Cardiff 2050:
City Regional Scenarios for Urban Sustainability

What would a sustainable future look like for Cardiff and South East Wales?

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Introduction

This report describes three distinctive long term (2050) city regional futures: i) Connected Cardiff; ii) Compact Cardiff–Wilderness Valleys; and iii) Orchard Cardiff City-Region. Developed through an in-depth participatory back-casting and foresight process, these scenarios are not predictions. Rather they are intended to open up debate and inform current societal choices through exploring how a range of pressures and societal responses might play out at the city regional scale.

The Cardiff 2050 City Regional Scenarios for Urban Sustainability were developed by the Retrofit 2050 project team on the basis of an extensive research process that spanned 2011-2013, including: a series of workshops that brought together national experts in the fields of water, waste, energy and transport; workshops incorporating regional stakeholders from local government, industry and civil society groups; semi-structured interviews with regional stakeholders; and a desk-based review of relevant policy documents and grey literature.

More specifically the Cardiff 2050 scenarios were developed using the Retrofit 2050 City Futures scenario tool[1]. The tool comprises three archetypal visions for sustainable retrofit city futures (the Smart-Network City; Compact City, and Self-Reliant Green City), each located within a 'possibility space' describing changes in: i) land use and urban form; and ii) social values and institutions.

The Cardiff 2050 City Regional Scenarios therefore represent an exploration of how these different articulations of urban sustainability can be manifest and grounded in the economic, political, social, technological and ecological transformation processes shaping the development of Cardiff and South East Wales.

The narrative for each of the Cardiff scenarios is built upon a 'pitch' developed by the participants during the regional workshop, intended to summarise Cardiff's bid for the prize of 'best retrofit city' in a fictional future 'European Sustainable Cities of 2050' competition[2]. The very different assumptions about future population and settlement patterns embodied in the scenarios also reflect the divergent views of the expert participants in the regional workshop.

1 Eames, M et al (2013) Retrofit City Futures: Visions for Urban Sustainability, available at www.retrofit2050.org.uk/sites/default/files/resources/retrofit2050visionreport-spreads-low-res.pdf

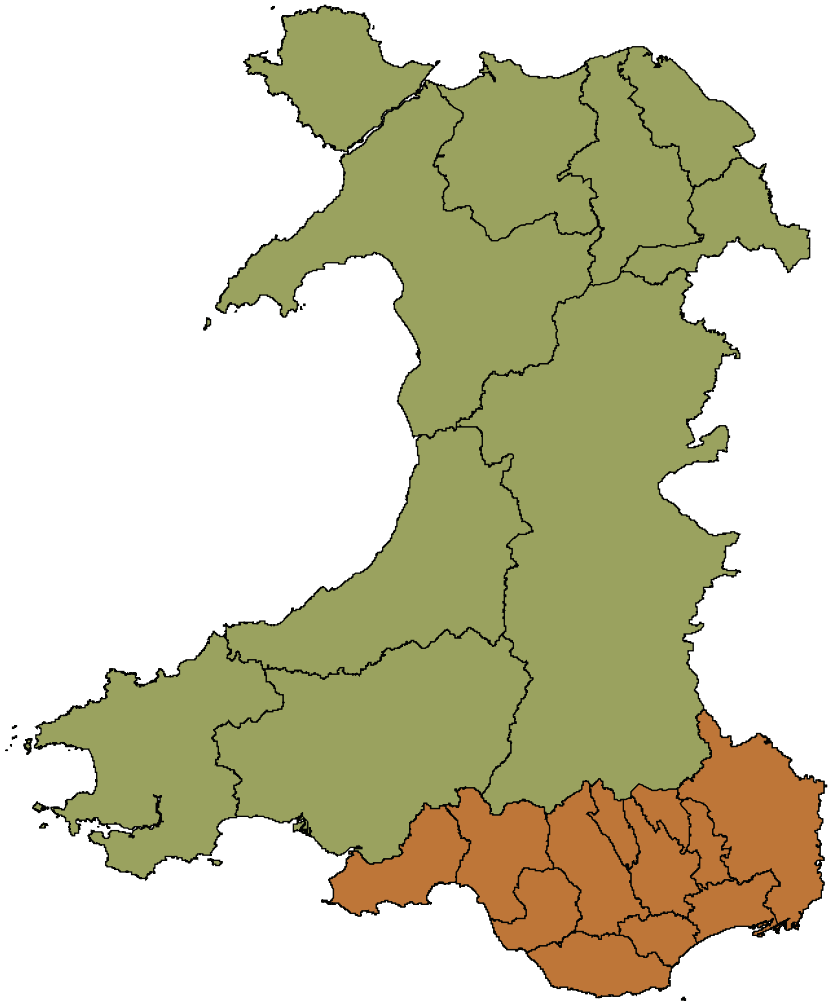
2 De Laurentis, C., Hunt, M., Eames, M., (2013), Retrofit City-Regional Futures Cardiff/SE Wales, Cardiff Scenarios Workshop Report, 17th of May 2013, WSA, Cardiff

The Retrofit 2050 Cardiff City Region

Until recently the concept of a Cardiff or South East Wales city-region was a rather nebulous one without a clear geographic or administrative boundary, or governance structure.

