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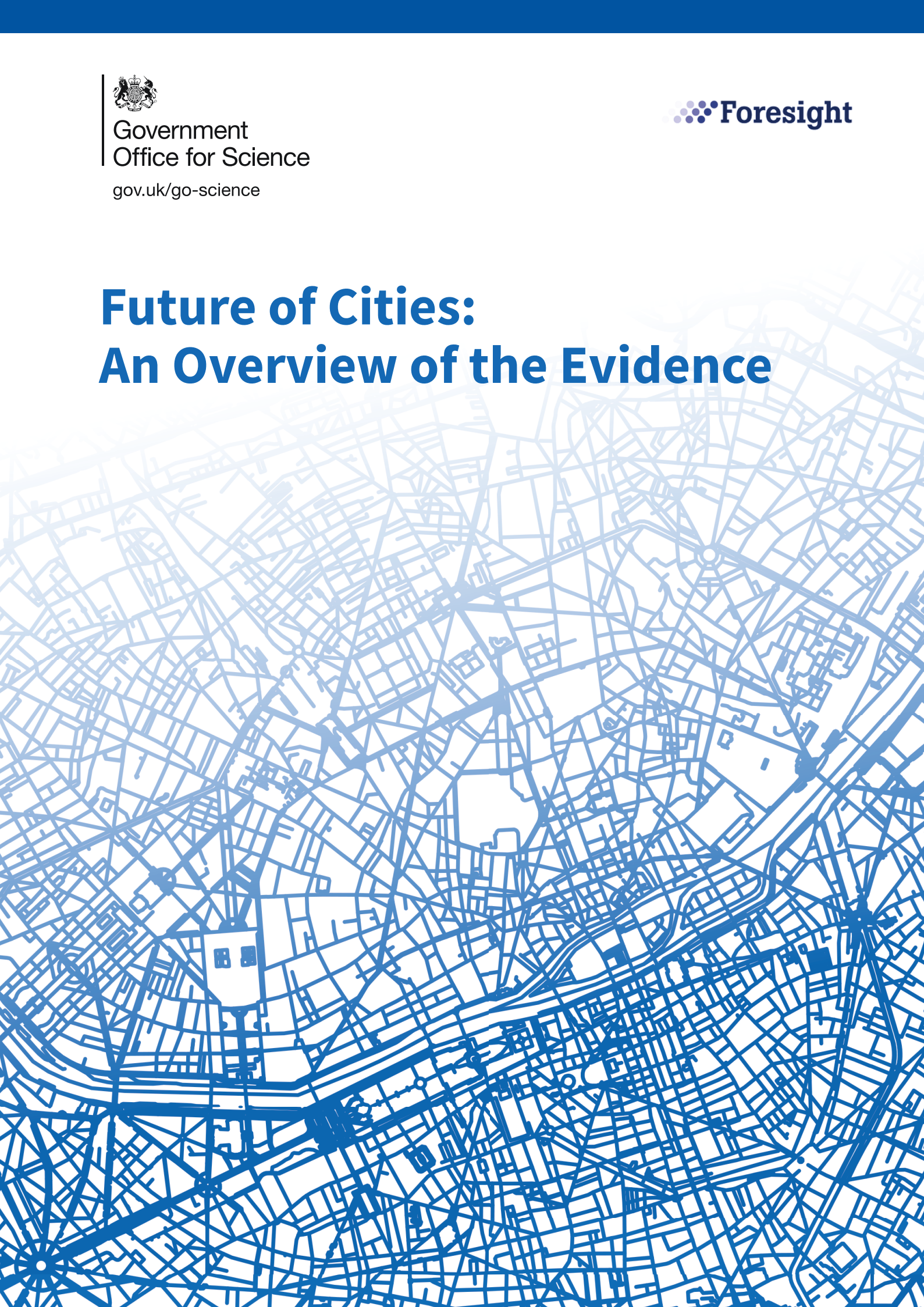
Foresight

Future of Cities: An Overview of the Evidence



Foreword

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Cities are continuously evolving, seeking to become more attractive as places to live, work and play. They are engines of economic growth as well as the key to our future health and wellbeing. It is not surprising that they are currently the subject of great focus and attention, academically and politically. In the UK, powers are being devolved to cities, which are increasingly taking control over their own futures and setting their own priorities. It is within this context that the Foresight project on the Future of Cities has explored how UK cities work today and how they will need to evolve in the future to meet the challenges and opportunities that the coming decades will pose.

Science and evidence, in the broadest sense, are key to developing a better understanding of what makes successful cities both 'liveable' and engines of economic growth. New technologies and innovative design will have a key role to play but predicting the future is simply not possible. To help cities, and the people that live in them, be more resilient and dynamic, policy makers will need to be able to think in a structured way about different possible futures, some more desirable than others.

To support city policy makers, the Foresight project has developed a peer-reviewed, interdisciplinary evidence base. Understanding the past is key to thinking about the future, so this evidence base looked backwards as well as forwards. The academic evidence has been enhanced by a series of seminars and interactive workshops which drew on the locally based expertise of those who make decisions in our cities today. This approach to evidence gathering has been critical to understanding the individuality of UK cities, as well as the commonalities.

Understanding the interaction between the local and national, and how national policy impacts differently across the UK and across cities, is critical when thinking about how cities are designed, developed and delivered. This report, and the evidence base which underpins it, make an important contribution to that understanding and I am indebted to the many authors and experts who contributed throughout the project to develop it.

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Context

The Foresight Future of Cities project was launched in June 2013 and run by the Government Office for Science. From 2010, the UK Government was rapidly developing a path in which an increasing range of negotiated powers were devolved to some cities and city-regions, making it an appropriate time to use the project to systematically explore drivers of change, options, and imperatives for the longer term future of UK cities.

At the same time, and in parallel with the Foresight Future of Cities project, a vast and diverse body of research and policy development work was produced by think tanks, universities, research institutes and commissions. This work was aimed at influencing possible future directions for UK urban policy and city development. There is no lack of ideas about the future of cities. The extensive expertise and understanding of UK cities, and what might ensure they are prosperous, healthy places in future is impressive, as well as encouraging. Building a clear framework for cities to succeed and prosper has been, and should continue to be, a collaborative process.

All cities are unique, and this diversity means that there is no 'one' future of cities or model pathway to follow: those concerned with the future of a given city, or system of cities, will have to forge their own paths and do their own future thinking. Whilst predicting the future is impossible, the current phase of dynamic urbanisation and re-urbanisation means that it is certain that it will be substantially different from now.

Project Focus: a long-term view of the future of UK cities in 2040 and 2065

In this context, the Foresight project has made a distinctive and specific contribution to the UK cities agenda by taking a longer term view of the future of cities. From a policy maker perspective, this is crucial as they need be able to navigate complex decisions, in a constantly changing environment, which will have impacts over a long timeframe. These decisions typically transcend sectors and areas of service delivery. For example, we are still living with the health impacts of the decision to promote car-oriented design in cities almost 50 years ago, and our cities are still adjusting to de-industrialisation processes that started in the 1960s.

To make effective decisions, policy makers need robust evidence about cities. The Foresight Future of Cities project combined traditional evidence gathering with expert insights from city officials, practitioners and decision makers. These were gathered through seminars and interactive workshops held by the Project Team and Lead Expert Group in over 25 cities across the UK.

The academic, peer-reviewed papers, as well as shorter essays and the outputs of seminars and workshops, were published throughout the project. This extensive

output can be found at https://www.gov.uk/government/collections/future-of-cities. But as cities constantly change and evolve so does the evidence base. Enhanced understanding and insights are being developed all the time and new solutions proposed. Therefore, even the best evidence gathered will only be a snapshot in time, quickly superseded by the next project or report. In this constantly shifting, fast-paced environment, the Foresight project identified that decision makers also needed methods for analysing new evidence as well as tools to help them consider the long run impacts of the decisions they take today.

Project Impact: methods and tools for decision making

As a result, the project focused significant attention on interactive workshops which used easily replicable methodologies and tools to draw practical conclusions about the future of cities at a national, local and sectoral level. To support this and refine these methodologies, the project established the 'City Visions Network'. Over 25 cities joined, alongside national government officials, academics, urban designers, practitioners, business representatives and third sector organisations to provide unique perspectives and insights as well as understand commonalities about cities. Six cities led the way by running their own Foresight projects and in the later stages of the project, Milton Keynes Council launched their 2050 Futures Commission, drawing on the expertise of the network, as well as the Foresight project team. Detail of this city-level work can be found in the accompanying *Foresight for Cities* report.

As this work progressed it was clear that a high degree of collaboration and integration is required in most of the important issues affecting the UK's internal development. Central and local government will need to forge new and agile ways of working together to help tackle both local and national challenges. Inspired by the Cabinet Office's work to open up national policy making, the Foresight project conducted a place-based open policy making experiment.

The starting point was the repeated concern cited in our seminars and workshops that too many of the UK's graduates appear to gravitate to London, at the expense of other UK regions. The project reviewed the evidence, noted the important policy developments already in train, and then considered what practical innovations might be mounted to tackle the issues involved. This experiment brought together six cities, with their universities and central government departments, in an action group focused on working out how more UK city-regions could be attractive to graduate talent. The details of this work are contained in another accompanying report, *Future of Cities: Graduate Mobility and Productivity*.

Towards the end of the project, whilst the evidence base the project had gathered was extensive, it was apparent that there were still gaps in our understanding of cities. The project held an interactive workshop with all of the academic experts it had consulted over the last three years, as well as leaders from the major urban research initiatives within the Research Councils, to develop an agenda for future urban research, *The Science of Cities: Future Research Priorities*.

Whilst the Foresight project has formally ended, the aspiration of the Lead Expert Group and Project Team is for the project to continue to inform the future of cities, through the use of these methodologies and tools and through the ongoing research agenda.

How to use this report

To provide an overview of the entire evidence base gathered during the Foresight Future of Cities project would require a report many times the length of this one. Rather, this report is a navigation tool. It is a resource which can be drawn upon by those wishing to get a holistic overview of the main challenges facing UK cities today, as well as by decision makers looking to access detailed, focused evidence and analysis on a specific topic. It provides the following;

- **A high level framework for analysing the evidence base** on cities and addressing the complexity and interdependencies within it,
- **Signposting to deeper analysis on specific topic** , particularly the working papers commissioned by the project which provide historical analysis and exploration of the future through scenarios,
- **Identification of ten key challenge** from the evidence base which the project feels will be particularly important to the future of UK cities,
- **A focus on the trends and areas of uncertainty** in relation to these challenges.

Structure of this report

The high level framework for analysing the evidence base on cities and addressing the complexity and interdependencies within it is made up of six themes which are summarised below. Each theme has a separate section in this report.

Framework for analysis

1. Living in cities encompasses people in the urban environment, including health, lifestyles, belonging and identity, culture and behaviour alongside housing, social disparities, public services and demography.

2. Urban economies looks at the aggregate economic performance of the national system of cities, the performance of individual city economies, including skills, labour market performance and a city's relationships to other systems (such as the European and global system of cities).

3. Urban metabolism and climate change looks at the stocks and flows through the urban environment, in terms of energy and resources but also more broadly where possible. It also includes the implications of climate change for cities and topics such as ecosystem services.

4. Urban form examines the physical characteristics that make up built-up areas, including the shape, size, density and configuration of settlements at all scales. This includes issues of physical accessibility within and between cities via public and private transport.

5. Urban infrastructure systems cover the provision of energy and water resources that society needs to function, and enable people, information and goods to move efficiently and safely. This includes energy, transport, water supply, waste, ICT, cultural/social, green and blue infrastructure.

