FUTURE CITIES:
UK CAPABILITIES FOR URBAN INNOVATION

CATAPULT
Future Cities

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CONTENTS

EXECUTIVE SUMMARY

Our urban future demands innovation. Cities are at the front-line in responding to global challenges of resource scarcity, climate change, unemployment, and ageing populations. While these are big challenges, they also present major new business and innovation opportunities.

Urban innovation is happening and city development is changing course. Cities are using new technologies, new business and financial models and innovative design approaches to provide their citizens with a good quality of life within a thriving economy, and with a reduced environmental footprint.

Professionals across industries and sectors are collaborating to create solutions. Rather than working in disciplinary silos to optimise systems in isolation, they are considering the city as a whole to maximise cross-sector synergies and avoid negative unintended consequences.

This report documents the wide range of UK industry, research and civic capabilities relevant for driving innovation for the world's future cities.

Chapter 1. The Future Cities Market

The challenges and opportunities faced by cities in the 21st century are stimulating new business activity. Demand is significant: cities across the world continue to grow and the global market for integrated urban solutions is estimated to be £200 billion by 2030.1 Five business capabilities are leading solutions development: **spatial** design, **physical** infrastructure, **digital** technology, **commercial** business services, and **social** service provision. The best solutions are combining expertise from across these five areas to deliver innovation on the ground. The broad range of capabilities required for developing these solutions presents a new market opportunity for many industries.

Chapter 2. UK Business Capabilities

Businesses in the UK are developing innovative products and services that are highly relevant to the challenges and opportunities faced by the world's growing cities. UK-based firms are working together in multi-disciplinary teams to create and export new products and services such as mobile phone apps, electric bus infrastructure, design for green urban space, open data standards, low-carbon building design, and new infrastructure financing models. The UK has strengths across a complementary package of spatial design, engineering, digital and business service industries.

Chapter 3. UK Research and Academic Capabilities

The UK has world-class universities conducting research and providing education in a range of disciplines relevant to urban innovation including architecture, civil engineering, computer science, product design and finance. Research and academic programmes are focusing on how to develop integrated city solutions and training urbanists in multidisciplinary ways of thinking and working. Universities are collaborating with businesses to accelerate innovation and make it relevant to real-world challenges. Business-led research and development facilities are drawing on the UK's strong innovation ecosystem in the sector.

Chapter 4. UK Civic Capabilities

Governments, together with civic organisations, are key players in supporting urban innovation. City governments are experimenting with new ways of delivering services and optimising city systems. They are engaging citizens using data and technology, creating specialised innovation teams, and using demonstration sites to trial new urban solutions. The UK government and professional organisations are setting standards and policies in relevant fields such as urban design, digital technology and open data, and are providing tools to give cities and local communities greater political autonomy.

Chapter 5. London's Capabilities

London has a unique combination of skills, business activity and research expertise that makes it a highly productive place for developing future cities solutions. The city's commercial strengths and world-class research base across the creative, finance, architecture, engineering, digital and real estate sectors represents a uniquely rich ecosystem for supporting urban innovation.

Chapter 6. Conclusion

The UK is well positioned to offer expertise, products and services to the global future cities market due to several key strengths:

- *Multidisciplinary approach:* Businesses are establishing collaborative cross-disciplinary teams to provide products and services for the world's cities. Engineers, urban designers, data scientists and sociologists are collaborating in the design of urban masterplans. Software developers, product designers and architects are creating new apps for urban navigation. Not only are firms working together in unexpected collaborations, UK universities, research centres, businesses and the public sector are using each other's strengths to accelerate urban innovation.

- *Project delivery:* The UK has capabilities across a range of industries required to deliver urban projects, including financial and business services, engineering, project management and construction services. In particular, the UK has the commercial expertise to manage large-scale urban projects, from London's Olympics to sustainable regeneration in Doha.

- *Urban planning and reinvention:* The UK is one of the world's most urbanised countries. The country has a well-established land-use planning system and its planning capabilities are used worldwide. With its rich urban heritage, the UK has developed expertise in transforming brownfield sites, retrofitting low-carbon solutions and using existing infrastructure in new combinations to address contemporary challenges.

- *Digital creativity:* The UK's diverse creative services combined with its fast-growing digital sector are producing innovative digital services for cities. Together the two sectors cover a range of complementary capabilities, from product and graphic design, to software and media development and advanced manufacturing.

- *Urban data, visualisation and modelling:* Universities and a vibrant start-up community of spatial data analysts are leading the take-up of newly available open datasets to create innovative visualisations and modelling techniques that help to improve the management and planning of cities.

- *Human-centred design:* Designing for the 'end user' is gaining prominence across diverse industries. Businesses and city councils are using new tools and methods to engage citizens in the design of places and public services. Centring the design of cities on people is crucial for making cities attractive and well-functioning places.

- *Standards setting:* Industry associations and government organisations have developed world-leading standards for urban design, open data, low-carbon, public service delivery and community governance. Standards such as BREEAM for green buildings and the BSI's Smart City standards have encouraged UK businesses to develop new services and products ahead of competition in overseas markets.

Despite the strengths of the UK ecosystem and capabilities for urban innovation, there is further work to do in developing UK capabilities across the business, research and civic areas – and the interconnections between these areas.

This report is intended to provoke conversation and connect a broad range of people: city government officials, digital entrepreneurs, architects, financiers, managers of utility companies, university researchers, and real-estate developers and engineers, to name a few. The number of actors involved in urban development is increasing and varies by local context.
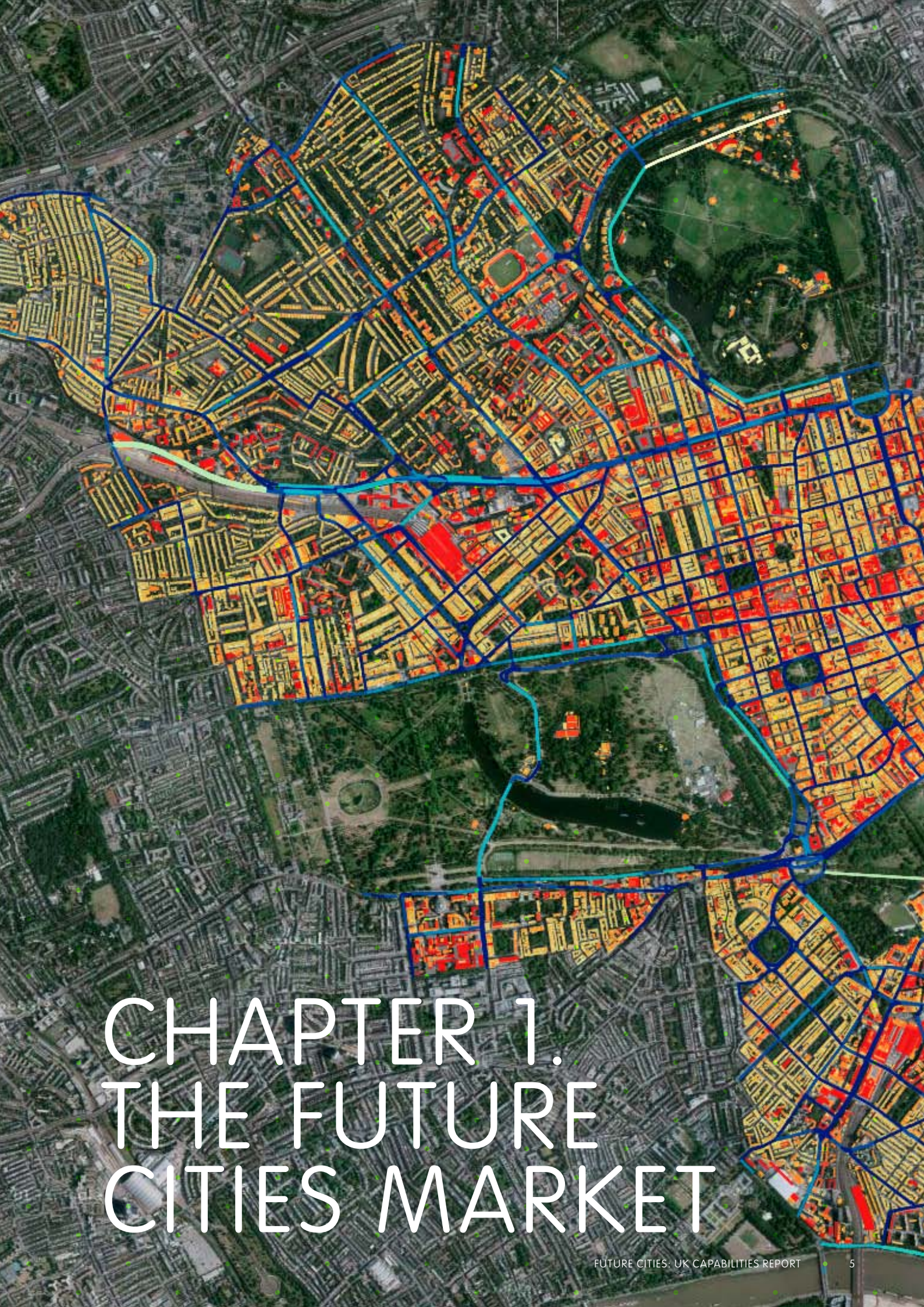
This report provides a snapshot of UK activity relevant to innovation for the world's cities. For UK businesses operating in the field it identifies the market opportunity and support mechanisms available for accessing this global market. For city leaders in the UK and abroad it shares examples of what works and offers examples of UK products and services that offer solutions to demanding challenges. For researchers and universities, it illustrates how research can be applied by business and city authorities to accelerate adoption of the best new thinking.

Report Methodology
This report describes capabilities relevant to urban innovation and categorises them into five types: **spatial**, **physical**, **digital**, **commercial** and **social**. In practise these capabilities usually work in combination to deliver innovation. By distinguishing them into five types this report provides a framework for identifying the range of industries involved in the development of urban solutions. The report also defines the actors behind these capabilities, including business, research and civic actors, which together constitute the ecosystem necessary for urban innovation.

The report provides an overview of the UK's capabilities for urban innovation by illustrating examples of activities led by businesses, universities and research institutions, and city governments and other civic organisations. Through case studies the report highlights the exportable products and services that have emerged from the UK's future cities innovation ecosystem.

This overview of the UK's capabilities is illustrative rather than comprehensive. Case studies, interviews and analysis of existing data have been used to highlight specific activities, products and services, but the illustrations are far from exhaustive and do not represent the complete range of innovative activities in the UK relevant to the needs of the world's cities.

CHAPTER 1.
THE FUTURE
CITIES MARKET

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Traditional models of urban development paid minimal regard to the scarcity of global resources or to environmental issues beyond immediate local impacts. Today, many cities are competing to attract and retain globally mobile talent and investment. As a result, city governments are placing a priority on becoming attractive places to live and work. In Beijing, for example, air pollution has reached such high levels that young talented professionals are avoiding the city, which could affect the city's economic prospects. In the global context of growing middle class aspirations, cities are seeking to provide their residents with a good quality of life, thriving economies, and reduced environmental impacts.

At the same time many cities across the world are struggling to provide basic services such as clean water, sanitation, education and healthcare. While some of the challenges faced by cities are widespread, such as transport and air pollution, there is considerable diversity in the nature and magnitude of challenges across the world. While London and New York struggle to retrofit 19th century water and transport infrastructure to meet 21st century needs, Luanda and Dhaka are running new electricity lines and water pipes into areas that have never benefited from reliable basic infrastructure before. Across the world, public authorities are demanding better and more cost-effective ways to deliver services that exploit the promise of new technologies in a context of strained budgets and intensified future risks.

New models of urban development are needed to meet these objectives. The market for urban innovation is large and growing. In the case of Beijing, the Chinese government plans to invest £10 billion (¥100 billion) over the next three years to improve air quality[3]. More widely, it is estimated that at least US$40 trillion will need to be invested in urban infrastructure over the next 20 years[4]. The market for smart city systems is estimated at over $400 billion by 2020[5] and the UK Technology Strategy Board estimates the size of the global market for integrated city solutions could be £200 billion by 2030[6]. These figures all suggest that companies, researchers and institutions that can provide the innovations that solve complex city problems will enjoy a sizeable and growing market for their skills, products and services.

City challenges and opportunities in the 21st century

Challenges	Opportunities

Population growth and stressed infrastructure

Cities in both the developed and developing worlds are expecting rapid growth in population. To support this growth cities have to develop and integrate their built environment, transport, communications and other infrastructure without increasing congestion.

Resource efficiency and low-carbon growth

With growing pressure on natural resources, many cities have set challenging targets for becoming more resource efficient and in particular to reduce their carbon footprint. City governments need to decouple economic and physical growth from resource consumption.

Resilient systems

Climate change, civic unrest and economic downturns have generated a new awareness of the importance of building resilience into city systems. City leaders and businesses are concerned with how to adapt existing infrastructure to withstand economic, political, environmental and social uncertainty.

