ISSN 2052-1618

Retrofit2050
Re-engineering the city 2020-2050: urban foresight and transition management

# Sustainable Urban Development to 2050: Complex Transitions in the Built Environment of Cities

Prof. Tim Dixon

Oxford Institute for Sustainable Development, Oxford Brookes University

Retrofit 2050 Working Paper

October 2011

WP2011/5

EPSRC Pioneering research and skills · Cardiff University Prifysgol Caerdydd · University of Salford Manchester · University of Reading · Durham University · Oxford Brookes University · University of Cambridge

**Sustainable Urban Development to 2050:**
**Complex Transitions in the Built Environment of Cities**


## Abstract

*The majority of the world's population now live in cities. This poses great challenges, but also great opportunities in terms of tackling climate change, resource depletion and environmental degradation. Policy agendas have increasingly focused on how to develop and maintain 'integrated sustainable urban development', and a number of theoretical conceptualisations of urban transition have been formulated to help our thinking and understanding in both developed and developing countries. Drawing on three case studies the paper aims to examine the key 'critical success factors' that need to be in place for cities to traverse a pathway to a more sustainable future in urban development terms by 2050. The paper explores how important the issues of 'scale' is in the context of complexity and fragmentation in the city's built environment, identifies the lessons that can be learned for future sustainable urban development, and the further research which is needed to address future urban transitions to 2050.*



**Prof. Tim Dixon**
**Professor of Real Estate, Director of the Oxford Institute for Sustainable Development**
**Department of Real Estate and Construction**
**School of the Built Environment**
**Oxford Brookes University**
**Gipsy Lane**
**Headington**
**Oxford OX3 0BP**
**T: 01865 873113**
**E: tdixon@brookes.ac.uk**

## 1.0 Introduction

Today some 50% of the world's population, or 3.5bn people, live in cities (UN, 2010), but between now and 2050 the world urban population is expected to increase by 84%, to some 6.3bn. This means that by the middle of this century the world urban population will be the same size as the world's population was in 2004 (UN, 2010). Nearly all the expected growth in the world population over the period to 2050 will be concentrated in the urban areas of the less developed areas which is expected to increase from 2.5bn to 5.2bn in 2050. Although megacities (with populations exceeding 10 million inhabitants) will increase in number from 21 today to 29 in 2025 they will only account for 10% of the urban population in 2025, whereas 45% of the world's urban population between 2009 and 2025 is expected to come from the growth of smaller cities (i.e. population of less than 500,000).

Whilst some previous projections in particular cities have proved to be excessive, such dramatic general increases in population are also expected to be accompanied by other demographic changes. In developed countries, for example, populations are aging and stabilising. As a result, most of the economic growth that is expected over the next decades is expected to come from developing or emerging economies, and the BRIC countries in particular (JLL, 2010).

Rapid urban growth carries both costs and benefits. The concentration of such huge populations in cities (primarily driven by rural depopulation (Satterthwaite, 2007)) and the continued quest for economic growth, have substantial implications for the world in terms of environmental impact, resource depletion, deteriorating ecosystems and climate change and presents huge challenges in meeting the goal of sustainable development (WBCSD, 2010). For example cities are responsible for some 75% of global energy consumption and 80% of greenhouse gas emissions (United Nations, 2007)[1]. This impact is part of what has been termed by some as the 'anthropocene' (Hodson and Marvin, 2010), which suggests that we have entered a new era (which started with the industrial revolution) when human activities have had a significant global impact on the Earth's ecosystems.

Yet cities also have potential benefits in ensuring that infrastructure and services and technological deployment to offset environmental impact could potentially benefit from increased concentration and economies of scale. On the other hand, in many instances cities have only in the last few decades developed robust and effective governance and planning systems to be able to set up pathways to achieving sustainable development, and in the developing world many cities still lack such systems (OECD, 2009). In short, cities are both a cause of environmental impact but also the 'victims', as they struggle to come to terms with mounting environmental and socio-economic pressures.

In response, a variety of strategies have been developed to enable cities to build the foundations to protect their 'ecological security', or the capacity that cities can mobilise to secure resources (such as water, energy, waste and flood protection) to ensure their continued economic and social development (Hodson and Marvin, 2009).

In policy terms, partly driven by the greater emphasis on cities in governance terms, there has also been an increasing emphasis on the concept of 'sustainable urban development' and how this can be achieved to enable cities to move towards a more sustainable future. In Europe, for example, Rotterdam Urban Acquis of 2004 promoted the concept of 'integrated sustainable urban development' (ISUD), which a

[1] It should be noted, as Dodman (2009) suggests, however, that in most cases the per capita emissions from cities are lower than the average for the country in which they are located.

system of interlinked actions seeking to bring about a lasting improvement in the economic, physical, social and environmental conditions of a city or an area within the city. The key to the process is 'integration', meaning that all policies, projects and proposals are considered in relation to one another (URBACT, 2010; EIB, 2010; Colantonio and Dixon, 2010).

Cities as centres of innovation are facing a combination of key environmental and socio-economic drivers of change over the next 40 years which include, besides climate change, rising energy prices; demographic change; increasing densification; social inclusion; information technology; and global competitiveness (Pinnegar et al, 2008). Moreover, policy drivers are also important at the city level. In the UK there are three examples of this: (i) The Climate Change Act 2008 establishes a new approach to managing and responding to climate change in the UK and creates a legally binding target to reduce the UK's emissions of GHGs to at least 80% below 1990 levels by 2050; (ii) there are emerging new requirements for more effective and integrated coordination of planning and infrastructure - for example as a result of the Planning Act 2008; (iii) the Low Carbon Transition Plan sets out longer term aspirations to develop systemic responses for the management of infrastructure networks – particularly the development of low carbon transitions within existing critical infrastructures – both in new build and existing developments.

There are therefore formidable issues to address if transitions to a more sustainable future in major urban areas are to be managed successfully. The overall aim of this paper is to examine the key critical success factors that need to be in place for cities to traverse a pathway to a more sustainable future in urban development terms by 2050. This paper focuses on cities in developed nations (but drawing on developing countries for comparison) and begins by identifying the key concept of 'sustainable urban development'. The paper then explores how important the issues of 'scale' is in the context of complexity and fragmentation in the city's built environment, before briefly reviewing how city transitions to a more sustainable future may be conceptualised. The paper then examines sustainable urban development in practice, using examples drawn from around the world, before identifying the lessons that can be learned for future sustainable urban development, and the further research that is needed to address future urban transitions to 2050.

## 2.0 Focus and definitions: towards sustainable urban development

Sustainability has become a key focus for UK government policy with an emphasis on social, economic and environmental well-being, or what is often referred to as the 'Triple Bottom Line' approach to sustainable development in academic literature (Elkington, 1997). This attempts to achieve development that promotes economic growth, but maintains social inclusion and minimises environmental impact (Dixon, 2007 and Dixon and Adams, 2008). For many the 'Russian Doll' model of sustainability offers a coherent way of integrating ecological thinking within all social and economic planning (Newton and Bai, 2009).

In turn this has been underpinned by policy guidance ('Securing the Future'), which seeks to set a new framework goal for sustainable development (SD) (HM Government, 2005) and revisions to national planning guidance which aim to strengthen the focus of SD principles within the wider UK planning system (for example, PPS1: Delivering Sustainable Development (CLG, 2005) and PPS 23: Planning and Pollution Control (CLG, 2004)).

In parallel with this we have seen the emergence of what might broadly be termed, 'sustainable urban development[2]' (SUD), which has often been used interchangeably with 'urban sustainability' (Richardson, 1994; Maclaren 1996). They may be differentiated, however, because sustainability implies a desirable state or set of conditions whereas SUD implies a process by which sustainability can be attained (Maclaren, 1996). More formally, SUD has been defined as (Wheeler, 1998):

*"development that improves the long-term social and ecological health of cities and towns."*

Wheeler goes on to suggest that a 'sustainable city' must be compact, promote efficient land use; have less automobile use, and better access; efficient resource use; less pollution and waste; restore natural systems; provide good housing and living environments; a healthy social ecology; a sustainable economy; community participation and involvement; and preservation of local culture and wisdom. There is perhaps a move or trend therefore to cities which are designed according to evolving principles of 'ecological urbanism' (Mostafy and Doherty, 2010; Hodson and Marvin, 2010).

The city has in fact become a key focus for promoting sustainable development policy within the UK and the wider EU. At a European level this has seen the further development of the concept of 'Integrated Sustainable Urban Development' (ISUD) which is designed to underpin the Lisbon Strategy for Growth and Jobs, and which was a cornerstone of the Leipzig Charter on Sustainable European Cities, which sought to (EC, 2009):

- make greater use of integrated urban development policy approaches (by creating and ensuring high-quality public spaces, modernising infrastructure networks and improving energy efficiency, proactive innovation and educational policies);

- pay special attention to deprived neighbourhoods within the context of the city as a whole (by pursuing strategies to upgrade the physical environment, strengthen the local economy and local labour market policy, instigate proactive education and training policies, and promote efficient and affordable urban transport).

Over the last 10 years therefore a common methodology for sustainable urban development has begun to take shape and has been promoted, following the emergence of a European 'Acquis Urbain', which builds on the experience gained in supporting integrated and sustainable urban development (EC, 2009). This methodology is also in line with the policy principles and recommendations laid down in the Leipzig Charter on Sustainable European Cities. The 2004 Rotterdam 'Acquis Urbain' is based on the following cornerstones (Ministry of Kingdom and Interior Relations, 2005):