For the purposes of the Retrofit 2050 project we took a broad view of the city-region as including the local authorities of Neath Port Talbot and Swansea to the west. This was intended to capture the strong economic connections between the three urban regions along the south coast (Newport, Cardiff and Swansea) which differ significantly from the neighbouring rural regions of West and Mid Wales. More recently the Welsh government has announced the creation of separate City Region Boards for Cardiff South East Wales and Swansea Bay.

The Cardiff City Region, as defined for the purposes of this report, is home to some 1.86 million people. That is 60% of the Wales' population despite spanning only 17% of its area. Indeed, the three urban centres of Swansea, Cardiff and Newport account for 24% of the Welsh population. Population density varies across the project area, with Cardiff by far the most concentrated.



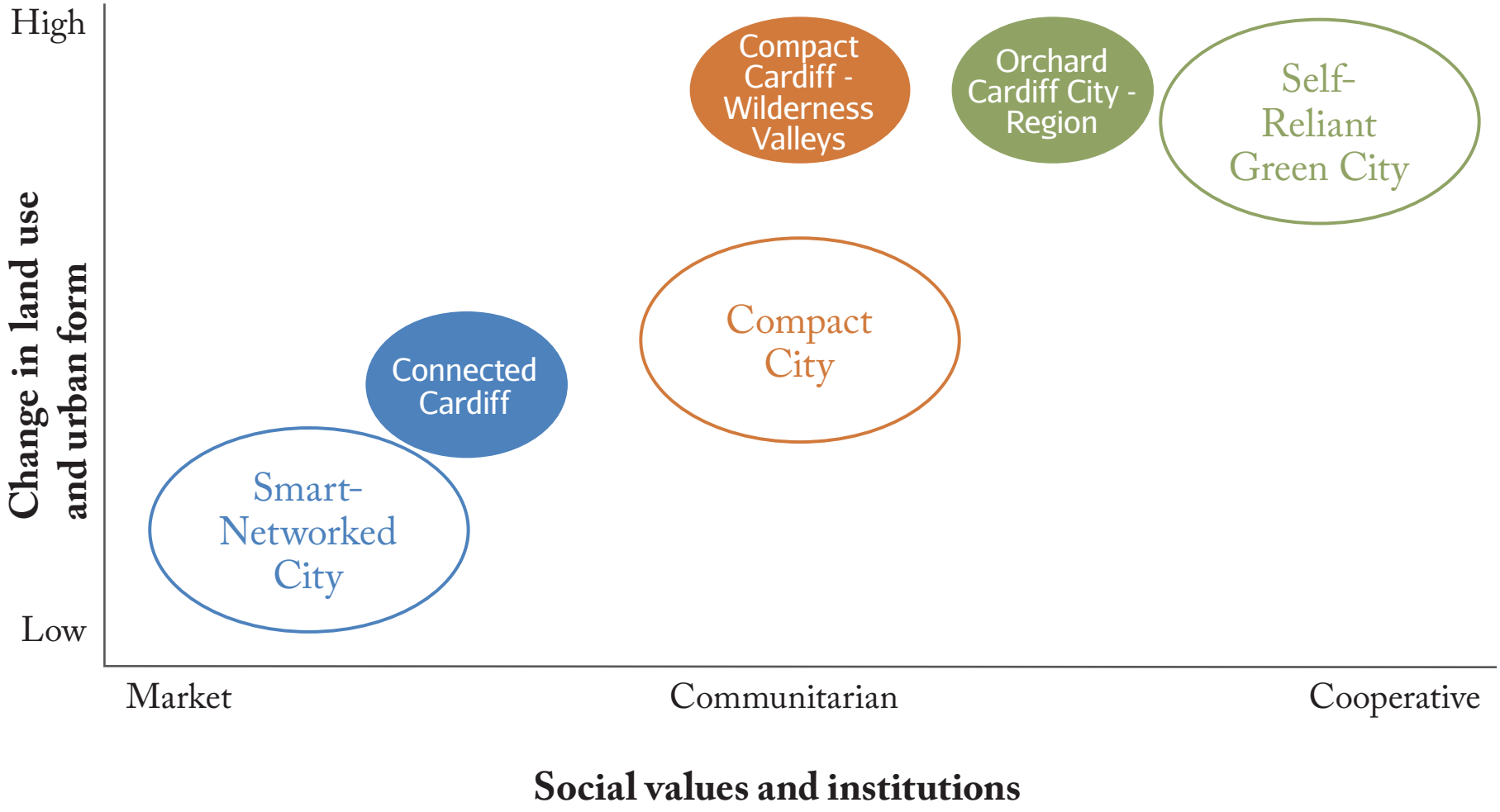
The Cardiff 2050 Scenarios

Cardiff and SE Wales can make a strong claim to have led the global transition to a carbon economy. In the mid-19th Century, the region was transformed by the rise of the iron and coal industries. Over much of the last hundred years, however, the region has undergone profound processes of de-industrialisation and economic decline. Today much of the region is relatively poor by UK and European standards. Despite these social and economic challenges, Cardiff and SE Wales form a politically and culturally dynamic city region, with a strong commitment to sustainable development and a low carbon future.

