cities were selected in 2012–2013, in the wake of the Fukushima Daiichi nuclear disaster triggered by the Tohoku earthquake and related tsunami of 2011, which further heightened the debate about how Japan was to realise its low-carbon energy future. In parallel, in 2010 the government launched the FutureCity programme, whose relationship is described as conceptually building on the EMC programme, albeit with a more pronounced socio-economic development focus informed by the national growth strategy (Regional Revitalization Bureau, 2014: 4; Promotion Council for the ‘FutureCity’ Initiative 2014: 3). This latter programme has to date recruited 11 model cities, of which four also feature in the EMC programme (Regional Revitalization Bureau 2014: 5). In total, 30 towns, cities and city-regions have been selected as part of this national effort to transition the country to a low-carbon, green growth future.

To be selected as an EMC, applicant cities have had to successfully demonstrate engagement with the following five criteria: (i) plans for drastic reduction of greenhouse gas (GHG) emissions, to comply with national targets – namely, at least 50% emission reduction by 2050 in comparison with the early 2000s (Murakami 2008: 4); (ii) excellence in acting as a model city, particularly in relation to pioneering integrated approaches to sustainable urban development; (iii) regional adaptability, to incorporate local characteristics and assets; (iv) the feasibility of proposed plans, with emphasis on engaging with local communities; and (v) long-term commitment to revitalising the city. Together, these selection criteria emphasise both substantive issues centred upon the transition to a low-carbon society, and process-related issues with focus on consolidating urban governance.

The reduction of GHG emissions is central to the selected cities’ proposals, with mid-term targets for 2030 ranging from 15% reduction in one case (Sakai) to 30–50% in most others (based on emissions in the 1990s–2000s), and rising to at least 50% and up to 70% by 2050. The national programme stipulates five areas of intervention in urban planning to achieve drastic reductions in carbon emissions: (i) prioritising ‘compact city’ development, including ‘walkable neighbourhoods’; (ii) upgrading public transport infrastructure; (iii) improving the energy performance of residential buildings; (iv) investing in renewable energy technologies; and (v) increasing carbon sequestration, with a focus on (re)forestation. The particular articulation of these intervention areas, and the related project definitions and socio-technical choices, are not prescribed by the national programme, but a matter for applicant cities to configure in their proposed action plans; they are thus expected to reflect the individual city profiles, including size of city, environmental conditions, industrial base, and residential make-up (Murakami 2008: 10). This is described in the official guidelines as a special feature of the EMC programme: promoting a low-carbon society policy by setting unified targets, while leveraging local characteristics (Murakami 2008: 11). Consequently, the EMCs display considerable variety (for case profiles, see e.g. Regional Revitalization Bureau 2011).

The national–local relationship defines the governance approach used to implement the EMC programme. On the one hand, there is strong national co-ordination, with the Cabinet Office (and its Regional Revitalization Bureau) taking overall charge of the initiative. As Shuzo Murakami, the chair of the EMC sub-committee appointed by the Prime Minister, explains: ‘...the Cabinet Secretariat is supporting the project rather
than specific ministries, such as the Ministry of the Environment or the Ministry of Economy, Trade and Industry, in order to promote cooperation among the national government ministries, between the national government and municipalities, and between businesses and universities’ (quoted in Edahiro 2009). On the other hand, local engagement is emphasised as being key to implementation: ‘The [EMC] subcommittee chooses model cities in order to promote drastic reductions of greenhouse gas emissions by encouraging local communities to promote integrated efforts that incorporate existing knowledge and information into social and economic systems and make good use of local characteristics’ (Edahiro 2009). This is echoed by Murakami: ‘...we need to provide information on what a low-carbon society might be like, share the idea with all citizens in a way that will increase their awareness. One effective way to do this is to present an existing case study of an environmental model city’ (quoted in Edahiro 2009).

To facilitate the multi-level governance process, the Cabinet Office set up the Promotion Council for Low-Carbon Cities. By 2011, it had attracted 204 members: 89 cities (including the selected EMCs), 46 prefectures, 12 ministries, 29 public organisations, and 28 private sector organisations. It chiefly acts as a platform for information sharing and policy discussion, organised through thematic working groups (e.g. sharing and disseminating best practice; developing standards for calculating GHG emissions of cities; promoting low-carbon measures and policies in cities). Several of the EMCs, notably Kitakyushu and Yokohama, act as working group convenors. The inclusion of both recognised EMCs and a larger number of non-EMC municipalities is seen as particularly important for replicating the innovation spearheaded by the pioneer cities.

Reconciling local, bottom-up innovation with national targets and top-down steering is recognised as a particular challenge for implementation of the programme. As a consequence, a national Committee for Creating Eco-Model Cities & Low Carbon Society was established to support EMCs with regular, independent evaluation. In turn, this has driven demands for common indicators, and even a national standard, for sustainable cities. In response, in 2010 the Japan Green Building Council launched its CASBEE for Cities assessment framework to provide a practical tool for evaluating and benchmarking city performance (Joss et al. 2015).

Overall, the EMC programme may be considered relatively successful so far, considering the participation of 23 towns and cities, plus a further seven cities through the related FutureCity initiative. Several factors seem relevant to this outcome: the initiative’s high national profile, due to ongoing direct support from the Prime Minister’s Cabinet Office; the level of resourcing provided through funding support and comprehensive governance processes; local buy-in from towns and cities nationwide, with significant participation in the competitive selection process and the Promotion Council for Low-Carbon Cities; and conceptual and programmatic continuity across governments (there have been five governments since 2008) and between the EMC programme and the more recent FutureCity initiative. Finally, there is arguably a further, historic factor at work: current eco city innovation is steeped in historical values and traditions, including earlier engagements in garden cities, eco towns and ecological industrialisation (van Berkel et al. 2009; Low 2013; Joss 2015: 139–141); this may partly explain the readiness of various stakeholders concerned to embrace the contemporary eco-model city challenge.
14.2.4 Future Cities (UK)

In 2012, the UK’s Technology Strategy Board (TSB) – a national innovation agency sponsored by the Department for Business, Innovation and Skills – announced a ‘Future Cities Demonstrator’ competition (TSB 2012). At a time of ongoing cuts to local authority budgets across the UK, the competition aimed to stimulate new thinking in local service provision, as well as open up markets abroad for new ‘smart’ urban management technologies, building on the UK’s recognised strengths in urban consultancy (Taylor Buck & While 2015). Thirty of the 50 cities expressing initial interest were each awarded £50 000 to develop feasibility studies. Among the 29 doing so (Table 14.5), 26 also submitted proposals for a ‘large-scale demonstrator project’. Glasgow was chosen from these as the overall winner in January 2013, receiving £24 m to deliver a series of now completed demonstrator projects (Macdonell 2015), while plans developed in the feasibility studies are being implemented unevenly elsewhere (Taylor Buck & While 2015: 13; Caprotti et al. 2016).

The competition conceptualised potential benefits for cities around the three pillars of sustainability, inviting proposals demonstrating ‘potential for a large impact on the economy, quality of life and environmental impact of the city’ (TSB 2013: 3). However, its overarching aim was to stimulate private sector innovation, and thus encourage economic growth and exports. This strong economic framing was complemented by a focus on hi-tech and digital innovation: the proposals judged most successful all promoted open-access data platforms. As one commentator observes with regard to Glasgow Future City: ‘[the] money was not earmarked for regeneration, or housing projects or even renewable energy schemes. It was all to be spent on technology’ (Macdonell 2015). Retrofitting possibilities were thus understood through the enabling possibilities of (data-driven) technology, rather than around predefined categories of concrete challenges.