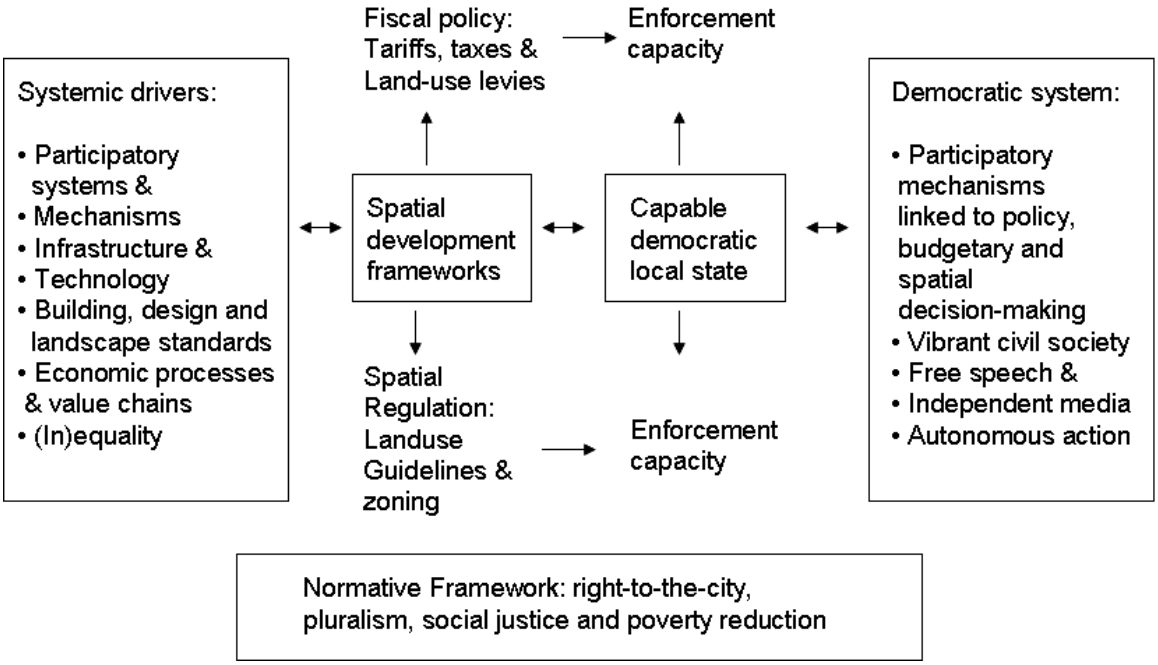
• The development of city-wide visions that go beyond each project and are embedded in the city-regional context;
• An integrated and cross-sectoral approach (horizontal and vertical coordination);

[2] The terms, 'development' and 'regeneration' are also distinguishable. For example, whilst development is seen as focusing on profit and commercially viable in its focus, regeneration should also incorporate elements of social and economic diversity to benefit existing communities (IPF, 2009; Dixon, 2011). In this paper, the term SUD is also taken to include regeneration.

- New instruments of urban governance, administration and management, including increased local responsibilities and strong local and regional partnerships;
- Financing and investing with lasting effects, concentration of resources and funding on selected target areas;
- Capitalising on knowledge, exchanging experience and know-how (benchmarking, networking);
- Monitoring the progress (ex-ante, mid-term and ex-post evaluations, and indicators).

This implies that governance systems are important and this issue has been also been highlighted in the work of Pieterse (2008). Whilst Pieterse focused largely on developing countries his work is important for highlighting key systemic drivers for sustainable urban development, such as participatory systems; infrastructure and technology and building, design and landscape standards as well as the importance of economic processes and basic inequality (Figure 1).

**Figure 1 Institutional dimensions of sustainable urban development (source: Pieterse, 2009)**




## 3.0 Scale and fragmentation in the city's built environment

The built environment in cities refers to (Moffatt and Kohler, 2008):

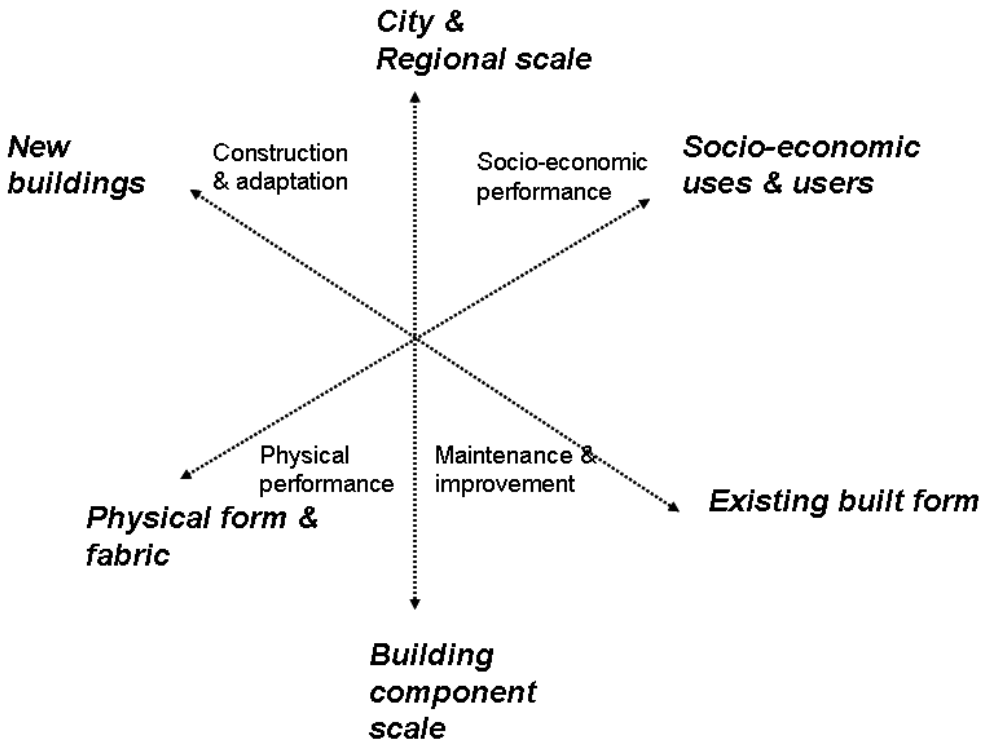
*"(human) made surroundings that provide the setting for human activity, ranging from the large-scale civic surroundings to the personal places".*

It is important to note in this context that the built environment does not just comprise buildings, infrastructure and transport therefore; it includes human community, cultural experiences and interaction of people (NZ Ministry for Environment, 2009).

We also find that there are a variety of perspectives on the built environment in cities ranging from physical perspectives including form and fabric; geographical and spatial perspectives; socio-economic perspectives including morphologies and typologies of cities; socio-economic perspectives including behavioural issues and

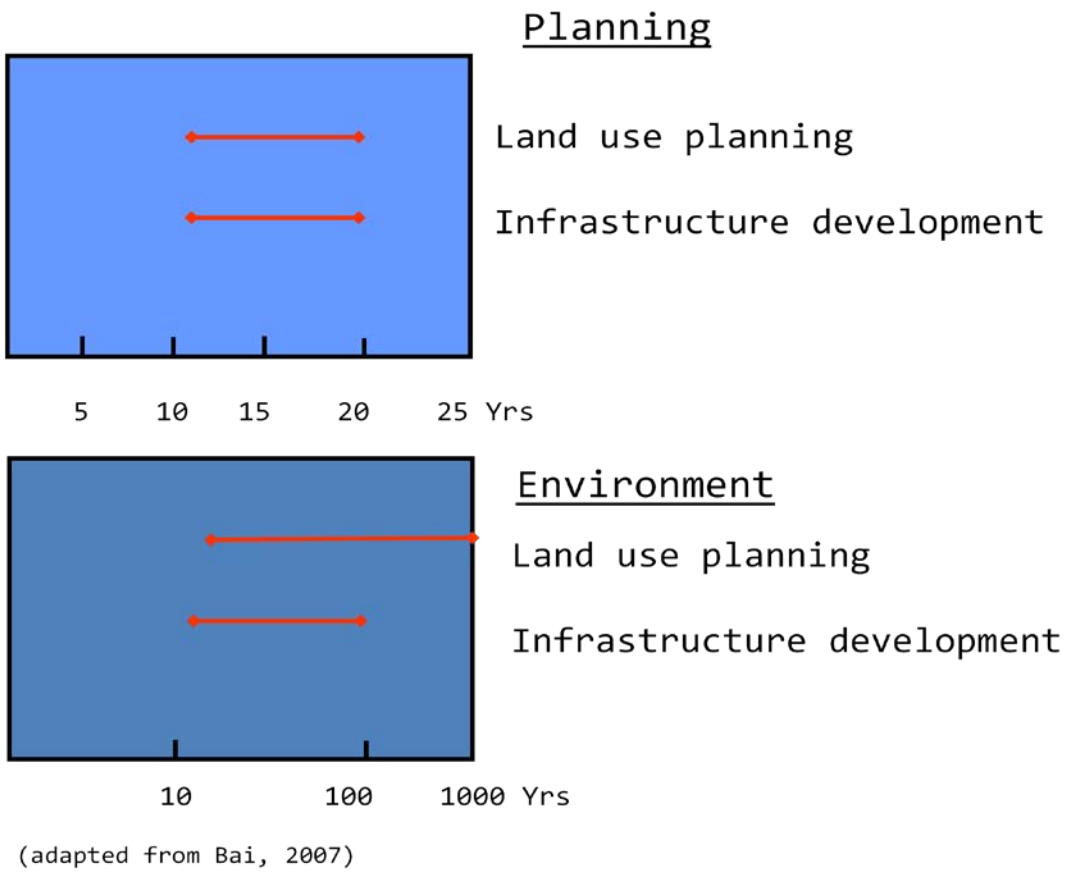
lifetime trends and policy and governance perspectives such as the 'urban renaissance' or 'sustainable community' discourses (Ravetz, 2008). Knowledge mapping of the built environment in cities must also recognise its complexity, and this can viewed on three main axes (existing/new buildings; physical/social; and scale, as Ravetz (2008) also suggests (Figure 2).

**Figure 2 Knowledge mapping in the built environment (source: Ravetz, 2008)**




This of course raises the issue of scale. Sustainable development can apply to building, neighbourhood, city, regional, national and global scales. Frequently our thinking has failed to treat the built environment as spatially connected and complex (Pinnegar et al, 2008). This spatial connectivity relates to the complexity of infrastructure, spaces and places and communities together with how urban form and function relate. In this sense a focus purely on buildings leads to lack of strategic focus. Moreover, as Bai et al (2010) suggest there is frequently an inherent temporal (*'not in my term'*), spatial (*'not in my patch'*) and institutional (*'not my business'*) scale mismatch between urban decision-making and global environmental concerns, where urban decision-makers are frequently constrained within short time-scales, their immediate spatial scale of their jurisdictions and within 'nested' governmental hierarchies (Figure 3). Despite these tensions, cities can and do address global issues because of the benefits this entails for local populations and cities as a whole through direct economic impacts (Bai, 2007).

**Figure 3 Variations in temporal scale (adapted from Bai, 2007) {(a) temporal scale of planning; (b) temporal scale of potential environmental impacts of decisions}.**




(adapted from Bai, 2007)

Cities also present a range of complex issues which differ in their scalar impact. As Bai (2003) suggests poverty-related issues tend to have local impacts; production-related issues tend to have local to regional impacts, and consumption-related issues tend to have regional to global impacts.

Nonetheless, as Hodson and Marvin (2010) suggest, cities are increasingly a focus for addressing sustainability issues because:

- Increasing economic globalisation and the changing relationships between national and sub-national spaces and economic activity have led to new spaces of governance and intervention;
- The development of such new state spaces has not received the same attention in relation to environmental issues as it has with regard to economic activity; and,
- There is the key issue of reconciling continued growth of cities with resource constraints and increasing competition.