The three scenarios set out in this report each describe a long-term vision of what a sustainable future might look like for the Cardiff city region, and analyse the conditions, processes and pathways necessary for their realisation. Each represents a distinctive articulation of urban sustainability and shows how a complex set of environmental pressures, political priorities and economic drivers ranging from climate change, energy security, economic growth, population change, social equity and long-term sustainability play out across the variegated (rural, post-industrial and urban) geographies of the Cardiff and SE Wales.

Figure 1 locates each of these visions in relation to our key dimensions of change. A brief summary of each vision then follows, before each scenario is described in full.

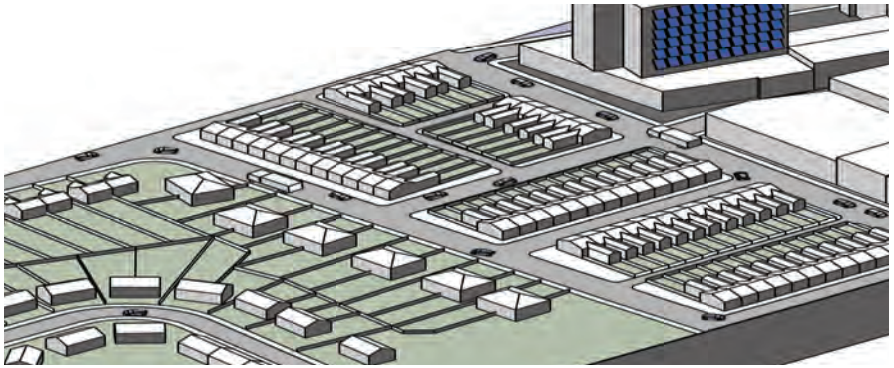
Figure 1: Locating the Cardiff 2050 Visions



Connected Cardiff

An efficient, innovative city-region with global influence

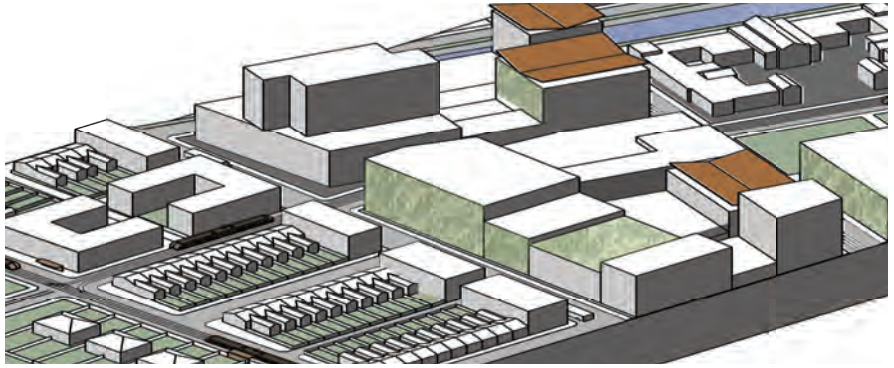
A vibrant economy focused on green technological solutions. Investment in the 2010s and 2020s drove stronger collaboration between the knowledge sector and commerce to create business clusters that are internationally competitive. Efficiency is a key policy goal, with all utilities overseen by a single body to consider resource management issues in the face of scarcity. Economic growth has underpinned investment in high quality housing, environments and social care services.



Compact Cardiff-Wilderness Valleys

High density urban areas in harmony with green hinterlands

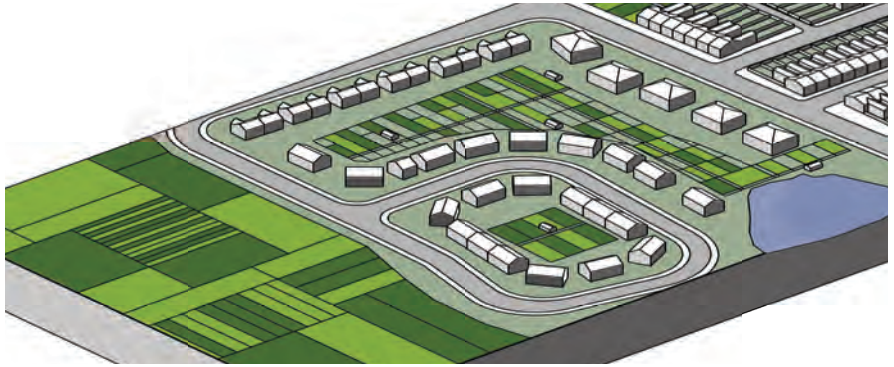
Urban centres predominantly comprise medium rise buildings based around boulevards and parks. Distinctive 'villages' within the city ensure a culturally rich region, connected by electrified rail and shared electric cars. The rural hinterland is returned to wilderness or used for food and biomass crops. Extensive investment in the 2020s – 2040s enabled rebuilding of urban centres with mixed use development and energy, water and waste networks fit for a compact city.



Orchard Cardiff City-Region

A flagship city-region championing self-reliance and community governance

Sustainability is at the heart of every policy. With far greater dialogue with communities, planning decisions are much more connected to the needs of communities. Academic research is focused on useful, practical knowledge. Half of all food eaten is produced with the city-region, with urban agriculture making a significant contribution to local employment. Priority is given to local energy production delivered by community-owned schemes.



