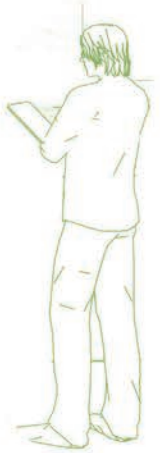
Retrofit City Futures: Visions for Urban Sustainability



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More information on the team and their work can be found at **www.retrofit2050.org.uk**

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Foreword

Retrofit 2050 is a large interdisciplinary project funded under the EPSRC Sustainable Urban Environments (SUE) programme.

The academic partners comprise: the Welsh School of Architecture (WSA), Cardiff University; Sustainable Urban and Regional Futures (SURF), Salford University; University of Reading; the Oxford Institute for Sustainable Development (OISD) at Oxford Brookes University; the University of Cambridge, Department of Engineering, Centre for Sustainable Development (CSD); and the Durham Energy Institute, Durham University.

Non-academic partners include Tata Colours, Arup, BRE Wales, Cardiff, Manchester City and Neath Port Talbot Councils, the Welsh Government, Environment Agency (Wales), Core Cities, RICS and Defra.

Retrofit 2050 aims to develop the knowledge and capability to support city-regional scale retrofitting in order to promote a managed socio-technical transition in the built environment and urban infrastructure. In so doing our work brings together four important questions for cities which have all too often been treated in a disconnected way: (i) "what" is to be done to the city? (ii) 'who' is involved in this process? (iii) 'why' will change take place? and "how" will it be implemented? That is, it seeks to bring together an understanding of future technological options and possibilities with the behavioural, political and wider institutional and governance challenges involved.

A specific objective is to articulate and appraise city-regional visions and prospective pathways for urban-scale retrofitting of the built environment. This report describes a set of three contextual scenarios for retrofit city-regional futures which have been developed as part of this work. The report is intended to stimulate creative thinking and debate about what a sustainable urban future might look like for our existing UK cities and the wider regions in which they are embedded out to 2050.

For further information about the Retrofit 2050 project please visit www.retrofit2050.org

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Introduction

In recent years the need to 'retrofit' or re-engineer existing buildings and urban infrastructures has gained increasing prominence. At a global scale, increasing 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. Whilst 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 US, particularly those with a long history of urbanisation, a critical challenge is how best to deal with an 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; renovation and refurbishment rates are between 2.9% and 5% of existing stock for domestic buildings and 2-8% for commercial stock, depending on the sector.

In the UK, the Climate Change Act and related 80% emissions reduction target for 2050 have done much to focus attention on the impact of the built environment in cities on carbon emissions. This is not surprising, given that emissions from buildings (35%) and industry (35%) account for more than two thirds of total green house gas (GHG) emissions in the UK, with the residential sector responsible for 23% and the non-residential sector 12%. Alongside this, there are emerging requirements for more effective and integrated coordination of planning and infrastructure: for example, the Planning Act 2008, the deployment of the new National Infrastructure Plan (2011), the Low Carbon Transition Plan (2009), Carbon Plan (2011) and Energy Act (2012). These documents set 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 in 'new build', and existing developments within and between cities.

However, urban sustainability requires much more than reductions in carbon emissions. It is a multidimensional problem which 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.

By itself a carbon emissions reduction target, no matter how important, can tell us rather little about the sort of future cities in which we might want to live. Now more than ever, cities 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 mobilize, deploy, and manage resources to achieve a desired future.

This report sets out three contrasting long term (2050) visions for retrofit city-regional futures, developed through an in-depth participatory backcasting and foresight process. These contextual scenarios are intended as a tool which can be adapted and used by a wide variety of stakeholders and organisations to stimulate discussion and inform future policy and long-term planning.

The Retrofit 2050 Visions

The three visions set out in this report each describe distinctive long-term visions of what a sustainable future might look like for core UK city regions in 2050. The scenarios are not predictions: they are intended to open up debate and inform current societal choices, through illustrating a range of possible sustainable urban futures. Each represents a distinctive articulation of urban sustainability.