This conceptual centrality of technological innovation was accompanied by the encouragement of active collaboration between different stakeholder groups: the most successful proposals, according to an analysis conducted for TSB, promoted ‘extensive engagement with a range of partners including industry, academia and citizen groups’ (Arup 2013: 50). The task of defining local problems, precise modes of addressing these, and potentially in leading ongoing activities and collaborations, was devolved to

Table 14.5 Twenty-nine municipal authorities submitting funded Future Cities feasibility studies.

<table>
<thead>
<tr>
<th>Feasibility study plus proposal for large-scale demonstrator project</th>
<th>Feasibility study only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birmingham</td>
<td>Glasgow(^a)</td>
</tr>
<tr>
<td>Brighton &amp; Hove</td>
<td>Greater London(^b)</td>
</tr>
<tr>
<td>Bristol(^b)</td>
<td>Enfield</td>
</tr>
<tr>
<td>Cambridge</td>
<td>Ipswich</td>
</tr>
<tr>
<td>Cardiff</td>
<td>Leeds and Bradford</td>
</tr>
<tr>
<td>Coventry</td>
<td>Leicester</td>
</tr>
<tr>
<td>Dundee</td>
<td>Manchester</td>
</tr>
</tbody>
</table>

\(^a\) Overall winner of large-scale demonstrator funding.
\(^b\) Shortlisted for large-scale demonstrator funding.

Source: Adapted from Arup 2013: 11.
city-level authorities. Despite this emphasis on enabling, devolved and collaborative governance, however, national government retained a dominant gatekeeping role by setting broad competition criteria and making final funding decisions.

An official assessment of the Future City Glasgow project was due to be completed in 2016 (Macdonell 2015), though does not yet appear to have been published. In any case, arguably the project – and therefore the competition which led to it – will succeed on its own terms if its initiatives are replicated in other UK cities. It seems reasonable to suppose that the competition did forge a space for collaborative strategising and innovative thinking, even if, as Taylor Buck & While (2015: 11) conclude, ‘the most developed submissions were based on ideas previously proposed or already under submission’. However, replicating technical solutions may be problematic if the successful ‘demonstrator cities’ turn out to be untypical. This risk is implicitly highlighted in Arup’s (2013) analysis of the competition proposals as a whole, in which cities identified barriers not only in terms of limited resources but also: low levels of citizen engagement and skills; difficulties for councils in reaching shared visions (and related viable long-term financial models); reticence to share data (see also Macdonell 2015); problems with the consistency and formatting of open-access datasets; and the precondition of strong local leadership. Taylor Buck & While (2015: 15) highlight the possible tensions between the goals of ‘improving the functioning of UK cities’ and ‘external export opportunities’, contending that the competition focused more on the latter. Although knowledge-sharing of different types was strongly encouraged (between different stakeholders locally, through the mandatory publication of submitted proposals, and through the intended export process), the expectation of encouraging innovation through intra-urban competition, reflecting the ‘competitive localism of UK national innovation policy’ (Taylor Buck & While 2015: 15), differentiates this scheme from a fundamentally collaborative national cities framework (Taylor Buck & While 2015).

The demonstrator competition displays some continuity with the ensuing Future Cities Catapult initiative, whose flagship projects include the £24m Glasgow Future City. This is one of 10 ‘Catapult’ initiatives jointly funded by Innovate UK (as TSB was renamed in August 2014) and the private sector; each will provide facilities and support for private companies in sectors identified as having significant international growth potential. Future Cities Catapult claims the ‘global future cities market’ will be worth £200bn annually by 2030 (Future Cities Catapult undated). Within these ambitions, the role of urban sustainability is conceptualised at best as co-constitutive with economic growth. Had these policy initiatives been primarily concerned with developing urban sustainability knowledge, they might have displayed more obvious linkages with the ‘garden city’ development proposals announced by the Department for Communities and Local Government in April 2014 (BBC News 2014; DCLG 2014), ongoing debates about the shortage of affordable housing in the UK, and indeed with the now-abandoned ‘eco-towns’ (Tomozeiu & Joss 2014) and ‘zero carbon homes’ policy initiatives instigated by the previous Labour government.

### 14.3 Comparative Observations

Taken together, the four initiatives prompt several comparative observations relating to the two research questions at the centre of this chapter: that is, concerning, on the one hand, the role of national policy in shaping the substantive and discursive engagement
in (local) sustainable urban development; and, on the other hand, its role in promoting and enacting potentially new governance approaches and practices.

### 14.3.1 Shaping the Content of Local Agendas

It may be unremarkable that national policy, as represented by the initiatives analysed here, should have aimed to prioritise and support sustainable urban development at local level; after all, public policy embodies a purposive stance and seeks to steer decision-making across the wider policy network. However, what is revealing is quite how instrumental policy can be in actively shaping the substantive agenda for urban retrofitting and future city planning. In other words, policy here is not merely about prioritising and lending recognition to an already known quantity – retrofitting cities – but it more fundamentally engages in definitional groundwork and, thus, provides substantive direction. In doing so, it reveals some important differences owing to particular underlying assumptions and approaches. In the case of Japan’s EMCs, for example, policy is almost exclusively defined in terms of the national priority of transitioning to a low-carbon society (GHG emission cuts of 50% or more by 2050). As a consequence, the five thematic areas of intervention, from transportation to building infrastructure, are defined primarily in terms of low-carbon energy strategies; and this is reflected in the specific innovations and activities that the selected towns and cities have prioritised in response. In contrast, the underlying approach of the French EcoQuartier initiative is deliberately comprehensive, informed by the concurrent goals of improving environmental performance, stimulating urban economic regeneration and growth, and incentivising technological innovation. Tellingly, a key measure for success quoted in the official literature is the number of renovated and new housing units (over 55,000) that have so far benefitted from EcoQuartier certification, alongside an emphasis on quality of urban life and environmental protection. Interestingly, Japanese policy has more recently sought to broaden its thematic approach, as reflected in the subsequent FutureCity initiative; while this is positioned as closely building on the EMCs, it nevertheless introduces a more explicit focus on economic and technological innovation, with an unmistakeable nod to the emergent ‘smart city’ discourse.

The UK’s Future Cities initiatives are similarly instructive, both for what their underlying policy approach does and does not articulate. While the triple-bottom line of sustainability is generally referenced, with economic development, quality of life and environmental protection all mentioned in principle, the actual policy formulation heavily privileges economic growth and related technological innovation, especially prioritising ‘smart’ digital technology. And by highlighting business export opportunities as a major benefit of Future City engagement, there is arguably a notable disconnect with the need for particular local regeneration, significant additional housing, and low-carbon energy generation – areas that have elsewhere been identified as policy priority for the UK. As a consequence, the city as a specific place for innovation seems almost incidental, other than serving the purpose of technological innovation for the global market. This can in no small part be explained by the fact that the Future City policy falls under the remit of the national innovation agency within the government’s business department; other departments with responsibility for communities and local government, the environment, and climate change, are notable by their absence. (A similar observation about disjointed policy was made in relation to the earlier English eco-town initiative; see Tomozeiu & Joss 2014.) In contrast, the EcoQuartier initiative is
run under the auspices of France’s ministry responsible for housing and urban–rural development, and is predicated on its complementarity and compliance with other, related policies and planning regimes. For its part, the EMC initiative is run from the Cabinet Office under the Prime Minister’s direction; together with the substantive, long-term policy goal of transitioning Japan to a low-carbon society by 2050, this places the retrofitting and regeneration of towns and cities centre stage.