Connected Cardiff

"Over the last forty years, South East Wales, with Cardiff at its heart, has turned itself from a regional capital into a city region with global influence. The starting point of this was a decision in 2013 to invest scarce public sector resources into much stronger collaboration between the knowledge sector and commerce. This helped foster business start-ups, and in particular encourage entrepreneurship through the commercialisation of ideas...

...This has generated over £500 billion of investment over the last forty years and fundamentally it was governed by two new organisations, the first of which is a development corporation that has successfully managed the interface between economic development, environmental management and the knowledge sector. This has created a new business culture in the city region and fostered a move away from a dependence on the public sector economy to one of true commercialisation. The second body formed was a single utility company, which brought together all the resource management issues that the region needed to manage in a world where resources were becoming scarcer. It brought together the water, energy and waste management industries into a single body that could become more efficient.

So what has this meant? Well, building on the success of the investment culture, and using 50% of the wealth generated, we have invested heavily in our connectivity networks, ICT and broadband has been a focus, as has public transport, with an emphasis on personal rapid transit. This has helped connect business clusters across the region and, building on the skills of the higher education sector, we have seen new business clusters develop in Swansea around life sciences, in the Heads of the Valleys around resource management and energy from waste, in Newport around media and ICT, and Cardiff, in the heart of the city region, providing the central business district for the region, with all professional services being located in the Enterprise Zone.

What has this meant then in terms of the communities? Well, what this has enabled us to do is to support our existing communities, build a sustainable economy, a local economy, which has helped us to invest in high quality housing, good quality environments, health and social care services. The population in each of our sub regions has increased by 50% and now we are beginning to market all our services across the globe to international markets, building on the innovation that we have created.

In terms of utilities, we have Smart Grids across the region, a single Smart Grid that combines all utilities, rather than the separate systems we had previously, and our businesses in the region are now accessing around 3 billion people across the globe.

Where do we go next? We continue to build, we continue to innovate, we now have the people resource within the region that can build on the success and we see that South East Wales, with Cardiff as its heart, will become more successful, building on the innovation sector."

Connected Cardiff Pitch for "Sustainable European City Award 2050", Retrofit 2050 project workshop

Pressures

Within the Connected Cardiff scenario, the pressures of economic competition, climate change mitigation and resource constraints are seen as opportunities for the city region to thrive with a vibrant economy that favours technological innovation, and in which 'green' growth becomes the predominant response to these threats. Urban sustainability in the city region is framed in terms of economic growth coupled with a culture of competition between city-regions at national and international levels. This requires concentrated investment in upgrading ICT and transport infrastructures, expanding housing supply for a rapidly growing population and retrofitting of the existing built environment.

Emerging Pathways

The Connected Cardiff scenario embodies a vision of the city-region as a laboratory, an experimental site, for smart living. This builds directly on current efforts to stimulate innovation and implement smart solutions in the city region. These range from investments to make Cardiff a 'super connected city', to promoting a high concentration of globally-known technological and knowledge enterprises and fostering business-university collaborations. In this future global economic competitiveness is based around the growth of business clusters across the region: in Swansea, specialised around life sciences; in the Heads of the Valleys around resource management and energy from waste; in Newport around media and ICT; and Cardiff, at the heart of the city region, providing the central business district for the region, specialising in professional services.

The current focus on improving the regions' connectivity and upgrading transport infrastructure also plays an important part in underpinning the development of this future This includes efforts to boost the role and links of Cardiff International Airport, improve connectivity between Cardiff and London/Heathrow and the proposed rail electrification to Swansea and the Valleys rail network, coupled with the development and delivery of an integrated metro style transport system that supports personal rapid transit. Further building blocks include roll out of smart grids and appliances. Despite efficiency gains total energy use in the city region remains high, with demand being met by a mix of low carbon energy sources and suppliers. Whilst private investment in building integrated renewables (particularly PV and heat pumps) drives significant growth in decentralised energy, high demand means that the system as a whole continues to be reliant on large scale suppliers.