The three visions are:

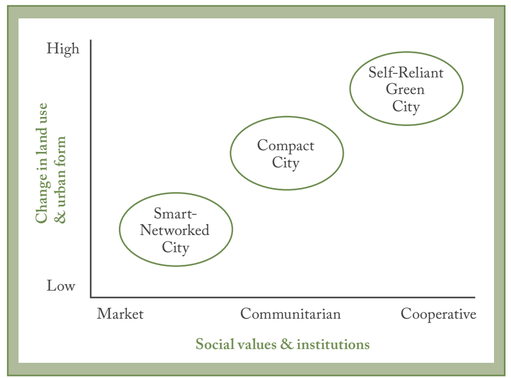
Smart-Networked City: envisages the city as a hub within a highly mobile and competitive globally networked society.

Compact City: envisages the city as a site of intensive and efficient urban living.

Self Reliant-Green City: envisages the city as a self-reliant bio-region, living in harmony with nature.

Each of these futures is located within a 'possibility space' described by two key dimensions of change for systemic urban retrofitting (figure 1):

- Change in land-use and urban form: This dimension describes the extent of change in patterns of land use and urban form within the city-region, on an axis from 'Low' to 'High'. At the low end of this axis changes in the built environment and urban infrastructure are largely overlaid upon or accommodated within existing patterns of land use and urban forms. At the high end, land use and urban form are radically reconfigured.
- Social values and institutions: This dimension 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.



Each scenario comprises a synopsis or 'guiding vision', together with a short narrative outline of the basis for each future. An associated portfolio of technological and social innovations in the domains of energy, water, and waste and resource use is given in each case.

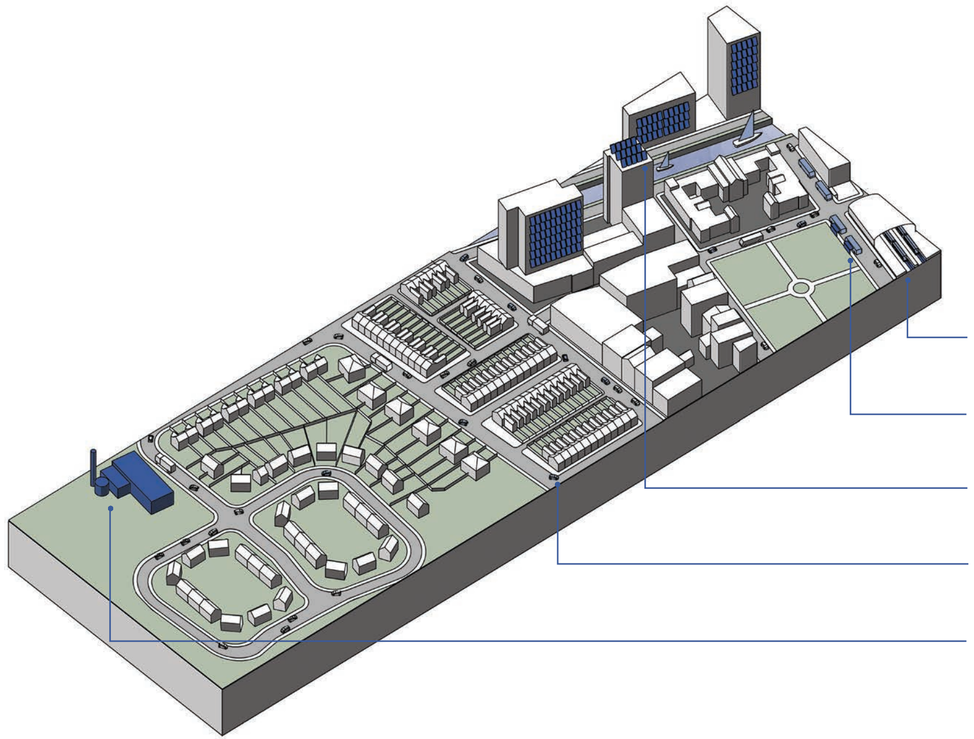
A brief summary of the key characteristics and indicative indicators for each vision is provided in table 1 below.