Income inequality

There is a growing income gap in many cities, which can be an influence on issues such as mortality and crime rates, education, employment, and potential for short-term social upheaval. Cities need to find ways to reduce income inequality and to grow more inclusively.

Demographic change and disease

City governments have to reduce the impact of an ageing population on healthcare and the economy. They need ways to mitigate the risk of emerging infectious diseases that spread easily where there is high population density.

Political autonomy and collaboration

City governments assume greater responsibility for service provision (energy, water, clean air and waste) enabling closer management. Complex global challenges like climate change are being addressed at a city level, where there is often political will to test policies and share initiatives with other cities.

Information and communication technology

The decreasing cost of sensors and increasing access to the internet and digital technologies are providing new ways to optimise city systems. The aggregation of data across the city is generating insights to improve city life functionally, economically, socially and environmentally.

Efficiency and economies of scale

Compact, densely populated cities enable energy-efficient transportation and utility networks. Cities create opportunities for integration and economies of scale across systems, for example, using waste heat from electricity production to heat water for homes.

Prosperity and innovation

Cities attract talent and investment and generate enormous wealth. The concentration of people, business and research speeds up the exchange of information and ideas, which drives innovation and creativity. Cities will develop specialisations to compete in today's globalised economy.

Civic engagement

Cities have proven to be centres of social movements. City governments tend to have better access to information than central government, allowing them to be more responsive to the needs of citizens.

An emerging range of city solution providers

Governments, researchers, and professionals are adopting new ways of thinking and working to create sustainable city solutions that exploit the benefits of new technologies. Spatial designers are shaping buildings and public spaces to be both cost effective and achieve high levels of environmental and social performance. Civil engineers and utility providers are considering multiple infrastructural systems simultaneously to improve service delivery and efficiency. Digital industries are using new technologies and datasets to provide fresh views of the city and bridge silos in city governance. Real estate and finance businesses are developing new mechanisms to fund and design more integrated urban developments. Government agencies and social service providers are using new technology to engage more closely with citizens' needs.

Some of these solution providers are relatively new to the future cities market – such as management and technology consultancies. More traditional built environment sectors have been integral to shaping cities for many years. Across sectors, businesses are reorganising to form new 'urban' teams and investing in developing new products and services for a growing cities market. New sub-sectors are also emerging, such as city service design, open data infrastructure and urban data analytics providers.

This diverse range of sectors relevant to the future cities market can be organised according to five capabilities: **spatial** design-led solution providers, **physical** infrastructure-led solution providers, **digital** and data-led providers, **commercial** finance and business service-led solution providers and **social** and governance-led providers. This organisation establishes a framework for understanding the different capabilities involved in the development of urban solutions – capabilities that in practise are usually implemented in combination to deliver innovation on the ground. The different role of each type of capability is illustrated in the planning and delivery of London's 2012 Olympic Park.

A city systems approach
Cities are complicated and messy systems. Urban problems are the result of multiple factors with far-reaching impacts involving complex feedback loops. Traffic congestion, for example, could be the result of increasing population, decreasing household size, expensive public transport, a lack of parking or the city's layout. In turn, congestion can lead to poor air quality and high noise levels, increased health risks, less enjoyable public spaces, reduced productivity and fewer tourists in the city. Each urban problem is part of an intricate system of interactions.

Given the complexity of urban problems, the most effective approach to resolving them considers a city's multiple systems simultaneously, rather than focusing on how to fix a particular element. A **city systems approach** is just this; it considers the city as a system and designs solutions to have maximum positive impacts, while minimising negative unintended consequences.

Adopting a city systems approach is challenging as it requires a new integrated way of working. Firstly, designers must work beyond single disciplines to develop a sufficient understanding of the urban system. Secondly, diverse stakeholders need to be involved to implement these designs. The structure of city governments tends to be based on 19th or 20th century institutional models, with separate departments for distinct city functions such as transport, energy and education. To solve 21st century problems these silos need to be broken down and a more integrated approach to city management and governance is required

Five capabilities for urban solution development

Sp

SPATIAL

Using spatial design and planning –
of buildings, public space and metropolitan areas –
to address urban challenges in an integrated way.

Ph

PHYSICAL

Infrastructure engineering, design and construction –
of transport, energy, water and waste systems –
to drive cross-system efficiencies.

Di

DIGITAL

Data analytics, software development and application
of ICT across city systems to derive new insights on the
city's form and operation.

Co

COMMERCIAL

Finance, governance and business models for enabling
more integrated forms of urban development.

So

SOCIAL

Citizen engagement, information sharing and user-
centred design to enable more responsive forms of
urban development that address residents' needs.

LONDON'S OLYMPIC PARK: DEMONSTRATING FUTURE CITIES CAPABILITIES

Sp SPATIAL
Urban masterplanning

At the heart of the masterplan for the Olympic site is the Queen Elizabeth Park. The Park's design uses the existing canal infrastructure and waterways to connect the park with its surroundings. Over 8,000 houses are being developed at the Park over a 20 year time-frame and will be arranged along streets, terraces and squares inspired by London's existing urban form. The plan incorporates an open, flexible grid of streets allowing for strong connections between the new and old city.

Ph PHYSICAL
Low-carbon district energy network

A low-carbon energy system heats and cools all buildings on the site. Two energy centres drive the system, generating hot and chilled water from gas-fired combined cooling heating and power (CCHP) plants. The energy centres are fuel and technology agnostic, enabling them to switch between gas and biomass for heat generation depending on fuel tariffs, and to integrate additional renewable technologies in the future.

Di DIGITAL
3D modelling and visualisation

Visualisations of the Olympic site were created in realistic detail to help stakeholders make important design decisions. Bespoke software was used to create virtual and physical models of the site. Visualisation is a powerful medium to help decision makers understand different design options. Animations of the park were used for public consultation and for media publications.

Co COMMERCIAL
Project and supply chain management

The Olympic site build was a time-constrained and complex project involving multiple suppliers and considerable delivery risks. The Olympic Development Authority's supply chain management strategy reduced risks from potential supplier insolvency. The project involved over 43,000 individual contracts and innovative procurement and monitoring processes were used to reduce delays from supplier insolvency. While some insolvencies did occur, active management and careful preparation reduced their impact on timely delivery.

So SOCIAL
Community participation

The Changing Places programme was launched in 2009 during the pre-Games period to extend the benefits of the Olympic Park regeneration to neighbouring communities. It drew upon the high levels of interest in the Games to involve 50 organisations and many volunteers to deliver a range of local, small-scale initiatives. Projects drew upon existing networks, such as local schools, universities and church groups, to transform vacant or underused public land into places for community benefit. One project provided schools with grants to transform unused areas of their grounds. Another project created a time-bank for people to exchange time as a currency to help maintain the Park. Overall 15,000 people helped create improvements at more than 580 sites.

Innovation for future cities

Innovation for the world's future cities involves technological innovation including the application of rapidly advancing information and communications technology, sensing and data analysis – but also innovations in city-making processes involving new ways of delivering, financing and managing city systems. Innovation in architectural design, infrastructure planning, software applications, finance models and citizen engagement are all relevant to building the world's future cities.

The environment needs to be conducive to innovation across these activities. This includes having political will and resources, high quality research, relevant skills and relevant commercial activity. It can be thought of as an ecosystem made of three components: **civic**, **research and academic**, and **business**. This follows the triple helix concept, which considers how the relationship between universities, industry and government enables innovation.

These three components of the future cities ecosystem all help build capabilities in the five areas essential for urban solution development. The combination of spatial, physical, digital, commercial and social capabilities work together to produce integrated solutions for cities.

To understand the UK's capabilities relevant to the world's future cities, the strength of the UK's ecosystem is considered. This report is structured according to these three ecosystem components – business, research, civic – and investigates how spatial design, physical infrastructure, digital technology, professional and business service and social service and governance innovation is being supported across the ecosystem.

From innovation ecosystem to new products and services: developing solutions for future cities

Future cities innovation ecosystem:

The combination of businesses, universities, research institutes and public sector actors enabling innovation

Business

Civic

Research & academic

Future cities capabilities:

Five capabilities and skill sets relevant to developing solutions for the world's future cities

Sp   Ph   Di   Co   So

Future cities solutions:

The products and services for cities created by combining expertise from the capability areas

Co
Sp

So
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**The Future Cities Catapult –
building the UK's urban innovation ecosystem**
The Future Cities Catapult has an important role to play in building UK innovation capacity for future cities, accelerating the innovation process and enabling the market for product and services to be bought and sold. The Catapult and its innovation centre in central London will help link business, universities and city governments through collaborative projects. The Future Cities Catapult has identified three immediate areas to focus on:

- **Prototyping**. Spotting, supporting and improving city-changing ideas, new urban products and services.

- **Proving**. Through our Cities Lab, pilot projects and new platforms for system-wide urban innovation via big data.

- **Scaling**. Through helping deploy innovations in major urban projects, accessing finance, removing barriers and creating the wider market-place.

By using these capabilities in real-world urban innovation projects, the Future Cities Catapult will help UK businesses and researchers meet the needs of the world's future cities.

CHAPTER 2.
UK BUSINESS
CAPABILITIES

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UK BUSINESS CAPABILITIES

This chapter looks at the innovation being generated by UK businesses for the world's future cities. It examines, in turn, capabilities for **spatial** design-led innovation, **physical** infrastructure engineering and construction, **digital** solution development, capabilities in **commercial** professional and business services and **social** and governance innovation. Exemplar products and services are highlighted in case studies to illustrate how UK businesses are taking the lead in developing future cities solutions. As can be seen through these examples, a broad range of business sectors can contribute to urban innovation.

Future Cities capabilities and example products and services

Future Cities capability	Example industries	Example products and services
Sp **SPATIAL**	• Landscape Design • Urban Planning & Design • Architecture & Design	• Urban Sustainable Masterplanning • Urban Water Management • Public Realm Design
Ph **PHYSICAL**	• Engineering • Construction • Utilities Provision	• Electric Transportation Infrastructure • Waste to Energy Infrastructure • Smart Water Infrastructure
Di **DIGITAL**	• Software • Hardware • Information Technology Services	• Digital Masterplanning • City Data Platform Design • City Data Analytics
Co **COMMERCIAL**	• Financial & Business Services • Property & Real Estate • Legal Services & Policy Development	• City Vision & Metrics Development • City Innovation Governance Design • Business Model Development
So **SOCIAL**	• Service Design • Community Services	• Service Design Services • Urban Design Crowdsourcing Platform

Sp SPATIAL
Urban design, planning and architectural capabilities

The UK has strengths in spatial design, architecture and planning. Architectural services provided by firms in the UK are exported all over the world, generating net exports of £314 million in 2012[7]. A survey of the world's top 100 architecture firms in 2013 showed 21 of the 100 are based in the UK, including some of the world's largest practices measured by fee income such as Aedas, Foster & Partners, Atkins, BDP and Zaha Hadid Architects[8]. The US is the only country that hosts the headquarters of more firms. Many of these names represent pioneering architectural practices that have enhanced the UK's reputation for offering world-leading design services. The UK built environment community has led work promoting a new understanding of place, bringing together planning, landscape, architecture, conservation and engineering[9]. With programmes such as 'The Festival of Neighbourhood' which explores the concept of what makes a good neighbourhood, the spatial design industries are ensuring they engage with the communities they serve.

As cities build higher and strive for greater resource-efficiency, **architecture firms** in the UK are developing innovative designs for clients all over the world. Small and large firms are working for a growing number of overseas clients and large firms are extending their global office networks. Architects in the UK are placing more importance on the public space around buildings to enhance their building designs. Their design approaches consider the building's scale and relationship to surrounding streets or squares to encourage public activity in these spaces.

In the last two decades **urban planning** in the UK has shifted its focus away from regulating the aesthetic design of individual buildings to enabling design at a large urban scale that addresses a more fundamental agenda. Planners are adopting a new set of tools to shape design decisions and create opportunities for good design that tackle higher order urban issues. The 'urban design framework' pioneered by the private sector is enabling higher quality development within an adaptable framework. King's Cross Central is an example of how such a framework can put the public sector in the driving seat. Developers are adopting design codes to define the 'must have' design parameters for their developments and to offer greater certainty of outcomes. The process of creating these codes helps to align interests between key stakeholders at an early stage, including the creative (architect), the market (developer) and the regulator (planner).

There is also a growing regard for the pre-existing city context; a sensitivity to 'place' in addition to physical problems and profitability. Planners increasingly have to express their work in a coherent and qualitative manner through reports and drawings to enable greater public contribution in the planning process. As the regeneration of urban neighbourhoods in the UK has become a common means of kick-starting economic growth in disadvantaged areas, planners are working in multi-disciplinary teams with economists, architects and engineers across all phases of a project, from conception and construction through to monitoring the delivery of long-term outcomes.

The natural environment is being recognised as an essential piece of infrastructure for our cities. **Landscape designers** in the UK are developing green infrastructure within cities at a range of scales – from planting trees, green walls and rooftop gardens, to creating urban farms, parks and wetlands. Alongside individual initiatives, there is an emphasis on designing city-wide living ecosystems to address major challenges such as biodiversity loss, urban heat island effects, and climate change risks. Landscape designers are creating business cases to capture the range of benefits secured through urban green infrastructure, improving the quality of life and health of residents, creating an attractive place to invest, increasing tourism, reducing crime and producing food.