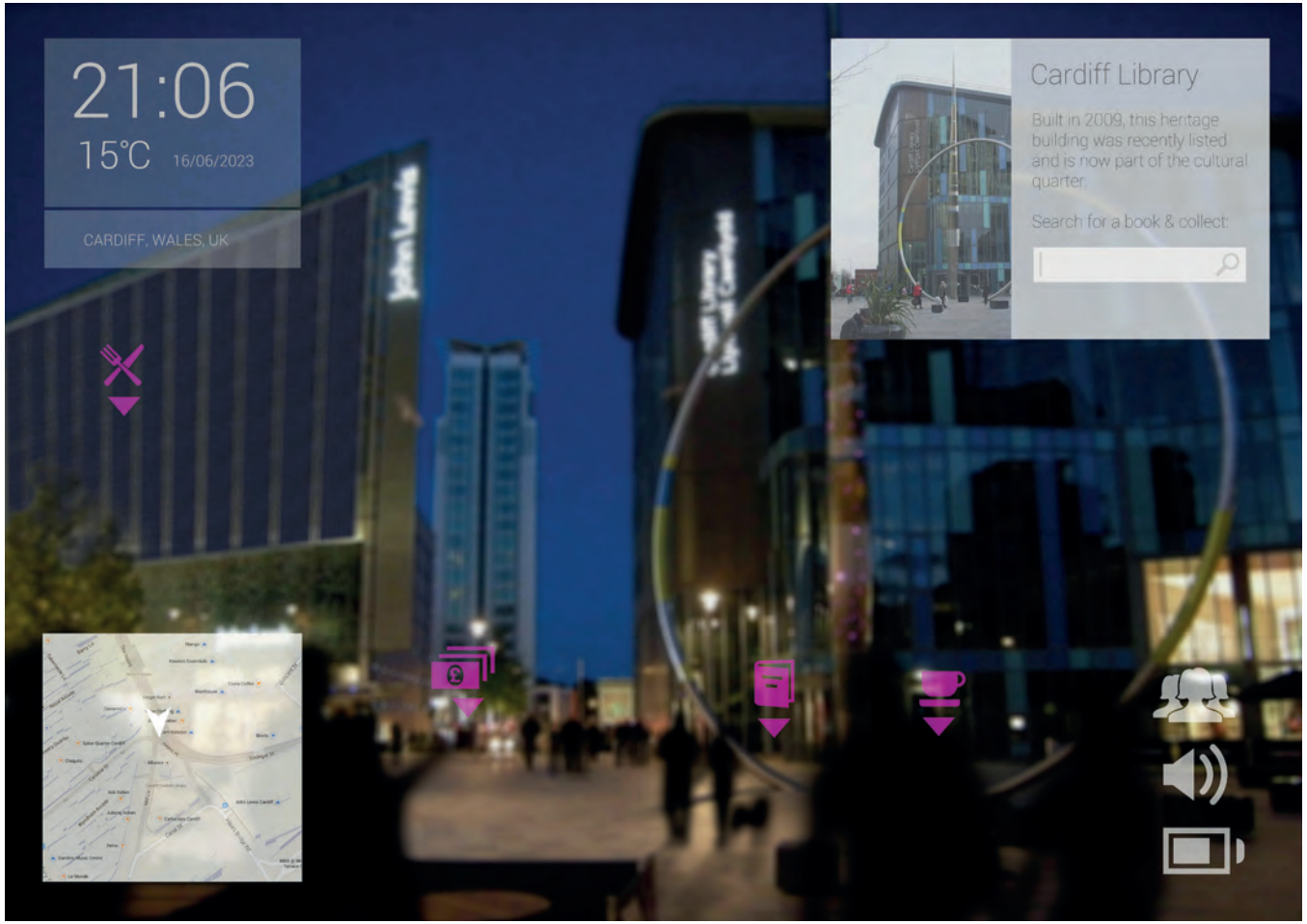
Primarily a technologically oriented future, Connected Cardiff envisages resource efficiency enhancement through the use of smart metering and smart grids and the adoption of integrated approaches to infrastructure (water, energy and waste).

Dynamics of change

Regional government plays an important part in realising the vision of a Connected Cardiff. Its role is to channel investments in building innovation capacity and to promote the city region in becoming an established node in global technological systems.

This will not only require the implementation of specific measures to stimulate innovation processes, it will also entail significant further development of and evolution in current governance structures. To overcome the imbalance and over-dependence on the public sector in the city-region economy, there is a need to develop a governance structure that sets a clear

regulative framework for fostering business start-ups and commercialisation of knowledge. State and regional interventions are required to help in providing the conditions for businesses and a vibrant business culture to thrive. Building a robust economy is a fundamental condition for realising the Connected Cardiff scenario. Innovations in public service delivery (e.g. creation of a MUSCO) and financial mechanisms (such as the creation of regional investment banks and funds) at city-regional level help to mark Cardiff out globally.



Connected Cardiff:
virtual information is integrated seamlessly into everyday life

Compact Cardiff–Wilderness Valleys

"This city is high density, which doesn't mean high rise: it means a lot of new build, medium rise properties, modern terraced properties, based around boulevards and parks, in previously unused spaces that are now more densely used. The city as a whole reflects 'villages' within the city - you've got many different regions, many more people, so it's a cosmopolitan, culturally rich area...

...Transport is an area where we've built on the success of the Cardiff city region Metro, which has extended from the initial stretch from Cardiff City, up the Valleys and across to Newport, to encompass the electrification of many other lines. This means journey times are very quick, just stopping at major population centres and bringing those who don't live in Cardiff into the centre.

The economy's very strong. In the 2020s, 30s and 40s, the process of rebuilding included bringing in a lot of mixed use development into the city. The old industrial areas of Cardiff were rebuilt to include mixed use manufacturing, housing and service industries. These good jobs in turn mean that we can afford to have good schools and thriving universities: a knowledge economy which reflects globalised aspects of the world but is also very strong in terms of focusing on the vibrant social Cardiff as well.