	Smart-Networked City	Compact City	Self Reliant-Green City
Change in land-use and urban form	**Low – moderate**	**Moderate** (densification)	**High** (extensification)
Social Values & Institutions	*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.	*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.	*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.
Economic Growth	3.0% pa	2.3% pa	<1.6% pa
UK Population by 2050	86.4 million	76.4 million	66.8 million
Urban Density (2050) (assuming a large city)	No significant change 40 dwellings per ha (or 160 people/ha)	Dense 70 dwellings per ha (or 275 people/ha)	Less dense 30 dwellings per ha (or 120 people/ha)

The Smart-Networked City

The city as a hub within a highly mobile and competitive globally networked society

Pervasive, information-rich virtual environments integrate seamlessly with the physical world. ICTs provide real time information to drive efficiencies through automation and intelligent control, and advanced market oriented solutions allow for the internalisation of environment costs. This is an open, outward looking society in which the mobility of people, goods and services remains high.



SMART NETWORKED CITY

The city as a hub within a highly mobile and competitive globally networked society

Higher economic growth

Increased urban densities and new suburban development

Pervasive ICT: Omnipresent real-time monitoring and information

Capital investment in centralised infrastructure systems

Widespread diffusion of building integrated renewables

Decarbonisation of private transport: Electric/hydrogen fuelled private cars prevalent

Market based mechanisms for recycling and resource recovery

Basis

This is a growth oriented vision predicated on high levels of trade and private consumption. Significant growth in UK population is accommodated through a mixture of densification of existing city centres and new suburban and green field development largely in line with current trends. The private sector takes the lead in the retrofitting of new technologies, systems and infrastructures, which are largely layered on to the existing built environment. Where changes in land-use do occur they are driven by demand for new housing and the impacts of e-commerce and ICT on the commercial and retail sectors. E-mobility (battery electric and hydrogen fuel cell vehicles) enables the decarbonisation of private transport and persistence of current mobility patterns. The pervasive role of ICTs in mediating social and economic relations continues to facilitate new forms of governance and participation, but also new forms of exclusion and segregation. The natural environment is not a prominent feature of this vision but can be viewed as providing a recreational resource.