CASE STUDY

Urban planning for biodiversity and climate change adaptation

Image: Andrea Vail

Example products and services

- Sustainable masterplanning
- Urban design
- Landscape architecture
- Green building design
- Urban water management

The Queen Elizabeth Olympic Park in East London is one of the largest new urban parks created in Europe for over a century; it is a green space at an XL scale. The park's development demonstrates UK innovation in integrated spatial planning, urban water management, landscape architecture and project delivery.

The design of the park's landscape was led by a combination of architects and urban planners (including Allies and Morrison, LDA Design, Hargreaves Associates, Tim O'Hare Associates, Hyland Edgar Driver), engineers and ecologists (including AECOM, Arup and Atkins) who worked together to identify innovative approaches to foster biodiversity within the park and to connect the park with London's wider needs. Some of the initiatives included:

- **Biodiversity planning**: Construction of the Olympic Park venues resulted in a loss of 45 hectares of existing nature conservation sites. A Biodiversity Action Plan was devised to ensure a new 45 hectare area was created that would provide a diverse range of new habitats and species in the park. The Plan defined the quality of the new habitat, including re-seeding the park with flora that would have originally inhabited the area and creating continuous corridors for wildlife movement. The plan incorporated a degree of flexibility to allow elements to be varied as the design developed, subject to stakeholder agreement.

- **Waterways strategy**: Before the Olympic development a series of inter-linked waterways flowed through the park site which suffered from issues such as poor water quality, flood risk, a lack of dredging and poor accessibility. A restoration strategy was devised by a team of landscape architects, geotechnical, structural, civil, drainage and river engineers, planners and ecologists to develop integrated solutions, including flood mitigation, recreational uses and contaminated groundwater monitoring.

- **Public realm design**: The design of the park landscape as a green, open space was closely related to the Olympic Delivery Authority's objective of creating a new public realm. The park aims to attract nine million visitors a year and to tie in with the surrounding fabric of the city, helping to improve local connections by linking green spaces and amenities.

The decisions behind the development of London's Olympic Park were related to London's broader green strategy – the All London Green Grid. This spatial planning framework was adopted by the city administration (Greater London Authority) to promote the design and delivery of green infrastructure across London, including the connection of natural urban systems such as the Green Belt and the River Thames. With a political framework in place, the Olympic Park's design could focus on the diverse benefits of urban green infrastructure, including biodiversity, healthy living, flood protection and economic uplift.

The UK provided the range of skills and capabilities to design and deliver on the multiple objectives for the Olympic Park. Companies specialising in landscape architecture, engineering, ecology and urban design collaborated to provide capabilities in all areas from designing the vision, masterplanning, assessment, to consultation and collaboration.

Many of the UK companies involved in the design and development of London's Olympic Park have since worked on overseas projects, using their innovative approaches to urban biodiversity in the export market. For example, Atkins has designed a large-scale mixed-use masterplanning project in Jeddah that focuses on creating access to green open space to support a strong community on the site[10]. Arup has developed a detailed masterplan for Wanzhuang eco-city in China that focuses on the conservation of agriculture and local farming skills[11].

"Two million tonnes of contaminated soil have been washed, 5 km of riverbanks cleaned up, 6,200 trees, 9,500 shrubs, 63,000 bulbs, 250,000 wetlands plants and 766,000 grasses and ferns have been planted. There are fields and lawns, wetlands, woodland and wildflower meadows. There are 675 bird and bat boxes, kingfisher walls and swift hotels, as well as habitats to lure otters, water voles, sand martins, amphibians, reptiles and a host of invertebrates." – http://learninglegacy.independent.gov.uk/

Ph PHYSICAL
Infrastructure, engineering and construction capabilities

The UK has strong capabilities in civil engineering and construction. Overseas civil engineering consulting work generated net exports of £4.1 billion in 2011[12]. The civil engineering sector files numerous patent applications each year, ranking fourth in the UK among selected technology fields after pharmaceuticals, organic chemistry and medical technology[13]. The UK's construction sector registers a relatively high number of patents and enjoys technological advantages over other G7 and BRIC countries[14]. The industry is also well placed to take advantage of green and sustainable construction opportunities. Large domestic infrastructure projects such as Crossrail and the Thames Tideway Tunnel are spurring innovative technologies and techniques in construction and engineering to be developed and trialled in the UK.

The growing demand for urban infrastructure globally combined with a greater accountability for social and environmental benefits by businesses and governments has influenced the designs and methods used by **civil engineering** firms in the UK. New ways of valuing and appraising infrastructure are being developed by engineering companies to measure a broader range of benefits. Business cases that include benefits such as social inclusion, health and carbon emissions in addition to economic productivity and agglomeration are being used to aid decision-making and to make the political case for new infrastructure. For example, sharp differences in social and health indicators such as life expectancy between East and West London were a key political incentive behind the Jubilee Line development in the 1970s and then later the 2012 Olympic Park in London.

UK engineers are also designing and influencing in ways that go beyond infrastructure to change the shape of the city more broadly. The decision to locate the Channel Tunnel Rail Link in east London's Stratford City rather than Waterloo was based on a business case made by the UK engineering firm, Arup, which involved economists, urban planners and engineers working closely together. The case included wider benefits such as a direct link to trains up to the north of the UK and development opportunities, such as Stratford City and Ebbsfleet.

Engineers are reconceptualising infrastructure in ways that cut across the traditional city verticals of transport, water, energy and waste. The electric bus scheme in Milton Keynes shows how the electrification of transport requires the city's electricity and transport network to be connected. This case study also shows the broad range of services being provided by engineering firms – from developing the charging technology for vehicles, to digging holes in the road and connecting the charging system to the local electricity network.

As the dynamics of electricity networks are changing in many cities due to growing demand, decreasing supply, and more distributed micro-generation, **utility service providers** in the UK are becoming more responsive to their consumers. Smart grid technologies are being adopted by electricity network operators and providers to monitor electricity distribution and usage. Faced with the prospect of lowering profit margins, many utility providers are focusing on retaining customers by providing new services and have developed smartphone apps to assist them.

Many UK engineering and **construction firms** have adopted Building Information Modelling (BIM) as a tool to support their development projects. BIM is a process that involves the generation and management of digital representations of physical and functional characteristics of places using software. It enables a virtual construction stage that is proving invaluable to designers (architects, engineers and planners) and to construction companies. BIM facilitates the horizontal integration of design activities and the vertical integration of the construction supply chain – which supports complex urban projects. UK firms including RIBA Enterprises have played world-leading roles in developing BIM software and shared standards that are increasing efficiencies across the design, construction and management phases of building life cycles.

CASE STUDY

Wireless electric bus charging technology and pilot services

Image: Electric Bus, Milton Keynes

Example products and services

- Wireless electric charging technology
- Electric bus design
- Electric bus operation
- Business case development
- Private Public Partnership design

The cost and logistics involved in running electric buses have prevented them from becoming mainstream in urban environments. In Milton Keynes an innovative wireless charging technology is being trialled to power a fleet of eight electric buses. The demonstration project illustrates UK capabilities in emerging transport technologies as well as in developing innovative commercial arrangements for procuring new urban infrastructure.

The project is led by 'MASP', a joint venture company created by Arup and Mitsui. MASP developed a business case for the charging technology that incorporated the environmental and economic benefits of the buses. Arup and Mitsui set up an enabling company, eFleet Integrated Service Ltd (eFIS), to bear the financial risk by buying the buses and charging equipment and leasing them to other parties. Energy, technology, component and service providers were brought on board to develop the electric buses.[15]

The electric buses draw power wirelessly from 120kW charger plates embedded in the road at either end of the 15-mile route. This enables the buses to run a continuous service for 17 hours a day, just like their diesel counterparts, but greener. Over the course of a year the eight buses will transport 775,000 passengers, cover 450,000 miles, and reduce carbon emissions by 270 tonnes.

A real-world environment was needed to test and showcase the buses operating at scale. Milton Keynes Council recognised that trialling the buses could attract investment and build on its image as a pioneering city. A five-year demonstration pilot was agreed that drew upon private funding from eFIS and public sector grant funding from the Green Bus Fund and the Department for Transport. The pilot enables all parties involved to examine how the new technology is performing in a real-world setting, using the city as a showroom for a new product offer. Today the buses are being examined by other UK cities and automotive manufacturers globally.

"An electric vehicle is a lot more responsive and a lot more sprightly than a conventional vehicle, so the drivers love them. From a passenger's point of view, they are clean, smooth and quiet" says Professor John Miles of Cambridge University, an Arup consultant and director of the Milton Keynes electric bus programme.

Di DIGITAL
Data, software and analytics capabilities

Digital technology is changing the way we experience cities. Broadband internet, smartphones, wireless sensors, software and computing are providing us with more efficient services, from transport to healthcare, new ways to communicate, and greater access to knowledge and new jobs. Across the many actors involved in urban development there is an increasing recognition of the importance of digital infrastructure.

The UK is a world leader in information and communications technology (ICT) industries. It is the highest net exporter of computer and information services among the G7 countries – with exported telecoms services worth around £5 billion, computer services worth around £7 billion and information services of around £2 billion in 2011[16]. The UK's digital economy is estimated to comprise over 120,000 firms and represents around 8% of the country's GVA. The government has focused investment on developing the digital economy and many city councils in the UK manage open data platforms driving progressive data-driven initiatives. The UK is at the forefront of using technology to shape new services and organisations. Compared to the other 143 countries, UK ranks first in terms of the impact of ICT on new organisational models, and ranks second in terms of the impact of ICT on creating new service and products behind Finland[17].

In the UK, large and small technology companies are developing products and services to capitalise on ICT and urban development. Many IT consultancy firms like Accenture, Cisco, IBM, Schneider Electric and Siemens, have created groups within their organisations to provide city-based technology services. Technology providers such as Philips, GE, Siemens and Schneider Electric, have also established departments to design technology products to address city needs. These companies are using ICT to deliver efficiency gains and improvements to city services and systems. In particular, sensor networks are collecting real-time information on the operation of city infrastructure to detect faults and increase responsiveness.

Businesses in the UK are harnessing 'big data' – the large volumes of information generated today through technologies such as sensors, smart meters, social media and mobile phones. There are businesses providing sophisticated data analytics services to deduce insights from these large unstructured datasets, such as the social behaviour of people in urban spaces. App developers are transforming these insights into commercial products (see CityMapper). Data visualisation services and virtual technologies are being provided to display data sets in innovative and compelling ways, such as Oculus Rift, the virtual reality headset that allows users to experience designs in 3D. Data privacy services and tools are being developed to ensure data is shared safely. These are just some of the digital business activities in the UK that are part of a new 'information marketplace', which relies on data as a core asset to drive the development of innovative applications that improve city living[18].

The wealth of digital skills and activity that have emerged in the UK is closely related to the country's adoption of open data – the idea that certain information should be freely available for people to use and reuse without restriction. Businesses and individuals in the UK have driven the release of data for public use, for example OpenStreetMap was created by Steve Coast in 2004 to encourage the development and distribution of free geospatial data. It is now considered to be the Wikipedia of geographic data – a free street map that is created and maintained by thousands of volunteers. The UK government was an early mover on open data, establishing its online data portal (data.gov.uk) in 2009, ahead of many other national governments.

CASE STUDY

Digital design and open data services for urban navigation

Image: Citymapper

Example products and services

- City data strategy
- City data platform design
- Open data standards & research
- Transport data analytics
- API management services
- App interface design
- Digital service business models
- Digital start-up financing

London, New York, Paris and Berlin – after launching two years ago, **CityMapper** is now used by millions of urban dwellers in some of the world's busiest cities. The success story of UK-based CityMapper represents a broader range of UK business capabilities for transforming city services through the application of data and digital technology.

CityMapper is a smartphone app that provides journey planning information in a way that is comprehensive and intuitive. Developed in London and launched in 2012, the app uses transport data released by the UK government and Greater London Authority public data platforms. By integrating multiple sources of data on London transport, CityMapper provides its users with a sophisticated view of how to travel to their destination. The app combines information on different transport modes (bus, tube, taxi, walking, cycling) and factors (prices, journey duration, real-time delays, weather, and calorie burn) – understanding that people make travel decisions based on the whole journey environment. CityMapper displays this information through a clearly designed user interface. Compared to historical one-dimensional public transport maps, CityMapper provides a revolutionary real-time view of urban mobility.

It is estimated that CityMapper is installed on half of the iPhones in London[19] and is currently beating competition from US navigation apps[20]. By informing millions of individual decisions, the app is helping to improve the balance between the supply and demand of transport in key mega-cities. From a city administration's perspective, CityMapper is increasing transport capacity at a fraction of the cost of building new physical transport infrastructure. The cost of CityMapper to city governments relates to the cost of providing transport data to the public. The UK was one of the first countries to release open, real-time public transport data in 2010. This enabled CityMapper to be an early mover in the transport app market. The founder, a former Google employee Azmat Yusuf, established the company in London's Tech City, where he had access to digital designers and funding from nearby venture capital firms.