There have been a number of challenges: there's been an awful lot of technological, social upheaval. Nowadays a lot of the Valleys towns are uninhabited; there were arguments made in the 2030s to actually bulldoze some of these areas as well, which of course led to some significant challenges. But what we have now is a greatly increased wilderness area in the areas surrounding the main population centres in the city region. What we have in these wilderness areas is a mixture of uplands and then also the cultivation of crops for both food and for fuel.

It's a zero waste city region: nothing goes to landfill and we're importing waste from other regions which can be used in turn for heating. We have compact centres that tie in very well with the new district heating networks. Again in the 2030s we saw this huge technical upheaval in terms of ripping out old infrastructure: very expensive at the time but putting in new networks which are fit for more compact areas. We now have a sequence of tidal lagoons and barrages running along the coast from Swansea, past Newport and then of course the Severn Barrage as well. That's from a coastal perspective, and then in the upland forest we have forestry and crop based biomass alongside food.

How do people get about in the city? Well, I mentioned the Metro, but also communitarian values: there are electric pool vehicles which are commonly used for personal transport; car ownership has dramatically dropped. Cars are still there for people to use but it's on a shared ownership basis.

In summary, it's a fantastic place to live: a culturally rich, high density city with a range of different footprints across the overall region."

Compact Cardiff Pitch for "Sustainable European City Award 2050", Retrofit 2050 project workshop

Pressures

Within the Compact Cardiff-Wilderness Valleys scenario, the continuation of long-term regional trends arising from processes of post-industrial decline, coupled with emerging challenges of climate change mitigation and adaptation, are critical factors for determining the direction towards sustainability to 2050. Socio-economic pressures and resource constraints underpin the need to re-engineer the built environment, framed in terms of opportunities to transform the city-region and those places and economic activities that have historically resulted in lock-in and decline. This scenario identifies major challenges in land use and is characterised by a dichotomy between the growth of medium-to-high density urban conurbations and a more wild and sparse rural hinterland.

Emerging Pathways

The transition towards sustainability under the Compact Cardiff-Wilderness Valleys vision sees the city region adopting a variety of spatial planning instruments to manage and contain urban sprawl with important implications for future land use change. The city-region is reconfigured around a collection of high density neighbourhood centres, focussed within and around Swansea, Bridgend, Cardiff and Newport. Compactness is achieved through a number of new developments and neighbourhoods in brownfield sites and underused spaces such as boulevards (for example Lloyd George Avenue and Newport Road) and parks.

The Compact Cardiff-Wilderness Valleys scenario entails evolution in the meaning of compactness. This is understood in a way that reflects the geography and morphology of the city-region and its economic and demographic characteristics. Developing this city vision not only requires efforts in implementing infrastructure (water, waste, energy) and transport specific measures but also requires changes in the current balance between green and built areas. This requires a change in social values to make up for the loss of green spaces and to make higher density living acceptable and desirable. Large scale disruptive change is also required to retrofit new infrastructure systems, such as district heating networks, in existing urban areas such as Cathays in Cardiff.

A mixed system of energy cooperatives and utilities companies assures that all area-based solutions for energy provisions and efficiency are harnessed.

New developments are compact, built to high energy efficiency standards and in ways that maximise the opportunities offered by heat networks, emulating developments already underway such as the urban village, the Mill, on the banks of the Ely River. Existing urban areas are re-built following the same criteria and retrofit becomes part of the rolling maintenance process. Projects such as the publicly funded energy efficiency flagship project ARBED to help eradicate fuel poverty and boost economic development and regeneration in South Wales also flourish. Significant improvements are also underway in infrastructure provision at neighbourhood level: an integrated travel system supported by the city-region Metro is coupled with an integrated cycling infrastructure and car-free suburbs.

The Compact Cardiff-Wilderness Valleys scenario also involves managed retreat from coastal areas and increasing de-population of the Valleys towns. In some localised areas this means demolition rather than retrofit of 'surplus' housing. At a regional scale renewable energy is boosted by exploiting new opportunities for biomass production, and the development of community-driven hydro schemes, tidal lagoons and barrages.

Dynamics of change

Institutional and financial innovations are central to promoting the adoption and deployment of low carbon technologies and infrastructure systems in the Compact Cardiff-Wilderness Valleys scenario. The development of this city vision identifies major challenges in land use planning and regulation. It requires combined efforts in implementing specific planning measures and spatial development plans and highlights the importance of coordination across existing administrative structures. Such high coordination demands a clear regulative frame with a strong governance structure capable of enforcing clear guidelines and directions for development. A prominent role is not only played by local and regional government, but also by community-owned development and investment companies. Overall there is a shift towards much greater regional accountability within the financial sector, with the emergence of regional banks and investment funds underpinning the sustainable development of the city-region economy.

Compact Cardiff - Wilderness Valleys: Cardiff is a mixed use, higher density urban centre while the rural periphery is re-greened.

Orchard Cardiff City Region

"We have now a city government which is committed to the principles of sustainability in every element of the policies that it delivers. And more importantly than that, we've engaged with the population in a way that has ensured that there's a very mutually supportive relationship, the government and the people are united in their determination for Cardiff to be a truly sustainable city. It's the positive outcome from all of the difficulties of the past thirty years...

...One of the achievements is full employment within the region. Now, a significant number of those people are employed in food production because 50% of the food that we eat is now produced within the region. We have a low oil, high labour economy. But we're not talking about drudgery here: we're talking about a re-imagination of what work means.