India’s Eco-Cities Programme represents something of a contrast to the other three initiatives in that the underlying policy stance appears less pronounced and directive: while the policy was broadly framed in terms of decreasing environmental pollution and improving urban living conditions, this was not explicitly linked to any wider national goals and targets. Instead, it appears to have focused almost exclusively on locally defined environmental and urban challenges, and the approach was characterised less by sustained, systematic urban retro-fitting than by punctual intervention aimed at raising local awareness and increasing visibility. This may well have to do with the fact that the initiative resulted from a bilateral collaboration (with Germany) and was, therefore, defined more in terms of international development aid aimed at local capacity building than as part of a wider national policy strategy.

In summary, the significance of the four initiatives may be seen as much in their exercising influence over how urban retrofitting (in the wider sense) is defined in the first place as in their elevation of the subject matter to national importance; and insofar as they are motivated by differing underlying normative goals and strategic priorities, their takes on retrofitting cities for the future vary considerably. As such, national policy may be a rather important, though often unacknowledged, avenue through which urban retrofit approaches and practices are forged.

**14.3.2 Governance Innovation**

Beyond the ability to fashion the thematic discourse, however, the initiatives arguably demonstrate further significance in terms of their potential as instruments to influence and shape the wider policy implementation processes. In doing so, they are noteworthy for their engagement in governance innovation for sustainable urban development. This is particularly the case for the EMC and EcoQuartier initiatives, whose substantive articulation and process designs place special weight on their intended contribution to facilitating and co-ordinating governance across the wider policy network. It is telling, for example, that the model character of the EMCs is defined as much in terms of displaying excellence in pioneering new, integrated approaches to urban planning and development, as of demonstrating low-carbon urban performance. In similar vein, it is significant that the first five key areas of engagement (Table 14.2) of the EcoQuartier scheme have an explicit governance focus under the heading ‘approach and process’; together, these areas explicitly emphasise integrative and long-term planning. The addition of the Label EcoQuartier certification process further reinforces this approach, since it is designed to create the necessary certainty and commitment to enrol private sector organisations and leverage in financial investment for the realisation of sustainable urban development projects. Consequently, in seeking recognition as EMC/ EcoQuartier initiatives, applicants are prompted to demonstrate – and are accordingly evaluated against – their proposals for putting in place effective integrative governance processes.
Such a new, collaborative governance approach is, however, not only incorporated within the policy tools themselves, enacted locally through the implementation of policy in relation to specific urban contexts (e.g. the application of an EcoQuartier in a specific town); it is more widely promoted across national policy networks and processes. Both the EMC and EcoQuartier initiatives have been instantiated through multi-level governance arrangements, whereby central government agencies act as overall convenors while at the same time collaboratively enrolling lower-tier (regional, local) government actors as well as non-governmental organisations for policy implementation. In the case of the EcoQuartier initiative, proposals are evaluated by a mixed group of experts, including local, national and private sector representatives; and a wider actor network has been created through the ‘Club National EcoQuartier’ and several similar regional associations, aimed at knowledge and policy transfer and shared practice learning, both among the selected EcoQuartier projects and among a wider circle of interested actors. Likewise, Japan’s Promotion Council for Low-Carbon Cities brings together several dozen towns and cities (including the selected EMCs), numerous prefectures, over 40 ministries and public organisations, and well over 20 private sector organisations, in an extended policy actor network. Significantly, while these governance structures are intended to act as catalysts for policy implementation and knowledge dissemination, they simultaneously contribute to the continuous formation of policy. For example, the Promotion Council for Low-Carbon Cities includes several working groups – some of which are led by selected EMCs – that generate thematic contents as input into the ongoing definition of what EMCs are understood to be.

Taken together, this places a dynamic, circular policy process at the heart of these initiatives, driven by the recognition that policy implementation requires the effective mobilisation of wider actor networks. This dynamic circularity relates to several dimensions, including: vertically, the national–local interrelationship (the EMC initiative makes this explicit with reference to ‘setting unified targets, while leveraging local characteristics’; Murakami 2008: 10); horizontally, public–public (city-to-city) and public–private sector interactions; and temporally, the policy formation–implementation process.

14.3.3 Factors Co-determining Policy Implementation Success/Failure

If as ‘model’ (EMC) and ‘exemplary’ (EcoQuartier) initiatives, these policies aspire to a new, integrative governance mode for sustainable urban development – and, as noted, their innovativeness may, therefore, arise as much from the governance approach as from the substantive urban sustainability goals – then it can, of course, not be assumed that such governance is achievable as a matter of course. Indeed, one can expect a far from ideal practice reality, given the multiple complexities involved in enacting policy for urban sustainability, although this should not in itself devalue the role of these initiatives. Gaining a critical, in-depth understanding of how these initiatives operate in particular practice contexts – though beyond the scope of this chapter – should therefore be the subject of further empirical analysis. Meanwhile, the following are some of the governance factors that might be expected to impact on the performance – and, hence, the perceived ‘success’ or ‘failure’ – of national policy initiatives for sustainable urban development. These factors are in play to varying degrees in the examples discussed here; however, they are arguably more pronounced in the case of the Indian
Eco-Cities and the UK’s Future Cities initiatives, accounting for their relatively weaker governance profiles compared with the EMC and EcoQuartier initiatives:

1) **Policy continuity**: if the purpose of a policy is more about agenda-setting, aimed at initiating and promoting policy discourse, then a short-term initiative may well be appropriate. However, if the purpose is to effect more long-term transformative change based on collaborative governance, then a more sustained policy implementation process is called for. And since retrofitting cities for long-term sustainable futures typically involve planning and development over several years if not decades, any policy that is short term may end up being disruptive rather than enabling. From this perspective, both the Indian Eco-Cities and UK’s Future Cities initiatives appear to be at a relative disadvantage, given their short intervention period, although the jury is still out on the other two initiatives, too. This then also suggests the need for more long-term policy analysis, in order to be able to evaluate policy implementation success/failure.

2) **Availability of structural and financial support**: even if the expectation is for a considerable degree of self-organising among policy actor networks, this still requires an element of central direction and co-ordination. Otherwise, the various actors expected to participate in policy implementation on the ground may not have sufficient confidence in government commitment, resulting in only cursory engagement. A clear framework, based on explicit parameters and transparent procedures, may well be necessary to elicit actor participation. And putting an initiative under the auspices of the Prime Minister’s office, for example, or issuing a national certification process, could send out an important signal of governmental dedication and support.

3) **Compatibility with formal planning**: a policy initiative which may be launched with good intention, but which ends up being too removed from, or out of sync with, existing planning and decision-making processes, could be disruptive to sustainable urban development, especially if it creates uncoordinated parallel decision processes and related accountability conflicts. Hence, a key question is the extent to which national policy initiatives for sustainable urban development, as discussed here, manage to complement existing local planning and decision processes and, furthermore, consolidate these by facilitating improved, co-ordinated engagement across the wider policy actor network.