CityMapper is part of a generation of data-driven start-ups that provide services to improve urban life. Apps are now available in the UK to help urban dwellers clean up graffiti (LoveCleanStreets), park their car (ParkRight and Park at My House), hail a taxi (Hailo), share things with neighbours (StreetBank), and order drinks at a crowded bar (Ordella, Bar Pass, Q App, and YQ?). As the amount of digital data grows with the proliferation of sensors in the city, such as smart phones, electronic ticketing machines, global positioning systems (GPS), so will the usefulness of digital services like CityMapper.

In the UK, the digital economy is growing fast, with businesses emerging at each stage of the value chain. Initially, IT companies are helping city governments to set-up open data platforms. Smaller companies are then analysing and packaging the raw open data into an easier format for web and app developers, such as Transport API. Towards the end of the chain, investors and start-up incubators are helping developers to commercialise their products and services. This "information marketplace" is changing the design and operation of cities in the UK.

"It is easy to see the 'smart city' as a system for command and control, and the smartphone as a tether. CityMapper shows that data can actually deliver freedom and serendipity." Matt Webb, Design Museum, London.

"Someone's commute is always seen as the worst part of their day and a negative experience. We're trying to change that... We're interested in the experience with the individual and the city, and how the smartphone empowers an individual to experience their city." Azmat Yusuf, CityMapper Founder[21]

Co COMMERCIAL

Project management, financing and real estate capabilities

Professional and business services supporting urban innovation are a key component of the UK's business capabilities for addressing the world's urban challenges. City-scale projects require the management of multiple stakeholders and access to sustained financing. Innovations by UK finance, legal, and real-estate development firms have all contributed to development and delivery of new solutions for cities in both the UK and abroad.

Across the professional service sector, the UK has significant comparative advantages in attracting and retaining firms. Leading financial, legal, and professional services firms have headquarters in the UK, including two of the "big four" accountancy firms, the "magic circle" law firms, and several leading banks including HSBC and Barclays. Two million people, or approximately 7% of the UK's workforce, are employed in financial and related professional services, contributing £174 billion to the UK economy in 2012[22]. Together, these professional services firms have led various innovations relevant to future cities – for example, through creation of new standards for buildings and urban open data, strategies for city system integration, and new funding mechanisms for infrastructure and building.

Legal services in the UK are recognised globally, particularly in the field of international and commercial arbitrations. UK legal firms are exploring new regulatory landscapes emerging from big data, open data and cyber security technologies. For instance, Bird & Bird advised UK government on the commercial and contractual aspects of the roll-out of new smart gas and electricity meters to households and businesses as part of the Smart Metering Implementation Programme.

Capabilities in **regulatory and standards development** has seen the UK at the forefront of developing new standards for green building, smart cities and open data. The BREEAM standard developed by BRE has become a worldwide assessment tool for green building. The British Standards Institute (BSI), in collaboration with the UK government, has established 'smart city standards' to accelerate uptake of innovations by UK cities.

Professional service firms in the UK are developing solutions to help the public and private sector overcome complex urban challenges and market barriers to uptake of innovation. Management consultancies are drawing upon their expertise in information technology, infrastructure, transportation, and using real-time data and sharp analytics to provide strategic advice on integrated city solutions.

For decades **financial services firms** have worked alongside government in financing and delivering large-scale infrastructure projects. In addition to Private Finance Initiatives and partnership models such as Local Improvement Finance Trusts, financial services firms are also helping governments develop innovative funding mechanisms.

For example, Manchester and Liverpool have set up revolving investment funds through the JESSICA[23] initiative including the £36 million Evergreen[24] and £30 million Chrysalis funds[25]. Both funds seek to make investments in major urban infrastructure and regeneration projects. Similarly, the £100 million London Green Fund was established to invest in energy-related projects to support the Mayor of London's low carbon agenda.

Whilst tax incremental financing has been widely used in the US for major redevelopment, infrastructure, and other community-improvement projects, the UK is now piloting such schemes in Glasgow and Edinburgh.

In the context of a strong domestic market, **property and real-estate developers** in the UK are seeking to achieve long-term gains from their urban investments. King's Cross Central shows how private developers are tying investments to long-term, large scale regeneration projects and developing their own design standards for urban developments.

Innovative real estate services are emerging to address challenges, such as the shortage of affordable housing and retail space in many UK cities. One example is Appear Here, an online marketplace for the short-term rental of retail space. This new service provides flexibility for retailers amidst financial uncertainty. Since launching in 2012 it has attracted £1 million in funding from digital and property investors[26].

CASE STUDY

Financing for Urban Regeneration: The Chrysalis Fund

Image: Woods Bagot

Example products and services

- Brownfield Regeneration
- Revitalisation Strategy
- Strategic Partnerships
- Funding & Advisory
- Major Infrastructure Project Management
- Revolving Investment Funds

The £30 million Chrysalis Fund was launched in Liverpool in 2012 with funding from the European Investment Bank, Homes and Communities Agency and the European Regional Development Fund through the JESSICA initiative. It is an example of an innovative financing mechanism for urban regeneration.

Managed by the Igloo Consortium comprising GVA Property Consultants, Igloo Regeneration, and Royal Bank of Canada and working in partnership with the Liverpool City Regional Local Enterprise Partnership, the Chrysalis fund seeks to make strategic investments that supports regional economic policies and sustainable development. A variety of financing options are available, including senior and mezzanine debt at sub-market rates which can supplement existing debt or sit alongside the developer's equity to make the project financially viable.

Projects must generate a return to allow for re-investments into prospective projects that create jobs and unlock economic growth in the future. In this way, the "revolving" fund delivers more impact over the long-term by investing in projects that are not otherwise financially attractive to private sector investors.

As of 2014, the Chrysalis fund has made three investments, including:

- Watson House: a £4.8 million loan towards the re-development of vacant Watson House, a Grade II listed property situated in the Liverpool City centre.

- Tratos UK Expansion: to support Merseyside's advanced manufacturing sector, the Chrysalis fund provided a loan of £3.5 million towards helping Tratos UK, a cable manufacturer, acquire 100,000 square feet of adjacent premises as part of the company's expansion plans. It is expected to create 100 new jobs for Knowsley.

- Liverpool Exhibition Centre: the Chrysalis fund committed an £8 million loan towards the 8,100 square metre exhibition centre in Liverpool. Opening in summer 2015, the exhibition centre will host large conferences and trade exhibitions.

These high-quality investments demonstrate how the private sector can work successfully in partnership with cities to deliver economic benefits to the regional economy.

"A huge amount of hard work and dedication has been put into the development of Chrysalis from across the Merseyside authorities and the Consortium. Chrysalis is an innovative approach to economic development and it will provide Merseyside with new opportunities and options." – Cllr Joe Anderson, Liverpool City Council Leader, 2012.

SOCIAL
Public engagement and service design capabilities

Innovations to promote public engagement with urban management are being developed by UK design-led businesses A range of activities has emerged that focus on engaging citizens to inform the design of services, goods and places. In the UK, businesses across many industries, from retailers to real-estate developers, have adopted new tools to gather and use feedback from their customers and users. Companies and governments are hiring creative designers to re-design services and products to better meet the needs of end users and to create compelling brands that centre on the user experience. The UK is well-positioned to provide these services with strong digital and creative industries and government support for citizen-centric design and community driven initiatives.

Community-led design is influencing the shape of UK cities and their services. People are coming together to re-design spaces and services in their neighbourhood, such as creating community gardens, renovating old buildings, or establishing community associations. Social media is lending greater levels of participation and longevity to these initiatives. Young people, who have often been less involved in more traditional forms of public participation, are becoming more involved in shaping their cities, from joining in city visioning exercises, preparing neighbourhood plans, commenting on specific design proposals, reporting roadside waste or potholes, or more generally commenting on the quality of council services. Governments and businesses are recognising community design as a sensitive way to improve urban areas, using the people who have the best knowledge of their local areas to implement change in an incremental and collective fashion. Crowd-funding businesses in the UK, such as SpaceHive, are becoming powerful tools to capture resources and opinion, to influence the built environment.

Businesses specialising in **service design** are re-organising public services to centre them around people and places. Service design is a relatively new discipline that considers the experience of the end user to redesign the provision of services and products. City councils and government agencies are using service design to identify overlapping services and cut costs, as well as providing a better experience to citizens. The Design Council, FutureGov, and Shift are among a growing group of service designers started in the UK. These companies aim to make public services more coherent across operational silos and to provide a genuine two-way process between citizen and government.

CASE STUDY

Crowd-sourcing the design of public space and infrastructure

Image: Paul Townsend

Example products and services

- Civic crowd-sourcing services
- Public realm design
- Crowd-sourcing platform design

By 2016, it is estimated that crowd-funding will raise £15 billion annually in the UK[27]. The recent success of this new form of fundraising is now being applied to the public realm. A UK start-up **SpaceHive** provides an online funding platform for civic projects. Since launching in 2012, SpaceHive has been replicated by communities, businesses and city governments around the world, to fund local public developments. It is an example of the UK's capability for financial innovation and public action.

SpaceHive enables anyone to pitch for funding from the digital community for projects that "make places better"[28]. Projects range from building new playgrounds and cleaning up parks, to developing public WiFi networks and community centres. The Liverpool Flyover project, for example, plans to turn a concrete flyover in the centre of Liverpool into an urban park that would cost less to build than the flyover's proposed demolition. So far 122 funders have pledged £17,000 to the project through SpaceHive and a community has been catalysed to support the project, including 30,000 followers on social media.

The funders for SpaceHive's projects include citizens, businesses and local councils. For citizens the appeal of SpaceHive is being able to directly invest locally in creative projects without having to spend time attending meetings and navigating opaque municipal planning procedures. The financial model behind SpaceHive is philanthropic – funders do not hold a financial stake in the project nor receive any monetary return, rather they gain a sense of ownership and 'feel good' as a result of helping the project.

For local authorities and councils, SpaceHive is a source of investment and ideas for public spaces. Many Councils across the UK have pledged money to SpaceHive projects, which provide a risk-free way for them to add their funds to make a project happen in the context of UK council budget cuts and a loss of capital funding for public space development.

Crowd-funding provides governments with a way to engage and test designs with their voters in addition to providing finance. George Ferguson, the Mayor of Bristol, has embraced crowd-funding as part of wider measures to attract investment to the city. London's Mayor Boris Johnson launched his pocket parks campaign, a scheme to create 100 green spaces across the capital, by offering to match money crowd-funded online. The UK government is exploring the possibility of offering tax breaks to crowd-funders for civic improvements, which would add 25% to the value of every pledge[29].

SpaceHive has attracted public funding and private investment from Deloitte and through partnerships with major brands such as Experian, the research giant. The SpaceHive team manages the fundraising portal and checks the viability of schemes before they are published on the website. Publicity, business and legal support is then provided to projects According to the policy director at SpaceHive, "users enter into a ready-made community of councils, architects, advisers and funders"[30].

There are limits to civic crowd-sourcing. The amounts raised are often not enough for large-scale civic projects – the most successful crowd-funded campaigns have generated funding around the tens-of-millions mark[31]. Projects can be broken down into crowd-fundable components – plank by plank in the case of Rotterdam's pedestrian bridge[32]. Yet it can be a challenge to maintain funding in the long-term across multiple phases of development. This is being overcome by using crowd-funding to complement more traditional funding models. SpaceHive is acting as a first step to generate support, which can then act as a catalyst to attract big money (from corporations, foundations, philanthropists and governments) for public projects.

Civic crowd-funding businesses similar to SpaceHive have sprung up around the world and city governments are launching their own crowd-funding initiatives. Supporting businesses are also appearing, like **Sidekick Creatives**, which helps designers to promote and sell their idea online using video production and social media. A directory of crowd-funding sites, **CrowdingIn**, shows the success of this financial innovation.

"The system makes it difficult for ordinary people to invest in pavements and parks, or increase footfall outside their business... SpaceHive has created opportunities for citizens to solve their own problems with market efficiency" – Chris Gourlay, founder of SpaceHive[33].

CHAPTER 3.
UK RESEARCH
& ACADEMIC
CAPABILITIES

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UK RESEARCH & ACADEMIC CAPABILITIES

Alongside capabilities across business sectors for urban innovation, the UK has a strong research base and world-class higher education institutions relevant to developing solutions for the world's cities. This chapter describes research and academic programmes that are providing the skills and knowledge to address the opportunities and challenges of the world's future cities.

UK Future Cities Research

The UK is a major centre of world-class academic research – with research across a range of disciplines being relevant for developing future cities solutions. The UK's best universities consistently rank among the world's leading institutions. In subjects with particular relevance to future cities, Cambridge, Imperial and Oxford are ranked in the world's top 50 universities for civil and structural engineering[34]. An assessment of Europe's top 50 architecture schools includes seven UK universities (five of which are in London)[35].