As Newton and Bai (2008: 4) suggest:

*'…the challenge of achieving sustainable development in the 21st century will be won or lost in the world's urban areas'.*

There is in practice therefore an increasing appetite from some cities to tackle transformation to low carbon economies within a relatively short timescale. As Kelly (2009) suggests, carbon emissions from existing buildings can be tackled through re-engineering the existing fabric of buildings; improving appliance efficiencies; decarbonising energy supplies; and changing behaviour.

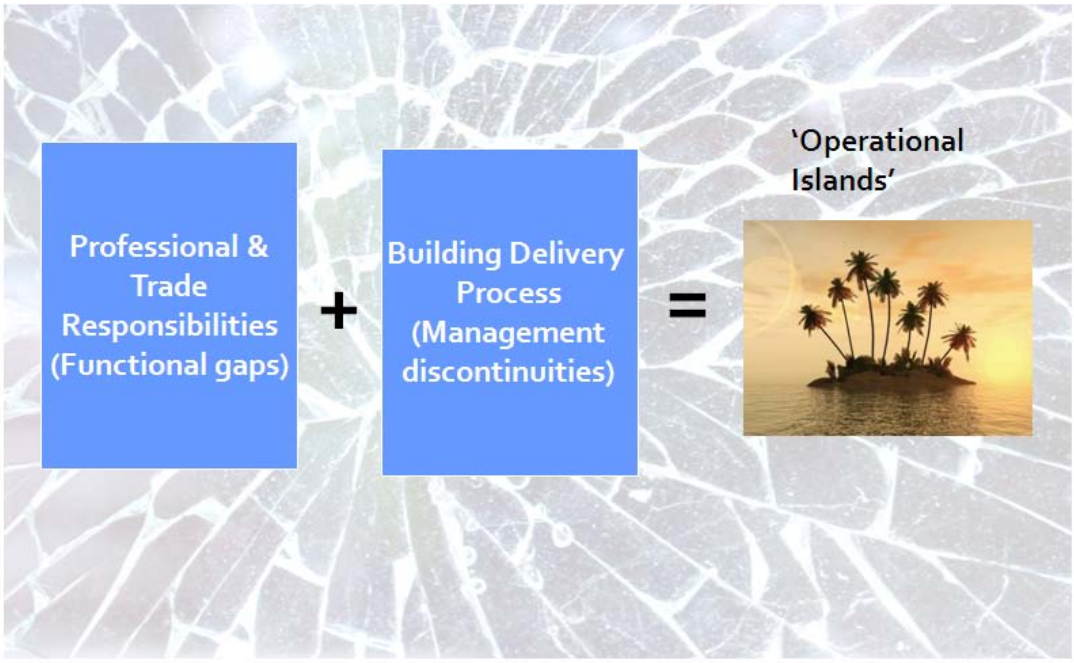
Globally for example cities have signed up to the C40 initiative, which is a network of cities dedicated to tackling climate change by reducing emissions. In the UK the Core Cities programme, which brings together the city-regional 'big hitters' in the UK such as Manchester, Birmingham and Bristol, has also focused on the low carbon agenda. For example, in the UK, Greater Manchester was designated the UK's first Low Carbon Economic Area (LCEA) for the Built Environment in 2009. Under the banner of *'From Red Brick to Green Brick'* the LCEA brings together the ten Greater Manchester local authorities under the leadership of the Greater Manchester Environment Commission to develop a combined programme that aims to accelerate the pace at which the existing buildings of Greater Manchester can be retrofitted so as to create jobs, business growth and productivity improvements (AGMA, 2010). The Greater Manchester Strategy is that by 2015 *"Greater Manchester has established itself as a world leader in the transformation to a low carbon economy"*, and analysis indicates that by 2015 Greater Manchester Low Carbon Economic Area for the built environment could:

- Deliver up to £650 million additional to the Gross Value Added of the economy;
- Support 34,800 jobs, including 18,000 in the supply chain;
- Benefit the UK through developing and sharing best practice, as well as economic spill-over benefits; and,
- Save 6 million tonnes of carbon from existing buildings.

Amongst its ambitions, the LCEA aims by 2015 to have retrofitted 75% of homes and to have strengthened the spatial planning framework so that by 2016 all new developments will be zero carbon. Government funding will not be forthcoming for the programme and so delivery will be dependent on private capital, including the European Investment Bank (AGMA, 2010).

A further issue cities face, however, in moving towards a sustainable future is the fragmentation and complexity present within the built environment industry (WBCSD, 2010; Carbon Trust, 2010). To take just the case of the non-domestic buildings supply chain (in relation to energy efficiency) in the UK, there are a large number of players involved from the upstream supply chain (investors, developers and agents) through to the downstream supply chain. Often there is a silo mentality in the industry with agents often having little interaction with designers and product manufacturers having little interaction with investors and developers who are procuring the building. This disconnection is played out many times over when new buildings and new projects in cities are commissioned (Figure 4).

**Figure 4 System integration is key to achieving energy efficiency in buildings (source: WBCSD, 2008)**



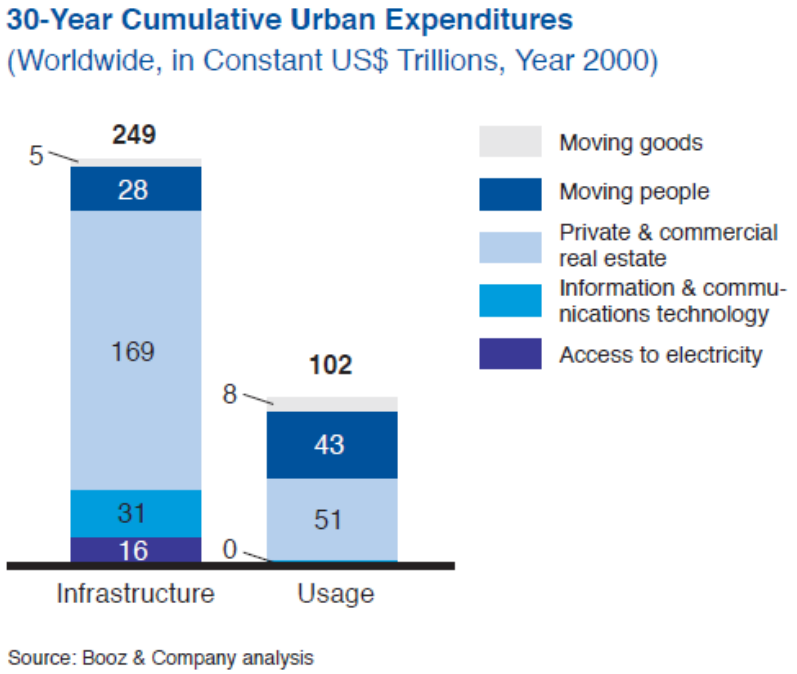

At a broader level, dealing with transformation presents a staggering cost for infrastructure in cities. A recent report by Booz and co for the WWF (Booz and Company, 2010) suggested that the economic challenge for both developed and developing nations is 'gargantuan' over the next 30 years. Booz's analysis suggests that global urban infrastructure and usage expenditures over the next three decades will exceed $350 trillion (or seven times global GDP) (Figure 5). This is partly because as smaller cities mature over time they generally follow a predictable pattern of expenditures and emissions related to infrastructure development and usage. In the UK this view of infrastructure renewal is supported by a recent Core Cities report (Core Cities, 2010) which suggests there is an escalating infrastructure deficit estimated at £500bn nationally over the next 10 years[3].

In short the Booz report goes onto suggest that there are three main pre-requisites to tackle such challenges:

- Cities must adopt aggressive energy reduction goals and best-practice approaches to urban planning.
- Innovative financing strategies are needed to provide $20 trillion to $30 trillion in funding for additional up-front capital costs, with developed nations working together to assist developing nations in their low-carbon urban infrastructure initiatives.
- The latest technological advances must be utilized to support and enable the planning, construction, and usage of urban infrastructure in all cities.

[3] The UK ranks only 34th in the world for its infrastructure behind Saudi Arabia and Malaysia, with only 1.5% of GDP spent (compared with 6% in Japan and 3% in France) (Core Cities, 2010).

**Figure 5 Urban infrastructure and usage expenditures (source: Booz and Company, 2010)**




In terms of planning for example, the report suggests that this means there should be long-term, strategic-level, low-carbon action plans, supported by a holistic national urban planning approach that enables the integration of large mainstream investment flows rather than a project-by-project approach on the sidelines of core development strategies and decisions. It will also require capacity building for policy making and financial instruments to assist the cities in developing nations with the up-front investments needed to create and undertake low-carbon initiatives. Nonetheless, key barriers operate at a city level as well: as recent US research showed, it can be difficult to secure participation in city wide retrofitting; financing options are currently limited; the green jobs argument is often poorly articulated; and pulling policy strands together in an integrated whole is often problematic (Institute for Sustainable Communities, 2009).

## 4.0 Conceptualising and theorising city transitions

Broadly speaking about 1-2% of all building stock in UK cities is 'new build'[4]. This means that the vast majority of stock comprises existing buildings, so achieving sustainable urban development on the scale required to transform our cities to 2050 will require a dramatic transformation of buildings, lifestyles and governance systems.

Understanding how these changes can be brought about and where we are in the overall cycle is therefore fundamental to planning and managing change in our urban areas. Urban metabolism models of cities have for example focused on the city as an 'organism' based on resource flows and systems thinking (Wolman, 1965). Such a model is useful for communicating key sustainable development goals for cities which might include (Newton and Bai, 2009):

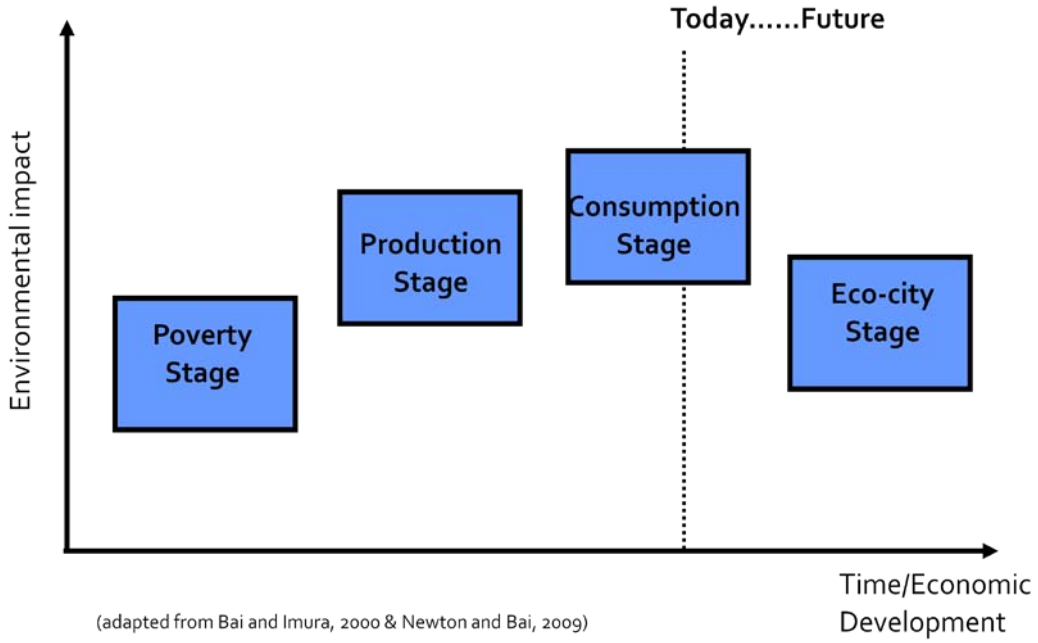
[4] An alternative representation of the same view is that about 80% of the UK's buildings standing in 2050 have already been built (GHK, 2010).