6. Urban governance includes issues of leadership, governance boundaries, structures, relationships between local and central governments, planning, place-making, aspects of public services and public finances.

This overview report sits alongside, and complements, three other reports from the Future of Cities project. Each demonstrates how the evidence gathered throughout the project can be used to catalyse action in relation to the future of UK cities;

- *Foresight for Cities* – sets out the benefits of evidence-based, long term thinking and developing a vision for the future for UK cities. This resource also offers practical lessons for implementing and managing a city foresight process and is aimed primarily at local government officials and partners.

- *The Science of Cities and Future Research Priorities* – examines what science can offer to understanding the future of cities, and in what direction research could most usefully be focused in future.

- *Future of Cities: Graduate Mobility and Productivity* – The Foresight project used an experimental approach of place-based, open policy-making to consider the topic of graduate mobility, which is an important element of high-skilled labour mobility and productivity (Challenge 5 in this report). This encouraged collaboration between national government and key local actors including local government, universities and employers to meet national challenges.

Executive Summary

Cities matter to the UK's future. They are already concentrations of population and employment, and will be home to much of the country's future population and economic growth. Cities are centres of commercial, cultural, institutional, and socia life. In short, they are both central to the shaping and delivery of national policy objectives, and the locations where broad social, environmental and economic changes play out in practice.

UK cities are highly diverse, each with a distinctive history and its own set of relationships with its neighbours and with central government. These unique relationships and systems make it difficult to generalise the future development of cities. This Foresight project has developed a broad evidence base and consulted local actors to understand challenges and opportunities from those most experienced in the issues affecting UK cities. The single theme which runs throughout this work is providing the best possible evidence for national and city level decision-makers.

A global agenda for cities

In addition to the scale and speed of global urbanisation, there are four reasons why the future of cities has been a growing global concern since the financial crisis.

1. Policy-makers at many levels and scales have recognised that cities will host the vast majority of future population and economic growth. If nations as a whole are to prosper from the shift to a dominant urban mode, cities need to be configured to achieve improved liveability and inclusion, and positive productivity and competitiveness outcomes.

2. There is now a widely understood historical record about the successes and failures of the last 150 years of urbanisation, especially in Europe and North America. This has raised awareness about the risks of regional economies entering negative path dependency, becoming too narrowly specialised, having unsuitable governance arrangements, or experiencing lock-in to unfavourable spatial patterns and transport development choices.

3. The specific risks and imperatives of carbon emissions, climate change, natural disasters and resource constraints are becoming clearer, especially at the city level. City and national governments are now under pressure to provide a vision of genuine sustainability and capacity to resist and recover from seemingly inevitable shocks and disruption.

4. Cities are now seeking to make the case for investment and fiscal decentralisation to fund large-scale reconstruction, renewal and a resilient and adaptable urbanisation based on 21st century design and life-cycle finance principles.

Key challenges and opportunities for UK cities

The evidence base suggests that almost all UK cities will face ten common challenges to some degree:

1. **Leveraging available data on city processes**. With data allowing more rapid and detailed feedback on policy impacts, there is emerging potential for increasing the efficiency of public service delivery. How can local governments make best use of the data available?

2. **Changing demographics**. How might the size of UK cities change in the future?

3. **Ageing population**. Given the increasing proportion of older people living in urban areas, how could cities provide attractive living and working environments for an ageing population?

4. **Divergent economic performances**. Economic performance varies across UK cities. Which sectors might increase employment opportunities outside the greater south-east and what supporting infrastructure could be required?

5. **High-skilled labour mobility and productivity**. How can cities attract and retain an appropriate mix of skills beyond the provision of employment opportunities?

6. **Integrating systems to make cities liveable**. There are increasing correlations between cities' well-being, liveability and economic performance. How do different patterns of spatial development enhance the liveability of UK cities?

7. **Managing risks to city environments and resource supply**. How should action within and beyond city boundaries reduce resource dependencies and carbon footprints?

8. **Increasing housing pressures**. How could city spaces be planned and developed to help meet housing demands as cities grow? How can we make successful places in 2065?

9. **Differential connectivity levels between and within cities**. How could enhanced transport links impact city employment levels?

10. **Changing ideas about decision-making and accountability**. What could devolution mean for civic participation and how people will be represented in cities and city-regions?

Some of these challenges can be addressed, or at least alleviated, through targeted action by collaborations of relevant parties. It is important to note that the above challenges are diffuse in their nature, for example, some may require 'designing out' over time or using whole-systems approaches to city planning and governance – but collaboration and experimentation are likely to be important in each case.

Foresight has developed a prototype for addressing these challenges using an experimental approach of *place-based* open policy-making. Graduate mobility is an important element of high-skilled labour mobility and productivity (challenge 5), and is the focus of a complementary Foresight work stream undertaken with national government, cities, universities and employers. The result of this collaboration is five interventions being taken forward in UK cities to improve the ways that cities work with their graduates. Further detail can be found in *Future of Cities: Graduate Mobility and Productivity*.

Future trajectories for UK cities

Extrapolating trends can be a useful starting point, but it is important to emphasise the inevitable uncertainty in the future of cities. Cities will face pressures and shocks over the next 50 years and there will always be surprises, opportunities, disruptions[17] [18] and unpredictable developments. For example, emerging trends might suggest that driverless vehicles could be in widespread use in cities over the coming 50 years. One outcome of such a scenario could be that high-value real-estate, currently used for car parking, would be freed up for higher value uses. However, there are multiple uncertainties in this outcome – not just relating to the vehicle technology, but also to the social context of cities which may lead to quite different outcomes.

Futures tools, such as scenarios or roadmaps, can stimulate discussion about how the social context and behavioural response might play out in different ways. This can help policy-makers make resilient decisions today, which will have beneficial impacts in the long-run. The project's *Foresight for Cities* resource provides guidance on the techniques and benefits of using such futures tools at the local level.

Commissioned evidence for the Foresight Project

1. Champion, T. (2014) *People in cities: the numbers*. London: Government Office for Science[1].

2. Champion, T. (2015) *What do the latest official sub-national population projections suggest for Great Britain's 63 cities?* (An addendum to 'People in Cities: the numbers.) London: Government Office for Science[2].

3. Clift, R., Druckman, A., Christie, I., Kennedy, C. and Keirstead, J. (2015) *Urban metabolism: a review in the UK context*. London: Government Office for Science[3].

4. Dunn, N., Cureton, P. and Pollastri, S. (2014) *A visual history of the future*. London: Government Office for Science[4].

5. Edwards, M. (2015) *Prospects for land, rent and housing in UK cities*. London: Government Office for Science[5].

6. Harding, A. and Nevin, B. with Gibb, K., Headlam, N., Hepburn, P., Leather, P. and McAllister, L. (2015) *Cities and public policy: a review paper*. London: Government Office for Science[6].

7. Martin, R., Gardiner, B. and Tyler, P. (2014) *The evolving economic performance of UK cities: city growth patterns 1981-2011*. London: Government Office for Science[7].

8. Martin, R., Gardiner, B. and Tyler, P. (2016) *Divergent cities in post-industrial Britain*. (An update to 'The evolving economic performance of UK cities: city growth patterns 1981-2011.) London: Government Office for Science[8].

9. Moir, E., Moonen, T. and Clark, G. (2014) *What are future cities? Origins, meanings and uses*. London: Government Office for Science[9].

10. Pratt, A. (2014) *Cities: the cultural dimension*. London: Government Office for Science[10].

11. Rapoport, E., Acuto, M., Chilvers, A. and Sweitzer, A. (2016) *The future of city leadership in the United Kingdom*. London: Government Office for Science[11].

12. Ravetz, J. (2015) *The future of the urban environment and ecosystem services.* London: Government Office for Science[12].

13. Slack, E. and Côté, A. (2014) *Comparative urban governance*. London: Government Office for Science[13].

14. Thompson, M. and Beck, M. B. (2015) *Coping with change: urban resilience, sustainability, adaptability and path dependence*. London: Government Office for Science[14].

15. Urry, J., Birtchnell, T. Caletrio, J, and Pollastri, S. (2014) *Living in the city*. London: Government Office for Science[15].

16. Williams, K. (2014) *Urban form and infrastructure: a morphological review*. London: Government Office for Science[16].

All working papers have been commissioned by the Foresight Project: The Future of Cities and have passed a double-blind peer review process.

The views expressed in these papers are the views of the authors and neither represent the views of the Government Office for Science nor the policy of the UK Government.

Project reports and papers are freely available to download at: https://www.gov.uk/government/collections/future-of-cities

Introduction: Shaping the future of UK cities

'Future cities' have been talked about – and visualised - for hundreds of years, as urban areas around the world have been imagined, planned, built, adapted and analysed. One of the most high profile visions in the UK is Ebenezer Howard's Garden City in 1903 (Figure 1 below), but there have been many more (Figure 2 below).

Figure 1: Ebenezer Howard's Garden City 1903[19]

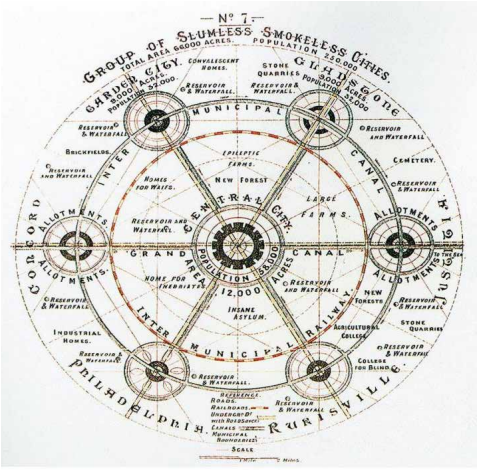
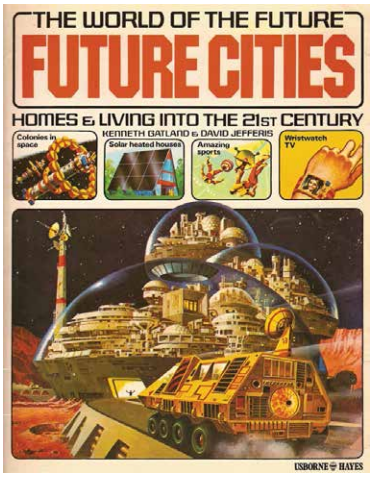


Figure 2: Reproduced from Future Cities by permission of Usborne Publishing.[20]



Not all of these visions came to pass of course, but they were driven by a strong impulse to transform our relationship with urban space[4]. They challenged the prevailing conditions and problems of cities of the time and sought to produce spaces conducive to different ways of living. The Foresight project commissioned work on *'A Visual History of the Future of Cities'*[4], which recognises the impact that visualisations and descriptors can have on how cities of the future develop.

The Future of Cities: agendas, terminologies and meanings

Architects, academics, planners, policymakers, businesses, charities and citizens (amongst others) have always been concerned with the futures of cities, focusing on actively shaping and managing urban areas to achieve positive productivity, liveability, and sustainability outcomes.

As a result a vast range of terms and ideas now make up the 'future city' lexicon. They reflect different stakeholder and interest group conceptions of the ideal city of the future. The popularity of individual terms, and indeed the meanings ascribed to them, have waxed and waned over time amongst academic, business, policy and civic communities[9].

For example, the 'Future of Cities' agenda is distinct from 'Future Cities' which tends to focus on the social and environmental dividends of utilising digital infrastructure and systems in city management. Considerations around the 'Future of Cities', by contrast, are more investigative and diagnostic, exploring alternative future drivers and scenarios. They focus on the spatial, governance, and infrastructure challenges of a global economy and society which is urbanising[21].