While research relevant to future cities sits within various academic disciplines, a number of UK universities have moved toward establishing explicitly urban-focused and multi-disciplinary research centres. Cross-faculty collaboration is enabling new combinations of academic thinking to tackle city challenges (see table 'Selected Specialist Urban Research Groups in the UK' at the end of this chapter). A number of universities including Glasgow, Newcastle, Manchester, UCL, Imperial and LSE have multiple centres working on cities-related research.

Alongside city-focused research institutes, academic work within more established disciplines has a long-standing interest in issues relevant to future cities. For example, there is extensive UK-based university research orientated around particular technology or functional areas such as building physics, water systems and transport systems.

The following map illustrates examples of specific research projects currently under way at UK universities. It shows the breadth and richness of activity across spatial design, infrastructure engineering, digital technology and social and commercial innovation for future cities. It is evident that many of the research projects combine disciplines and approaches; for instance, the Retrofit 2050 project investigates how innovations in spatial design, technical engineering and commercial business models can contribute to accelerating the retrofitting of the built environment towards sustainability goals.

Public research funding in the field is predominantly distributed through the Engineering and Physical Sciences Research Council (EPSRC) which alone has over £100 million of active research grants related to 'urban' research.

Image: Robert Pittman

Universities are not working in isolation but collaborating with the private and public sectors to apply research in real-world contexts and partner up for demonstration and testing of urban innovations. For example, the Intel Collaborative Research Institute on Sustainable Connected Cities brings the technology company together with UCL and Imperial College London to develop adaptive urban technologies using methods from computer science, the social sciences, design and architecture. Siemens' 'Crystal' Urban Sustainability Centre in London combines research and development with the demonstration of new technologies in public exhibitions and events.

The UK government is funding research through the research councils and leading urban-related research programmes such as the Future of Cities Foresight Programme, launched by the Department for Business, Innovation and Skills (BIS), and the 'future proofing cities' research carried out by the Department for International Development which assessed how cities can respond to environmental risks.

UK Future Cities Higher Education

The UK's universities are not only conducting research, but are developing skills for the next generation of practitioners that can address the world's urban challenges. UK universities have strong education programmes across all five areas of future cities activity – training spatial designers, infrastructure engineers, computer scientists and digital technologists, business, governance and social innovators.

EPSRC is increasingly using its Centres for Doctoral Training (CDT) programme to target PhD training in specific topic areas, and to connect higher education to industry and other partners. At least 25 CDTs across the UK are relevant to building capabilities for future cities.

Selected UK university urban research programmes

Methodology: This map shows a selection of research programmes in the UK focused on urban research. The research programmes were identified by reviewing a range of sources, including private company websites and lists of UK government and EU research funding. This map shows a selection of those identified and is intended to show the variety of research across the future cities framework.
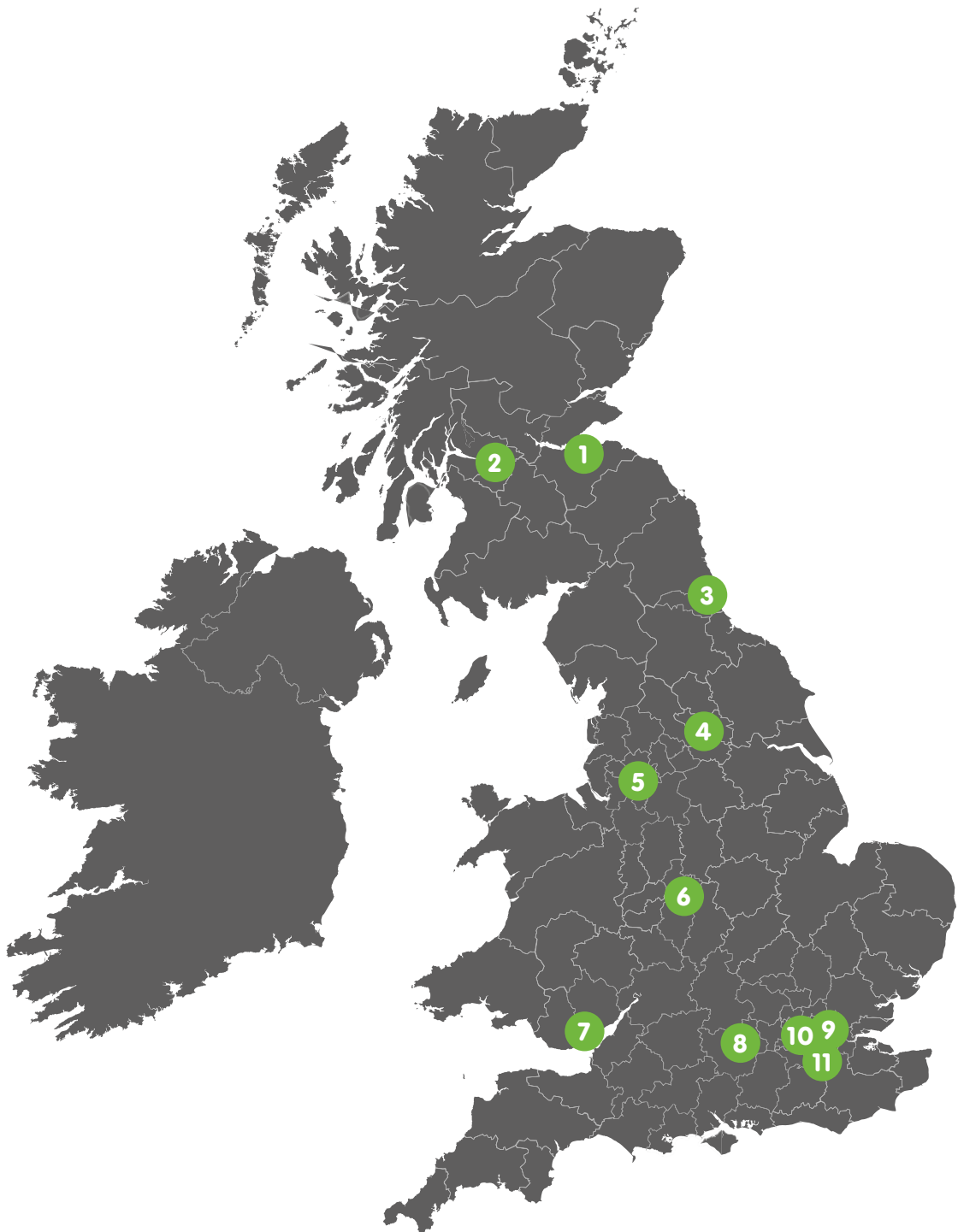
1 Mobility, Mood and Place `Sp` `So`

University of Edinburgh
Creating a user-centred approach to the design of built environments to make mobility easy, enjoyable and meaningful for older people.

2 Glasgow Urban Lab `Sp` `So`

University of Glasgow; Glasgow School of Art
A collaboration between the Mackintosh School of Architecture and Glasgow City Council. It links research, practice and education, focusing on urban regeneration and placemaking.

3 Infrastructure Business Models, valuation and innovation for Local Delivery (i-BUILD) `Co` `Ph`

Newcastle University; University of Leeds; University of Birmingham
Defining business models to better exploit the technical and market opportunities that emerge from the increased interdependence of modern infrastructure systems. i-BUILD focuses on infrastructure at the scale of neighbourhoods, towns and cities where infrastructure is most dense and interdependencies between infrastructures, economies and society are most profound.

4 Reducing urban heat demand `Co` `Ph` `Di`

University of Leeds
Developing decision-making tools for public and private sector stakeholders to analyse heat demand and test interventions in the city energy system. Potential interventions can be primarily technological, e.g. use of low-carbon heat technologies in housing estates, or primarily policy-based, e.g. supplementary planning guidance on connections to heat networks.

5 Sustainable Urban Regeneration `Co` `Sp` `Ph`

Salford University; Universities of Manchester, Napier, Liverpool, Dundee and West of England
A digital simulator and a library of good practice to support regeneration professionals with decision-making. For instance, housing regeneration decisions require technical information on density, tenure, condition and so on, but also tacit information on the perceptions of different actors on the effect of gentrification on crime or property values. The simulator combines different types of information helping stakeholders to recognise key decision points and guiding them towards appropriate evaluations.

6 Mapping the Underworld `Di` `Ph`

University of Birmingham; University of Bath; University of Leeds; University of Sheffield, University of Southampton; UK Water Industry Research
Exploring how technologies can map the location of buried pipes and cables in the urban context. A multi-sensor device is being developed that uses ground penetrating radar (GPR), acoustics and electromagnetic technologies to locate infrastructure in all ground conditions without the need for probing excavations.

7 Retrofit 2050 `Co` `Sp` `Ph`

Cardiff University; Oxford Brookes University; Salford University; Durham University; Cambridge University
Generating insights for policymakers on how to navigate the transition towards urban environmental sustainability by modelling future scenarios and social and technical pathways for the systematic retrofitting of UK city-regions.

8 Advanced Climate Technology Urban Atmospheric Laboratory `Di` `Co` `Ph`

University of Reading
A virtual urban environment (City-VUE) to engage engineers, meteorologists, policy makers and the public, on the urban climate and specifically, the adaptation of buildings to a warmer London climate. Data is used to assess the effect of building layout on city ventilation, and develop tools to optimise urban renewable energy generation.

9 Water Sensitive Urban Design (WSUD) `Sp` `Co` `Ph`

CIRIA (Construction industry research and information association)
A collaboration of organisations considering approaches to water sensitive urban design – the process of integrating water cycle management with the built environment through planning and urban design.

10 Digital Cities Exchange `Di` `Co`

Imperial College London
Exploring ways to digitally link utilities and services within a city, enabling new technical and business opportunities.

11 Sustainable Connected Cities `Di` `Co` `Sp` `So`

Intel; Imperial College London; University College London
Investigating, developing and deploying adaptive technologies that can optimize resource efficiency, and enable new services that support and enhance the quality of life of urban inhabitants and city visitors. The research approach combines methods from computer science, the social sciences, interaction design and architecture.

Five research programmes in the UK illustrate how the different future cities capabilities are being developed in academic contexts.

Sp SPATIAL

Urban form and sustainability

A consortium of universities examined the claims that more compact, high density and mixed-use urban forms are environmentally sound, efficient for transport, socially beneficial and economically viable. Sustainability was measured through socio-economic and environmental indicators. Urban form was measured with respect to physical configuration, layout, connectivity, density, housing form, mix of uses, green public space and gardens. Findings both support and refute the claims that high-density, compact urban development is more sustainable than low-density, indicating that the relationship between urban form and sustainability is complicated.

De Montfort University; Heriot Watt University; Oxford Brookes University; Sheffield University; Strathclyde University.
www.city-form.org

Ph PHYSICAL

Energy and urban planning

A cross-disciplinary research project at the University of Cambridge spanning the built environment, transport and urban land use. The impact of different technologies in building, transport, district power systems on energy use and emissions are assessed at an urban and national scale, alongside the impact of urban planning and urban design. The aim is to help practitioners and policy makers to reduce energy demand and the environmental impact of cities by quantifying the uncertainties for energy use using state-of-the-art techniques, in the wider context of socio-economic, physical, and regulatory factors.

University of Cambridge
www.eeci.cam.ac.uk

Di DIGITAL

Reading the city through data

Space Syntax uses urban data, spatial technology and predictive analytics to forecast the effects of planning and design decisions on the movement and interaction of people. Created at The Bartlett, University College London in the 1970s, this science-based, human-focused approach has led to key discoveries on the relationship between spatial layout and movement, land use, safety, land value, and carbon emissions. One of the UK's oldest and most successful university spin-off companies, Space Syntax has provided strategic consultancy services to a wide range of clients, including property investors and developers, public municipalities, community groups and building operators. Its highly graphic and data-rich approach has been used on urban projects worldwide for over 25 years.

The Bartlett,
University College London
www.spacesyntax.com

Co COMMERCIAL

A holistic city methodology

The Liveable Cities research programme is centred around the development of a holistic City Analysis Methodology (CAM). CAM will measure how cities operate and perform in terms of their people, environment and governance. The methodology incorporates four lenses for urban analysis: environmental, social economic and government. Using the CAM, the Liveable Cities team are developing realistic and radical engineering solutions for achieving the UK's carbon reduction targets and will test them in three UK cities: Birmingham, Lancaster and Southampton.

University of Birmingham,
Lancaster University, UCL,
University of Southampton
www.liveablecities.org.uk

So SOCIAL

Design to improve people's lives

Based within London's Royal College of Art, the Helen Hamlyn Centre for Design develops innovative and empathic designs for industry. It has three research labs: Age & Ability, Work & City, and Health & Patient Safety. The Work & City Lab investigates how designers can make living and working in our cities more inclusive and sustainable; from designing low energy lighting to enhance learning in schools, to using digital media to enable new forms of civic engagement, to redesigning the London black cab for all ages and abilities.