- Using resources more efficiently;
- Using waste as a resource;
- Restoring and maintaining urban environmental quality;
- Enhancing human wellbeing; and
- Promoting highly efficient and effective urban and industrial planning, design and management systems.

Haughton (1997) also suggests four different models of the relationship between cities and their 'environmental hinterlands'. These comprise 'self-reliant' cities which encapsulate the city as an 'urban metabolism' (see also Guy and Marvin, 2001 and Wolman, 1965); 'redesigning cites' which is based planning for compact and energy efficient regions; 'externally dependent cities' which follow a linear model for metabolism; and a 'fair shares' model, which incorporates environmental value with social justice and links the best elements of the previous three models.

The goals relating to urban metabolism fit with what has been termed 'eco-city' status or what has also been called 'Stage IV' of the phases of 'urban environmental transition' (UET) (Bai and Imura, 2000; McGranahan, 2007) (Figure 6). In one sense this is linked to the Kuznets curve of environmental development, whereby cities follows an inverted U-curve of environmental development. However, as Newton and Bai (2009) observe, many consumption trends do not follow this shape (for example, greenhouse gas emissions and biodiversity loss) and the same pattern may not be applicable to all cities. Further research (Newton, 2006, Bai and Imura, 2000) also suggests that resource use may also often not be reduced over time because of geographical separation of populations from the location of resource extraction (i.e. out of sight, out of mind); the relatively easy externalisation of such impacts; and weak governance systems.

**Figure 6 Conceptual illustration of stage model in relation to major urban environmental problems (adapted from Bai and Imura, 2000 & Newton and Bai, 2009))**




UET offers an approach which is based on empirical analysis. The concept comprises four main components (Newton and Bai, 2009:9):

- cities can be viewed as complex systems that are subject to constant change, which constitutes a dynamic evolutionary process;

- urban environmental profiles of cities are diverse, but there are certain commonalities in the longitudinal dynamics among different cities;

- there is a strong non-linearity in the trajectories of the environmental evolution of cities, rather than there being a fixed common pattern;

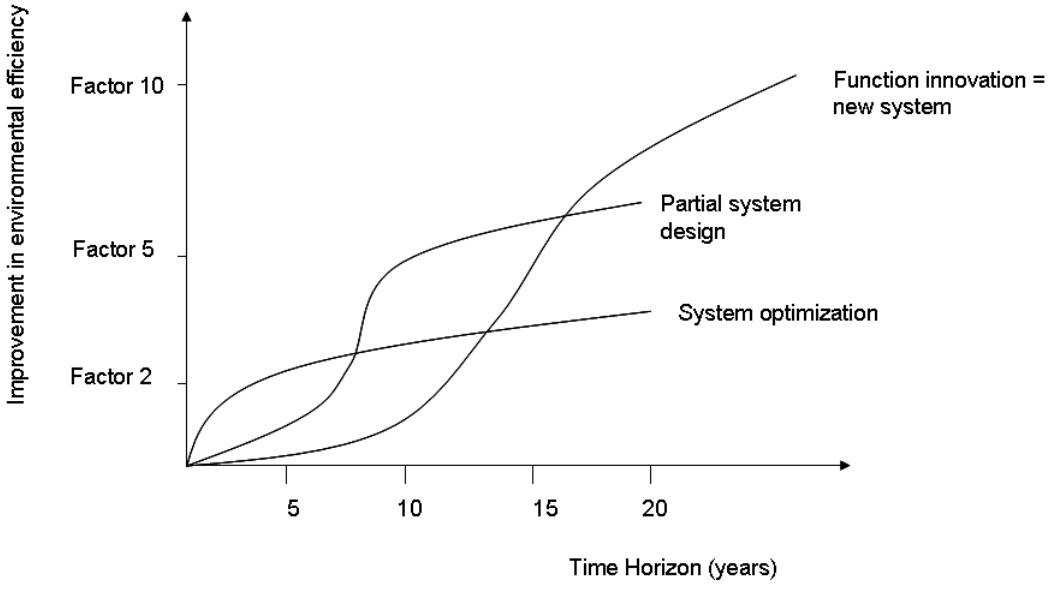
- the trajectory is shaped by a unique combination of endogenous and exogenous forces, reflecting both the external pressures and the responses within the city (Bai 2003).

It should be noted that the evolutionary patterns noted in Figure 6 do not automatically translate into a sustainability transition, as recent work by (Ooi, 2007) shows. Moreover, the importance of governance systems is not adequately catered for in such models. Indeed the concept of 'ecological modernisation', which focuses on technological change, or the promotion of structural shifts to less carbon intensive economies through market mechanisms (with a minimum role played by the state), has been criticised for its 'one size fits all' approach, which may well not be appropriate to developing countries (Lankao, 2007).

Alternative approaches have been developed therefore to deal with the complexities of what are essentially systems innovations, or large-scale transformations in the way broader societal functions such as transportation, communication, housing and energy are fulfilled (Geels, 2005).

Innovations have varying impacts in society: 'incremental' innovations may improve environmental efficiency (i.e. by Factor 2) but larger jumps (i.e. by Factor 10) may only be possible with system innovations. As Figure 7 shows, substantial leaps in efficiency are required for sustainability to be achieved and require not only technological artefacts but also new markets, user practices, regulations, infrastructures and cultural meanings (Geels et al, 2004).

**Figure 7 System optimisation versus system innovation (source Geels et al, 2004)**

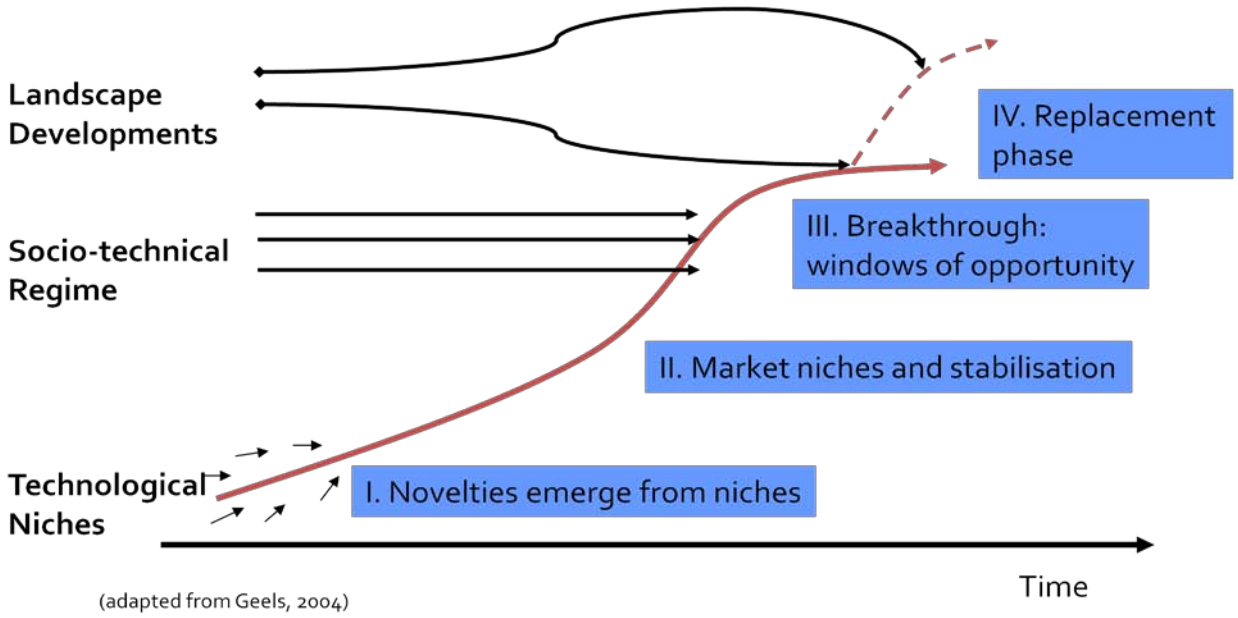


Such approaches (which include technological transitions and transition management) focus on transitions, which can be defined as (Rotmans et al, 2001:2):

*'a gradual, continuous change within a society or culture.'*

Much of the thinking behind this has evolved in the Netherlands and is a response to the complexities and socio-technical responses needed to plan and manage the substantial societal and institutional change required for sustainability. The work of Frank Geels (for example, Geels 2002; 2004[5]) has been seminal in this respect in identifying three interlocking levels where innovation occurs, and which set out and define the landscape or terrain over which transitions to sustainability occur (Shackley and Green, 2007). These comprise what is called an integrative multi-level perspective (Geels, 2004) (Figure 7).

**Figure 8 Multilevel perspectives on transitions (Geels, 2004)**




In Geels' model (Figure 8) the three levels comprise:

- Landscape (cultural and political values and deeply embedded socio-economic trends);
- Technical regime (specific policies, technologies, institutions, practices and behaviours); and
- Technological Niches (emerging new technologies).