Energy

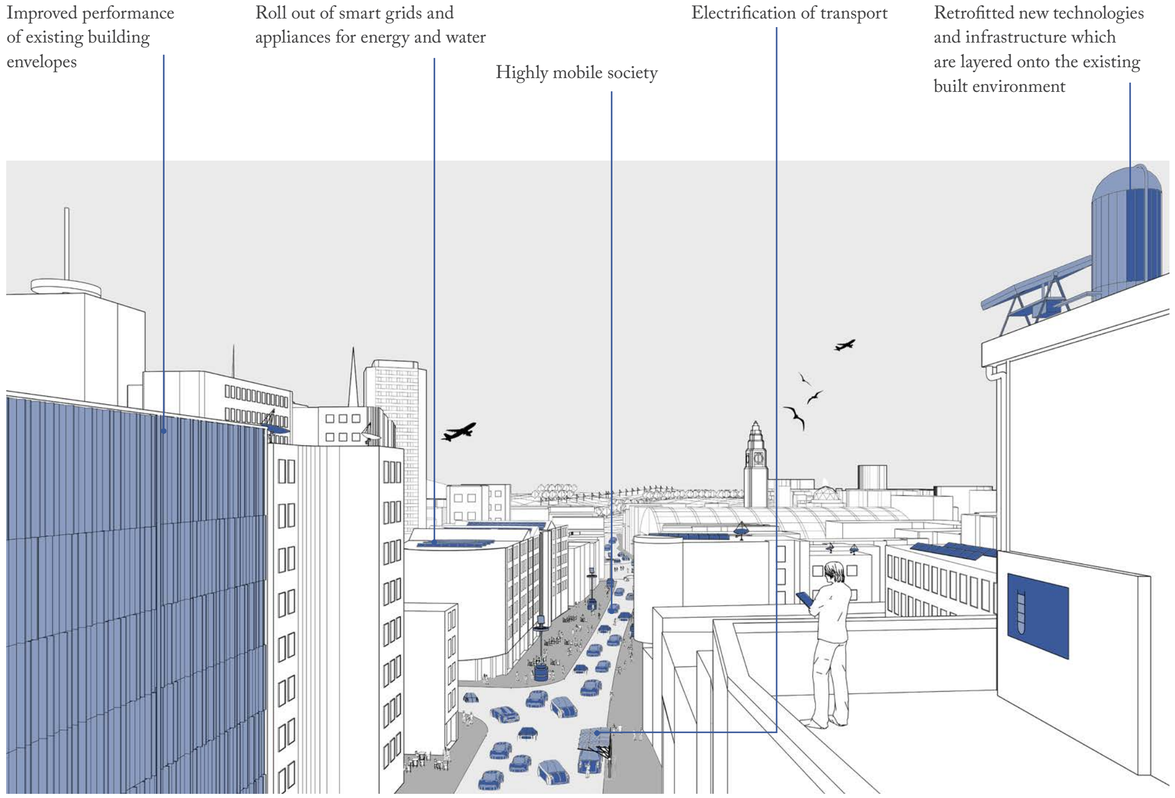
This is an electric future. Despite significant improvements in end-use efficiency and widespread diffusion of building integrated renewables, total energy use remains high. Electrification of heat and transport result in very significant increases in electricity demand. Alongside the role out of smart grids and appliances, there has been widespread application of novel materials and products (vacuum panels, phase change materials, etc) to improve the performance of existing building envelopes. The focus of deployment of micro-generation and renewable technologies (heat pumps, PV, etc) is at the individual building scale.

Water

Smart metering and appliances coupled with market instruments, such as rising tariff structures and trading of water credits, drive improvements in the efficiency of water use. Industry supports continued capital intensive investment in centralised infrastructure systems including 'new' supply through water recycling (advanced treatment of grey water for portable use, etc) and desalination.

Waste and Resource use

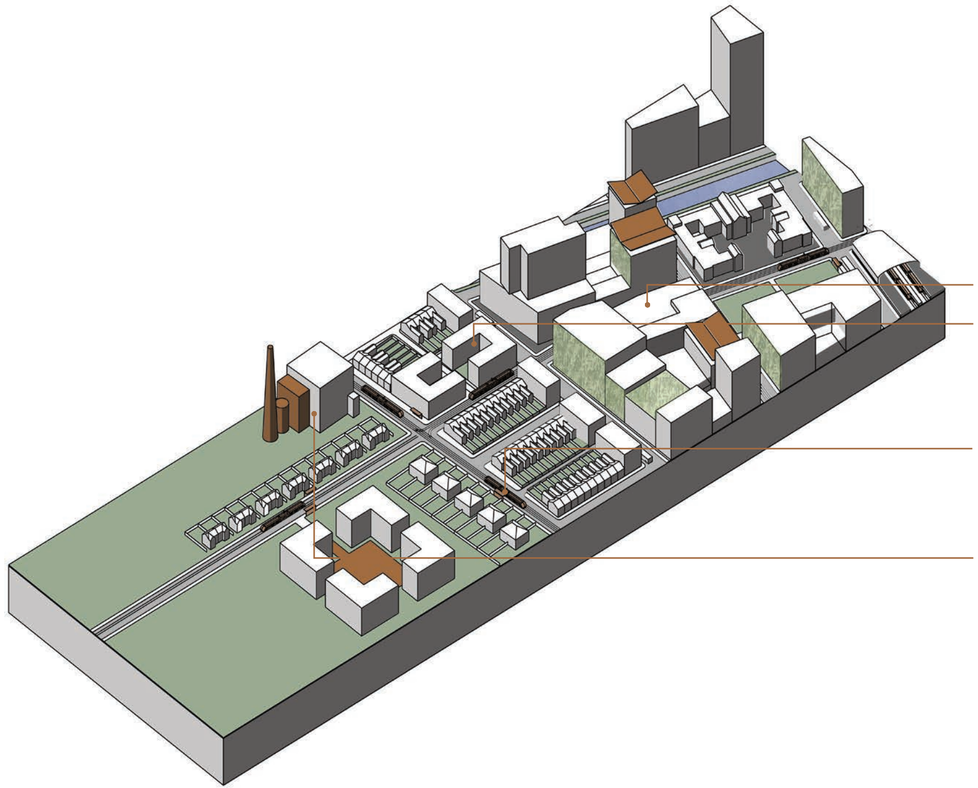
The development of novel materials, technological obsolescence and continued growth in absolute consumption represent significant challenges for waste management, requiring high levels of investment in infrastructure for recycling and resource recovery. As with energy and water, advances in ICT facilitate the development of market based mechanisms to enhance incentives for resource recovery and recycling.