One of the interesting things is that the profession of planning has changed: it's no longer an isolated ivory tower, sort of in a bubble, an inward looking kind of occupation, but the planners and the training of planners is very much linked to the real needs of the area and the community. So planners understand what the issues of the real world are in 2050 and engaging in a way that ensures that the whole economy of the area properly works.

Research that's done at the university is all about finding practical solutions to practical problems. We're particularly proud of work on energy, where we've got district heat networks ensuring high efficiency of energy use, priority to local energy production, we've got community based energy schemes. Waste is really properly recycled and minimised in every possible way. We're looking at, in terms of water, a sustainable urban drainage system that ensures that water is available. I should say that none of this city has ever been about looking backwards. We're a high tech city as well as being a sustainable city, and that is particularly evidenced in food production. As well as the huge areas we've got of food production in public land areas - some of them were formerly just underused parks - but we also have high tech, computer controlled hydroponic greenhouse towers which are themselves very visible around the city. One in particular is made out of old Range Rovers, which have been made into a huge tower in which hydroponic food is grown, and that is a massive sort of monument to what the city's all about. And it attracts tourists from all over the place to come and see this, it's sort of a monument to what we stand for.

As for transport, we have green corridors, electric cars, shared cars. Part of our achievement, as well, has been to foster a sort of society where people don't just live in little boxes and get in little boxes to go to other boxes, as a part of our adapting to the sustainable future, there's much more overlap between families and communities and a much more openness and mutual support.

So we're very much a mutually supportive as well as a sustainable city. And part of what we do is export some of our ideas: part of our economy is selling what we've learnt to other parts of the world, we've become a model, we've become a sort of a flagship of what a sustainable economy can look like. In the same way that we used to sell coal all around the world, now we sell our ideas and our vision around the world and it's created an amazingly thriving economy for the whole area. In the heart of the city, in the capital city of the area, Cardiff Castle will be used as a massive orchard and one of the biggest farmers' markets in Europe will take place there every week as a symbol for what we stand for."

Orchard Cardiff City Region "Sustainable European City Award 2050", Retrofit 2050 project workshop

Pressures

The vision of an Orchard Cardiff city region emerges as a response to the pressures exerted by systemic ecological and economic crises. It goes beyond simply reducing emissions and increasing renewable energy production, requiring major changes in the way society functions. It requires a paradigm shift in which sustainability replaces growth as a key driver for the city-region. A declining population presents opportunities for radical changes in land use. Bottom up and grassroots innovations are widespread, whilst a sustainable spatial plan at regional level provides coordination for specific interventions and actions

Emerging Pathways

The Orchard Cardiff vision builds upon a number of diverse and varied local experiments addressing local problems. It recognises the importance of the role played by communities and grass roots movements, such as Cardiff Transition Town, Cardiff Taffs Local Currency Scheme and local food initiatives that question the current economic growth imperative. This scenario highlights the importance of distributed energy and demand reduction. Local energy production and community-based energy schemes serve the dual purpose of providing green energy and embedding sustainability as a way of life. Examples such as Awel Aman Tawe Energy Project in Swansea, the Cwm Clydach Micro Hydro Development in the Rhondda Valley and the Llangattock Green Valleys initiative in the Brecon Beacon are championed and replicated. Eventually the flourishing of such initiatives allows communities to minimise their reliance on the national grid.

As the importance of such systems of community energy grows this model of shared community ownership expands to other sectors. Neighbourhood centred infrastructure for urban agriculture (including composting, land, skills and tools share) are widespread and Cardiff Castle's grounds become the home of one of the biggest farmers' markets in Europe. The rise of urban agriculture is particularly important in this vision, with 50% of all food eaten in the city-region produced there. Areas of public land such as Bute Park in Cardiff are used for food production, and new hydroponic greenhouse towers for intensive urban farming are built on vacant land within the city. All green and blue spaces are harnessed for the provision of ecosystem services. Green corridors are maintained throughout the city-region, with the boundaries between urban and rural becoming less defined. The Orchard Cardiff city region has become a flagship model of urban sustainability.

There are limits to and rationing of energy use and these are widely accepted. Locally recycled and carbon neutral or negative insulation materials are used to improve building envelopes, extending to 50% of all buildings. Small scale, low capital cost solutions for waste and water treatment and recycling are pervasive.

Dynamics of change

The Orchard Cardiff scenario envisages the role of local and regional governments as an enabler to facilitate social learning and community action. This future requires radical changes in the governance of the land-use planning system, allowing much greater local autonomy and control. At the same time the development of a regional sustainable spatial plan provides the basis for coordinating specific actions and is key in managing different zones for energy production, water management, flood protection, etc. The value shift towards community ownership is reflected in the restructuring of the region's financial system, with the emergence of

locally based cooperative banks, building societies, community investment funds and community share schemes to fund infrastructure development and renewal.