Helen Hamlyn Centre for Design,
Royal College of Art
www.rca.ac.uk/research-innovation/
helen-hamlyn-centre/

EPSRC Centres for Doctoral Training relevant to future cities

Institution	Name of Centre for Doctoral Training
Cranfield University	Centre for Doctoral Training in Engineering for the Water Sector
Durham University	Multidisciplinary Centre for Doctoral Training in Energy
University of Exeter	Centre for Doctoral Training in Water Informatics: Science and Engineering
Imperial College London	Centre for Doctoral Training in Sustainable Civil Engineering
	Energy Futures Doctoral Training Centre
University of Cambridge	Centre for Doctoral Training in Sensor Technologies and Application
	Centre for Doctoral Training in Future Infrastructure and Built Environment
University of Liverpool	Centre for Doctoral Training in Quantification and Management of Risk and Uncertainty in Complex Systems & Environments
	Centre for Doctoral Training in New and Sustainable PV
University of Manchester	Centre for Doctoral Training in Power Networks
Newcastle University	Centre for Doctoral Training in Cloud Computing for Big Data
University College London	Centre for Doctoral Training in Urban Sustainability and Resilience
	Centre for Doctoral Training in Energy Demand
University of Leeds	Centre for Doctoral Training in Technologies for a Low Carbon Future
Loughborough University	Industrial Doctorate Centre for Innovative and Collaborative Construction Engineering
Newcastle University	Centre for Doctoral Training in Digital Civics
University of Nottingham	Horizon Doctoral Training Centre for the Digital Society
University of Oxford	Centre for Doctoral Training in Autonomous Intelligent Machines and Systems
University of Reading	Centre in Technologies for Sustainable Built Environments
University of Sheffield	Centre for Doctoral Training in Energy Storage and its applications
University of Southampton	Centre for Doctoral Training in Sustainable Infrastructure Systems
	Industry Doctoral Training Centre in Transport and the Environment
University of Strathclyde	Centre for Doctoral Training in Future Power Networks and Smart Grids – a partnership between the University of Strathclyde and Imperial College London
University of Surrey	Centre for Doctoral Training in Sustainability for Engineering and Energy Systems
University of Warwick	Centre for Doctoral Training in Urban Science and Progress

Selected Specialist Urban Research Groups in the UK[36]

Institution	Group	Description
University of Birmingham	Centre for Urban and Regional Studies	Spatial and social planning studies including economic development, regeneration and urban resilience. www.birmingham.ac.uk/schools/gees/departments/curs/
	Liveable Cities	Collaboration between Birmingham, Lancaster, Southampton and UCL – creating an integrated, multi-disciplinary city analysis methodology. www.liveablecities.org.uk/
University of Cambridge	Martin Centre	Architectural group with substantial activity in urban design and urban land use modelling. www.martincentre.arct.cam.ac.uk/ www.urbanconflicts.arct.cam.ac.uk/
	Centre for Sustainable Development	Engineering group focusing on the social and environmental aspects of urban infrastructure and services including energy and water. www-csd.eng.cam.ac.uk/
	Energy, Transport and Urban Infrastructure	Research theme within the Department of Engineering focusing on energy, transport, information, buildings, water and waste treatment in the context of the urban environment. www.eng.cam.ac.uk/research/strategic-themes/energy-transport-and-urban-infrastructure
University of Glasgow	Urban Big Data Centre	Focus on methods and technologies to manage, link and analyse multi-sector urban data, both historic and real time. www.urbanbigdatacenter.wordpress.com/8-2/
	Urban Studies	Research theme of the School of Social and Political Sciences focusing on governance, urban economics and neighbourhood wellbeing. www.gla.ac.uk/schools/socialpolitical/research/urbanstudies/
Goldsmiths, University of London	Centre for Urban and Community Research	Research group within the Department of Sociology focusing on community, ecology, governance, and citizenship. www.gold.ac.uk/cucr/
Heriot Watt University	Institute for Housing, Urban and Real Estate Research	Social policy emphasis with research themes including housing design and housing policy, residential and commercial property markets and social exclusion. www.sbe.hw.ac.uk/research/ihurer.htm

Institution	Group	Description
Imperial College London	Urban Water Group	Engineering group with focus on sustainable water management, urban flooding, integrated catchment management, smart technologies for asset management and performance measurement.
		www.imperial.ac.uk/ewre/research/currentresearch/urbanwater
	Urban Energy Systems	Engineering group with focus on integrated modelling for the design and operation of urban energy systems to improve energy efficiency and environmental impact.
		www.imperial.ac.uk/urbanenergysystems
	Digital City Exchange	Collaboration between the Engineering and Business School focusing on model-based digital innovation in cities.
		www.imperial.ac.uk/digital-economy-lab/partnernetworks/dce
	Intel Collaborative Research Institute in Sustainable Connected Cities	Collaboration between Imperial, UCL and Intel focusing on use of computer science and human centred design techniques to creating new urban systems and services.
		www.cities.io/
King's College London	Cities@King's	Based in the Department of Geography, focuses on aspects of social, economic, political, historical and cultural change in cities.
		www.kcl.ac.uk/sspp/departments/geography/research/cities
London Metropolitan University	Cities Institute	Based in the Faculty of Social Sciences and Humanities, research on urban economic development, housing, transport and culture.
		www.citiesinstitute.org/
London School of Economics	LSE Cities	Emphasis on how the design of cities impacts society, culture and the environment and also on city governance.
		www.lse.ac.uk/LSECities/home.aspx
	Cities@geography	Based in the Department of Geography and Environment focusing on urban regeneration, governance and sustainable development; mega-projects.
		www.lse.ac.uk/geographyAndEnvironment/research/cities/
University of Leeds	Centre for Spatial Analysis and Policy	Group based in geography focusing on applications of GIS to urban systems modelling.
		www.geog.leeds.ac.uk/research/centre-for-spatial-analysis-and-policy/

Institution	Group	Description
University of Manchester	Centre for Urban Policy Studies	Research on urban and regional policy. Themes include evaluation of area-based urban policy initiatives, spatial planning, spatial analysis and public participation. www.sed.manchester.ac.uk/research/cups/
	Centre for Urban Resilience and Energy	Research on urban aspects of energy, climate change and spatial systems from a social science perspective. www.seed.manchester.ac.uk/research/centres/cure
	Global Urban Research Centre	Urban development and globalisation including topics of poverty, inequality, conflict, housing and climate change. www.seed.manchester.ac.uk/gurc/
Newcastle University	Centre for Earth Systems Engineering	Engineering group focusing on analysis, design, and management of coupled human, environmental and engineered systems with strong focus on urban infrastructure networks. www.ncl.ac.uk/ceser/
	Centre for Urban and Regional Development Studies	Group based in geography, politics and sociology with a focus on local and regional economic development. www.ncl.ac.uk/curds/
	Global Urban Research Unit	Planning/architecture group with focus on urban planning, politics and the environment. www.ncl.ac.uk/guru/
University of Oxford	Programme for the Future of Cities	Based in the Institute for Science, Innovation and Society with an anthropological focus. www.futureofcities.ox.ac.uk
	Infrastructure Transitions Research Consortium	A consortium of nine universities led by Oxford working on the development of new decision support tools for national infrastructure planning. Scope is national rather than urban but many projects have urban implications. www.itrc.org.uk/
University of Salford	Centre for Sustainable Urban and Regional Futures	Based in the School of Built Environment, this group works in three areas; urban futures, cultural intermediation and urban retrofit. www.salford.ac.uk/built-environment/research/research-centres/sustainable-urban-and-regional-futures
University of Warwick	Warwick Institute for the Science of Cities	Gathering city-scale data and transforming it into knowledge, capitalising on emerging developments in big data and in interdisciplinary solutions to urban challenges. www.wisc.warwick.ac.uk/research/

Institution	Group	Description
University College London	Centre for Advanced Spatial Analysis	Originally established as a GIS centre with strong urban focus, now orientated towards simulation, spatial data and visualisation.
		www.casa.ucl.ac.uk
	Urban Laboratory	Group with a strong geography/planning focus working in the areas of urban housing, ecology, design and data.
		www.ucl.ac.uk/urbanlab/
	International Centre for Infrastructure Futures	Consortium of six universities led by UCL, focusing on the development of innovative business models for infrastructure investment, with a strong focus on cities.
		www.icif.ac.uk/

CHAPTER 4.
UK CIVIC
CAPABILITIES

CHAPTER 4.
UK CIVIC CAPABILITIES

City governments and other civic organisations are central actors in driving UK urban innovation. Government activities taking place at the municipal and national level are supporting experimental and innovative approaches to urban management in the UK – helping drive demand for new products and services relevant to the world's cities.

Local authorities are experimenting with new forms of service delivery, new technologies and working in partnership with business and research centres to connect innovation with real-world challenges and demonstrate new solutions in situ.

Civic organisations are important components of the UK's ecosystem for urban innovation with citizens developing fresh ways to manage and plan city systems. Central government is supporting innovation through targeting industrial support and funding in the sector.

City Governments

City governments in the UK are adopting innovative approaches to urban development and attracting investment to trial new integrated solutions. With their budgets significantly reduced over the last five years, UK city councils have been forced to innovate to deliver cost efficiencies. There are some common themes across UK city council's work relevant to future cities solutions:

- **Citizen engagement:** City administrations are adopting new ways of engaging the public to increase efficiency, build trust in local politicians and increase citizens' participation in decision-making. Many councils provide webcasts or live streams of their meetings and allow residents to film, tweet or blog during open council meetings[37]. They have created facilities to allow people who live, work or study in the area to submit or sign e-petitions on any matter for which the council or its partner organisations have responsibility[38]. New techniques have been developed to involve citizens in council budget decisions, gaining input on trade-offs such as increasing revenues from parking fines or reducing property costs to avoid cuts in services[39].

- **Open data and digital innovation:** A growing number of IT experts are being recruited by city councils to support them with the delivery of online services and data analytics. For example, the Leeds Data Mill, supported by the Leeds City Council provides an online platform for sharing city data. The Greater Manchester Data Synchronisation project brings together three Manchester local authorities, to improve sharing of city data between local governments and other users (see Manchester case study).

- **Infrastructure finance innovation:** Due to constraints on public finances, city leaders are looking for new ways to finance urban infrastructure. For example, Milton Keynes adopted a scheme called the Milton Keynes Tariff to forward-fund £400 million of new infrastructure, enabling the future development of 15,000 dwellings and 500,000 square metres of commercial floorspace in the city's designated expansion areas. As negotiated with landowners, an agreed schedule of infrastructure was provided with an initial £80 million forward-funding from the Treasury with the costs defrayed by the payment of a guaranteed fixed levy per home built or a per square metre of employment land developed, rather than negotiating individual Section 106 agreements. Tariff payments vary depending on the type of development and payment is due when the development meets a major milestone, allowing for the bulk of payments to come from the developers' cash flow, rather than financed up front.

- **Low-carbon:** Cities across the UK have taken responsibility for reducing carbon emissions, leading innovations to improve efficiency and reduce energy consumption in buildings, public services such as street lighting and through shifting passenger transport toward lower-carbon modes (see Bristol case study). Some cities have undertaken advanced research into the most cost-effective initiatives for reducing emissions such as the Leeds City Region, which collaborated with the Centre for Low Carbon Futures to identify low carbon investments that generate significant savings from lower energy bills[40].

- **Technology demonstration projects:** Local authorities are initiating experimental projects that demonstrate the use of cutting edge technology for improved city performance. For instance, Milton Keynes City Council is a key partner together with the Future Cities Catapult, Neul, ARM, BT and the Open University to establish an 'internet of things' demonstrator, providing an open access network for machine-to-machine communication using TV white-space. The project is currently testing new uses for the technology including for the city's rubbish collection and car parking.

- **Infrastructure analysis:** Cities are assessing their current infrastructure portfolios to spot efficiency savings and are looking ahead to detect future infrastructure gaps. For example, the Mayor of London has commissioned work to assess the capital's strategic infrastructure needs up to 2050 in London's first Long Term Infrastructure Plan[41].

- **Innovation teams and centres:** Councils are setting up teams that work across departments to identify and deliver innovation internally. They are also driving innovation within their cities by creating centres and events that bring together businesses, people and institutions to help the flow of ideas across sectors and industries. These forums facilitate localised knowledge spill-overs and create the conditions for innovation.

CASE STUDY

Bristol:
reducing carbon emissions with smart energy

Growing populations, increasing demands
Bristol is one of the UK's fastest growing cities: its current population of 441,300 is expected to rise by 31% by 2028. Smart City Bristol, launched in 2011 and building on the Smart City Bristol Report, is a collaborative programme between the public sector, business and community which aims to meet the city's environmental, social and economic challenges and opportunities through smart technologies and digital connectivity. Led by Connecting Bristol, it brings economic and environmental benefits, as well as behaviour change by ensuring that citizens co-design, trial and test smart technology that is eventually fully integrated and complementary to their lives.

One of Smart City Bristol's three focus areas is smart energy. This will help meet the energy needs of its citizens and businesses as well as contribute to Bristol's carbon emissions reduction target of 40% by 2020 from a 2005 baseline, and unlock investment in new forms of energy generation and management.