Improved performance of existing building envelopes
Roll out of smart grids and appliances for energy and water
Highly mobile society
Electrification of transport
Retrofitted new technologies and infrastructure which are layered onto the existing built environment

The Compact City

The city as a site of intensive and efficient urban living

Urban land-use, buildings, services and infrastructure provision are optimised in order to create dense urban settlement forms that encourage reduced demand and more efficient use of energy and resources. Concentration in urban centres reduces pressures on the periphery. Significant efficiencies are obtained through systems integration and re-design.



COMPACT CITY

The city as a site of intensive and efficient urban living

Basis

This is a moderate growth vision where regional economies are strongly coupled to investment in community infrastructure and local supply chains. Moderate growth in the UK's population and rural migration into the city are accommodated through increasing urban densities, entailing significant retrofitting of neighbourhood level infrastructure and built form. Mixed use neighbourhoods, coupled with developments in ICTs, reduce the need to travel; walking, cycling and public transport predominate. Regional government, local authorities and social housing providers play an active role engaging communities, regulating social behaviour, intervening in property markets and leading the development of local infrastructure projects. Concentration of population in urban centres reduces pressures on the rural environment. Within the city there is intensive use of green and blue space, including green roofs and walls to fulfil multiple functions (leisure, combating heat island effects, water management, food production, etc).

Energy

In this vision, area based solutions combine options from a limited portfolio of successful low carbon technologies which are deployed at scale. Improvements to individual building envelopes, distributed micro-generation (e.g. fuel cell CHP) and building integrated renewables (solar thermal. PV, heat pumps, etc), sit alongside the development of community and city scale heat and power networks (exploiting biogas & biomass CHP, industrial heat, etc). Walking, cycling and low carbon mass transit systems contribute to significant reductions in transport energy use.

Water

Area based initiatives link deployment of Rain Water Harvesting (RWH) technologies and investments in SUDS with stricter regulation of individual consumer behaviour.

Waste and Resource use

Efficiency gains are sought through systems integration. Heat and power from advanced waste (including sewage) treatment technologies make a significant contribution at an urban scale.