Figure 3 illustrates just a few of the terminology and conceptions of success which are most widely used by those working in specific city-related fields, or concerned with particular future city outcomes. Sometimes terminology or phrases take on both narrow and wide meanings when used by different audiences. For example 'smart cities', when used in a narrow sense, refers to the way Information and Communication Technologies (ICT) can improve city functionality, proposing that use of the right hardware, software and technology platforms can solve many or most urban development challenges. However, a broader conceptualisation of smart cities – more commonly considered by academic and policy user groups, rather than corporates – places emphasis on good city governance, empowered city leaders, smart or 'intelligent citizens' and investors *in tandem with* the right technology platform[9].

Figure 3: Future cities – conceptions of success.

ENVIRONMENTAL	SOCIAL	ECONOMIC	GOVERNANCE
Garden cities	Participative cities	Entrepreneurial cities	Managed cities
Sustainable cities	Walkable cities	Competitive cities	Intelligent cities
Eco cities	Integrated cities	Productive cities	Productive cities
Green cities	Inclusive cities	Innovative cities	Efficient cities
Compact cities	Just cities	Business friendly cities	Well-run, well-led cities
Smart cities	Open cities	Global cities	Smart cities
Resilient cities	Liveable cities	Resilient cities	Future cities

Source: Adapted from Moir, E., Moonen, T. and Clark, G. (2014) *What are future cities? Origins, meanings and uses*. London: Government Office for Science.

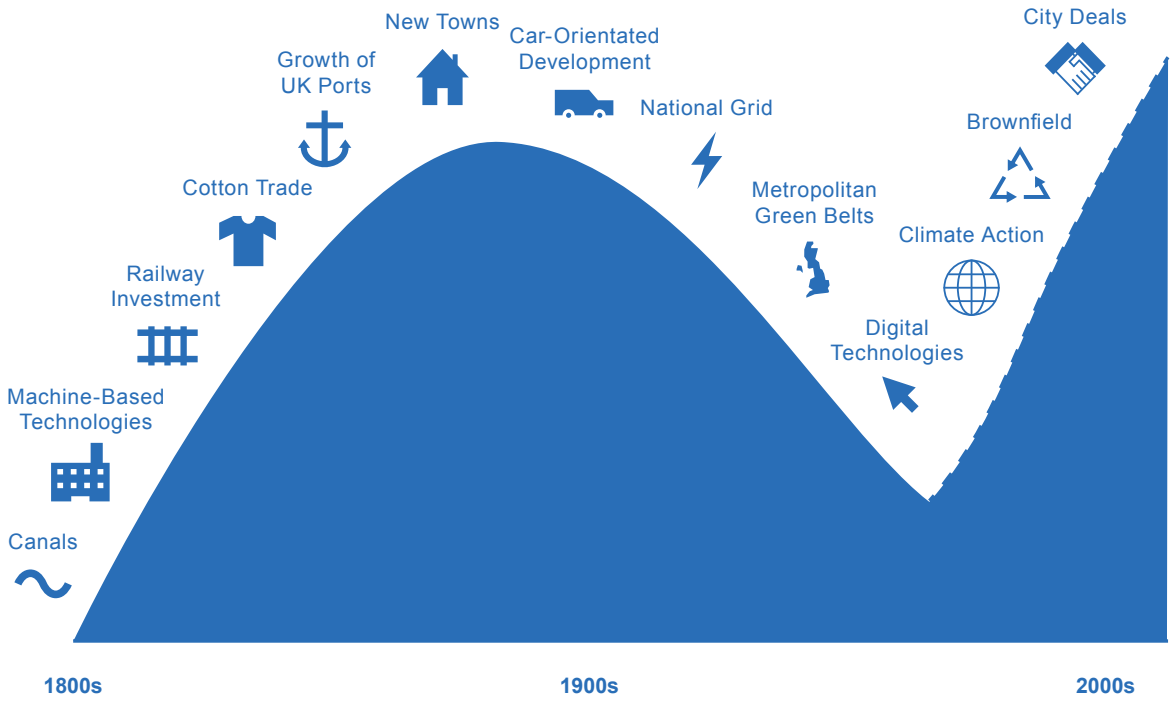
The Future of UK cities: Setting the Scene

Where are we now?

Historically one of the most centralised countries in the world, the UK is now undergoing devolution which presents an opportunity to do things differently. Over the coming 50 years, almost all government policies are likely to affect cities, whether explicitly or implicitly. Decisions taken now will determine the health, wealth and resilience of cities and the nation in the future. Cities are the contexts in which services are delivered, policies are enacted and investments are made, so well-informed national policy built on robust evidence will help create better cities which can add value to national policies.

There have been many urban developments in the UK in the past 200 years (see Figure 4). Cities have increasingly shifted away from manufacturing-based industries towards a knowledge-based service economy, including finance, information communication technologies (ICT) and creative industries. Cities are at different stages in this transition[7 16], and London's transformation is the most advanced in the UK.

Figure 4. Selective representation of two centuries of key UK urban developments



Source: Foresight

In the past, UK cities have been perceived as places affected by economic, environmental and social problems. Explicit urban and regional policy has at times sought to help parts of the UK overcome these challenges (particularly inner cities, which were often worst affected) with varying degrees of success and some unintended consequences[6]. The repopulation of former industrial areas gained momentum in the 1990s with large-scale dockland and riverside redevelopments and gentrification. This was followed in the 2000s by the development of high-density apartments in city centres and infill/backland schemes throughout the urban fabric[16], and planning policy has at times been targeted at the redevelopment of brownfield land, particularly in the early 2000s[16 5].

In the UK today, as well as around the world, cities are now widely recognised as critical assets in supporting major national policy objectives, playing a fundamental role in national social and economic life. Cities can be many things:

Economic assets	Social hubs	Environmental beacons
Locations to drive trade, productivity, and innovation by providing connectivity and proximity that can't be easily achieved elsewhere	Places to increase standards of living, promote social mobility, tackle social disparities and improve social cohesion	The most resource efficient way to accommodate growing populations, and to reduce environmental impacts, if they are well managed and resourced

What can we know about the future?

All cities, including those in the UK, are unique and this diversity means that there is no single future of cities or model pathway to follow. Whilst it is not possible to predict the future with precision, the current phase of dynamic urbanisation and re-urbanisation means that it is likely the future will be substantially different from today. Cities are complex and unpredictable systems, so established trends will not necessarily continue into the future and cities will inevitably face developments and shocks over the next 50 years that we cannot foresee[18 19]. These include global 'landscape' changes such as geopolitical events and natural hazards, which cities cannot predict or influence, but uncertainty does not always mean there will be negative consequences. There will also be unforeseen opportunities, which cities can capitalise on.

Science and evidence can help us understand something about these possible future directions and provide decision-makers with key considerations to bear in mind when developing policy[21] [22]. An important part of this process is to take stock of how cities have developed to the present and use these trends to help identify plausible future trajectories and scenarios, some of which may be less appealing to policy makers than others. Considering a range of different futures for UK cities can reveal whether decisions being made today are likely to support preferred outcomes in the future.

The Cities project therefore commissioned evidence to look backwards, before looking forwards. The historical horizon was the same as the future horizon: 50 years. This provided the critical context for understanding how UK cities could develop in the future, looking across different spatial systems. The project evidence base indicates that the future will see changes in how UK cities look physically, although the fastest changes are likely to be in the ways people live, move, behave and interact in cities. For example, the types of employment they have, the ways they commute and collaborate, how they are governed, they types of food that they eat and where it comes from.

Systems and Interdependencies

Over the last decade national governments, across the globe, have started to think about the future of cities, for example Brazil created a Ministry of Cities in 2003 and in 2004 the Indian government launched an independent Ministry for Urban Development[23]. In the UK, the government created a new role of Minister of Cities in 2011, charged with considering the impact of policies on Britain's urban areas.

This trend reflects a growing realisation that policymakers need to plan for the future of individual cities as well as a national system of cities. Increasingly it is seen as national governments' role to try to actively support the whole national system of cities with effective system level policies in areas such as connectivity, regulatory, institutional and fiscal frameworks. As economies develop, national governments are also expected to pay attention to knowledge production and complementary 'eco-systems', asset endowments and specialisations[23].

A system of cities

Cities exist in interdependent regional, national and continental systems, whose sizes and relationships determine each city's functions, specialisms and opportunities for evolution. These systems interact with each other to foster a system of systems within the city that includes: land use, transport, waste, water, energy, soft and hard infrastructure and social, economic and environmental processes. Understanding these city systems and working to integrate them is key to city progress. For example, in Singapore, Copenhagen, London and Bogota engineers, utilities and telecoms providers work together to ensure road works

optimise efficiency and minimise disruption. This reduces costs for citizens and businesses and illustrates the benefits of conscious coordination within cities. The project has focused on the interdependencies in these systems to help understand diverse links between them and some of the cross-cutting topics.

National systems of cities can be polycentric* or they can be dominated by one particular city in the system. Country size, character of economic development, and the nature of governance systems play significant roles in shaping how national systems emerge and evolve. In many countries around the world, larger cities often have more diversified and service-oriented economies. Their greater scale can mean they have more potential to create new firms and encourage mature or lower value-added industries to move elsewhere. Smaller cities, on the other hand, are often more specialised in either industry or services and can be highly innovative, although they may produce or trade in more standardised goods. They may remain competitive by supporting larger cities, either by hosting relocated sectors, by offering service support functions, or by developing complementary specialisations.

The UK System of Cities

In the UK, the system of cities is characterised by the concentration of a significant proportion of the national urban population, wealth, financial flows and production in London. London is by far the largest city within the UK. However, it does not function alone in the system, drawing on a wider network of small and medium sized cities including Reading, Milton Keynes, Oxford and Cambridge to form a metropolitan area of approximately 20 million people. Managing and connecting the growth of the London mega-region will present both challenges and opportunities over the coming 50 years.

Outside London and the greater south-east, the UK has multiple systems of cities which vary in their economic make-up, demographic composition and politics. For example, large metropolitan areas have emerged around the UK's core cities**, including Manchester, Leeds, Liverpool, Sheffield and Newcastle. The combined assets of this system could be augmented through greater connectivity and devolution of governance arrangements which would enable the region to work together as a polycentric and clustered region for growth and investment.

Foresight's evidence shows that smaller UK cities performed more strongly over the past 30 years[7]. During the coming 50 years, enhancing smaller cities and developing new small cities as locations of competitiveness and productivity will also be critical to addressing national imperatives.

* Polycentric cities - are organised around several political, social or financial centres. In the UK, Stoke is an example of a polycentric city, having been formed by a federation of six towns in the early 20th century.

** Core cities - Core cities are the 10 economically largest areas in England, Scotland and Wales outside of London: Birmingham, Bristol, Cardiff, Glasgow, Leeds, Liverpool, Manchester, Newcastle, Nottingham and Sheffield.

UK cities are also embedded within a *global* network of cities, characterised by continuously increasing levels of inter-city connectivity, exchange and competition. UK cities host many global company headquarters, comprise major global cultural and tourism destinations, and are deeply embedded within the internationalisation of capital. London is most prominent and influential, but all UK cities play a role in the international system.

Cross-cutting topics

The Future of Cities project has considered the main drivers of urban change within the multiple and complex systems acknowledged here. The following three examples demonstrate topics which cut across the six themes which provide the analytical framework for the project, yet are directly impacting the development of cities now and in the future. These are data, technology and health.

Key challenges and opportunities from the evidence

Leveraging available data on city processes - With data allowing more rapid and detailed feedback on policy impacts, there is emerging potential for increasing the efficiency of public service delivery. How can local governments make best use of the data available?