Engaging citizens to save energy at home
Bristol is using various smart techniques to reduce peak and overall energy demand across its building stock. With European funding, '3-E Houses' is deploying smart metering technology in 100 social houses to explore energy use reductions, and therefore minimise carbon impact and lower citizens' bills. Real time monitoring and management of energy consumption shows citizens how much energy they consume, helps integrate renewable energies into residential energy provision through smart metering technology, and enable development of tools to design and evaluate energy savings plans. The project has partners in Bulgaria, Germany, Spain and the UK, where they include Bristol City Council, Toshiba and Knowle West Media Centre.

Based on previous studies, 'standard' smart metering can have just a small percentage impact on energy use. However, when citizens are engaged in energy use decisions, much bigger energy reductions are possible: early results from 'time of use' trials suggests peak time reductions of up to 20%. UK partners in 3-E Houses have developed cartoon-like, 'gamified' user interfaces to increase the sense of ownership and encourage regular smart meter use, resulting in a 20% reduction in energy consumption across the three city areas involved. Such UK expertise can be commercialised and replicated in other global cities.

Reducing energy demand across the city
The city is also reducing energy demand through a targeted service for public building staff. It comprises ICT-based energy decision support, awareness and management services and is part of the international Smart Spaces project with almost 20,000 professionals and staff users involved in 11 pilots in eight countries. Bristol is deploying this in over 500 public buildings including all council offices and locally managed schools. Bristol City Council will also partner with SystemsLink, a UK provider of local authority energy management software, to develop a smart system that accurately records the council's energy use, using daily energy meter readings to identify where waste is occurring and where savings can be made.

Developing renewable alternatives
Where demand reduction is already optimised, the city is working to integrate renewable energy sources into its grid. It is using smart technology developments to do this, for example integrating solar power and battery storage. Like many cities, Bristol faces grid connection challenges for the large scale roll-out of solar PV and other low-carbon technologies. The So La project enables the city to overcome the network limitation of a low voltage distribution network, and provides energy storage options. Energy can then be provided to citizens at peak requirement times, saving energy and carbon and increasing energy security. A pilot in ten schools, one office and 30 homes, is funded through Ofgem's Low Carbon Network Fund, and the partners include Bristol City Council, Western Power Distribution, Siemens, the University of Bath and Knowle West Media Centre.

www.bristol.gov.uk/page/environment/council-action-climate-change

CASE STUDY

Manchester:
linking open data across city councils

Image: Greater Manchester Data Syncronisation Programme

Unlocking open data

Data collected by local authorities and other city organisations is a potentially rich source of information to help city planners, managers and citizens make decisions about developing and using their city. However, data is often not widely available or is not published in accessible and re-usable formats, making it difficult for other parties to use.

UK cities are increasingly realising the value of open data for transparency, improved public service delivery and citizen engagement. With the direct economic returns from opening up and re-using public sector data estimated at £1.8 billion per year in the UK[42], more and more new open data infrastructure initiatives are launching, including the Greater London Authority's DataStore and Glasgow's Open Data Portal.

Manchester is developing its linked open data infrastructure through the Greater Manchester Data Synchronisation Programme. Established by three local councils – Salford, Trafford and Manchester City – the programme is enabling the free flow of public sector data between councils and more widely among businesses and citizens. The programme is translating data held in different formats across different organisations into a common format held within a central repository for the Greater Manchester region. The programme is coordinated by local Manchester innovation lab, FutureEverything, with support from the Future Cities Catapult and Connected Digital Economy Catapult.

Developing an open data framework

Since launching in September 2013, the programme has already established the key infrastructure for sharing open data – a common region-wide 'quad store' for linked data. 'Code fellows' working within the councils are identifying and publishing new datasets in an open format, while building skills and capability for open data within the region. In parallel, the programme has engaged the local digital community, including a number of SMEs, promoting use of the data through new software applications. At a programme-organised hackathon, 20 developers used the data to build new apps and services. One idea conceived during this event that a team of developers is now working towards commercialising is 'Light Raider', an obesity-fighting app that uses the newly released council data on street lamp locations to inspire and challenge users to explore running and walking routes.

In the second phase of the programme, the platform will be rolled out to include a wider set of local authorities within Greater Manchester. In the longer term, the approach developed for building open data capacity within Manchester and facilitating collaboration among councils may offer a translatable model that could be applied across the UK and abroad.

Scaling innovation

This is a relatively low-cost civic initiative with potentially large benefits. Compared with the costs of bespoke IT infrastructure, this £150,000 project is inexpensive with benefits and potential applications as wide-ranging as the datasets released. Greater Manchester Councils could see cost savings from improved transparency in government, increased efficiency of public services and the added benefit of avoiding procurement costs for bespoke IT services as they are instead provided by grass-roots developers. Based on cost-assessment of other initiatives, the scale of potential monetary benefits from Manchester's open data is likely to be significant. For example, NHS data sharing of hospital infection rates is estimated to save £34 million per year across the UK, while a comparison of city procurement costs in Washington DC found that a grass-roots open data hackathon costing US$50,000 produced IT solutions that would have cost US$2.6 million if developed internally by the city.

Building UK capacity

Wider benefits from the programme include development of skills and capability in Manchester and the UK for open data infrastructure development, data analytics and software development. A Manchester company, Swirrl, has provided the underlying data infrastructure for the programme. SMEs are already using the newly released data to build and commercialise apps, offering opportunities for skills and capability-building among Manchester's already vibrant tech community. Ultimately, the release of open data has potential wide-ranging benefits for city residents through application of data to tackle challenges such as health, waste collection, transport and energy use.

www.gmdsp.org.uk/

UK City Government Initiatives

A selection of initiatives carried out by city governments provide an overview of future cities activities in the UK.
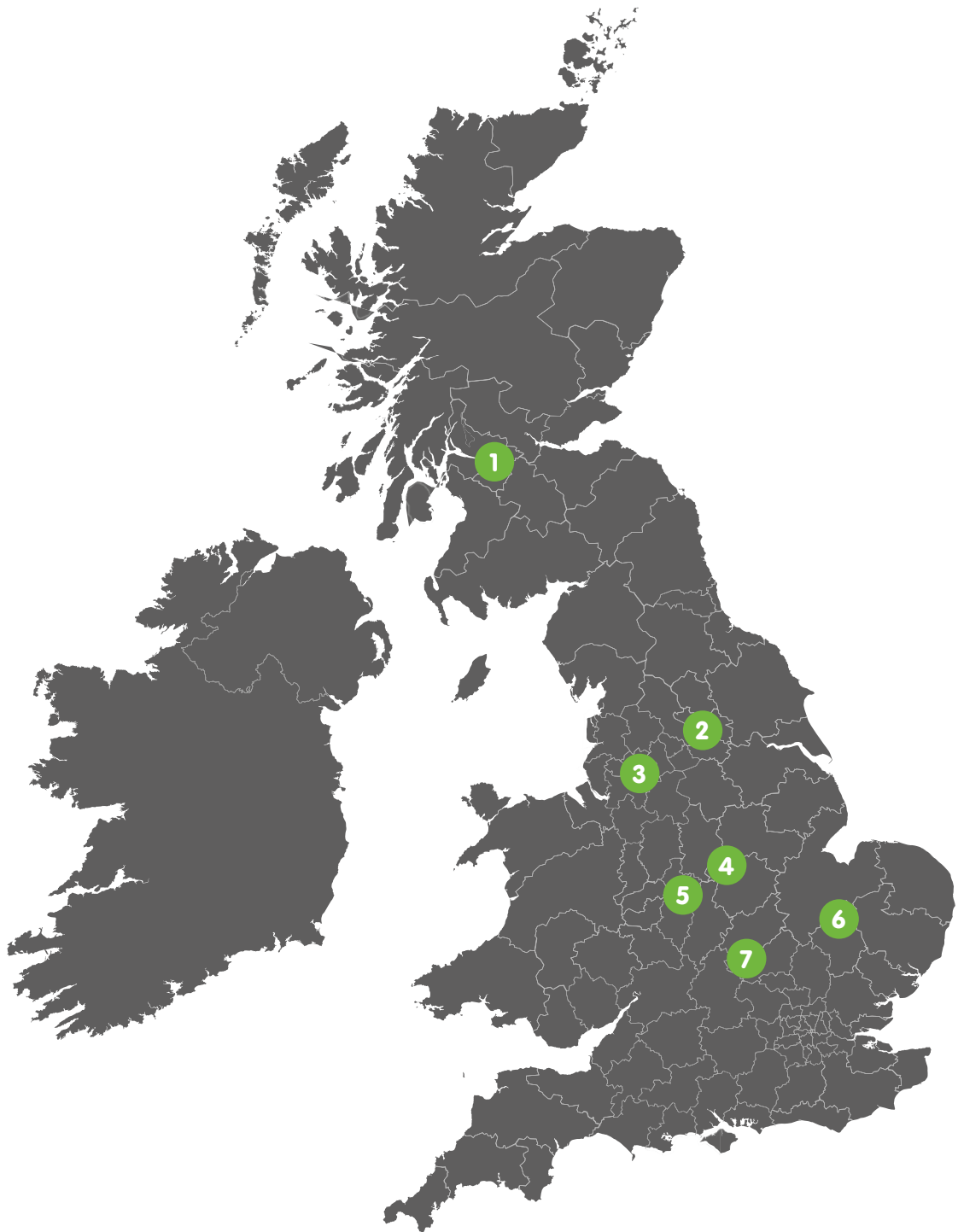
1 Glasgow City Council

Future Cities Demonstrator
The Technology Strategy Board's £24 million grant has kick-started the Glasgow City Council's smart city programme. Pilot projects include an open data platform, city operations centre and intelligent street lighting.

2 Leeds City Council

Leeds Data Mill
The open data platform for Leeds creating a city-wide culture of data publishing and experimentation with the aim of improving city life.

Green Infrastructure Strategy
A strategy that defines a vision for the green spaces and environment in the city region and their relation to other city initiatives such as housing and regeneration, transport and economic drivers.

3 Manchester City Council

Manchester Digital Development Agency
An organisation within the council to develop a digital strategy and technology-focused projects for the city.

Manchester Carbon Literacy Project
A training programme that provides a day's tuition on 'carbon literacy' to everyone who lives, works or studies in the city.

4 Leicester City Council

Virtual Power Plant
The Council is exploiting an opportunity in integrating energy demand and supply at a city-scale through the creation of a Virtual Power Plant.

Climate Change Programme of Action
A programme involving over 40 organisations to help the city meet its target of a 50% reduction in carbon dioxide emissions by 2025 from the baseline year 1990.

5 Birmingham City Council

Birmingham Smart City Roadmap
A strategic vision for adopting smart city initiatives that respond to economic, well-being, mobility and environmental challenges.

Big City Plan
A 20 year vision for the future development of Birmingham's 800 hectare city centre that has received over £1 billion of public investment.

6 Cambridge City & Cambridgeshire County Council

Starpath
A new street-illuminating technology trialled by the Council which absorbs light during the day through ultraviolet particles in the pavement and emits an artificial glow at night.

Cambridgeshire Guided Busway
The longest guided busway in the world, connecting Cambridge with key towns in the surrounding region using buses along old railway lines.

7 Milton Keynes Council

MK:Smart
A collaborative initiative to develop digital city solutions in the areas of transport, energy and water management. A data hub supports the initiative by acquiring and managing data relevant to city systems from a variety of sources.

Local Investment Plan (2012-26)
A comprehensive plan that outlines the investment requirements and funding mechanisms to deliver projects across Milton Keynes, including 28,000 new homes and 40,000 new jobs by 2026.

CASE STUDY

The Future Cities Demonstrator Programme

The UK government, through the Technology Strategy Board (TSB), has promoted city-led innovation through its recent Future Cities Demonstrator Programme. Glasgow, Bristol, London and Peterborough all received funds in 2012 through a competitive funding process with applications received from 30 UK cities. The funding aimed to promote use of new digital and communications technologies to solve urban challenges in an integrated way – by not only optimising single systems but providing benefits to multiple urban systems.

Glasgow:
building a city-wide future cities demonstrator

Glasgow, Scotland's biggest city and the UK's number two financial centre after London, has transformed itself from an industrial city based on shipbuilding and manufacturing to a modern and diversified economy. With a population growing faster than expected, the Glasgow City Council is working hard to develop integrated systems that improve health, reduce crime and increase resilience.

Addressing the everyday challenges that concern people living in Glasgow such as crime, transport and affordable energy, lies at the heart of the council's proposal to become the UK's first 'Future Cities Demonstrator' city. Selected out of 30 cities, Glasgow City Council secured £24 million from the UK government's innovation agency to kick-start its plans to make life in the city smarter, safer and more sustainable through technology, open data and open engagement with citizens.

Since launching in January 2013, the city has delivered a range of pilot programmes and initiatives focused on improving and exciting civic participation in the conversation around a smarter Glasgow. From smart lighting to better bin collection, optimised travel to improved job opportunities, the Glasgow demonstrator is testing new technology and applications for citizens that can improve local quality of life and create new economic opportunities for the city.