Critics have argued that TT is built on normative visions and fails to address the contested concept of sustainability (see Berkout et al, 2004 and Genus and Coles, 2007). However, Transitions Theory (TT) has been heralded by many as providing a way of explaining historical transitions such as sailing to steam ships, horses to cars and from propeller aircraft to jets, and has also been deployed in analysing recent changes in the energy system in the Netherlands (see for example, Eames and McDowall, 2010 ). Similarly work by Newton (2007) suggests that three horizon

[5] See also: http://www.sussex.ac.uk/profiles/228052

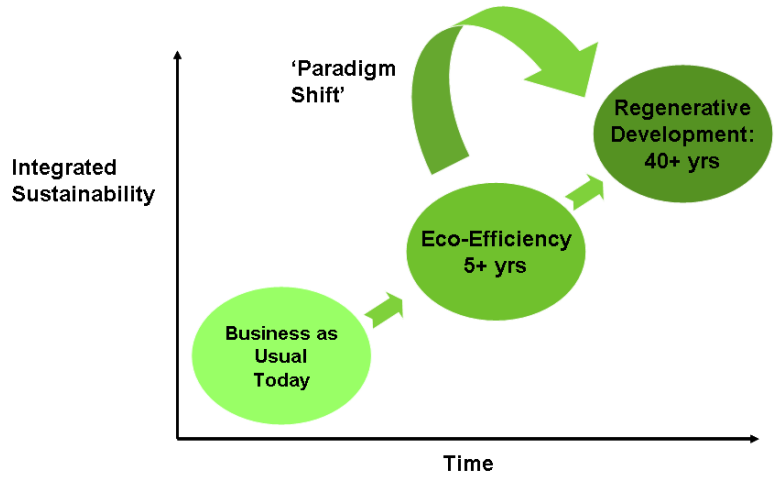
thinking can help plan for transitions. For example, Horizon 1 innovations include products capable of immediate implementation as a result of their relative maturity of development and demonstrated superior performance; Horizon 2 innovations are those capable of bridging from the present situation until sustainable infrastructure and processes can be widely implemented (H2 occupies the next generation (up to twenty years from now); and Horizon 3 thinking deals with innovations are where radical change to the performance of our human settlements will need to occur.

At a national scale some governments have also started to plan for transition using rather different models and concepts. For example, in New Zealand the government, which is responsible for some 30% of all construction, has promoted and adapted the concept of 'regenerative development' (RD) (New Zealand Government, 2009). This departs from the thinking that the best a building can be is environmentally neutral. RD is based on systems thinking and (New Zealand Government, 2009: 8):

- Sees humans, human developments, social structures and cultural concerns as an inherent part of ecosystems.
- Questions how humans can participate in ecosystems using development to create optimum health.
- Seeks to create or restore capacity of ecosystems and bio-geological cycles to function without human management.
- Understands the diversity and uniqueness of each place (socially, culturally and environmentally) as crucial to the design.
- Sees the design process as ongoing, indefinite and participatory.

RD therefore goes beyond 'business as usual' and 'eco-efficiency' because it produces positive benefits, and can be distinguished from 'restorative development' because active human arrangement is not part of RD whereas it is present in restorative development (New Zealand Government, 2009). In terms of timescale RD is seen as a longer term ambition than business as usual and eco-efficiency (Figure 9) with a paradigm shift or transition needed over 40 years.

**Figure 9 The transition to regenerative development (adapted from New Zealand Government, 2009)**




At the city level, however, there has been little research so far to examine how TT can help our understanding of transitions to sustainability through sustainable urban development (Hodson and Marvin, 2009; Hodson and Marvin, 2010b). This is

perhaps surprising given the fact that urban development models (see Haugthon, 1997, and others for example) have also been developed to suggest how cities might reduce their environmental impact. There is therefore a need to address this gap with further research which examines how the disconnect between two key issues may be resolved; firstly, 'what' is to be done to the city, through technical knowledge, targets, technological options and the costs of re-engineering, and secondly, 'how' will it be implemented through institutions, public policy and governance.

## 5.0 Sustainable urban development: what does it look like in practice?

Clearly theoretical constructs can aid our understanding of the substantial transformations required at city level if our built environment is to be sustainable by 2050. But what does sustainable urban development look like in practice? If new urban development is to be truly sustainable then it will need to fulfil key criteria. As discussed in the previous section the urban metabolism model suggests that key sustainable development goals should be met (Newton and Bai, 2008). There has therefore been an increasing trend in the literature surrounding sustainable urban development to cite case studies which exemplify these principles. The World Bank's Eco2 City initiative (World Bank, 2008), for example, suggests there are several factors which need to be in place for cities to be both 'economically' competitive and 'ecologically' sustainable. Approaches should be city-based, for example, and incorporate an expanded platform for design and decision-making within a 'one system' framework. Cities should also utilise an 'investment framework' which values sustainability and resilience across the whole lifecycle of buildings. Much of this mimics some of the characteristics of ISUD identified earlier, but also controversially attempts to draw parallels between developed and developing countries.

Moreover, as was suggested earlier, scale is an important issue and both new buildings and existing buildings will need to be tackled if our cities are to achieve a sustainable future. However, in many instances substantial new developments from around the world and which serve as exemplars of ISUD, are recognised primarily as 'new build', sometimes in the context of 'regeneration,' but in other cases, 'development'. In this sense ISUD is recognisable through its strong focus on the three pillars of sustainability and its basis on 'partnership', 'participation' and 'integration' (see for example, Dixon, 2007; Williams and Dair, 2007).

The following three short case studies are therefore included to exemplify these trends and characteristics in relation to 'new' development.

***5.1 Hammarby Sjostad, Stockholm, Sweden.*** The transformation of the former industrial and harbour area around the Hammarby Lake in Stockholm is one of the biggest urban development ventures in Europe (Figure 10). This is an urban extension to Stockholm's inner city and is often cited as an exemplar of integrated environmental urban design. The urban extension is based on a 200ha brownfield site to the south of Hammarby Lake and will provide 11,000 homes and 200,000 sq m of commercial space when it is completed in 2018, with a total population of 30,000. The development is characterised by strong stakeholder engagement through what is known as the Hammarby Model, a systematic approach to integrating energy, water and waste systems in a holistic way so that resources used in one part of the system are recycled for use in other parts of the system. The overall objective of the community is to reduce environmental impact by 50% compared with other suburban areas in Stockholm. The area was remediated using solidification and stabilisation techniques.

**Figure 10 Hammarby Sjostad, Stockholm, Sweden (source: http://commons.wikimedia.org/wiki/File:Hammarby_Sjostad.jpg)**

***5.2 Dockside Green, Vancouver Island, Canada.*** Dockside Green is a 1,300,000-square-foot (121,000 m2) mixed-use community currently under development in Victoria, British Columbia, Canada. It is a co-development of Vancity Credit Union, Canada's largest credit union, and Windmill West, a partnership (quote) "dedicated to designing and building only the best urban environments". According to Dockside Green's 2007 Annual Sustainability Report, the project's first two phases "Synergy" and "Balance" are well beyond Platinum certification levels with 63 points each (52 are needed for Platinum). Probably the most important aspect of Dockside Green's environmental aspirations is the building of a centralized biomass gasification plant that converts waste wood (tree clippings, construction excesses) into a gas that is burned to provide hot water and heat. Additional natural gas boilers will also be used in peak periods. It is hoped that the biomass plant will not only make Dockside Green neutral or even negative in terms of greenhouse gas production but even allow it to sell energy to surrounding communities. Dockside Green has also publicly committed to using the "LEED for Neighborhood Development" and places strong emphasis on community. The overall design of the Dockside Green is in general agreement with the principles of New Urbanism, a school of thought in planning that favours mid-to-high density neighbourhoods with a focus on community and the ability to walk to most of a resident's daily needs. Designs focus on creating an intimate atmosphere on city streets, narrowing them and bringing the faces of buildings closer to the streets themselves. Dockside Green is also linked with Vancouver's move to position itself as the world's 'greenest city' by 2020 [6].

***5.3 Curitiba, Brazil.*** Curitiba is the capital of the Brazilian state of Paraná (Figure 11). It is the country's 7th largest city and has the best economy in southern Brazil. The city is Brazil's 4th richest and has a GDP in excess of USD 17 billion, according to IBGE (Instituto Brasileiro de Geografia e Estatística: http://www.ibge.gov.br/home/). The city has been heralded as a fine example of

[6] For example, all new commercial and multi-family buildings are required to meet the strictest energy efficiency requirements in Canada. Vancouver has established a forward-thinking Transportation Plan for the city. The City has designed for a variety of road users by supporting transit, creating greenways and incorporating bicycle lanes. The result is a 44% increase in walking, a 180% increase in bike trips and a 10% reduction in vehicle trips since 1997. Transit ridership has increased by 50% in the last decade (source: http://vancouver.ca/sustainability/building.htm).

sustainability with much of its success attributed to Jaime Lerner former mayor of the city. Key to its success has also been the Plano Diretor which was adopted in 1968, and which integrated land use and transport to produce an axial system. A single unified planning unit, the IPPC, has ensured Curitiba has a highly effective public transport system (75% of commuters take the bus with the result that there is 25% less congestion in Curitiba, and 30% lower fuel consumption than in other similar sized Brazilian cities), excellent recycling facilities and a green and liveable environment (much of which is integrated with flood protection work). Everyone has easy access to public transport and the five arterial routes from the city centre to the outskirts have been used as the growth corridors of the city, with density decreasing away from the growth corridors. In the 1990s, the city started a project called Faróis do Saber ('Lighthouses of Knowledge'), which are free educational centres, including libraries, Internet access, and other cultural resources, aimed particularly at children.

**Figure 11 Curitiba, Brazil**
(source: http://commons.wikimedia.org/wiki/File:Curitiba_seen_from_above.jpg)

Other examples of new sustainable urban development exist elsewhere in the world. For example, in the Middle East, cities are competing and vying with each to incorporate sustainability principles into their masterplans and to try and lead the sustainability agenda. Some of these developments are controversial in terms of their environmental impact, but others, such as Masdah, have been held up as exemplars of sustainability (Stillwell and Lindeberry, 2008).

## 6.0 What lessons can we learn from cities as they seek to move towards a more sustainable future?

It is clear that cities will follow different trajectories in the future and that 'one size does not fit all'. The World Business Council for Sustainable Development report (Vision 2050) (WBCSD, 2010) suggests there are a spectrum of cities globally which have different requirements and needs (Table 1). For example 'green' cities such as Masdah in Abu Dhabi, (UAE) are planned cities designed and built from scratch. 'Brown' cities such as London or Seoul are already established metropolises where the majority of buildings is 'legacy' stock. 'Blue' cities such as Dhaka, Bangladesh and New Orleans, USA are situated in low lying areas and are frequently susceptible

to flooding[7] and so will also require special adaptive measures, whilst 'red' cities, such as Mumbai and Soweto, with booming populations but inadequate resources, present opportunities to develop affordable, scalable and eco-efficient solutions that could improve quality of everyday life. Further research (OECD, 2009) has also shown that those cities which promote higher environmental quality will maintain and enhance economic attractiveness.