Data

New data is being generated on an enormous scale and nowhere more so than in cities. Many everyday activities and interactions within urban environments can be harnessed to generate a variety of data, ranging from apps and social media to satellite imagery. It is not just the quantity but also the veracity of data which is increasing – emergent information technologies show what people do, not just what they say they do. From autonomous vehicles to intelligent lampposts, to industrial bins which tell the relevant Local Authority when they are full, to using online journey planners to inform transport timetabling, cities are already successfully demonstrating the value of data and analytics.

To make sense of this vast data-flow, it is necessary to develop better ways to analyse it. Just as important then as new data-generating technologies are emergent new methods of analytics, such as machine learning, data-mining, pattern recognition, profiling, simulation and optimisation algorithms.

Cities can increasingly be seen as a key challenge – a modern-day ‘enigma code’. Harnessing data and analytics to make sense of the patterns within this code and thus cracking the ‘science of cities’ is a key future challenge. These ideas are explored in *The Science of Cities Future Research Priorities*.

A key new source of data emerging is the Internet of Things (IoT). Cities will be a major test-bed for the proliferation of the IoT on the managing, planning and operation of assets. IoT is essentially the general phenomenon whereby digital networks are connecting up infrastructure, appliances and people through various digital devices.

It is estimated that 50 billion such devices will be connected by 2020[24].
There are three main types of IoT interaction:

i. Machine-to-machine (e.g. sensor-controlled mechanisms)

ii. machine-to-people (e.g. online purchases, Radio Frequency Identification (RFID) cards such as 'Oyster' cards)

iii. People-to-people (e.g. through Skype, Twitter etc.)

These interactions have the potential to transform how public, private and community services are delivered and how people interact with each other and their environment. The capabilities to analyse and use this data and to act on the resulting insight must be in place before this vision of the future can be realised. Further discussion about the implications of this for government at all levels can be found in the paper the project produced for the Smart Cities Forum, *Data and Analytics: Resources for Cities*[24].

Technology

Technologies are not just materials and devices, but socio-technical systems. They are configurations of people and things that 'work'. Cities are both themselves technologies for living and nests of evolving socio-technical sub-systems, which are both shaped by, and shape, their city[25].

Technology presents cities with opportunities to improve coordination of city systems, contribute to service delivery, and improve the citizen experience, particularly in the context of socio-technical relationships – that is, the interface of technology with behaviour. Smart homes could alter the use of urban space, but with an increase of social alienation or a reduction in the number of sites where people can interact[6 26]. In addition to 'smart technology', the project considered the role of more mundane and domestic technologies, for example, the flush toilet, the electric light, and the Otis elevator safety mechanism[25]. The high-rise cities of the 20th century would not have been possible with only chamber pots, candlelight and staircases.

Once technological systems are built, they may stay in place for a long time. Complex or heavy infrastructure with large amounts of capital invested, or simply the defining of standards, may constrain future decision-makers, making these systems appear immovable. This is referred to as lock-in. While it can prevent cities opting for something better later on, it is not always bad and can

be harnessed to help improve life in cities. For example, lock-in which resulted in a greater emphasis on railway-oriented development, rather than car-based development, might have been beneficial in the long-run. For a scan of some future technologies which could affect the future of cities, see **Annex B**.

Health

Human decisions are strongly shaped by urban contexts, so city living presents a series of challenges and opportunities for public health. The Foresight Future of Cities project has broad perspective on health and cities which considers urban health and wellbeing as a total 'ecosystem'. Evidence suggests that a whole-picture approach to improving health is needed for future cities – not just the delivery of better healthcare services[27]. If a more comprehensive and holistic way of looking at health in cities is adopted, then healthcare services within this bigger picture can be better designed and targeted on need with more efficient use of resources over longer time cycles. For example, a more modular approach to building healthcare facilities in cities could enable clinics, GP practices and hospital departments to be scaled up or down in line with the fluctuating demand.

Designing future cities that adapt to the life course of the population, from birth through to old age, will also be important to maintain health and well-being across all age groups. The quality of the physical environment plays an important role in mental well-being[28]; among the significant factors are noise and light levels, building layouts and way finding, and access to nature. The design of everyday products, buildings, transport systems and information communication devices, all contribute to levels of stress or contentedness; a sense of inadequacy or self-efficacy; and isolation or connection to others[29]. Clear links have also been demonstrated between land use and public health, which cut across socio-economic status. The areas in our cities where the fewest people exercise have twice the housing density and 20% less green space than the areas with the most active population[30], and Greenspace Scotland found that "better health is related to green space regardless of socio-economic status"[31].

Thematic Overview of the Evidence

Living in Cities

Living in cities encompasses people in the urban environment, including health, lifestyles, belonging and identity, culture and behaviour alongside housing, social disparities, public services and demography. In addition, the project recognises that cities are the nexus of retail, consumption, arts and public services. How people live in cities will be influenced by changes within the other thematic areas of the project's analytical framework, which are examined in the following sections.

Four working papers commissioned by the project look at these topics in more depth. They are:

- *Living in the city*
- *People in cities: the numbers*
- *Cities: the cultural dimension*
- *Coping with change: urban resilience, sustainability, adaptability and path dependence.*

Key challenges and opportunities from the evidence

Changing demographics. How might the size of UK cities change in the future?

Ageing population. Given the increasing proportion of older people living in urban environments, how could cities provide attractive living and working environments for an ageing population?

What is a city?

In geographical terms, there is no agreed definition of a 'city' and in the UK there is no single consistent or official definition that is used as the basis for public policy interventions. Primary Urban Areas (PUAs) were first used by the Department for Communities and Local Government (DCLG) in *the State of the English Cities* report[32] and are currently used by the Centre for Cities[33].

As such, these were agreed as the basic units for much of the analysis undertaken in the Foresight Future of Cities project. PUAs are defined as major towns and cities with a population of 125,000 or more, and are identified in terms of their geographical built–up area within contiguous local authority districts. Figure 1 shows the 64 PUAs in the UK, by regional division and size group. It is worth noting that Centre for Cities revised their definition of a PUA in early 2016 and now consider a PUA to have a population of 135,000 or more[34].

Figure 5. 64 PUAs in the UK, by regional division and size group

CITY SIZE GROUP	SOUTH & EAST ENGLAND	NORTH & WEST ENGLAND	REST OF UK
Major City *(deemed to be of metropolitan status)*	London	Birmingham Leeds Liverpool Manchester Newcastle Sheffield	Belfast Glasgow
Large City *(other cities with 275,000 or more people)*	Bournemouth Brighton Bristol Leicester Nottingham Portsmouth Reading Southampton	Birkenhead Bradford Coventry Huddersfield Hull Middlesbrough Stoke Sunderland Wigan	Cardiff Edinburgh
Small City *(125,000-275,000 people)*	Aldershot Cambridge Chatham Crawley Derby Gloucester	Barnsley Blackburn Blackpool Bolton Burnley Doncaster	Aberdeen Dundee Newport Swansea

Source: Adapted from Champion, T. (2014) *People in cities: the numbers*. London: Government Office for Science

Note: Size groups are based on 2001 Census population for Primary Urban Areas delineated at ward level, plus status for Major Cities.

How might the size of UK cities change in the future?

In the UK, cities have undergone a series of changes in the last 50 years which have affected the size of their populations. A comprehensive discussion of this can be found in *'Living in the City'*[15], which notes that many cities underwent rapid 'de-industrialisation' in the twentieth century, with a relocation of manufacturing plants out of city centres and often out of Britain altogether. This economic restructuring led to much inner city deprivation with often very rapid population decline, as experienced in Merseyside and in many coal-mining, steel-making and textile-based towns and cities.

Until the early 1990s, counter-urbanisation and economic transformation contributed towards shrinkage of the UK's cities: between 1981 and 1991, PUAs lost 0.3 million people, while non-city areas of the UK saw an increase in population by 1.1 million[1]. However, some areas of inner city decline were then subject to gentrification, beginning most notably in Islington in north London. Previously semi-derelict houses, flats and warehouses were bought up cheaply as developers and homeowners were able to turn them into newly configured places for urban living[15]. In the decade between 2001 and 2011, the 64 PUAs experienced a substantial resurgence, growing by 2.4 million, accounting for nearly 60% of national population growth[1].

Analysis commissioned for the Foresight Future of Cities project considered how city population numbers have changed over the last 30 years and the possible implications of these trends to 2040 and 2065, building on the *State of the English Cities Report*. This analysis identified the single most important factor affecting the future growth and size of cities as being the pace of the UK's overall population growth. This is because the 64 PUAs in aggregate make up over half (54%) of total population and they have broadly matched national growth between 2001 and 2011[1]. Subsequent analysis conducted using the 2012-based sub-national projections, which did not include Belfast, indicated that in terms of growth rate at a city level, 63 PUAs will contain 17.7% more people in 2036 than in 2011, compared to the overall British figure of 15.5%. Major Cities (including London) will increase by 20.6%, Large Cities up by 15.9% and Small Cities up by 14.8%. All of these are higher than the non-cities' 12.3% increase in population[2].

Analysis of the regional picture showed that the most stable element of the past three decades, from 1981-2011, is that South & East England's decadal growth rate has stayed at about 4-5% points above the rates of the other two parts of the UK. Looking to the future, the paper noted that it seemed likely that all three regional divisions would broadly track the national population growth rate but with the margin between South & East England and the other two regional divisions being maintained. However, three key areas of uncertainty were identified[1]. Firstly, how closely UK population growth will be to the ONS 'principal projection', secondly how this might be distributed across the country and thirdly, whether cities will maintain their recent share of this growth. Detailed analysis can be found in *'People in Cities: the numbers'*.

How can cities provide attractive living and working environments for an ageing population?

People in Cities: the numbers[1] also considered the age structure of UK cities and indicated that the 64 PUAs in aggregate would tend to track the national ageing trend expected over the next 50 years. At the UK level the main change between 2012 and 2062 indicated by the ONS principal projection is a substantial increase in the proportion of people aged over 75 and a shrinkage of all the younger broad age groups.

For cities, however, the analysis indicated that the pace of ageing is unlikely to be as rapid as the national picture. In aggregate, the cities are very unlikely to entirely escape the major national shift into the over-75 age group, but on the basis of recent performance, the proportion of the urban population aged under-30 in 2062 may not be markedly different from its current level of 40%[1].

An ageing population will bring both challenges and opportunities for central and local government, with impacts on a wide range of public services. The *Foresight Future of an Ageing Population* project has collected evidence which is intended to form the basis for a range of policies and actions to:

- Maintain wellbeing throughout life, for all individuals regardless of their generation
- Improve quality of life for older people and enable them to participate more fully in society
- Ensure everyone can access the tools and facilities to help them live a long and healthy life.

Three papers commissioned by Government Office for Science for the Ageing Population project have findings of particular interest for cities and city-decision makers: *Future of Ageing: transport and mobility, Future of Ageing: adapting homes and neighbourhoods and Future of Ageing: health and care infrastructure*.

Key challenges presented by an ageing population are a greater prevalence of chronic illnesses and long-term frailty/disability, both of which affect individual mobility. There is also likely to be a requirement for living spaces which are adaptable to the needs of older populations, including serving as sites of long-term health care. Evidence commissioned for the Future of Cities project shows that an older population can provide cities with opportunities as well as challenges. For example, as the proportion of older people participating in work, education, leisure and cultural pursuits increases, they will have a key role to play in the socio-economic sustainability of the city, and by working for the voluntary sector contribute to its governance. Older people will form a growing cohort of consumers: the older consumer market is forecast to grow by 81% up to 2030, compared with 7% growth in the 18-59 age group[15].

Case Study

Foresight's *Future of an Ageing Population* project commissioned a case study to look at how the experience of the public can be harnessed to address the challenges and opportunities of ageing and demographic change[35] Dr. Lynne Corner coordinates VOICE (Valuing our Intellectual Capital and Experience) North which is based at Newcastle University. She reflects on how VOICE North has developed a community of 'research active citizens' to support innovation in these areas.