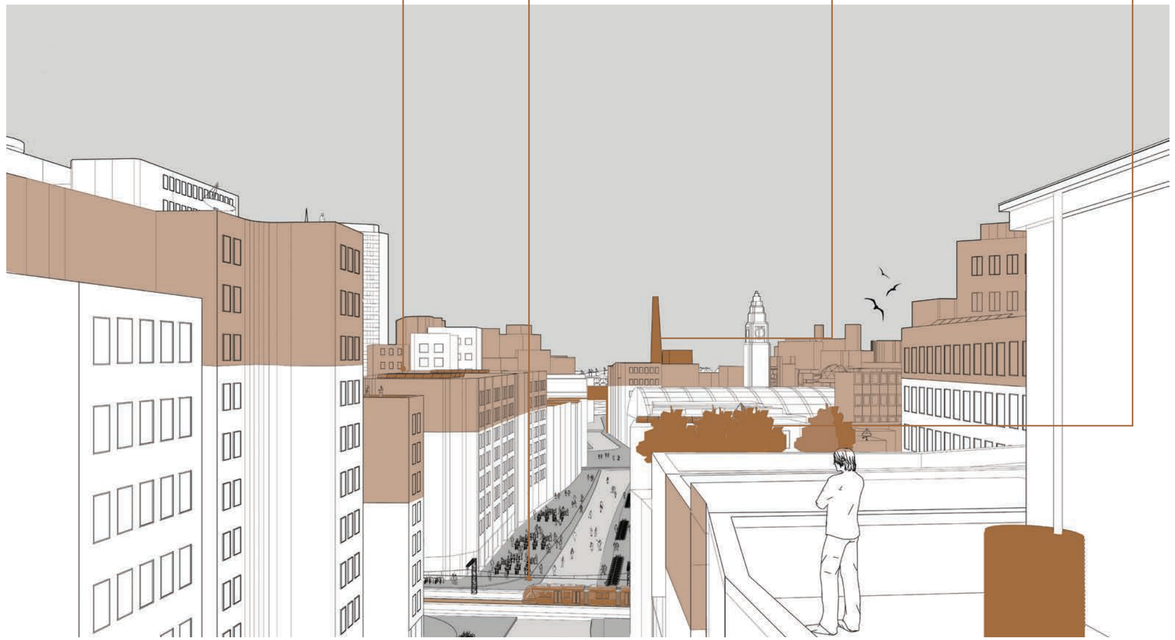
Efficiency gains sought through systems integration

Improvements to building envelopes and distributed micro-generation

Walking, cycling and public transport predominate

City scale heat and power networks

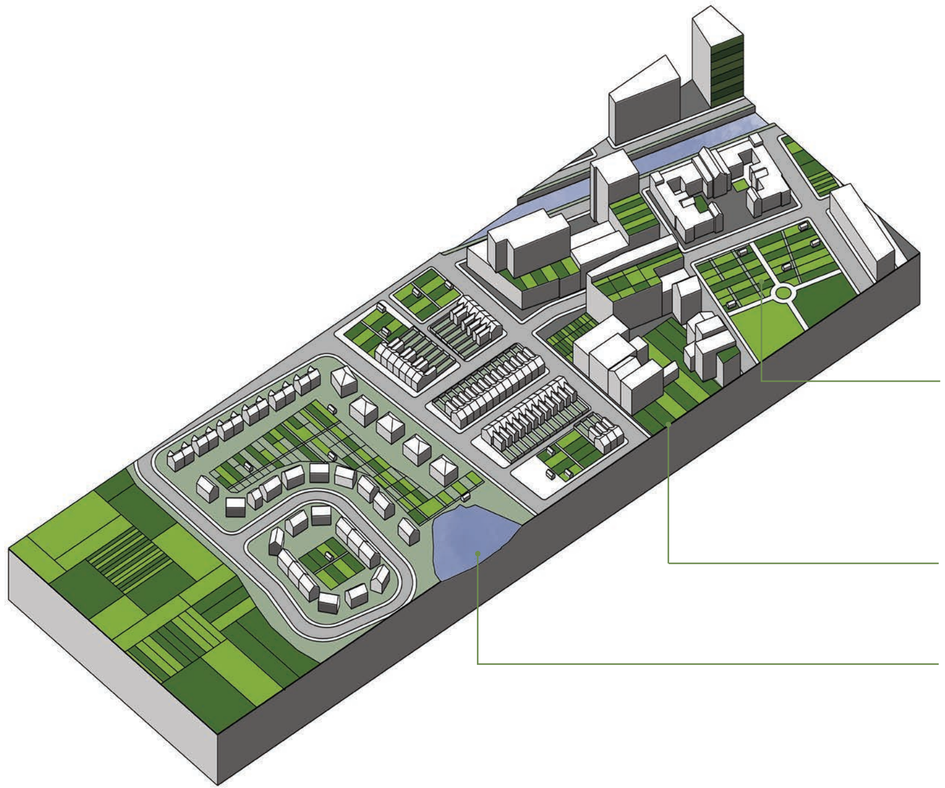
Intensive use of green space including green roofs and walls