### 14.4 Conclusions

In analysing the contribution of national policy, based on the four exemplars from France, India, Japan and the UK, we do not wish to make any claim about whether such initiatives necessarily represent an effective means of generating substantive sustainability transitions at the urban level. Tracing and evaluating concrete outcomes and indirect effects is a long-term undertaking, requiring further empirical research – and this undertaking is potentially complicated by the possibility that frameworks encourage local actors to ‘repackage’ already planned activities, rather than incentivise innovation. Instead, this chapter has drawn attention to the conceptually innovative multi-level governance arrangements which such policy frameworks entail. We, therefore, argue, that their potential force is to engender dispersed networks of decision-making (while
also noting several factors mitigating against this). At the same time, their underlying pur-
positive stances can have strong shaping roles in the types and qualities of decisions made, with implications for the practices of sustainable development within towns and cities.

Taking the longer view, the key to national policies for urban sustainability gaining traction and catalysing broader change may lie in their ability to resonate with wider networks of societal actors. The ‘horizontality’ of this desired outcome, however, does not imply that similar initiatives in future should seek to obviate more hierarchical regulatory and institutional structures. Rather, the preconditions for the wider resonance of ‘soft’ governance approaches, which seek to incentivise and enable sustainability innovation rather than impose solutions from the national centre, may relate in a fundamental sense to the qualities of their interactions with existing formal decision-making processes over time.

References


Part IV

Overview of Key Themes from the Book
15

Conclusions and Reflections: Retrofitting Cities for Tomorrow’s World

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Overview

In this chapter, we reflect on the main findings of the EPSRC Retrofit 2050 programme, setting this in the context of the main themes which have emerged from this book, and the wider policy and practice debate around the future of cities in the UK, and internationally. The chapter therefore outlines the key challenges that must be understood and addressed if cities are to be successful in their urban retrofit ambitions, and concludes by placing the EPSRC Retrofit 2050 research in the wider context of urban foresight or futures studies of cities.

15.1 Introduction

Cities are home to a wide range of environmental and resource depletion problems, but also present a wide range of opportunities to address these problems, harnessing their creativity and innovative potential to find novel solutions. In much of Europe, as Sir David King alludes to in his foreword to this book, the urban sustainability agenda is focused not only on new smart cities or eco‐towns, but also on addressing our inefficient, aging building stock and urban infrastructure. In the UK, for example, the built environment is responsible for over two‐thirds of our total carbon emissions, and some 75–85% of the buildings standing in 2010 will still be in use in 2050 (Power, 2008; Ravetz, 2008).

This focus on re‐engineering, or retrofitting, the built environment has risen in importance in recent years in both the academic and policy and practice arenas. To retrofit literally means to layer on a component or feature not fitted in construction or manufacture (see Chapter 1). The term has been used in a built environment context interchangeably with terms such as ‘refurbishment’ or ‘conversion’. But at a city‐scale retrofit means something more comprehensive. The EPSRC Retrofit 2050 project...
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therefore defines ‘sustainable urban retrofitting’ as the directed alteration of the fabric, forms or systems that comprise the built environment to improve water, energy and waste efficiencies (Eames, 2011).

From a technical perspective, at least, there is an increasing understanding of what types of technological change could deliver in terms of significant reductions in carbon emissions across domestic and commercial building and physical infrastructure, and the sorts of costs governments will face in implementing these changes. Moreover, research increasingly shows that these changes can deliver extensive economic, societal and health benefits in the cities and communities where they occur, in the country as a whole, and even on the world stage (LSE Cities, 2012). These benefits can contribute to job creation, quality of life, fuel poverty, air quality and energy security to name but a few (Floater et al., 2014). Yet despite this understanding about the need to retrofit our cities to reduce emissions and increase energy efficiency, and a developing knowledge base about what needs to be done in particular cities and communities, a critical question remains: how do we do this at the scale needed to generate positive outcomes for our economies, environment and communities?

The EPSRC Retrofit 2050 project has sought to address this question in a way that is holistic and systematic (see also Chapter 1 of this book). To do so it employed processes of comparative case studies, reviews of potentially disruptive technology and policy innovations, national and regional scenario backcasting workshops and modelling of the built environment across multiple scales. More information on the project can be found at www.retrofit2050.org.uk. This work has explored multiple, sometimes competing long-term visions of what a sustainable city-region could look like, and quite radically different framings of the urban retrofit agenda held by different parts of society (Eames et al., 2013a, 2013b, 2014). We can be sure that currently there is little or no consensus about where we should be heading, or how we should get there. Scaling up retrofit activities will require a coordinated and strategic approach, bringing together different stakeholders and societal interests (e.g. policymakers, owners, occupiers, developers, financiers, contractors, utilities). The aim must be to foster new forms of governance which move beyond policy and political cycles capable of delivering systemic change in the years to come.

In this chapter we therefore reflect on the main findings of the EPSRC Retrofit 2050 programme, setting this in the context of the main themes which have emerged from this book, and the wider policy and practice debate around the future of cities in the UK, and internationally.

15.2 Critical Factors for Successful Urban Retrofit Transition

15.2.1 Emerging Themes from the Book

Certainly any national programme of retrofit would have to look to city-scale action as a key component, but of course, the very nature of any large-scale retrofit programme is complex and challenging. As a recent report by Arup (2016: 2) on UK national residential retrofitting pointed out:

A national residential retrofit programme will intersect with policy and legislation, cut across departmental and devolved boundaries, and will involve
influencing every household of every tenure. In the need to change behaviours it has some similarities to public health campaigns such as drink-driving or smoking; and it has similarities with the digital switch-over in ensuring a mass technology shift.

This was certainly a theme that comes strongly through the writing in this book as well. Getting the appropriate governance structures in place is paramount to the success of urban retrofitting. For example, Dixon and Karvonen in Chapters 2 and 3, respectively, argue for the importance of integrated thinking in both the commercial and residential property sectors in the UK, and this is also true of the Australian context (Chapter 5). Technical issues around ‘deep retrofitting’ can act as a barrier, however, as Swan et al. showed in Chapter 4.

Similarly, the ability to transition and create an effective strategy for sustainable urban retrofit is founded on a proper understanding of the context for modelling those transitions and pathways. For example, Eames et al. (Chapter 6) showed the importance of understanding energy consumption patterns across a city-region such as Cardiff, and Mavrogianni et al. (Chapter 7) showed how often contradictory requirements in building requirements can create tensions in urban retrofit. But we must also recognise the importance of ‘integrating across scales’; and how it is also important to understand what happens, for example, at neighbourhood level (Chapter 8).

Clearly, we should also recognise the importance of steering and navigating our way to a sustainable future by 2050 in our urban areas. Chapter 10 focuses on how we can accelerate this, drawing on our understanding of transitions, and Chapter 11 on London shows how important a university’s role can be as part of the wider ‘ecosystem’ of understanding urban futures (see also Goddard and Vallance, 2013), However, we must also recognise that cities are ‘messy’ and ‘complex’, and Chapter 12 on Australian cities is a potent reminder that ‘greyfields’, whilst presenting challenges for urban retrofitting, also present potentially underutilised opportunities. Chapter 9 also offers valuable insights into the role of foresight and scenarios in examining the future of cities. In a similar vein, Chapter 13 on the EPSRC Retrofit 2050 ‘visioning’ process in Cardiff provides thoughts and guidance as to how city regional futures should be grounded in a specific context.