The North East is a small and reasonably cohesive region. It is fortunate in having superb universities with world-class research on ageing, from all disciplines including biomedicine, computer science, engineering and social sciences. The North East also has the widest inequalities in income distribution and health of any English region and so it is imperative that we effectively utilise partnerships between academia, public and voluntary sector and industry to co-develop innovative responses and solutions using the best available evidence to tackle health inequalities across the life course and directly involve citizens in co-developing solutions to healthy ageing.

VOICE (Valuing our Mental Capital and Experience) North is a lively and creative organization, based at Newcastle University since 2009 and a model which can be used to support the involvement of the public to support innovation. It was established as a mechanism to harness the immense experience and collective wisdom of the public at scale to capture their ideas, insights and vision as active partners in developing and indeed demanding innovative solutions to the challenges presented by ageing populations and demographic change. With well over 1000 people involved, it has supported over 100 research projects and business opportunities in the last 18 months.

The majority of members are older people, but people of all ages and backgrounds are involved. VOICENorth has invested in creating a flourishing community of 'research active citizens', with partnerships between members of the public and patients working with academics, policy makers and businesses to co-create and translate research evidence and supporting innovation. Projects are extremely varied – they range from developing new engineering solutions and technologies, to health service design, developing interventions to tackle inequalities, working longer, improving public transport and housing design and exploring the role of arts and culture in supporting well-being. Older people themselves are a valuable resource in helping to identify unmet need and design, develop and trial products and services.

Urban Economies

Urban economies include consideration of the economic performance of the national system of cities, the performance of individual city economies, including skills, labour market performance and a city's relationships to other systems (such as the European and global system of cities).

The following evidence papers commissioned for the project provide more detail:

- *The evolving economic performance of UK cities: city growth patterns 1981-2011*
- *Divergent cities in post-industrial Britain. (An update to 'The evolving economic performance of UK cities: city growth patterns 1981-2011.)*

Key challenges and opportunities from the evidence

Divergent economic performances of UK cities: Economic performance varies across UK cities. Which sectors might increase employment opportunities outside the greater south-east and what supporting infrastructure could be required?

Graduate mobility and productivity: How can cities attract and retain an appropriate mix of skills beyond the provision of employment opportunities?

Divergent economic performance

Economic growth over the past three decades or so has been highly unequal and divergent across the UK's main cities. Many of the former industrial large towns and cities of northern Britain have lagged persistently behind those in the south. The weaker performance of many of the northern cities has attracted Government attention in the past few years. Improving the growth performance in the country's northern cities is seen as a way to increase jobs and incomes for the people living there, but also improve the UK's productivity[7] [36].

It is important to understand the factors that contribute to the differing levels of economic performance of UK cities, because this will shape how urban economic challenges are constructed and therefore how policy is formulated. The evidence base suggests four factors are particularly important, and these are developed below. A further factor is the governance structure of a city – the range of its institutions, the nature of collective decision–making, leadership and strategic policy. This is examined in the section on Urban Governance.

1. The role of size/agglomeration
2. The role of economic specialisation and the tradable base
3. The role of competitiveness
4. The role of human capital

The role of agglomeration / city size

Agglomeration refers to the accumulation of productive activities in close proximity to one another[37]. It is often thought to influence the form and growth of cities because the environment it creates can foster further concentration of people and firms in cities, which can lead to positive externalities, such as productivity advantages. However, the evidence is not clear-cut and little is known about the long-run evolution of agglomeration economies in cities. For example, a city that experiences sustained deindustrialisation is likely to find that the positive externalities that had developed around its manufacturing base, decline. This might mean cities have to 'rebuild' agglomeration economies, as their economic structures change.

There also appears to be no clear correlation between economic performance and city size[38], although this should not be taken to suggest that agglomeration economies are unimportant. The growth rates of output and employment in the majority of the core cities have consistently been below the corresponding growth rates for the national economy. Even London up to the late-1980s lagged national growth, but since then has undergone a major 'turnaround' in economic performance[7].

The role of economic specialisation and the tradable base

According to some observers, economic specialisation is the motor of city growth[7]. Empirically however, the debate about how specialisation and diversity in UK cities relates to performance is somewhat inconclusive (see Figure 6). There is growing evidence that sectoral specialisation might matter less than functional specialisation and there are other studies that stress the importance of diversity of cities in product space, as well as the relatedness of their knowledge and their technologies. These questions remain far from settled, in part because of the difficulties inherent to measuring diversity in any complex system[39]. Empirically, diversity has remained difficult to characterize unambiguously because measures are linked to particular classification schemes or taxonomies, for example, the number of professions in a city. The outcome will depend on how finely similar functions (in this case professions) are differentiated[40].

There is also much debate about whether specialisation is beneficial when it comes to a city's long-run performance and ability to withstand shocks, that is, its resilience. Evidence commissioned for this project indicates that much depends on the particular type(s) of specialization involved. A city or region specialized in heavy, capital-intensive sectors may end up being far less adaptable over time than a city specializing in knowledge intensive, information capital based activities[7].

Figure 6: Specialised versus diversified citie

SPECIALISED CITIES	DIVERSIFIED CITIES
Advantages	
Specialised pool of labour	Access to wide pool of labour skills and talent
Development of specialised knowledge base and inter-firm knowledge spillover	Cross-fertilisation of ideas between different sectors can lead to knowledge spillovers and product innovations
Presence of up and downstream firms	Variety offers market scope for new ventures and suppliers
Tend to be smaller, hence less crowding costs	Better able to withstand shocks, because diversity acts as a buffer
Sector-specific institutions	Tend to be larger, and hence offer a significant home market
Disadvantages	
More risk from adverse shocks, especially in mono-sector cities	Tend to be larger, leading to higher production costs (wages and land)
Prone to path-dependent lock-in (e.g. because of technological relatedness of firms, imitative innovation, or dense input-output relationships)	

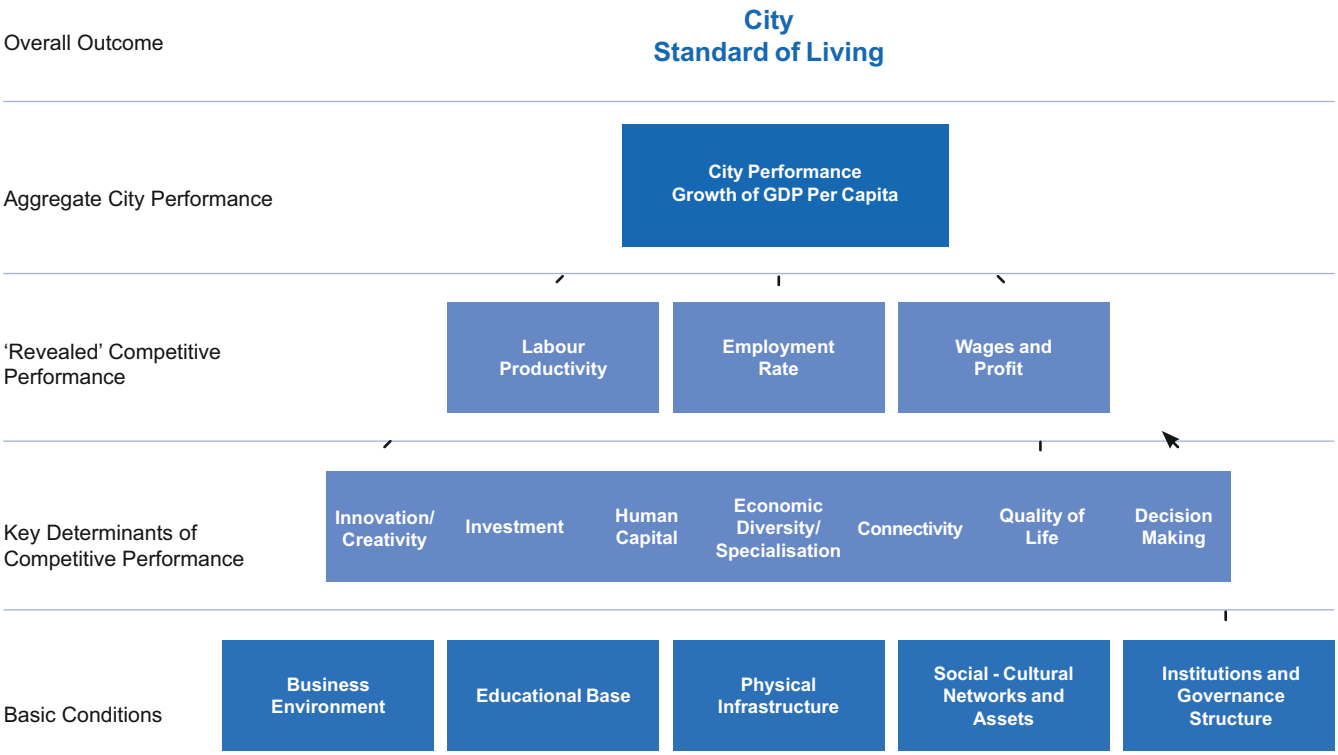
Source: Adapted from Martin et al. (2014) *The evolving economic performance of UK cities: city growth patterns 1981-2011*. Government Office for Science, London, UK

The role of competitiveness

There is no one overarching theoretical perspective that can capture the full complexity of city competitiveness. It must reflect something about how a city's specific economic, social, physical and institutional assets come together to influence the willingness of business to invest there, the desire of people to work and live there, and the effectiveness and efficiency with which the city's activities operate. Figure 7 shows the complex sets of factors, conditions and determinants of a city's competitiveness.

A city's competitiveness is a dynamic process. How well a city's firms and workers adapt to the ever-shifting threats and opportunities that arise in the global economy determines whether they remain competitive in their respective industries and services. But adaptation is also about how well a city's economy is able to develop new industries, sectors, skills and technologies over time and reconfigure its economic structure to take advantage of new markets and knowledge.

Figure 7: Possible factors influencing a city's economic competitivenes



Source: Adapted from Martin et al. (2014) *The evolving economic performance of UK cities: city growth patterns 1981-2011*. Government Office for Science, London, UK

The role of human capital

Theories of economic growth have emphasised the role of human capital for local and regional economic performance[41]. Understanding of its importance is increasing in line with national and academic interest in the ability of cities and regions to produce, attract, and retain highly qualified graduate labour[42]. The current national framework for increasing productivity, for example, includes a commitment to long-term investment in skills and human capital[36].

Evidence indicates that between 1994 and 2005 a third of the UKs economic growth was considered to be a result of the expansion of higher education[43]. Universities play an intrinsic role in the UK economy, supporting economic growth and contributing to regional growth by increasing skills, supporting innovation and attracting investment and talent[43]. In the UK, 60% or more of growth is generated by those with tertiary education[44]. High-skilled labour is therefore a critical factor for the broader success of city economies, and to creating the circumstances in which city-regions can attract talent and investment.

Urban Metabolism

An urban metabolism can be thought of as the inflows of material and energy resources, the outflows of wastes and emissions and the retention of materials as stock in the built environment and infrastructure. These complex and interconnected sets of systems can exist entirely within the city but most stretch into the area surrounding the city (the hinterland) and/or wider national or global systems to reach essential services and resources[3].

The concept of the city or urban ecosystem is related to urban metabolism and considers how urban areas interact with (and must be responsive to) other surrounding environments[9]. Cities through history have grown and prospered by inter-dependency with their hinterland and natural resources. These eco-systems can be seen as providing 'services' to human societies and economies, and are often referred to as 'eco-system services'[12].