**Table 1 Four categories of cities with different attributes and prospects (adapted from WBCSD, 2010)**

| | 'Brown' | 'Red' | 'Green' | 'Blue' |
|---|---|---|---|---|
| **Example** | London | Mumbai | Masdah | Dhaka |
| **Development** | Gradual | Ad-hoc | Deliberate | At risk |
| **Assets** | Cultural history, outdated buildings | Resilience, diversity, ability to manage scarcity | Clean slate for innovative, holistic solutions | Potential for innovative solutions |
| **Buildings** | New construction and retrofit | Affordable and low impact housing | Holistic design | Adaptation |

Many cities are vying with each other to become the world's greenest city, and that includes cities which also have a significant legacy stock (Siemens, 2010) For example, Vancouver has developed a plan to be the world's greenest city by 2050 and has adopted an ambitious action plan to achieve its target (and in competition with cities such as London, New York, San Francisco, Sydney and Stockholm). The Action Plan for Vancouver is founded on three main goals with key targets in place for 2020 (Vancouver Greenest City Action Team, 2010a):

Green Economy and Green Jobs:

- To gain international recognition as mecca of green enterprise, by creating 20, 000 new jobs by 2020.
- To eliminate Vancouver's dependence on fossil fuels by reducing GHG emissions by 33% from 2007 levels.

[7] A recent report suggested that 136 port cities with 40 million people are vulnerable to rising sea levels. In asset terms the value exposed is USD 3,000 bn or 5% of global GDP in 2005 (OECD, 2010)

- Lead the world in green building design and construction by making all new construction carbon neutral and improving building efficiency of existing buildings by 20%.

Greener Communities

- Green mobility and making walking, cycling and public transport the preferred options (by 2020 the majority of trips should be through these modes).
- Zero waste so that by 2020 solid waste per capita going to landfill or incinerator is reduced by 40%.
- Easy access to nature and green spaces with everyone living within a 5 minute walk of such space by 2020 which will also see the planting of 150, 000 more trees.
- Lighter footprints and achieving a one planet ecological footprint so that by 2020 per capita footprint is reduced by 33%.

Human Health

- Enjoying the best drinking water of any major city in the world by meeting/beating national and international standards and reducing per capita consumption by 33% by 2020.
- Access to the cleanest air of any major world city by meeting/beating WHO targets by 2020
- Becoming a global leader in urban food production so that by 2020 the carbon footprint of food production is reduced by 33%.

To fast track the city towards the 2020 targets seven 'quick start actions' have been developed (Vancouver Greenest City Action team, 2010b):

- Require Green Building Retrofits (Action 7)
- Engage Large Emitters in GHG Reduction (Action 39)
- Develop an Integrated Energy Strategy (Action 11)
- Advocate for Immediate Investment in Public Transit (Action 29)
- Develop a Green Economic Development Strategy (Action 1)
- Implement City-wide Composting (Action 30)

As the Action Plan states (Vancouver Greenest City Action Team, 2010a: 11):

*"The greenest city in the world will be a vibrant place where residents live prosperous, healthy, happy lives with a one-planet footprint, so as not to compromise the quality of life of future generations or people living in other parts of the world".*

Vancouver already has leading status as the world's most 'liveable' city, and this is founded on a strong focus on social sustainability, which very often is overlooked in sustainable urban development. A comprehensive definition with a special focus on urban environments is provided by Polese and Stren (2000: 15-16) who define social sustainability as

*'Development (and/or growth) that is compatible with harmonious evolution of civil society, fostering an environment conductive to the compatible cohabitation of culturally and socially diverse groups while at the same time encouraging social integration, with improvements in the quality of life for all segments of the population'.*

In Vancouver's SDP, social sustainability is defined as follows (City of Vancouver, 2005: 12):

*'For a community to function and be sustainable, the basic needs of its residents must be met. A socially sustainable community must have the ability to maintain and*

*build on its own resources and have the resiliency to prevent and/or address problems in the future'.*

The Vancouver model (Colantonio and Dixon, 2010) suggests that to develop communities which are socially sustainable requires us to acknowledge that there are three main building blocks:

- Firstly, basic needs: appropriate and affordable housing.

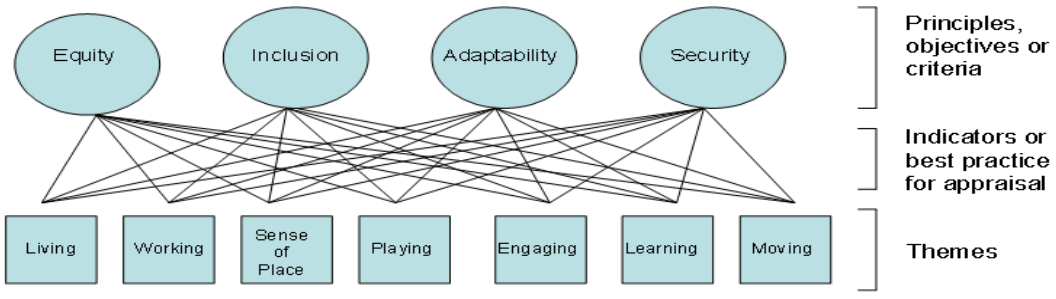
- Secondly individual or human capacity, which refers to the attributes and resources that individuals can contribute to their own well-being and to the well-being of the community as a whole, such as skills, education employment, lifelong learning.

- Thirdly, social community or capacity which is defined as the relationships, networks and norms that facilitate collective action taken to improve upon quality of life and to ensure that such improvements are sustainable (i.e. social interaction; public spaces; culture and the arts).

Figure 12 illustrates how the pursuit of these overarching milestones of social sustainability (which is adaptable to changing requirements) is guided by four principles (which include equity, inclusion, adaptability and security) and policy actions in seven areas, or themes. Furthermore, related research (Colantonio and Dixon, 2010) has shown that to be successful in social sustainability terms requires certain 'critical success factors' to be in place, which include:

- Strong brand and identity for projects at the relevant scale;
- Local community participation and empowerment;
- Innovative and effective partnership models which bring together the private and public sectors; and,
- Strong planning policies and governance models.

**Figure 12 Vancouver Model of social sustainability (source: Colantonio and Dixon, 2010)**




ISUD requires city authorities to consider the three dimensions of sustainable development in an integrated and coherent way, and it is becoming increasingly clear that for ISUD to succeed and for cities to follow a sustainable pathway to 2050, that

we need to understand the differences between 'piecemeal' approaches and 'systemic' approaches (Table 2). As May and Marvin (2009) suggest this requires new ways of thinking and bringing a socio-technical approach to bear.

**Table 2 Systemic and Piecemeal Approaches Compared (source: May and Marvin, 2009)**

| Systemic | Feature | Piecemeal |
|---:|:---:|---|
| System/Network wide | ***focus*** | Projects & experiments |
| Coordinated | ***governance*** | Ad hoc |
| Retrofitting and new build | ***scale*** | New build |
| Long term commitment | ***time*** | One-off - episodic |
| Multi-actors | ***actors*** | Inside project |
| System change | ***key indicators*** | Project completion |

This transformation also requires a difference in culture and approach in both the city and its built environment. There are five main dimensions or critical success factors to this new thinking which can provide a strong basis for ISUD which in turn links with the concept of a managed transition[8]:

**CSF 1: Stronger governance systems and strategic planning regimes at all scales.** There has frequently been a failure to develop systems and regimes which can apply at a city scale and which can be adaptive and flexible enough to cope with disruptions and uncertainty over what is a relatively long time scale to 2050. Frequently governance and planning systems have been beset by expediency issues and have failed to address longer term systemic problems. For example, climate change action at an urban level happens through a combination of local regulations, urban services, programme administration, city purchasing, property management and consultation and dialogue with local stakeholders (Lamia and Robert, 2009). Change may also be relatively easier to instil where the public sector plays an important role in a city. Urban policies also require better 'joining up': for example, spatial planning policies which promote higher densities and better mixing of uses can help create more sustainable transport options (Table 3).

[8] Some of the thinking here is based on work by OECD (2010); Institute for Sustainable Communities (2009); and WBCSD (2008).

**Table 3 Synergy in urban policy (source: OECD, 2010)**

| Impact → | Transportation | Renewable energy | Waste and water |
|---|---|---|---|
| **Land-use Zoning** *Land-use zoning determines the density, height of buildings, and proportion of undeveloped land on each property.* | Segregation of land uses impacts travel distances and frequency; transit-oriented development zones encourage use of mass transportation. | Zoning density can constrain on-site renewable energy production but can also increase efficiency of service delivery. | Zoning density can determine the efficacy of delivery of waste, recycling and composting services; and the energy required and efficacy of delivery of water services |
| **Natural Resources** *Natural resource policies determine which areas are preserved from development and what uses are acceptable on them.* | Natural resource policies affect the placement of road and mass transportation infrastructure. | Natural resources endowment makes certain renewable energies possible | |
| **Building** *Building policies, including building codes, affect building materials, construction types, and other physical conditions* | | Building codes can require the on-site generation of renewable energy. | Building codes can require design and building materials that produce less construction waste. |

Note: Policy sectors with no shading demonstrate highest impact. Policy sectors with shading demonstrate lower impact. Policy sectors with grey shading demonstrate no impact.

**CSF 2: Better integration across the built environment**. As was suggested earlier in this paper there has frequently been a failure to integrate thinking across professions in the built environment. This is important to recognise operationally at a building project level and through individual and group actions also plays out at a city level. Frequently there is failure to learn from projects and transfer knowledge about sustainability effectively. In the built environment there is also a tendency to approach issues with a silo mentality, with planners, designers and architects taking different views of how to achieve the end result. Often projects are fast tracked and we lose the true virtues of sustainability. Moreover, in design terms, the details of sustainability are lost on senior decision-makers through lack of clarity. Finally, there is often too much focus on capital costs instead of whole life costs, and frequently knowledge transfer or best practice is lost (WBCSD, 2008). However, the built environment offers high level opportunities for market growth and jobs creation, as adaptation requirements drive change. As GHK (2010) point out, in relation to the UK and globally, these opportunities which are largely based around retrofitting and new build are expected to feed through in the short term and beyond (Table 4).