Orchard Cardiff also requires much greater interaction between universities, practitioners and municipalities to stimulate co-creation and dissemination of knowledge and innovation that is shaped towards relevant and practical results. The latest energy technologies, planning innovation and sustainable architecture principles are adopted and offer opportunities for social learning. Efforts have to be taken at all levels to shift the growth paradigm to be more inclusive and sustainable. Such efforts are monitored by a powerful elected Green Ombudsman responsible for protecting the interests of future generations and acting as policy advocate for sustainability across all fields of regional and local policy.

Orchard Cardiff City-Region: home to the largest farmer's market in Europe, a tourist destination and symbol of what the city stands for.

Scenarios Summary and Indicative Indicators

	Connected Cardiff	*Compact Cardiff - Wilderness Valleys*	*Orchard Cardiff City- Region*
Change in land-use and urban form	**Low - moderate** Continued suburbanisation	**High** Dense urban centres and 're-wilding' of rural hinterland	**High** 'Extensification' of urban and peri-urban communities
Social Values and Institutions	**Market and State** play an important role in orienting values, with emphasis on private consumption. Networked governance with regional government, public sector, local authority and intermediary organisations acting as facilitators for business. A culture of inclusiveness is promoted.	**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 communitarian values co-exist and underpin new models of participation and shared ownership; the regional government provides guidance and promotes a consensus around principle of urban metabolism. Mutualism and local self-reliance are coupled with strong concerns for social equity.
Indicative population and population changes (2050)	**2.75 million** High population growth Inward migration	**2.25 million** Moderate population growth Internal re-distribution	**1.75 million** Moderate population decline Outward migration
Household size (2050)	**1.95 persons per house** Business as usual trend	**2.32 persons per house** City centre living	**2.60 persons per house** Return to 1970 household sizes
Change in building stock composition (2014- 2050)	**640,000 New build** **770,000 Retrofitted** **30,000 Demolished**	**310,000 New build** **660,000 Retrofitted** **140,000 Demolished**	**60,000 New build** **610,000 Retrofitted** **190,000 Demolished**

	Connected Cardiff	*Compact Cardiff - Wilderness Valleys*	*Orchard Cardiff City- Region*
Pressures	Economic competition; climate change mitigation and resource constraints.	Long-term regional trends of post-industrial decline; climate change adaptation and mitigation.	Systemic ecological and economic crises; sustainability replaces growth as key driver.
'Building Blocks' of Emerging Pathways	ICT & broadband networks: 'Super connected city' 'Smart City' lab Growth of existing business clusters Electrification of Cardiff & Valleys lines Smart Metering and smart appliances Energy efficiency apps Urban energy, waste and water monitored centrally Multi-utility super grids Metro system Modal shift from car to public transport (50:50) Passive house is the norm Heat pumps in 30% of all homes	Electrified transport system Shared car ownership & car free suburbs Development of urban heat networks Retrofit part of rolling maintenance Universal water metering and water management systems Renewable energy cooperatives Demolition programmes for hard to treat and 'surplus' properties Managed retreat from coastal and upland areas Metro system Tidal Lagoons Barrages along the coast from Swansea	Integrated Metro system Neighbourhood centred infrastructure for urban agriculture Electrification of Cardiff & Valleys lines Car free suburbs Local community owned energy production Retrofit uses local carbon neutral/negative insulation materials Private rented property minimum EPC C Retrofitting sustainable urban drainage systems Public land used for food production Hydroponic greenhouse towers 100 % rainwater harvesting Pervasive small scale, low capital solutions for waste treatment and recycling
Dynamics of change (governance system)	Regional government investment in building innovation capacity allows city-region to become established as node in global technological innovation systems	Institutional and financial innovation allows adoption and deployment of low carbon technologies and infrastructure systems	Bottom-up and grassroots innovations with local and regional government acting as enabler to facilitate social learning and community action.

Insights from the Cardiff 2050 Scenarios

The Cardiff 2050 City Regional scenarios set out in this report highlight the importance of the region's natural and built environment, and its particular economic, social, political and demographic context in shaping different expectations of the city's future.

Using the Retrofit 2050 City Futures as a 'jumping off point' provided a rich and time-efficient framework for iterating and exploring a diverse set of place specific scenarios for the city region's transition to urban sustainability.

Whilst not intended as predictions, we contend that each scenario embodies relatively coherent set of plausible, often strongly contrasting, assumptions, expectations and choices about the future development of the Cardiff city region. Moreover, despite the very different values and perspectives which they embody, taken together the three scenarios also suggest a number of common insights which might form the basis of robust strategies for the future development of the Cardiff city region. Specifically these commonalities suggest particular attention be paid to the importance of:

• Innovation in local and regional governance structures to drive forward and co-ordinating systemic large-scale change;

• Developing innovative and accountable financial mechanisms and institutions capable of mobilising resources and channelling long-term investment in the city-region's infrastructure and build environment;

• Fostering and supporting large-scale experiments in the development and deployment of sustainable technologies and infrastructure systems at neighbourhood and city scales;

• Increasing the attractiveness and efficiency of public transport infrastructure, through for example investment in an integrated 'Metro' system that supports intra- and inter-regional mobility;

• Promoting a sense of place and growth of the 'sharing economy'- to enhance the resilience and efficiency of local systems of provision – from car-share schemes to community energy and food initiatives.

About the Retrofit 2050 Project

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 included 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.

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

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