As well as depending on global systems, the metabolism of cities can have profound effects on the rest of the world – for example, through carbon emissions and their role in climate change. At the Paris climate conference (COP21) in December 2015, 195 countries adopted the first-ever universal, legally binding global climate deal. The key elements, which include a long-term goal of keeping the increase in global average temperature to well below 2°C above pre-industrial levels and an aim to limit the increase to 1.5°C[45], will require city-scale action.

In the future, cities will inevitably face some external 'shocks' from a range of factors, including the impact of climate change, so they will need to adapt and be resilient. For example, they may decide to develop localised ecosystem services, such as green infrastructure, to mitigate flood risk or have greater reliance on local energy production

The following working papers commissioned for the project provide further detail:

- *Coping with change: urban resilience, sustainability, adaptability and path dependence.*
- *The future of the urban environment and ecosystem services*
- *Urban metabolism: a review in the UK context*

Key challenges and opportunities from the evidence

Managing risks to city environments and resource supply: How should action within city boundaries reduce resource dependencies and carbon footprints?

Integrating systems to make cities liveable: There are increasing correlations between cities' well-being, liveability and economic performance. How do different patterns of spatial development enhance the liveability of UK cities as they grow?

Managing risks to city environments and resource supply

Most forms of ecosystem within the typical UK city have improved over the last 50 years, including habitats and micro-climates, greenspace and green infrastructure, air quality, water quality, and land contamination[12]. However, evidence indicates that many ecosystems' qualities depend on patterns of development, in the context of population and housing growth, and there are risks posed by a range of factors, including urban development and infrastructure and increased urban densities[12]. In addition, the UK is also facing considerable changes to its climate by 2065 through drier summers, and warmer, wetter winters and more extreme weather events. The biggest changes in precipitation in winter will be experienced by the UK's western cities while water and heat stresses will affect southern cities[12]. Within cities, these changes will be felt by people as effects on the physical environment. Heat vulnerability will be a particularly urban challenge – for example, London contains 40% of the neighbourhoods with a high vulnerability to heat risk[12] and, as a result of its spatial extent, will likely need different interventions to smaller cities.

In recent years, cities worldwide have taken the lead in planning and acting on unsustainable development, particularly through city networks such as the C40 network. This trend is likely to become of increasing importance over the coming decades as cities sense their vulnerability to climate-related risks[46]. In the UK, the National Policy Planning Framework (NPPF), has 12 underpinning principles, one of which is to support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change, and encourage the reuse of existing resources, including conversion of existing buildings, and encourage the use of renewable resources, for example, by the development of renewable energy[47].

Some cities have already created guidance documents on how to move to a lower-carbon state, including mini Stern reviews of Birmingham[48], Leeds and Hull, and there are international examples of cities where the integrated design of sustainable neighbourhoods have achieved substantial reductions in energy intensity compared with conventional designs. A strong example is Vauban (Freiburg Germany), which uses under 60 kWh/m2 for building energy use[3]. Evidence commissioned for this project indicates that if London and other city centres continue to increase the density of the urban form, for example, by exploring underground space more intensively[49 50 51], new and exciting forms of urban-eco-systems could emerge. Some possibilities include green roofs and living walls, elevated walkways and cycle ways, vertical gardening and aquaponics, semi-enclosed micro-climates in public spaces and atriums, bio-mimicry* on urban rivers and waterfronts, and creative landscapes for climate adaptation.

* The Biomimicry Institute defines biomimicry as an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies. The goal is to create products, processes, and policies—new ways of living—that are well-adapted to life on earth over the long haul. https://biomimicry.org/what-is-biomimicry/

In many urban forms there is potential for ordinary dwellings to host diverse ecological habitats, with integrated breathing walls, passivhaus-type conservatories**, flow-form waterfalls, rare species nests, and generally with eco-design embedded in the low-carbon re-engineering of the building stock[12].

Enhancing well-being, liveability and economic performance

There is a good evidence base relating to the role that ecosystem services play in the economic prosperity, wellbeing and liveability of UK cities. The *UK National Ecosystem Assessment* (2014)[52] for example, notes that embedding green and blue infrastructure*** into developments can help adaptation to climate change, reducing both flood risk and the negative effects of the heat that cities produce. Tree-lined avenues and community woodlands lock up carbon and absorb particulates from the atmosphere, both improving air quality and benefitting people's health by reducing respiratory diseases.

Furthermore, there is evidence that engaging with nature through access to gardens and parks improves people's mental and physical well-being. The Department of Health suggests that increased access to greenspace could reduce national healthcare costs by more than £2 billion per year[53]. As a result of these demonstrable benefits, ecosystem services have become relevant to policy development and implementation.

Figure 8: Exercise in green space in the city - a proactive approach to health

Image courtesy of the Helen Hamlyn Centre for Design, Royal College of Art

** Passivhaus or 'Passive House' is the fastest growing energy performance standard in the world. The robust approach to building design allows the designer to minimise the heating demand of the building. The standard can be applied to residential buildings as well as commercial, industrial and public buildings. From: www.passivehaus.org.uk/standard

*** Kirby, V, & Russell, S (2015) *Cities, green infrastructure and health* cites an EC definition of Green Infrastructure as being 'a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings'.

The Marmot Review (2010) for example, recommended that spatial planning should: *"Fully integrate the planning, transport, housing, environmental and health systems to address the social determinants of health in every locality. Prioritise policies and interventions that both reduce health inequalities and mitigate climate change"*[54].

Urban metabolism analysis can provide much of the evidence which relates to these policy priorities. First, the quantities of energy, wastes, industrial production and other flows determined in urban metabolism are required when calculating the greenhouse gas inventories of cities. Second, measures of the efficiency of resource use in cities have been established based on urban metabolism studies. Third, in an urban planning and design context, urban metabolism has also been used as a framework for undertaking the design of sustainable or low carbon districts/neighbourhoods within cities. Fourth, urban retailers and consumers may make more informed purchasing decisions if they have knowledge of the impacts of their choices[3]. This is particularly important as it is likely that reducing the environmental impact of cities will also require a change in citizen behaviours. Although the long lifespan of much existing physical infrastructure means that lifestyles and behaviours are often locked in by these systems, there are aspects of urban lifestyles, for example, car-based travel, which are likely to be responsive to policy incentives to move towards a lower-carbon economy[3]. This is because consumers replace cars on a relatively regular basis.

There are a range of methods and tools which policy makers can use to aid decision making and articulate plans and policies that are compatible with the objectives of citizen well-being and the development of economic potential (*The Future of the Urban Environment and Ecosystem Services* provides further detail). However, the *UK National Ecosystem Assessment* (2011) concluded that the natural world and its ecosystems are consistently undervalued in conventional economic analyses and decision-making[53]. In the *Assessment Follow On*, published in 2014, it noted that there were wide gaps in the knowledge of the value of ecosystem services to local authorities, largely because the locally specific data is lacking to undertake the necessary valuation[52]. Evidence gathered for the Foresight project indicates that better spatial and temporal data for both urban and environmental sides is needed to address this[12].

Urban Form

Urban form – the layout of cities, streets, buildings and open spaces as well as the wider settlement pattern – strongly shapes human behaviour and social outcomes. It facilitates connections that support and maintain social and economic interaction and it accommodates the various flows of people, goods, food, water and energy that constitute the city.

The following working papers commissioned by the project consider these topics in more detail:

- *A visual history of the future*
- *Prospects for land, rent and housing in UK cities*
- *Urban form and infrastructure: a morphological review*
- *What are future cities? Origins, meanings and uses*

Key challenge from the evidence

Increasing housing pressures: How could city spaces be planned and developed to help meet housing demands as cities grow? How can we create successful places by 2065?

The pattern of development since the 1947 Town and Country Planning Act has been broadly based on suburban developments, contained by green belts (although there have been selective incursions into green belts for housing development). In parallel, there have been successive waves of garden cities and new and expanded towns. The trend towards suburbanisation, the development of out-of-town retail and service facilities and the growth of fast road travel created a business-park economy[15], which affected many high streets and city centres.

However, more recently, there has been a trend towards gentrification of inner-city areas, as previously semi-derelict houses, flats and warehouses have been bought up relatively cheaply and reconfigured into new dwellings. Larger UK cities have experienced a reurbanisation of jobs and businesses[55]. Some of the UK's fastest growing economic sectors (principally creative industries and technology) are attracted to places which are structured in more traditional densely connected street networks rather than newer business park layouts.

The return to city centre living has been led by the bigger cities. The populations of city centres in large cities doubled between 2001 and 2011, principally driven by students and young professionals. A recent survey conducted by Centre for Cities suggested this was because of access to work, culture and leisure facilities and that the growth of many small and medium-sized cities has been slower, driven by families and workers in non-professional occupations[56].

In 2015, the Government set out a target of 200,000 new homes per year and one million new homes to be built by 2020. However, in the year to the end of June 2015, only 131,500 homes were completed[57]. Many reports have set out the possible effects of failing to increase homebuilding: low productivity, rising homelessness, stalled social mobility, declining pension savings and a rising benefit bill – all of which risk undermining the competitiveness of our cities[58 59].

In the short-term, the main barriers to meeting housing demand are the price and availability of land, along with the practices of developers[5]. Evidence suggests that patterns of housing demand have long-term origins[5] and will also require long-term solutions. While regulatory frameworks and legislation could be adjusted in various ways to address short-term barriers to meeting housing demand, more factors will be critical for the liveability of cities in the longer term. These are explored in the following section.

Characteristics of successful urban forms in 2065

The Foresight project has shown that the experience of living in a city is about more than housebuilding and our evidence base suggests place-making will need to be a key element of planning over the coming 50 years[16]. A paper commissioned for this project has developed a set of characteristics for successful urban forms in the UK in 2065, which are summarised in Figure 9.

The paper systematically assessed the relative merits of different models of future urban form against these success criteria, both for existing places and the construction principles for new places. The models for future urban form include options such as intensification of existing urban settlements, new development of the periphery of existing urban settlements and dispersed developments in small villages and hamlets. Innovative exploitation of urban underground space, tested for future resilience, is a means of achieving greater densities[50 60].

From this, the most plausible options for urban form in the future were identified. A key finding was that developing new places in a dispersed way was likely to result in increased costs per capita in terms of public service delivery and provision of energy, water and transport infrastructure. The full analysis can be accessed in the project's evidence paper, *Urban form and infrastructure: a morphological review*[16].

Figure 9: Characteristics of successful urban form in the UK for 2065

CHARACTERISTICS OF SUCCESSFUL URBAN FORMS IN THE UK FOR 2065:		
Environmental	Social	Economic
Make sustainable use of the UK's land resource, accommodating demographic change without loss of valued land	Adapt to future changes (social economic and environmental in a socially equitable way	Do not cause land/property/price shocks/instability
Make sustainable use of the UK's environmental resources (including protecting and enhancing biodiversity)	Are desirable to the population	Enable efficiencies in infrastructure costs
Are physically adapted for the UK's future climate	Provide a range of housing types and tenures to meet needs and be affordable	Enable efficiencies in public services costs
Do not contribute to future climate change (i.e, reduce carbon emissions, exceeding or matching international targets)	Are accessible for all	Enable efficiencies in transport costs (for suppliers and residents)
Improve (or do not worsen air quality)	Provide access to health/education/ cultural/leisure services for all	Support local economies and economic diversity
Facilitate efficient water management systems	Are healthy	Attract inward investment
Facilitate efficient energy management (systems and behaviours)	Are safe	Facilitate innovation and creativity
Facilitate efficient transport management (systems and behaviours)		Facilitate efficient ICT provision
Facilitate efficient waste (solid and water) management (systems and behaviours)		
Facilitate the efficient integration of different infrastructure systems		

Source: Adapted from Williams, K. (2014) *Urban form and infrastructure: a morphological review*. Government Office for Science, London, UK

Urban Infrastructure

Infrastructure underpins the functioning of society. Hard infrastructure provides the energy and water resources that society needs to function, and enables soft and digital infrastructure to support people, information and goods to move efficiently and safely[16]. Infrastructure is deemed successful when it 'meets demand and provides reliable, cost effective and high quality services'[16].