Finally, Chapter 14 on the international dimensions of eco cities and retrofit offers an interesting comparison of retrofit approaches at city level.

The three dominant themes in this book are therefore vital to our understanding of urban retrofitting:

- **Governance and dynamics of urban retrofit**: the first part of the book focused on the issues involved in the development of wider metropolitan frameworks for retrofitting activities. This book has shown how important the development of frameworks for private sector investment are in providing the impetus for large scale retrofit, and how an understanding of the development of partnerships and the relationships with existing local community can help foster successful retrofit experiments and projects in cities.

- **Modelling urban transitions and pathways**: the second part of the book has highlighted the importance of tools and principles for guiding policy makers and practitioners from simple ‘what if’ questions, based on a single modelling technique, to more interlinked tools that capture not only the metric change, but the spatial and temporal nature of modelled urban transitions.
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- **Steering and navigating sustainable urban transitions**: the chapters in the third part of the book have shown how the development and implementation of policy approaches, governance-oriented tools, and broader institutional frameworks can help steer and navigate sustainable urban transitions. But the book has also highlighted a range of important issues which need to be considered, including complexity and uncertainty; participation and inclusion; the integration of appraisal, learning and evaluation; and the challenges and opportunities for reflexive governance.

But what does the EPSRC Retrofit 2050 programme itself tell us about the critical challenges of urban retrofitting, and how does it link with these key themes? In the next section we set out the main findings from this research, and reflect on the linkages with the thematic findings from this book, before ending with a final look to the future and the role and importance of urban foresight methods.

### 15.2.2 EPSRC Retrofit 2050: Main Findings

The EPSRC Retrofit 2050 project’s exploration of the critical challenges in scaling up urban retrofit suggests that cities will need to enshrine eight key elements in order to deliver sustainable cities in the years to 2050. These are:

- An inclusive urban retrofit agenda, bringing together communities and interests from across the city-region.
- Compelling retrofit city visions to motivate change.
- Improved modelling and decision support tools to facilitate long-term planning.
- Institutional capacity, planning and governance systems that are adaptive and fit for purpose.
- Access to finance to incentivise and facilitate investment in change.
- Effective partnerships that bridge stakeholders, both public and private, local, regional and global.
- Long-term sharing of risk and benefits to ensure that investment is both attractive and equitable.
- A whole systems approach, overcoming the short-term, piecemeal approach that is currently prevalent.

Each of these issues will now be considered in more detail.

#### 15.2.2.1 An Inclusive Urban Retrofit Agenda

Over the course of the project, the research team interviewed a broad range of the sort of actors who could participate in and drive a transition to sustainability, including local government officers, civil servants, private sector companies, community groups and charities. Many of them were already engaged in retrofit activities in different parts of the UK, with a geographical focus of London, Manchester and Cardiff. These interviews revealed quite different motivations and framings of the retrofit agenda, incorporating diverse governance systems and social interests and employing different ideals of what a sustainable city would be.

In particular, the project explored the different approaches at play in Greater Manchester and the Cardiff City-Region. At the UK level, the retrofit agenda focuses on economic processes of market making and addressing market failures where they prevent households and businesses from investing in cost effective energy measures...
Critical Factors for Successful Urban Retrofit Transition

(Dixon et al., 2014b and see Chapter 3 of this book). In Greater Manchester, this top-down, economic approach can be characterised as retrofitting on the city, where regional political and business interests have sought to achieve a first-mover advantage and position the region as a leader in the emerging UK retrofit market. By contrast, the Cardiff City-Region has adopted a rationale of retrofit as a delivery mechanism for its overarching commitment to sustainable development. Here the Welsh Government’s agenda is enacted in partnership with local authorities (LAs) and social housing providers as well as wider societal interests. It focuses on area-based solutions that seek to regenerate areas through material improvement, job creation and reduction of fuel poverty. This contrast is explored in more detail in De Laurentis et al. (2012).

In the cities studied, we find a diverse range of bottom-up initiatives where retrofitting is grounded in the context of the city: its history, its communities and the economic and social realities it faces. While seeking to access resources, these initiatives construct contextually rich rationales around environmental and quality of life values.

Moreover, retrofit is not only found in these sorts of larger, clearly defined initiatives. It is also bound up in routines of day to day life (Shove and Walker, 2007). Changes in people’s lives create new contexts for retrofitting activities (e.g. having children, moving house, fitting a new kitchen or bathroom, building an extension).

An inclusive urban retrofit agenda must seek to reflexively reconcile each of these competing, though often complementary, framings through consultation, experimentation and consensus building, remaining aware of specific local contexts throughout the process. This theme is also covered in Chapters 2, 3, 5, 6 and 10 in this book.

15.2.2.2 Compelling Retrofit City Visions

Visions of the city have long played a central role in the development of urban civilisation, be they utopic or dystopic in nature (Eames and Dixon, 2012). They play a number of important roles in moving towards sustainable cities. They help people make sense of the future and determine what sort of future they find desirable, giving them an arena in which to evaluate their values and priorities. They promote discussion and debate, and provide a space for consensus building. Similarly, they help attract, mobilise and deploy resources in order to drive change. These potential uses have been observed and used in governance systems across Europe, notably the Transition Management approach pioneered in the Netherlands (Hunt and De Laurentis, 2014). This is a theme which is also highlighted in Chapters 6, 9 and 11 in this book.

The EPSRC Retrofit 2050 project has developed a set of distinctive retrofit city futures, developed through a series of participatory workshops with experts. This process is described in detail in Eames et al. (2013a, 2013b) and Dixon et al. (2014b). The EPSRC Retrofit 2050 city visions include the following:

- ‘compact city’ of intensive and efficient urban living;
- ‘smart-networked city’ hub within a networked, competitive society;
- ‘self-reliant green city’ in harmony with nature.

Each of these visions have different implications for people, technology and governance structures. Also, importantly, these futures are not intended as self-contained predictions. Rather, they draw attention to the competing pressures and dynamics capable of shaping the evolution of cities. For example, the self-reliant green city is shaped by significant change in the way social values and institutions operate. The smart-networked
city is created by a layering of technology over our existing infrastructures with sharp increases in efficiency from technological and information advances.

Of course, every city is to some extent unique. When considering the future of cities, we need to consider the complex economic, social, political and demographic structures that go along with their natural and built environments (Dixon et al., 2014a, 2014b). These futures are therefore intended as a ‘jumping off point’ or tools that can underpin discussion and planning processes.

15.2.2.3 Improved Modelling and Decision Support Tools
One key barrier identified over the course of the research was a lack of appropriate modelling and decision support tools to aid long-term thinking. The complexity of the built environment in cities represents a significant challenge: as well as comprising a large number of diverse communities and interests, and a wide range of types of buildings and infrastructure, cities are also complex in the sense that they are subject to feedback loops that cannot be easily predicted (Rotmans, 2006). As such, modelling tools have an important role to play in understanding how change may look in the light of particular governance choices, facilitating more comprehensive decision making. In recent years advances in ‘top-down’ and ‘bottom-up’ models have allowed the development of increasingly sophisticated simulation tools for use at the building and urban scales. However, these models are static in nature and are unable to tell us relatively little about the dynamics of change in transition by themselves (Dixon et al., 2014a, 2014b).