The Self-Reliant Green City

The city as a self-reliant bio-region, living in harmony with nature

A self-replenishing, largely self-reliant system of circular metabolism, where resources are local, demand is constrained and the inputs and outputs of the city are connected (cradle to cradle). In many ways this is an inward facing society, but one conscious of its global responsibility to 'live within its limits'.



SELF-RELIANT GREEN CITY

The city as a self-reliant bio-region, living in harmony with nature

Lower economic growth

Fall in urban densities

Cooperative and collectivist values underpin new models of shared ownership

Significant decrease in overall energy consumption

Re-localisation of production and consumption

Rise of urban agriculture

Green and blue space, local biomass and biodiversity are all harnessed and integrated into the city

Mend and make do culture – focus on re-use and recycling

Basis

This is a low growth vision where systems of community ownership, trading and exchange focus on the creation and maintenance of local value, equity and sustainable wellbeing. Lower UK population growth is accompanied by outward migration from urban centres. 'Green fingers' replace the green belt as the extensification of urban living and rise of urban agriculture promotes the blurring of urban-rural boundaries. Despite falling urban densities, the transport intensity of economic activity declines significantly with the clustering and re-localisation of production and consumption. A high level of diversity and experimentation underpins the development of local solutions, exploiting the principles of urban metabolism through fragmented and piecemeal retrofit activities. Green and blue space, local biomass and biodiversity are all harnessed in the provision of ecosystem services (food production, energy, shelter, water and waste treatment).

Energy

Demand reduction, facilitated by significant behavioural changes, results in a Demand reduction, facilitated by significant and universal behavioural changes, results in a significant decrease in overall energy consumption. The limits and rationing of energy use are widely accepted. A diverse range of distributed renewables (PV, micro hydro, wind, etc), coordinated through local grids at the community level, provide a significant proportion of the energy mix.

Insulation and improvements to building envelopes maximise the use of local, recycled and carbon neutral/negative materials (hemp, wool, straw, etc). There is extensive use of local biomass and solar thermal technologies for domestic heat and hot water.

Water

A more holistic and decentralised approach seeks to integrate water management into urban design, as lower urban densities and re-greening of city centres provides extensive opportunities for retrofit of SUDS. Changing social norms support demand reduction. Decentralisation of the industry is accompanied by a shift to low capital cost RWH and decentralised water treatment technologies.

Waste and Resource use

Reduced demand coupled with a mend and make do culture significantly reduces pressure on non-renewable resources. Small scale, low capital cost solutions (anaerobic digestion with bio-gas production, composting, etc) are favoured for waste treatment, energy recovery and materials and nutrient recycling. There is an overall focus on optimising sustainable use of renewable resources, including use of locally sourced carbon neutral and negative materials in construction sector.

Insulation and improvements to building envelopes using recycled and local materials

Diverse range of distributed renewables are shared by community networks: PV, micro hydro, wind, local biomass, solar thermal

Cycling and walking predominate

Green fingers/corridors replace green belt

High levels of diversity and experimentation for local solutions

Using the Visions

The Retrofit 2050 visions are intended as a starting point from which to explore the future of core UK city regions, although the prospective social and technological changes, and accompanying societal choices, they highlight may have a wider resonance beyond the UK context.

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.

Of course every city is to some extent unique. 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. Moreover, it is necessary to recognise the diversity of values and interests, which will shape different expectations of the future within any individual city.

The next stage of the Retrofit 2050 project is to use the visions to explore the systemic urban retrofit of Greater Manchester and Cardiff/South East Wales.

For further information on the Retrofit 2050 project or advice on using the visions contact retrofit2050@cardiff.ac.uk

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