Cities act as nodes within a wider, relatively mature, infrastructure system – the UK's system of cities – in which relatively slow-changing urban forms provide the

setting for more rapidly changing 'flows' of capital, people, material and energy resources, wastes and emissions, referred to in the previous section as the 'urban metabolism'. In this context, the interrelationship between 'urban form' and 'flows' is critical to understanding societies' infrastructure needs[16].

The following paper commissioned for the project provides further detail:

- *Urban form and infrastructure: a morphological review*

Key challenge from the evidence

Differential connectivity levels between and within cities: How might enhanced transport links impact city employment levels?

Transport infrastructure: increased demand

Much physical infrastructure, including the UK's transport networks, is 'fixed' and has life-spans and a set geography of hundreds of years. These systems need to provide reliable and high quality services within both relatively 'slow' changing urban forms and the rapidly shifting 'flows' of the 21st Century. The challenges associated with this have been brought into sharp focus in the last two decades with the acceleration and intensification of flows, particularly those associated with demographic change[16].

There has been steady growth in demand for transport infrastructure over recent decades, particularly at the inter-city scale. The number of passenger journeys on franchised rail services in Great Britain reached 1.654 billion in 2014-15. This is an increase of 4.2%, (67.3 million) on the previous year, and an increase of 69.5% since 2002-3, when only 975.5 million journeys were made[61]. Meanwhile, the growth of road transport (including freight) has been facilitated by the construction of motorways and a fast road network from the 1960s – 1980s. Forecasts by the Department for Transport(DFT) suggest a growth in future road demand of between 19% and 55% between 2010 and 2040.

However, forecasts in national traffic growth can mask variations that occur across areas, roads and vehicles. For example, the strategic road network (SRN) ('trunk roads' managed by the Highways Agency[62]) represents around 2% of the total of England's road network, but it carries around one third of the total motor vehicle traffic in England[63]. The DfT forecasts an increase of between 24% and 72% in vehicle numbers driving on the SRN by 2040[64]. The 2015 Spending Review announced that the Roads Investment Strategy will include resurfacing over 80% of the SRN and delivering over 1,300 miles of additional lanes[65].

However, the impact of the digital revolution on how people communicate, shop and work is widely recognised and starting to have an impact on transport provision and demand. The *Intelligent Mobility Traveller Needs and UK Capability Study*, published by the Transport Systems Catapult in October 2015 drew on

interviews with 10,000 respondents, 100 experts and 50 companies. It shows that UK travellers are ready for innovation in the way they travel: 53% always look for ways to optimise their journey, 39% would consider using driverless cars if they were available and 31% of journeys made today in the UK would not have been made if alternative means were available that did not necessitate physical travel[66].

Equally though, evidence commissioned for Foresight indicates that new means of communication are generally complements (rather than substitutes), for a new communication method, or a reduction in the costs of one method, will increase all forms of communication. So the greater ease and reduced cost of digital communications have increased the number of face-to-face meetings[67].
In addition, in high value-added service and technology sectors, face-to-face contact is particularly important because growth of those businesses depends critically on the exchange of ideas, and tacit knowledge that can only be conveyed in person[67].

Enhanced transport links and employment in cities and city-regions

Recently, there has been an increasing government focus on the role of quality infrastructure in supporting productivity growth. Delivering the right infrastructure at a local, regional and national level, across the UK, is a central component of the government's long-term economic plan[68] and there is a particular focus on transport infrastructure. It is the largest of the infrastructure sectors represented by the Infrastructure Plan Project Pipeline in terms of number of projects (302), and the second largest in terms of expenditure required (at £127.44 billion)[69].

Transport investment is a relevant dimension for understanding labour mobility and employment density because it is an important factor shaping the location decisions of businesses, along with the availability of suitably skilled labour[70]. In the 20th century, companies were attracted to suburban locations by their ease of accessibility by car and proximity to motorways. Evidence commissioned for the Foresight project indicates that today, improvements to public transport speed and reliability – particularly rail links – can often diminish the advantages of being close to motorways. By locating in city centres businesses can also accommodate workers' environmental concerns, allowing them to take advantage of the growing trend for walking or cycling to work[71].

The nature of infrastructure development, including transport, is that it embodies massive investments, and therefore both private and public investors have a significant interest in the projections, predictions, and forecasts that underpin policy decisions[16]. Evidence suggests that cities will need to develop long-term, evidence-based investment plans to be able to identify infrastructure schemes with high economic, social and environmental value and impact, as well as the institutional vehicles to engage the private sector to deliver them. This requires a holistic view of city-region ecosystems including liveability, social infrastructure and cost frameworks[67]. It also requires testing against future scenarios that span the extremes of plausibility to understand the potential consequences of radical social and economic change[21 72 73].

Urban Governance

Urban governance refers to the process through which democratically elected local governments and the range of stakeholders in cities – such as business associations, unions, civil society, and citizens – make decisions about how to plan, finance, and manage the urban realm[14].

Urban governance is important for a number of reasons. It is critical in shaping both the physical and social character of urban regions. It has an impact on the quantity and quality of local public services and the efficiency with which they are delivered. It determines whether costs are shared throughout the city-region in a fair and efficient way. Urban governance also affects the ability of residents to access their local government and engage in local decision-making[74], as well as the extent to which local governments are accountable to citizens and responsive to their demands[14].

Evidence indicates that different urban governance structures each have their advantages. It is broadly argued that smaller governments bring greater efficiency, access and accountability, while larger ones bring greater economies of scale, equity and regional coordination[14]. Debates about the appropriate scale for urban governance are also increasingly influenced by the widely held-view that contemporary city-regions compete on the international stage, independently from their national government[11].

The following papers commissioned for the project provide further detail:

- *The future of city leadership in the United Kingdom*
- *Cities and public policy: a review paper*
- *Comparative urban governance*

Key challenge from the evidence

Changing ideas about city decision-making and accountability:
What could devolution mean for civic participation and how people will be represented in cities?

The UK has long been regarded as one of the most centralised states in Europe. However, the urban governance system in the UK is currently in rapid and continuous evolution. Its highly centralised nature is evolving into a negotiated and customized model with local leaders striking deals with government according to local preferences and appetites[75]. It is important to see the devolution of power to cities and city-regions within the UK in the wider national context of the United Kingdom and its constituent nations.

In 1998, three Devolved Administrations were created in Scotland, Wales and Northern Ireland and granted limited powers over areas such as education, housing, healthcare, local government and some transport. Since then, the range and depth of devolution has increased in each nation[76]. In England, the Local Government Finance Act 2012[77] granted councils the ability to retain 50% of their business rate yields for the first time. The Localism Act 2011[78] also provides local authorities a degree of discretion to offer business rate discounts, and most importantly set out the basis for City Deals - bespoke governance and financing agreements to be entered into between central government and individual cities. Manchester has been a pioneer in exercising these provisions, agreeing an 'Earn Back' deal with the Treasury which allows the city to retain part of the uplift in local tax yields if these taxes can be shown to result from local investment in infrastructure. Separate from the City Deal, Manchester will also become the first English region to get full control of its health and social care spending from April 2016[76].

Decision-making and accountability

The Future of Cities project commissioned a series of workshops with over 20 UK city leaders in 2014 and 2015. Further detail can be found in *The future of City Leadership in the United Kingdom*[11]. Evidence gathered from these workshops indicates that as direct providers of many critical services, city leaders understand that with devolution comes a need to be accountable and responsive to their citizens. These leaders regarded robust public engagement as critical to the long-term sustainability of democratic urban governance[11].

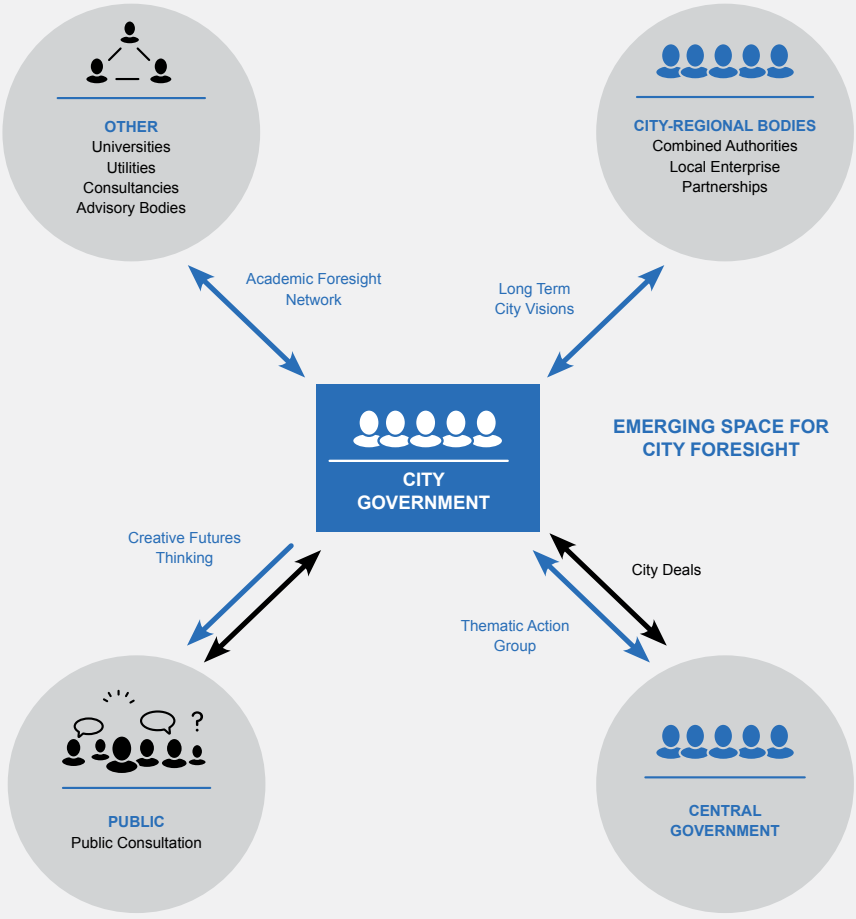
This is particularly important given that in the UK, whilst citizens might have a strong and growing affinity with their cities and local areas, evidence suggests this does not necessarily translate into local electoral engagement. Some cities are experiencing public disengagement with local democracy, there are perceptions that local councillors in some cities are demographically unrepresentative, voter turnout is low and the membership of traditional political parties has fallen[11 14]. Moreover, *The Speaker's Commission on Digital Democracy*[79] highlighted a number of key areas where future citizens should be concerned, particularly in relation to the ability of citizens to understand and use electronic means of voting. One of the implications is that citizens could be disadvantaged with respect participation to community life and political process, where they may have limited or no access to emerging technologies that become mainstream.

Evidence commissioned for the Cities project indicates that there are reforms which could mitigate these impacts, for example equipping young people to live and work in a more computational world. Shifting society towards digital creation rather than just consumption could catalyse a profound change in civic engagement[80]. City leaders in the Foresight workshops also felt that in future, national political contests should make adequate space for the discussion of local issues, which would go some way to addressing, in many places, concerns over trust and honesty that are affecting voter turnout and civic participation[11].