Models and tools that engage with users and allow them to explore potential retrofit futures are essential in planning sustainable futures. Many current models constrain the users to ‘business as usual’ scenarios in terms of energy usage, where land use change is limited to new build, economic growth is assumed as necessary and societal change is limited in scope to population growth. Whilst these models are praiseworthy, they still place limits on the ‘thinking space’ inhabited by decision makers. Approaches based on group modelling and system dynamics techniques may have scope to highlight the tool and data requirements to cover the scope of potential visions for 2050, but crucially they need to engage with decision makers early in the modelling process to facilitate understanding of change dynamics.

As models are only as good as the data put into them, the availability and quality of information remain important limiting factors. However, the emergence of data rich cities will support more detailed modelling processes (Lannon et al., 2016), with data sets such as the new Energy Performance Certificates supporting more effective models. The model developed by the EPSRC Retrofit 2050 project is explored in detail in Xing et al. (2012), and the chapters in the second part of this book also focus on the issue of modelling in some detail.

15.2.2.4 Institutional Capacity, Planning and Governance
There has frequently been a failure to develop city-scale governance and planning systems that are reflexive and flexible enough to cope with change and uncertainty over the long term. Indeed, beset by short political time scales and a human tendency to prioritise the near future, governance systems have struggled to take into account the sorts of changes needed to underpin a transition to sustainability: there is often a disconnection between short-term planning horizons and environmental ambitions.
and targets (Meadowcroft, 2011). They have also tended towards a piecemeal approach rather than a systemic approach that recognised the multiplicity of interests involved. For example, climate change action at an urban level takes place through a combination of local regulations, urban services, programme administration, city purchasing, property management and dialogue with local stakeholders.

Urban policies also require better ‘joining up’: more integrated thinking that avoids policy silos and considers the city as a whole. For example, spatial planning policies that promote higher densities and better mixing of uses should be considered alongside sustainable transport options. Often, this sort of thinking has not occurred since decision making is distributed across professions and stakeholders. Within the retrofit of a single building, planners, architects, designers and owners may hold different views of what would constitute a successful project. This problem is only exacerbated at the city level. Frequently, projects are fast tracked and sustainability gains are lost. Furthermore, the details of sustainability aims are often lost on senior decision makers due to lack of clarity and understanding, while knowledge transfer and best practice are neglected. Finally, there is too much of a focus on capital costs instead of whole life costs, where energy efficiency and resource costs can be represented (WBCSD, 2010).

The commercial property regime is a case in point. Here fragmentation, complexity and conservatism in decision making hampers change and promotes a business as usual approach. This means that stronger, mandatory policies are needed to drive change, such as Display Energy Certificates (Dixon, 2014 and Chapter 3 in this book). Moreover, the nuances of different approaches to urban retrofit within cities needs to be recognised, so that understanding the politics and purpose of such experimentation and efforts to integrate retrofit and governing need further research (Hodson and Marvin, 2016).

However, the built environment offers opportunities for market growth and job creation, often based around retrofitting new and existing buildings. Therefore, to bring together the range of actors, issues and institutions involved for urban retrofit will likely require an aggregating body, acting as a focal point for integrating priorities and responses. This is also a key point recognised by Arup (2016) in a report on a UK national programme of residential retrofitting, where pooling of projects by the same client and bundling projects owned by multiple clients can create economies of scale, and the issue of governance has been highlighted as a primary issue in the first and third parts of this book (see e.g. Chapters 2 and 10).

However, in the UK the recent city devolution movement may offer some further opportunities for city-wide actions, although this may be difficult in an era of local government austerity, and more limited funding opportunities. Cities have been at the heart of the UK government’s policy agendas since 2010, and in May 2015 the government introduced the Cities and Local Government Devolution Bill (enacted in 2016) which opens the way for cities to have greater powers over investment and spending, in return for new devolved governance structures. ¹ Ultimately this is designed, in the eyes of the government, to promote regional economic growth and to innovate in the provision of public services. Greater Manchester is the first major city to take complete a settlement of these new powers: a new mayor was elected in 2017 to represent the

1 The Bill relates to England and Wales, but its practical effect is in England only.
city-region and new powers will include investment in transport and housing, the setting of local planning strategy, greater powers over land development and control of police and fire services. The mayor will also be able to control borrowing against future increases in local business rates (Policy Exchange, 2016). It is too early to say whether this new evolving governance structure will create improved opportunities for city-wide retrofit programmes.

Interesting governance initiatives are also emerging internationally. A report from the C40 Cities Climate Leadership Group/Tokyo Metropolitan Government (Takagi et al., 2015) showed that a number of cities around the world were developing their own codes for new buildings, and major retrofits, which were more stringent than national or state codes. Examples in this group include: Melbourne’s 1200 Buildings Programme; New York’s mandatory benchmarking scheme (Greener Greater Buildings Plan); and Philadelphia’s Building Energy Benchmarking Ordinance. Similarly, in some US cities, and also Tokyo, mandatory reporting and retro-commissioning is becoming more common (e.g. Singapore and Hong Kong). Tokyo itself is a unique example of how a city can introduce a mandatory cap and trade programme, with an emissions target, focused on buildings.

15.2.2.5 Access to ‘Green’ Finance

The financial challenge of wide-scale retrofit is substantial (see Chapter 3). Cities could, over a longer time scale, develop a combination of fiscal instruments and incentives together with financing mechanisms to achieve sustainability goals, but it is not an easy task. The UK approach has been characterised by the creation of the Green Deal and the Green Investment Bank. However, under the current UK government both initiatives have been curtailed. Primarily offering loans to customers making energy efficiency improvements to their home, the Green Deal was hailed as ‘the biggest home improvement programme since the war’, but never took off on the scale envisaged, as homeowners were not convinced by the relatively high costs of loans, and complexity of the scheme (Rosenow and Eyre, 2013). As of February 2015, just 5306 Green Deal plans had been completed and in 2015 Green Deal funding was ended (Cadywould, 2015). Also, perhaps best classified now as a wasted opportunity, the UK Green Investment Bank (UKGIB) became operational in October 2012, with £3 billion in UK taxpayer capital dedicated to its mission of ‘accelerating the UK’s transition to a more green economy, and creating an enduring institution, operating independently of government’ (UKGIB, 2016). The bank backed 21 green projects and committed over £700 million, mobilising a further £2 billion in private finance, but in 2015 plans to sell off the bank were announced. On 3 March 2016 the UK Government launched the process to move the Green Investment Bank into the private sector and details were set out in statements from the UK Government and the Green Investment Bank. The transaction is expected to involve both the sale of existing shares owned by the UK Government and also the commitment of additional capital for the Green Investment Bank by new investors.