**Table 4 High level opportunities in the built environment, UK and global markets (source, GHK, 2010)**

| Short term (5 years) | Medium term (+ 5 years) |
|---|---|
| New commercial and domestic developments will drive innovations in energy and water management and control technologies.<br><br>Increased adaptation awareness by property developers and domestic owners will create greater demand for both innovative retrofit solutions (e.g. insulation, ventilation, flood protection, water saving) and training and support services for building managers. | Global new build and retrofit markets are likely to grow substantially, requiring technologies and design, engineering and construction services.<br><br>Opportunities for green infrastructure and re-designing/re-engineering urban areas for climate resilience will start to become important.<br><br>Eco-towns in the UK will provide good demonstration site potential. |

**CSF 3: An integrated approach to sustainable development which recognises the importance of social and economic issues alongside environmental issues.** Critics of the ecological urbanism agenda have suggested that (i) environmental and economic issues have frequently been pursued at the expense of social sustainability (Dixon et al, 2007; Colantonio and Dixon, 2010); and (ii) that the creation of 'ecological enclaves' may result (Hodson and Marvin, 2010a)[9]. An integrated approach which recognises the importance of the three pillars of sustainability within all projects at a city scale (and above and below) is therefore essential. This also mans promoting urban green growth strategies which promote greener public services; greener industrial production; raising education and awareness programmes in cities to help underpin technology deployment and supporting innovative R & D (OECD, 2010)

**CSF 4: Access to innovative 'green' finance and ability to use 'green' taxes at a city level and nationally.** Achieving viable city scale retrofit programmes will be challenging. Cities could, over a longer timescale, develop a combination of fiscal instruments and incentives together with financing mechanisms to achieve sustainability goals, but there are a number of challenges to implementing policy at city level and above. For example, building performance standards vary internationally and there is often a 'disconnect' between owners and operators in buildings (WEF, 2010). Alternatively, existing buildings tend not to capture the imagination in the same way as new buildings, because organisations often do not set ambitious targets for refurbishments as they don't perceive that inspired or innovative solutions are required (Carbon Trust, 2008). At a larger scale carbon taxes and climate change levies are introduced at a national level, although there are examples of city level tax regimes such as the carbon tax ion the City of Boulder, Colorado. Some countries, such as the Netherlands have made the greening of their tax systems an explicit policy goal (OECD, 2010), and innovative value capture techniques have been used to capture enhanced land value to pay for infrastructure (for example, Tax Increment Financing in the USA). Cities will also need to lever investment finance, perhaps through an increased use of Clean Development Mechanisms (CDM); improved connection with carbon markets; and tapping into the

[9] For some, however, the recession has, in fact, provided a rationale for challenging the mainstream discourse of sustainability and regeneration. For example, Evans et al (2009) suggest that a more 'organic' model of urban regeneration, based on bottom-up community action should replace what they consider to be the essentially private-sector led, 'commodity-based' model, which, for them, has frequently failed to deliver on social sustainability.

potential carbon bond market (Kidney et al, 2009). In the UK[10] the concept of the Green Investment Bank (GIB) has been developed, and a recent report (GIB Commission, 2010) suggests the GIB could help catalyse low carbon investment by, for example, unlocking project finance through equity co-investment, first loss debt and insurance products for low carbon technologies and infrastructure; creating 'green bonds' to access to the substantial pools of capital held by institutional investors, which would be attractive to long-term investment horizons of pension funds and life insurance companies. The GIB could also provide the scale of capital needed to fund the low carbon transformation, and provide green ISAs, which would be an important and transparent way for retail investors to make a contribution to the funding of green infrastructure.

**CSF 5: Effective and innovative partnerships between the private and public sectors.** 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 which proves that green buildings are worth more in the market than conventional buildings. However, there is emerging evidence (Chegut et al, 2010) that in some instances in some sectors, there may be a 'green' premium. Proving the business case is fundamental to getting the private sector to respond to the needs and requirements of retrofitting cities, but the presence of public sector actors is fundamental to success within a framework of regime change which requires new polices and new instruments. Cities have a role to play in this through the jobs/green growth agenda (GHK, 2010; OECD, 2010). For example, New York's 'Greener Cities, Greater Buildings Plan' is expected to create 17,800 construction-related jobs and in Freiberg, Germany, the city's old and historic buildings are being retrofitted in ambitious retrofitting plan (OECD, 2010). Finally, retrofitting or re-engineering cities should recognise that within cities, land and property ownership patterns are key to understanding how future trajectories of change will play out. Understanding patterns of urban land and property ownership is important not only because the size and configuration of land holdings affects urban morphology through new development, regeneration and refurbishment of existing land and property, but also because historically, the timing of land sales affects the nature and shape of urban development by reflecting contemporaneous architectural and planning styles (Kivell, 1993; Dixon, 2009). Land ownership also confers economic and social power and wealth on owners who can also potentially exert influence upon urban planning policies and outcomes (Massey and Catalano, 1978; Kivell, 1993).

## 7.0 Conclusions

Cities are increasingly the arena for tackling climate change, resource depletion and environmental degradation. Cities are seen as the problem and the solution in this respect, and they can in a positive sense act as 'policy laboratories', with many cities in the world taking action on climate change and green issues. Landmark polices, for example, include those formulated by Vancouver, Seoul, Stockholm, Toronto, Copenhagen, New York, London and Tokyo (Lamia and Robert, 2009).

The costs and complexity of transforming cities through major retrofitting programmes are immense. New build programmes can tackle some of the issues we have to deal with to 2050 as evidenced by the growth of the 'eco city' concept, and there are some exemplary developments from both developed and developing countries as to how to achieve step change. Nonetheless, the biggest wins will come through major retrofitting programmes at urban scale.

[10] The C40 Large Cities Climate Leadership Group has also partnered with the Swiss Government, ECOS and the World bank on a programme called Carbon Finance Capacity Building as the first step for cities being given access to sources of funding currently targeted at national governments (OECD, 2010).

Theories and conceptualisation of how to achieve these transformative trajectories of change range from Kuznets curves through to more complex Transition Management theory and Three Horizon thinking. Further research is needed to assess how such theoretical constructs can be applied and help shape our understanding at city scale.

There are also substantial caveats to the view that transformative change can happen at city level. It is clear that 'one size' does not fit all, and that there are key differences between developed and developing countries when it comes to transformative urban change. The price of change does not come cheaply therefore, and unplanned actions can have surprising consequences. In the much-discussed case of Detroit, as the car industry and associated industry declined and economic deprivation and stagnation took root (with more than 40% of its land now vacant), whilst in one respect the city has 'died' it has in another sense been reborn, or at least come to terms with 'shrinkage', through the collective actions of its residents and community groups as a centre for 'urban farming' (Popper and Popper, 2010; Sattherthwaite et al, 2010).

Planned, rather than unplanned, transformative change can in theory provide more coherent and managed outcomes, and further research is needed to enable us to understand how complexity can be overcome through large scale systemic restructuring. This requires further research[11] to address:

- Systemic change in the organisation of built environment and infrastructure and that critically this is both a technological and societal challenge that requires integrated socio-technical knowledge, capacity and responses.
- 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.
- Relevant governance structures and capabilities to develop new social visions and technological expectations, to enrol and align stakeholders, to deliver effective and efficient material change in infrastructure.
- Recognition that technology impact can operate at a range of scales from individual buildings through, for example, to the wider spatial impacts of information and communications technology on future urban land use patterns.

[11] A new programme of research dedicated to addressing these issues is due to start this year. The EPSRC programme, *Re-Engineering the City 2020-2050 (RETROFIT 2050): Urban Foresight and Transition Management* will address the critical challenge for contemporary urbanism: how do cities develop the knowledge and capability to systemically re-engineer their built environment and urban infrastructure in response to climate change and resource constraints? The programme of work brings together OISD at Oxford Brookes University with the Low Carbon Research Institute at the Welsh School of Architecture (WSA) at Cardiff University; The Centre for Sustainable Urban and Regional Futures at Salford University; and the University of Cambridge, Department of Engineering, Centre for Sustainable Development (CSD).
See: http://www.brookes.ac.uk/schools/be/oisd/news/retrofittingcities.html

In turn this requires certain critical success factors which will be in place and help transform cities including: stronger governance systems and strategic planning regimes at all scales; better integration across the built environment; an integrated approach to sustainable development which recognises the importance of social and economic issues alongside environmental issues; access to innovative 'green' finance and ability to use 'green' taxes at a city level and nationally; and effective and innovative partnerships between the private and public sectors. As the recent report on 'Green Cities' in the USA (Living Cities, 2010) suggested:

*'It is no longer a question of 'if' the nation will begin the challenging transition to a greener economy but 'how' we will get there.'*

It is at the city scale that the battle for a sustainable urban future by 2050 will be won or lost.

**References**


AGMA (2010) *Greater Manchester's Low Carbon Economic Area for the Built Environment Joint Delivery Plan.* Association of Greater Manchester Authorities.

Bai, X., (2003) 'The process and mechanism of urban environmental change: and evolutionary view', *International Journal of Environment and Pollution*, Vol 19, No 5, 528-41

Bai, X., and Imura, H. (2000) 'A Comparative Study of Urban Environment in East Asia: Stage Model of Urban Environmental Evolution', *International Review for Environmental Strategies*, Vol. 1 No. 1, 135-158.

Bai, X., McAllister, R., Beaty, R., and Taylor, B. (2010) 'Urban policy and governance in a global environment: complex systems, scale mismatches and public participation', *Current Opinion in Environmental Sustainability*, 2:1-7

Berkout, F., Smith, A., and Stirling, A. (2004) 'Socio-technical regimes and transition contexts', in Elzen, B., Geels, F.W., Green, K. (eds.), *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy.* Cheltenham: Edward Elgar, 48-75.

Booz and Company (2010) *Reinventing the City: Three Prerequisites for Greening Urban Infrastructures.* Booz and Company for World Wildlife Fund.

Carbon Trust (2008) *Low Carbon Refurbishment of Buildings: A guide to achieving carbon savings from refurbishment of non-domestic buildings.* Carbon Trust.

Carbon Trust (2010) *Building the Future, Today.* Carbon Trust.

Chegut, A., Eichholtz, P., Kok, N., and Quigley, J.M. (2010) 'The Value of Green Buildings: New Evidence from the UK'. *Paper presented at ERES Conference*, Milan, June.

City of Vancouver (2005) *A Social Development Plan for the City of Vancouver: Moving Towards Social Sustainability, Administrative Report A7*. Vancouver, Canada.

City of Vancouver (2010a) *Vancouver 2020: A Bright Green Future-An Action Plan for Becoming the World's Greenest City by 2020*. Vancouver Greenest City Action Team.

City of Vancouver (2010b) *Greenest City: Quick Start Recommendations.* Vancouver Greenest City Action Team.

CLG (2004) *Planning Policy Statement 23: Planning and Pollution Control*. Communities and Local Government (CLG): London.

CLG (2005) *Planning Policy Statement 1: Delivering Sustainable Development*. Communities and Local Government (CLG): London.

Colantonio, A., and Dixon, T (2010- forthcoming) *Urban Regeneration and Social Sustainability*. Wiley-Blackwells

Core Cities (2010) *Core Cities Driving Recovery: A New Partnership with a New Government.* Core Cities.