In addition, distributing leadership responsibilities among a range of people and groups was seen as a means to empower and enable a broad variety of actors to get involved in city leadership and decision-making. Many workshop participants recounted how they have been most effective when they have engaged with their communities to find the relevant people to come together around an issue. This networked, collaborative approach is seen as a more sophisticated mode of leadership than hierarchical models[11 74].

City Foresight is the science of thinking about the future of cities and it may offer leaders a chance to set a new and distinctive direction for their areas, while engaging creatively with partners and citizens, including young people. Evidence for the *Foresight for Cities* report[81] indicates that futures thinking can encourage an emotional engagement that may motivate people to become more involved with civic matters – such as finding opportunities for new social enterprises to deliver public services, or organising crowdsourced funding for environmental projects. This in turn may engender civic pride, rebuild trust in municipal leadership, and increase electoral turnout.

Figure 10: Groups engaged in city foresight



Source: Foresight

Conclusion

The Foresight Future of Cities project has developed a comprehensive evidence base on specific issues relating to cities, and summarised that evidence base in this report. The project has attempted a distinctive approach, combining traditional evidence gathering, with long-term futures thinking on city challenges and finally perspectives from city stakeholders at the local level. Working with national and local government the project brought together a range of actors involved in city decision-making and policy-making processes, adapting an open policy-making approach to city-level engagement – generating new ideas between national and local government.

From the evidence base, this report has distilled ten key challenges for the future of UK cities as well as opportunities which cities can take advantage of. Underpinning these are cross-cutting themes such as technology and health, and a sense of the complex independency of the issues. Whilst these ten challenges and opportunities are not exhaustive, and different stakeholders may place different emphasis on some areas over others, they can be a useful starting point for the prioritisation of national and local government focus on cities. Foresight has worked with local and national actors on the separate *Graduate Mobility and Productivity* project to demonstrate new way of making policy in a devolution context.

Most commentators will agree that the future of the UK is entwined with the future of its cities, and this relationship has grown stronger over recent years because of the economic and population growth in cities. As the process of devolution plays out in an incremental way, the role of national government will adjust as it operates in a context where powers are devolved. Cities will play an increasingly important role in determining the success of national policy issues, even if those issues are seemingly ‘place-blind’. Equally, cities will be socially and spatially affected by national policy priorities, whether or not that is the explicit intention of those policies. Historically, the UK has benefitted from its rich and diverse urban network, and in the future our national success will be tied ever more closely to the strength of our cities.

Annex A: Methodological note*

There is no agreed definition of a 'city' in terms of geographical boundaries. Different authors, and different studies, use different definitions. In the UK there is no single consistent or official definition that is used as the basis for public policy interventions. This makes analysis, especially over time, far from straightforward, and contrasts with the situation in the United States, where an official system of 381 metropolitan statistical areas (MSAs), defined by the US Office of Management and Budget, can be used to study urban trends and developments.

Ideally, cities would be defined spatially in economically functional terms. Towns and cities can be thought of as labour markets, so that an obvious functional definition would be in terms of distinct travel to work areas (TTWAs), that is as spatial units within which the bulk of the resident people also work. This is the basis of the US MSAs referred to above: these are defined as one or more adjacent counties or county equivalents that have at least one urban core area of at least 50,000 population, plus adjacent territory that has a high degree of social and economic integration with the core as measured by commuting ties.

Defining cities as TTWAs requires the analysis of commuting patterns. In the UK, TTWAs are defined as those areas in which generally at least 75% of an area's resident workforce work in the area and at least 75% of the people who work in the area also live in the area. The area must also have a working population of at least 3,500.

But using these TTWAs to delimit cities is problematic. There is the issue of designating which TTWAs correspond to cities: what should be the minimum population size to qualify as a city? Given that some TTWAs in the UK are quite small in population, and hardly constitute cities, some criteria would have to be found to amalgamate neighbouring TTWAs into larger units. There is then the problem that for areas with a working population in excess of 25,000, self-containment rates as low as 66% are accepted. Further, there has been a steady trend over time in longer-distance commuting, so that the geographical boundaries of many TTWAs have expanded. The result is that while there were 334 TTWAs across the UK in 1981, in 1991 this had fallen to 314, and in 2007 (based on 2001 data) to 234. A further revision of the TTWAs has just been completed based on the 2011 census which has reduced the number of TTWAs to 228.

*Adapted from: Martin, R., Gardiner, B. and Tyler, P. (2014) The evolving economic performance of UK cities: city growth patterns 1981-2011. London: Government Office for Science.

While it could be argued that these changes merely reflect the reality that the labour market boundaries of cities have expanded as travel to work patterns have widened, it means that data on TTWAs are not comparable over long spans of time (the same issue arises with MSAs in the US). And in any case, there are only limited economic data collected for the UK TTWAs; crucially no regular output data are published on this basis. The only plausible way forward would be to select those local authority districts that corresponded most closely to the 228 TTWAs and then to construct the required data series from local authority estimates.

Given these problems, and in the absence of official city statistical units, the Foresight Future of Cities project employed primary urban areas (PUAs) as the basic units for much of its' analysis. The PUAs are defined as major towns and cities with a population of 125,000 or more, and are identified in terms of their geographical built–up area within contiguous local authority districts. The list of 64 such PUAs, and the local authorities included in them, is given in the table below. These PUAs cover less than 10 percent of the national land area, but account for more than 60 percent of national output (GVA), and contain 70 percent of the country's skilled workforce. These PUAs do not match travel to work areas, however, and are typically smaller in geographical coverage, so that they are not wholly congruent with cities as commuter-based economically functional units. This is a significant limitation of using these PUAs, and should be borne in mind when interpreting the analyses.

The UK System of Cities Defined as Primary Urban Areas City and Local Authority Districts Included

ENGLAND

- **Aldershot** Rushmoor, Surrey Heath
- **Barnsley** Barnsley
- **Birkenhead** Wirral, Ellesmere Port & Neston*
- **Birmingham** Dudley, Birmingham, Sandwell, Solihull, Walsall, Wolverhampton
- **Blackburn** Blackburn with Darwen
- **Blackpool** Blackpool, Fylde, Wyre
- **Bolton** Bolton
- **Bournemouth** Bournemouth, Poole, Christchurch
- **Bradford** Bradford
- **Brighton** Brighton and Hove, Adur
- **Bristol** City of Bristol, South Gloucestershire
- **Burnley** Burnley, Pendle
- **Cambridge** Cambridge
- **Chatham** Medway
- **Coventry** Coventry
- **Crawley** Reigate and Banstead, Crawley
- **Derby** Derby
- **Doncaster** Doncaster
- **Gloucester** Gloucester
- **Grimsby** North East Lincolnshire
- **Hastings** Hastings
- **Huddersfiel** Kirklees
- **Hull** City of Kingston upon Hull
- **Ipswich** Ipswich
- **Leeds** Leeds
- **Leicester** Leicester, Blaby, Oadby and Wigston

- **Liverpool** Knowsley, Liverpool, St. Helens
- **London** Gravesham, City of London, Barking and Dagenham, Barnet, Bexley, Brent, Bromley, Camden, Croydon, Ealing, Enfield, Greenwich, Hackney, Hammersmith and Fulham, Haringey, Harrow, Havering, Hillingdon, Hounslow, Islington, Kensington and Chelsea, Kingston upon Thames, Lambeth, Lewisham, Merton, Newham, Redbridge, Richmond upon Thames, Southwark, Sutton, Tower Hamlets, Waltham Forest, Wandsworth, Westminster, Epping Forest, Broxbourne, Dacorum, Three Rivers, Dartford, Elmbridge, Epsom and Ewell, Mole Valley, Runnymede, Spelthorne, Watford, Woking.
- **Luton** Luton
- **Manchester** Bury, Manchester, Oldham, Salford, Stockport, Tameside, Trafford
- **Mansfiel** Ashfield, Mansfield
- **Middlesbrough** Middlesbrough, Redcar and Cleveland, Stockton-on-Tees
- **Milton Keynes** Milton Keynes
- **Newcastle** Gateshead, Newcastle upon Tyne, North Tyneside, South Tyneside
- **Northampton** Northampton
- **Norwich** Broadland, Norwich
- **Nottingham** Nottingham, Erewash, Broxtowe, Gedling
- **Oxford** Oxford
- **Peterborough** Peterborough
- **Plymouth** Plymouth
- **Portsmouth** Portsmouth, Fareham, Gosport, Havant
- **Preston** Chorley, Preston, South Ribble
- **Reading** Bracknell Forest, Reading, Wokingham
- **Rochdale** Rochdale
- **Sheffiel** Rotherham, Sheffield
- **Southampton** Southampton, Eastleigh
- **Southend** Southend-on-Sea, Castle Point, Rochford
- **Stoke** Stoke-on-Trent, Newcastle-under-Lyme
- **Sunderland** Sunderland
- **Swindon** Swindon
- **Telford** Telford & Wrekin
- **Wakefiel** Wakefield
- **Warrington** Warrington
- **Wigan** Wigan
- **Worthing** Worthing
- **York** York

SCOTLAND

- **Aberdeen** Aberdeen
- **Dundee** Dundee
- **Edinburgh** Edinburgh
- **Glasgow** East Dunbartonshire, East Renfrewshire, Glasgow City, Renfrewshire, West Dunbartonshire

WALES

- **Cardiff** Cardiff
- **Newport** Newport
- **Swansea** Swansea

NORTHERN IRELAND

- Belfast Belfast City,
- Carrickfergus

Annex B: A horizon scan of technologies in the future of cities

The pace of technological development is too fast to look accurately 50 years ahead. However, from horizon scanning we can see a number of specific technologies likely to affect UK cities in the future. These include:

TECHNOLOGIES	POTENTIAL IMPACT ON UK CITIES
Big data, data science	• The use of real time data and huge datasets to become a part of mundane reality
Internet of Things	• Pervasive sensing, smart workplace and connected home • Impact on city-based public service delivery, citizen-science influence on public resource allocation?
Satellites and commercial applications of space	• (What implications from enhanced urban sensing?)
Agri-science	• Large increase of urban farming (greater urban resource self-sufficiency)
Life sciences, genomics and synthetic biology	• 'Living buildings' with carbon-capturing building materials, algal biomass production, bioluminescence • Medical advances leading to increased longevity, influences demographic change
Robotics and autonomous systems	• Driverless vehicles, drones (work-travel patterns, investment priorities for strategic road networks, congestion, reduced freight on roads, new patterns of trade between cities?) • Automation of labour
Advanced materials and nano-technology	• Smart materials • Multifunctional public realm
Additive manufacturing /3D printing	• Reintroduction of manufacturing to urban centres (reduced freight on road network …) plausible impacts on urban form/high streets/energy flows. Relocalisation
Micro/distributed energy generation	• Impact on urban form? • Greater demand for public transport and non-motorised travel • New grid requirements
Energy storage technologies including cheap, high capacity batteries	• To enable widespread adoption of micro and distributed generation methods
Smart meters	• Reduce energy consumption, greater potential for distributed small scale energy generation?
District heating and cooling	• Higher density urban form development, more shared living spaces • Needs to overcome cultural resistance among UK householders

Sources: GO-Science/Cabinet Office Review of Emerging Technologies (forthcoming); HM Government (2013) *Eight Great Technologies* https://www.gov.uk/government/publications/eight-great-technologies-infographics (accessed 30/09/2014); Gartner Technology Hype Cycle 2014; Clift, R., Druckman, A., Christie, I., Kennedy, C. and Keirstead, J. (2015) *Urban Metabolism: a review in the UK context*. London: Government Office for Science.

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- All working papers have been commissioned by the Foresight Project: The Future of Cities and have passed a double-blind peer review process.
- The views expressed in these papers are the views of the authors and neither represent the views of the Government Office for Science nor the policy of the UK Government.

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