Scaling up retrofit in the domestic sector is highly dependent on access to finance, but in terms of making commercial property retrofit an attractive proposition it is also fair

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2 See also Chapter 3.
to say that existing buildings tend not to capture the corporate imagination in the same
to new buildings do (see Chapter 3). In commercial property, for example, retrofit
projects will be competing for capital with other corporate activities that are given a
higher level of priority. Similarly, even in the domestic regime, energy efficiency
improvements will have to compete with other demands on household budgets and will
suffer accordingly. The development of ‘green’ finance will therefore require greater
availability of capital but also information and incentives to encourage change. Drawing
on the experience of the successful Energiesprong ('Energy Leap') programme (see also
Chapter 10), Rosenow and Sagar (2015) suggest, for example, eight key policy initiatives
which could help scale up retrofit nationally and at city level, and resolve the difficulties
associated with the Green Deal:

- Government should set an overarching ambition and a long-term trajectory for
  energy efficiency improvements in the UK. This should take the form of minimum
  standards for all domestic properties being sold or let, and should gradually increase
  in-line with carbon reduction targets set out by the Committee on Climate Change
carbon budgets. These standards should differ depending on the housing type.
- The Department for Energy and Climate Change should undertake a review of the
  metrics used for home energy performance.
- Government should introduce a financial incentive for consumers at a key trigger
  point: when buying and selling their house. Stamp Duty Land Tax (SDLT) should be
  reduced in line with each Standard Assessment Procedure (SAP) point a property
  reaches above the mid-point of revenue. Conversely, SDLT should be increased for
  each SAP point a property is below this.
- In addition, Government should enable city regions to retain the revenue generated
  from SDLT, and use this new power to introduce more local and bespoke incentives
  for people to improve their homes. This approach should initially be trialled within a
  leading city-region, then rolled out to other cities and LAs over time.
- As part of ongoing city devolution deals, a portion of national infrastructure funds
  should be devolved to cities to invest in energy efficiency schemes via an open
  competition.
- A ‘Help to Improve’ scheme should be introduced, where Government guarantees the
  cost of a property’s investment in energy efficiency retrofit and provides funding
  through an intermediary to reduce the interest rate of the loan.
- Government should devolve revenue from a range of low carbon taxes and levies to
city-regions. This should initially be piloted with a percentage of the overall amount.
  A portion of these funds should be used to deliver home energy efficiency schemes.
- Government should encourage LAs to designate ‘Warm Home Zones’ to help target
  areas where low EPCs and poor public health outcomes coincide. Within these areas,
  LAs should introduce additional incentives for home owners and stricter regulations
  on landlords. The quantifiable benefits to health and social outcomes in each area
  should be re-invested locally.

Essentially, therefore, the proposed scheme involves moving away from a top-down
approach to one which tackles low take-up through the creation of effective demand
drivers and a tailored local framework with devolved governance and delivery (see
Section 15.2.2.4). Similar policy measures have also been advocated by Westminster
Sustainable Business Forum (2016), who also support the concept of the Dutch
Energiespring programme, which provides deep whole house retrofits and where government acts as broker between installers and the customer, making retrofitting more financially attractive. In the Netherlands this approach of removing this responsibility from householders and giving them energy performance contracts is said to be delivering significant results. Green mortgages, which are specialist mortgages used to fund energy efficiency measures, are also advocated as helping provide a way of rolling out retrofit. At a city level several new financial vehicles are developing to fund major ‘green’ projects in the context of energy, water and waste. For example, revolving funds, which capture and reinvest some of the savings of early investments, can be used to finance domestic building retrofits and other projects. Current examples include the UK Salix fund and the Thai Energy Efficiency Revolving Fund (Gouldson et al., 2015). Municipal ‘green bonds’ are also developing in a number of cities to fund large-scale green infrastructure projects, which include renewable energy and climate change adaptation and mitigation projects. Essentially a green bond is a standard fixed income instrument where the proceeds are applied exclusively to funding green projects, either through use of proceeds; project specificity; or securitisation (RBC Capital Markets, 2014). Gothenburg in Sweden was the first city to offer a municipal green bond in 2013 when it issued bonds to the value of SEK 500 million and a further issue of SEK 1.8 billion in 2014. In Gothenburg the bonds have been used to finance water treatment plants, biogas production and electric vehicles. Johannesburg also issued green bonds in 2014 to finance biogas and solar geyser projects. Other cities have also trialled tax increment financing (TIF) (or new development deals) to capture land value improvements from public infrastructure investments including Manchester through the UK government city deals (Sandford, 2014).

15.2.2.6 Effective Partnerships

Given the diversity of actors involved in building and city level change, effective partnerships are crucial if change is to be holistic and substantial. Furthermore, a partnership approach allows for a less fragmented and more consensus-based path forward in making choices and carrying out change.

Well-constructed public and private partnerships (PPPs) can potentially offer better value for money than traditional procurement methods and can enable risk sharing at a time when public purses are constrained. At a building level, there is still a lack of research to prove that green buildings are worth more in the market than conventional buildings. However, there is emerging evidence that in some sectors, there may be ‘premium’ value associated with higher rated, energy efficient commercial buildings. For example, a growing number of empirical studies establish a relationship between superior environmental certification of buildings and measurable financial benefits. The rationale behind the existence of a premium for green products can be linked to the intrinsic benefits that they offer, which has created additional demand for them. Such demand can also translate into an increased ‘willingness to pay’, and the resultant sale and rent premiums may be a necessary compensation for higher construction costs in such buildings (van de Wetering, 2017). Establishing this ‘business case’ of proven additional value is fundamental to persuading the private sector to respond to the needs and requirements of retrofitting cities, but the presence of public sector actors is also crucial to drive new policies, instruments and ambitions.
Cities have a role to play in the green growth and employment agenda. For example, New York’s Greener Cities, Greater Buildings plan is expected to create 17 800 construction-related jobs (PlaNYC, 2009). A partnership approach allows for gaining the greatest level of societal benefit from retrofitting activity. This also means Universities can play a key role in developing coherent city visions (see Chapter 11).

Retrofitting processes must recognise that within cities, land and property ownership patterns are key to understanding future trajectories of change. This is in part because of urban morphology, which will frame new development, regeneration and refurbishment. It will also have an impact because the timing of lands sales will affect the nature and shape of change, creating potential windows for change (Foxon et al., 2013).

15.2.2.7 Long-term Sharing of Risks and Benefits
The current dominant economic, institutional and policy framings of retrofit focus on commercially ‘cost effective’ measures. This is typified by the ‘Golden Rule’ which was at the heart of the Green Deal. These business models inevitably focus on the ‘low hanging fruit’ – smaller, relatively cheaper technological fixes at the expense of bigger changes. In commercial property retrofit, this manifests where payback requirements and lease length often act to disincentivise innovations in technology deployment (Dixon et al., 2014a). In domestic buildings, households are likely to be averse to taking on high levels of debt when there is risk and uncertainty attached to future benefits. Retrofit for deep decarbonisation will require business models that consider risks and benefits in the long term, ensuring that they are effectively and equitably distributed.

15.2.2.8 A Whole Systems Approach
Currently, the retrofit agenda is in large part focused on individual projects, taking a piecemeal approach. A major concern of the Retrofit 2050 project was to shift to a holistic approach that considers how change can scale up to the sort of level needed to address climate change, resource depletion and energy security concerns. This is investigated in more detail in Eames (2011).