Dixon T., Colantonio, A., and Shiers, D. (2007) *Socially Responsible Investment (SRI), Responsible Property Investment (RPI) and Urban Regeneration in the UK and Europe: Partnership Models and Social Impact Assessment, Measuring Social Sustainability: Best Practice from Urban Renewal in the EU.* 2007/02: EIBURS Working Paper Series, September 2007 (Oxford Brookes).

Dixon, T (2007) 'The Property Development Industry and Sustainable Urban Brownfield Regeneration in England: An Analysis of Case Studies in Thames Gateway and Greater Manchester', *Urban Studies,* Vol 44, No 12, 2379-2400

Dixon, T (2007) 'The Property Development Industry and Sustainable Urban Brownfield Regeneration in England: An Analysis of Case Studies in Thames Gateway and Greater Manchester', *Urban Studies*, Vol 44, No 12, 2379-2400

Dixon, T, and Adams, D. (2008) 'Housing Supply and Brownfield Regeneration in a post-Barker World: Is there enough brownfield land in England and Scotland?', *Urban Studies*, 45(1) 115-139

Dixon, T. (2009) 'Urban Land and Property Ownership Patterns in the UK: Trends and Forces for Change', *Land Use Policy*, (DIUS Foresight Land Use Futures Programme), Volume 26, Supplement 1, 2009, Pages S43-S53

Dixon, T. (2011-forthcoming) 'The Property Industry and the Construction of Urban Spaces: Crisis or Opportunity?' in Flint, J., and Raco, M. (eds) *Sustainable Cities*, Policy Press

Dodman, D. (2009) 'Blaming cities for climate change? An analysis of urban greenhouse gas emissions inventories', *Environment and Urbanization*, 21 (1), 185-201

Eames, M., and McDowall, W. (2007) 'Sustainability, foresight and contested futures: exploring visions and pathways in the transition to a hydrogen economy', *IFZ International Summer Academy on Technology studies: Transforming the Energy System*, Austria, August.

EC (2009) *Promoting Sustainable Urban Development in Europe: Achievements and Opportunities.* European Commission: Brussels.

EIB (2010) *Frequently Asked Questions* (accessed March 2010 from: http://www.eib.org/products/technical_assistance/jessica/faq/)

Elkington, J. (1997) *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*. Capstone: Oxford, UK.

Geels, F. (2005) 'Processes and patterns in transitions and system innovations: Refining the co-evolutionary multi-level perspective', *Technological Forecasting and Social Change*, 72,681-696.

Geels, F., Elzen, B., and Green, K. (2004) 'General Introduction: system innovation and transitions to sustainability', in Elzen, B., Geels, F.W., and Green, K. (eds) *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy.* Edward Elgar.

Geels, F.W. (2004) 'From sectoral systems of innovation to socio-technical systems: insights about dynamics and change from sociology and institutional theory', *Research Policy*, 33, 897-920.

Genus, A. and Coles, A.M. (2007) 'A Critique of Geels' Multi-level Perspective of Technological Transition', *IFZ International Summer Academy on Technology studies: Transforming the Energy System*, Austria, August.

GHK (2010) *Opportunities for UK Business from Climate Change Adaptation*. DEFRA.

Green Investment Bank (GIB) Commission (2010) *Unlocking Investment to Deliver Britain's Low Carbon Future* (Accessed September 2010 from: http://www.climatechangecapital.com/thinktank/ccc-thinktank/publications.aspx)

Guy, S., and Marvin, S. (2001) 'Constructing sustainable urban futures: from models to competing pathways', *Impact Assessment and Project Appraisal*, June, 131-139

Haughton, G. (1997) 'Developing sustainable urban development models', *Cities,* Vol. 14. No. 4, 189-95

HM Government (2005) *Securing the Future: Delivering UK sustainable development Strategy.* DEFRA: London

Hodson, M., and Marvin, S. (2009) 'Urban Ecological Security': A New Urban Paradigm?' *International Journal of Urban and Regional Research.* Vol.33: Issue 1. pp.193-215.

Hodson, M., and Marvin, S. (2010a) 'Urbanism in the Anthropocene', *City*, 14:3, 299-313

Hodson, M., and Marvin, S. (2010b) 'Can cities shape socio technical transitions and how would we know if they were?', *Research Policy*, 39, 477-85.

Institute for Sustainable Communities (2009) *Scaling Up Building Energy Retrofitting in US Cities*. Living Cities/Institute for Sustainable Communities.

IPF (2009) *Urban Regeneration: Opportunities for Property Investment.* Investment Property Forum (IPF): London.

JLL (2010) *Global Market Perspective, March*: *A BRIC built recovery?*. Jones Lang LaSalle

Kelly, M. (2009) 'Retrofitting the existing UK building stock', *Building Research & Information*, 37:2, 196-200

Kidney, S., Mellon, K., Silver, N., and Williams, C. (2009) *Financing a rapid, global, transition to a low-carbon economy*. Climate Bonds Initiative.(Accessed September 2010 from: http://climatebonds.net/wp-content/uploads/2009/12/climate_bonds_28Dec09.pdf)

Kivell, P. (1993) *Land and the City: Patterns and Processes of Urban Change.* Routledge: London.

Lamia, K.C., and Robert, A (eds) (2009) *Competitive Cities and Climate Change*. *Regional Development Working Papers N° 2*. OECD Publishing

Lankao, P. (2007) 'Are we missing the point? Particularities of urbanization, sustainability and carbon emissions in Latin American cities', *Environment and Urbanization*, Vol 19(1), 159-175.

Living Cities (2010) *Green Cities: How Urban Sustainability Efforts Can and Must Drive America's Climate Change Policies.* Living Cities.

Maclaren, V. (1996) 'Urban Sustainability Reporting', *Journal of the American Town Planning Association*, 52(2):184–202

Massey, D., and Catalano, A. (1978) *Capital and Land: Landownership by Capital in Great Britain.* Arnold: London.

May, D., and Marvin, S. (2009) *The SURF-ARUP Framework for Urban Infrastructural Development.* SURF; ARUP.

Ministry of Kingdom and Interior Relations (2005) *Ministerial Meeting Urban Policy: Cities Empower Europe Conclusions - Dutch Presidency 2004* (accessed March 2010 from: http://www.bmvbs.de/Anlage/original_983143/Urban-Acquis-englisch-_November-2004.pdf)

Moffatt, S., and Kohler, N. (2008) 'Conceptualizing the built environment as a socio-ecological system', Building Research and Information, 36(3), 248-68

Mostafi, M., and Doherty, G. (eds) (2010) *Ecological Urbanism.* Harvard University Graduate School of Design and Lars Publishing.

Newton, P. (2007) 'Horizon 3 planning: meshing liveability with sustainability', *Environment and Planning B: Planning and Design*, 34, 571–575.

Newton, P., and Bai, X. (2008) 'Transitioning to Sustainable Urban Development', in Newton P. (ed). *Transitions: Pathways Towards Sustainable Urban Development in Australia.* Springer Publishing.

NZ Ministry for the Environment (2009) Rethinking Our Built Environment: Towards a Sustainable Future. New Zealand Government

OECD (2009) *Cities, Climate Change and Multilevel Governance.* OECD: Paris.

OECD (2010) *Cities and Green Growth: Issues Paper for the 3rd Annual Meeting of the OECD Urban Roundtable of Mayors and Ministers*.

Ooi G.L. (2007). 'Urbanization in Southeast Asia: assessing policy process and progress toward sustainability', *Journal of Industrial Ecology*, 11(2), 31–42.

Pieterse, E (2008) *City Futures: Confronting the Crisis of Urban Development.* Zed Books Ltd

Pinnegar, S., Marceau, J., and Randolph, B. (2008) *Innovation and the City: Challenges for the Built Environment Industry.* City Future Research Centre, University of New South Wales.

Polese, M. and Stren, R. (eds) (2000) *The Social Sustainability of Cities: Diversity and the Management of Change.* University of Toronto Press, Toronto, Canada.

Popper, D., and Popper, F. (2010) 'Smart Decline in Post-Carbon Cities', in Heinberg, R., and Lerch, D. (eds.) *The Post Carbon Reader: Managing the 21st Century's Sustainability Crises*. Watershed Media.

Ravetz, J. (2008) 'State of the stock-what do we know about existing buildings and their future prospects?', *Energy Policy*, 36, 4462-2270

Richardson, N. (1994) 'Making Our Communities Sustainable: The Central Issue is Will' in Ontario Round Table on Environment and Economy (1994) *Sustainable Communities Resource Package*, Ontario Round Table on Environment and Economy, Ontario.

Rotmans, J., and van Asselt, M.B.A. (2001) 'Uncertainty in integrated assessment modelling: a labyrinthic path', *Integrated Assessment*, 2001(2):43-57

Sattherthwaite, D. (2007) *The Transition to a Predominantly Urban World and Its Underpinnings.* IIEDL London

Sattherthwaite, D., McGranahan and Tacoli, C. (2010) 'Urbanization and its implications for food and farming', *Phil. Trans. R. Soc. B* 365, 2809–2820

Shackley, S., and Green, K. (2007) ' A conceptual framework for exploring transitions to decarbonised energy systems in the United Kingdom', *Energy*, 32, 221-236.

Siemens (2010) *European Green City Index.* Siemens.

Stillwell, B., and Lindabury, S. (2008) *Masdah: Evaluating the World's Most Sustainable City.*

UN (2007) 'City planning will determine pace of global warming' (accessed September 2010 from http://www.un.org/News/Press/docs/2007/gaef3190.doc.htm)

UN (2010) *World Urbanization Prospects: The 2009 Revision.* UN: New York

URBACT (2010) *Understanding Integrated Urban Development* (accessed march 2010 from: http://urbact.eu/en/header-main/integrated-urban-development/understanding-integrated-urban-development/)

WBCSD (2008) *Energy Efficiency in Buildings.* World Business Council for Sustainable Development.

WBCSD (2010) *Vision 2050.* World Business Council on Sustainable Development.

WEF (2010) *Governors Meeting for Real Estate. Davos-Klosters, Switzerland: Report.* World Economic Forum.

Wheeler, S. (1998) 'Planning Sustainable and Livable Cities', in: LeGates, R.T. and Stout, F. (eds) *The City Reader.* Routledge.

Williams, K., and Dair, C. (2007) 'A framework for assessing the sustainability of brownfield developments', *Journal of Environmental Planning and Management*, 50 (1), 23-40.

Wolman, A. (1965) 'The Metabolism of Cities', *Scientific American*, 213(3):179-190.

World Bank (2010) *Eco2 Cities: Ecological Cities as Economic Cities.* World Bank.