However, there are some encouraging signs that more systemic perspectives are beginning to gain purchase in city-scale energy, water, waste, transport and data systems. This thinking of a city as a ‘system of systems’, and the related development of a ‘science of cities’, was at the heart of the recent UK Government Office of Science Future of Cities Foresight programme (Government Office of Science, 2016a). This work found that, in relation to the future of cities, much of the available science base is not being routinely applied to the tasks of policy development and planning, and that a key research priority is the application of systems analytics to both the UK system of cities and to particular city systems. However, many new data are becoming available through the ‘big data’ revolution, and an important related research challenge is how to design the architecture of the information systems needed to support systems analytics. Also, the analysis dimension of the knowledge base needs to support policy development and planning, but as long-term forecasting is practically impossible, the focus has to shift to scenario development and the ways in which policies and plans can support more or less desirable scenarios through, for example, visioning techniques such as backcasting. This is a research challenge in itself and increasingly the urban challenges that we face are seen as being ‘interdependent’, ‘interdisciplinary’ and ‘interprofessional’.
This changing emphasis also requires thinking about retrofitting in an integrated way. As the Future of Cities programme pointed out (see also Chapter 9), in the context of our wider understandings of urban form (Government Office of Science, 2016a: 28):

Significant investment in long-term programmes of retrofitting, upgrading and remodelling existing urban areas and infrastructure requires a new understanding of how such transformative work aligns with the sustainability, resilience, liveability and smart agendas in cities, if it is ultimately to meet cities’ and citizens’ aspirations.

In the UK there is also much we can learn from international experience, particularly where the challenges to deployment are technological as in the case of urban heat networks. Some UK cities are leading the way with novel programmes that take a more holistic approach, such as Arbed in Wales (Hunt and De Laurentis, 2014) in relation to energy efficiency and Bristol in relation to energy production. In Bristol, for example, the Bristol Solar City project aims to install 1 GW of solar photovoltaics by 2020, with opportunities for local community groups to invest in installations on council properties rent-free and Bristol Energy,³ a municipal company owned by the city council, was established in 2015. This focus on city-level energy in a number of cities globally (and increasingly in the UK) is seen as offering the potential to provide local generation and generate a new source of income for cities. The high levels of trust that cities and LAs have from their local communities means that city-energy suppliers could prove to be very popular, which would disrupt the energy market and help improve trust. In terms of investment, some leading LA pension funds have started to invest in low-carbon energy. For example, Lancashire County Pension Fund has committed approximately £200 million to low-carbon projects including a £12 million investment in Westmill Solar, a UK solar cooperative. However, many believe that there is greater potential to invest in energy at city level, and some cities are also taking innovative action to boost their local economy, often underpinned by central government grants in the form of City Deal funding or EU grants. Aberdeen, for example, is planning to become a global pioneer in the use of hydrogen, produced using excess power from nearby offshore wind farms (Platt et al., 2014).

The development of ‘sticky’ infrastructure, such as heat networks, has the potential to bind larger commercial property interests, both with each other and with publicly held city retrofit agendas. This can help overcome some of the problems of complexity and conservatism in decision making (Dixon et al., 2014a). In the longer term, it is clear that such systems-level innovation holds the potential for deep cuts in carbon emissions and radical improvements in the broader sustainability and quality of city living.

15.3 Summary: Foresight for a Tomorrow’s World of Cities

This volume has brought together expert perspectives on a selection of the technological, behavioural and societal changes that could underpin a transition to a sustainable built environment by 2050. This chapter has outlined the key challenges

³ https://bristol-energy.co.uk/.
that must be understood and addressed if cities are to be successful in their urban retrofit ambitions.

Indeed, since EPSRC Retrofit 2050 was completed, several other projects examining retrofit at city scale have been developed internationally (see also Chapter 1). In Scandinavia, Demos Helsinki’s Retro Smart project\(^4\) examined the existing building stock of cities through the lens of ‘smartness’, which uses new and potentially disruptive technologies to retrofitter existing buildings with new solutions in three key cities: Lahti, Stockholm and Oslo. Interestingly the research included a strong focus on futures thinking through scenarios and a conceptual framework anchored against the multi-level perspective (MLP) (Demos Helsinki, 2014, 2015).

In Australia, the *Visions, Scenarios and Pathways for Low-Carbon Resilient Futures in Australian Cities* [Visions and Pathways (V & P) 2040] project\(^5\) aimed to explore and articulate visions, scenarios and pathways for a low carbon and resilient built environment in Australia (see also Chapter 1). The project combined research with a range of engagement strategies to develop visions and scenarios for Australian cities in 2040. Research focuses on the challenges and opportunities of moving to a ‘low carbon’ future and maintaining resilience in the face of a changing climate. The research and engagement process used visioning techniques to characterise possible futures, understand and analyse socio-technical innovations that could contribute to their realisation and examined transition scenarios and pathways to 2040 and beyond (Ryan et al., 2015).

This implies that thinking about the future of cities is seminal and central to our understanding of urban retrofit futures. Relatively few cities currently think about their futures in the long term (40–50 years) and in an integrated and holistic way (Tewdr-Jones and Goddard, 2014; Dixon and Cohen, 2015; Tewdr-Jones et al., 2015; Swain, 2016) but the recent UK Government Office of Science Future of Cities Foresight programme has highlighted the importance of urban foresight methods in helping cities move beyond ‘business as usual’ or ‘probable views’ of the future (Government Office of Science, 2016b; Ravetz and Miles, 2016). Changing governance structures and changing agendas also provide an opportunity for cities to position themselves for new future roles. The benefits of urban foresight include the ability to explore local strengths; refining strategy and vision; tacking major challenges through partnerships and creating opportunities for civic engagement (Opoku et al., 2014).

Developing a coherent approach to urban foresight is vital if we are to understand the future of cities. In a wider, generic sense, this could involve the following sequential but iterative process (Government Office of Science, 2016b):

- exploring aspirations and visions;
- understanding histories and the present;
- exploring future trends in a city;
- considering future options based on policy and practice;
- testing future options;
- connecting with roadmaps or the pathway and trajectory to particular futures.

As cities face critical challenges influenced by changing demographics, divergent economic performance, housing pressures and increasingly severe environmental

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\(^4\) http://smartretro.demoshelsinki.fi/.

\(^5\) http://www.visionsandpathways.com/about/project-objectives/.
Conclusions and Reflections: Retrofitting Cities for Tomorrow’s World

constraints and impacts, it is vital to take a systematic view of the city. As the UK Future of Cities Foresight programme suggested (Government Office of Science, 2016b: 17):

Today, as central government is devolving power and responsibility, there is much to be gained from taking a systematic view of the long-term future of our cities. It is also a time when public institutions are being reshaped to achieve greater operational efficiency and effectiveness, and so decision makers need tools and processes that have high impact with relatively low resource investment. City foresight can respond to these needs. Its activities can be low cost, transferable, and simultaneously unlock multiple benefits, which can be seen across the two primary levels of governance: the national ‘system of cities’ level and the local ‘city system’ level.

Despite this, of course, the future remains continually uncertain, characterised by changing risks and uncertainty, and providing a dynamic backdrop for decision makers in the UK and internationally. However, the EPSRC Retrofit 2050 project has sought to answer key questions and provide useful tools for policy makers and decision makers.6 This book has shown that failure to plan for the future of urban retrofit is not an option, because ‘failure to prepare and plan means preparing to fail’. As Sir David King noted in his foreword to this book:

More than ever, there is a need for both national government and city administrations to work together, thinking of cities not as a series of discrete services – energy, transport, healthcare and so on – but as a constellation of systems that must work together, with policies and regulations in place to encourage them to do so.

References


6 See more on the programme of completed research at www.retrofit2050.org.uk.


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