Making Glasgow safer with intelligent street lighting

Safety is a major concern for people living in Glasgow. Last year, 40% of citizens reported incidents of antisocial behaviour and high local crime is considered a deterrent to walking or cycling around the city, especially at night. The Intelligent Street Lighting Demonstrator was rolled out to address this, with 72,000 old fashioned street lights replaced with LEDs and sensors to measure footfall, lighting and climatic data such as air pollution. The intelligent street lights detect and respond to local activity, brightening in response to approaching pedestrians and cyclists, and dimming when no one is around. By improving local light levels, these automated street lights are encouraging people to get out and about, while reducing energy consumption by up to 60%, with proportionate cost savings for the council.

As the intelligent street lights are connected to the internet, they can also be used to coordinate more sophisticated responses to address crime in the city. Lots of noise and increased footfall are often an early indicator of antisocial behaviour. In response, lighting automatically brightens to help calm fights before they escalate, and an alert is sent to the central operations centre where the information can be investigated alongside real-time, high-definition CCTV footage and an appropriate response can be coordinated, such as deploying police to the area.

Using data to forecast outbreaks of crime for early intervention is part of the move towards predictive management of city issues. Data from across the city is integrated and processed in the Glasgow Operations Centre, a £12 million, state-of-the-art integrated traffic and public safety management system. Bringing together public CCTV, Glasgow Community Safety Services, Traffic Management Services and the Resilience and Safety Team, this centralised hub can assess and respond to situations large and small across the city. It will also help facilitate and safeguard the Glasgow 2014 Commonwealth Games.

Making data accessible and useful for citizens

Central to the council's wider plans to engage citizens in its plans for a smarter city, the council is making its data publicly accessible via the Glasgow Open Portal. From locating available parking spaces to WiFi zones and even Counsellors' expenses, the portal currently has over 300 datasets that can be downloaded for free, or accessed via easy-to-use dashboards and smart phone apps. The council estimates it will save millions of pounds annually by reducing Freedom of Information requests as a result of making its data available online. The portal is also receiving interest from the innovator community, with hackathons and community app development initiatives being delivered across the city.

This is a snapshot of the activities of the UK's first Future Cities Demonstrator, through which Glasgow has become a test bed for technologies that can be used by others and joins a network of future cities around the world reaping the benefits of an open, citizen-centred approach to smart development.

http://futurecity.glasgow.gov.uk/

UK Government

At the national level, a number of UK government initiatives aim to stimulate urban innovation:

- **Industrial Policy:** Government establishment of the Future Cities Catapult, together with the Technology Strategy Board funds for urban innovation, aim to increase the UK's global competitiveness in providing products and services for the world's future cities. The Government's Information Economy and Construction Sector strategies identify these future cities-related sectors as areas of competitive advantage for the UK and aims to grow global market share for UK businesses. The strategies include initiatives for linking private and public actors in driving industrial innovation. The Department of Business Innovation and Skills (BIS) hosts a regular 'Smart Cities Forum' bringing together policy-makers, businesses and academics to accelerate growth and strengthen collaboration among smart cities players.

- **Regulatory standards:** The UK government has invested in the development of standards to support urban development. To guide the deployment of digital technology in urban development 'smart city standards' are being defined by the British Standards Institute and the Open Data Institute is developing platforms and protocols for the management and use of public data by local authorities. To support spatial design, the Commission for Architecture and the Building Environment (CABE), established in 1999 and now part of the Design Council, provides national standards to guide design in the built environment. CABE introduced important practices, such as the Design Review, which have been adopted by other countries as an assessment tool for development of a successful built environment.

- **City autonomy:** The City Deals policy, launched in 2011, gives new powers to 28 cities in the UK. Led by the government's Cities Policy Unit, the deals are part of an ongoing process of decentralisation legislated through the Localism Act 2011[43]. The Act allows city governments new powers such as being able to set up Mayoral Development Corporations.

- **Public-private collaborations for local growth:** The UK government has promoted urban economic growth with initiatives such as the introduction of Local Enterprise Partnerships, a Regional Growth Fund and a Growing Places Fund. These policies recognise cities as engines of economic growth and the value of collaboration between private, public and third sector bodies. Development corporations have been created to govern large-scale developments, for example the £200 million planned transformation of Ebbsfleet in Kent[44].

- **Service design:** The government has incorporated new functions to support the design of public services. For example, the Behavioural Insights Team develops innovative ways of changing public behaviour using insights from behavioural psychology[45]. Future Gov is a consultancy that uses new media and social technology-based tools to improve public service delivery and citizen engagement[46]. Both government initiatives also provide their services outside the UK to governments in other countries. With 82% of the UK population online, the government has focused on providing high quality digital services and has developed a Government Service Design Manual that sets the criteria that government digital services need to achieve before going live online.

- **Community design:** The UK government has adopted innovative policies to enable locally-driven, community and business initiatives. For example, the new 'Community Right to Build' initiative is enabling local communities to undertake small-scale, site-specific, community-led developments. It gives communities the freedom to build new facilities where they want them, without going through the normal planning application process. To provide better, more inclusive community services, the UK government's 'Whole Place Community Budgets' is a novel approach to reforming public services and is estimated to achieve a saving of between £9.4 billion and £20.6 billion over five years.

Technology Strategy Board

The Technology Strategy Board (TSB) is the UK's national innovation agency. It supports innovation across sectors, including for future cities. The TSB aims 'to accelerate economic growth by stimulating and supporting business-led innovation'. It has a vision "for the UK to be a global leader in innovation and a magnet for technology-intensive companies, where new technology is applied rapidly and effectively to create wealth".

The TSB delivers its objectives through a wide range of innovation programmes and mechanisms including the Catapult Centres (such as the Future Cities Catapult), Collaborative Research and Development, Knowledge Transfer Partnerships, Knowledge Transfer Networks and Innovation Vouchers. Funding for innovation projects is usually matched by the businesses involved. Taking into account partner and business contributions, the TSB has enabled around £2.5 billion of UK investment in innovation during the past five years.

A number of the TSB's 14 priority sectors relate to future cities including the built environment, digital economy, sensors and photonics, energy and transport. The built environment focus area includes an emphasis on low-carbon and sustainability in the built environment. The TSB funded the Future Cities Demonstrator programme and established the Future Cities Catapult to accelerate innovation in the field.

Civil Society

The UK has a diverse civil society, with an increasing amount of service delivery undertaken by voluntary organisations. Professional bodies build skills and capacity in the sector, with the Institute of Civil Engineers and the Royal Institute of British Architects being active players in policy and skills development. Other non-government organisations such as 'Registered Providers' (formerly known as Housing Associations) have led the way in constructing energy efficient homes as a way of combating fuel poverty among tenants as well as promoting sustainability. Civic Voice, a network of local civic societies, has taken a keen interest in publicising the opportunities arising from neighbourhood planning and the Community Right to Bid to protect assets of local value[47].

RIBA

The Royal Institute of British Architects (RIBA) is the UK's professional body for architects. It aims to 'champion better buildings, communities and the environment'. RIBA sets professional standards, supports the export of UK architectural expertise, publishes research and influences government policy on the design of the built environment. RIBA, alongside other professional bodes such as the Institution of Civil Engineers is an important player in the UK's future cities innovation ecosystem, upholding standards, educating members and the public and leading cutting edge thinking on cities and the built environment. For example, RIBA has played an important role in developing internationally used standards and software for Building Information Management (BIM).

BRE

The BRE (Building Research Establishment) Trust is the UK's largest charity dedicated to built environment research and education. Over its 90-year history it has supported innovation in the building and construction industries. Headquartered in Watford, BRE today operates globally, providing independent testing, certification, research and education services.

BREEAM (BRE Environmental Assessment Method) is the world's leading green building assessment tool, setting standards for sustainable building and construction methods. BRE's testing facilities enable experimentation with innovative construction materials. The BRE's training and education develops skills for the industry in topics including BIM, building energy efficiency, fire standards and health and safety.

ODI

The Open Data Institute (ODI) is a collaboration between leading businesses, entrepreneurs, universities and researchers, government and civil society to unlock value from open government data. Launched by the UK government in 2012, the ODI is an independent, non-profit, company based in east London. Its mission is to "catalyse the evolution of open data to create economic, environmental and social value". The ODI has identified a set of core activities that include training, research, developing standards and policy, supporting start-ups using open data, building networks, hosting events, and fostering international collaboration.
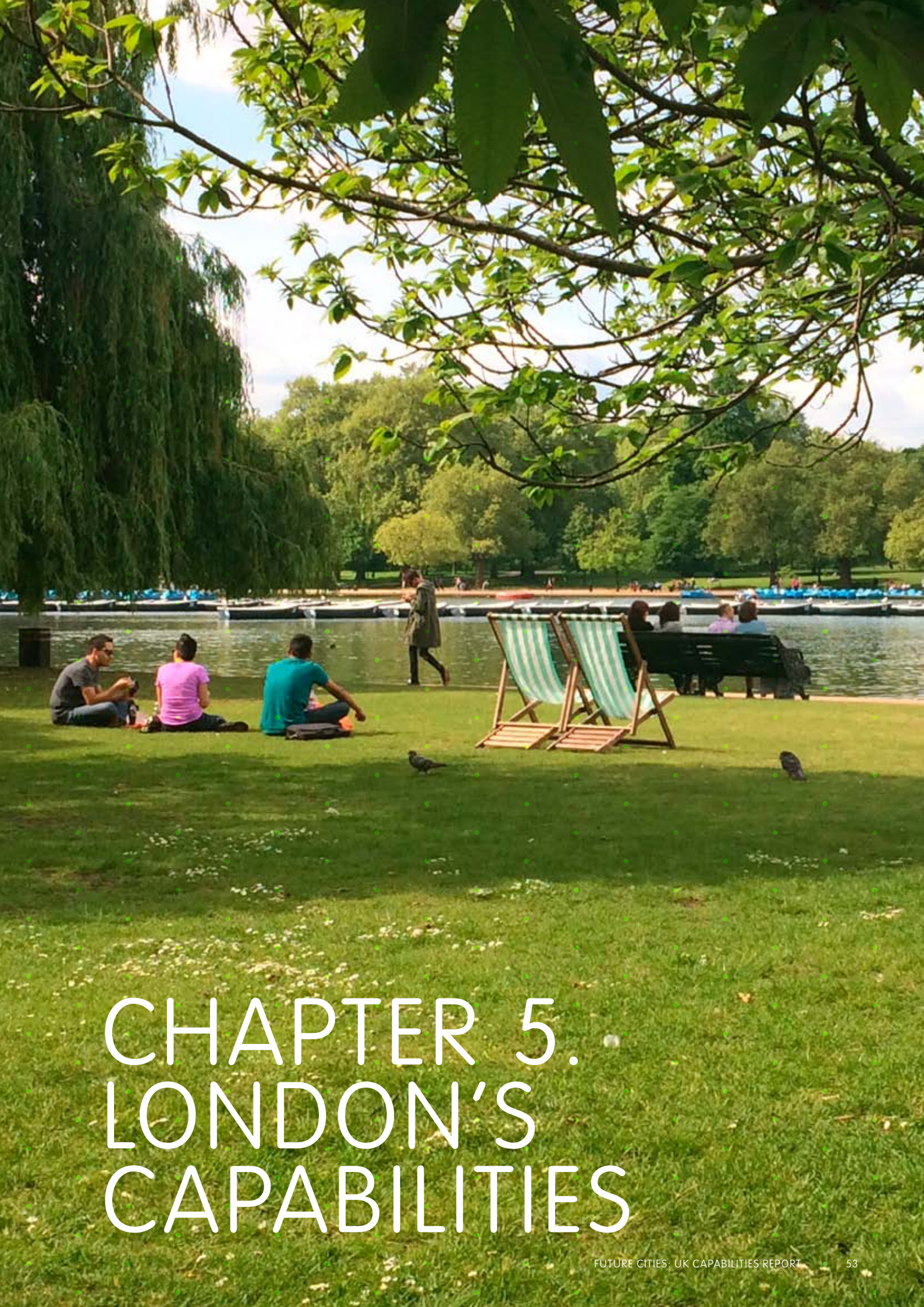
CHAPTER 5. LONDON'S CAPABILITIES

CHAPTER 5.
LONDON – A GLOBAL HUB FOR URBAN INNOVATION

London is a dense concentration of business, research and civic capabilities that supports innovation for future cities. Diverse expertise across spatial design, civil engineering, digital economy, and professional business services come together in London in a uniquely rich combination.

Particular strengths of the London ecosystem for urban innovation include the following:

- **Economic diversity:** London has strengths across the sectors relevant for urban solutions development. The city draws inward investment and major companies from all over the world. It is home to one of the world's greatest concentrations of architecture, engineering and built environment firms[48]. For example, five of the world's top 50 architecture firms are headquartered in central London[49]. The city is also at the heart of the world's financial markets and has a fast-growing technology sector, closely tied to its diversity of creative services, including advertising, digital media, graphic design, and visual arts. The city has a critical mass of business capability in project management, real estate and legal services, supporting delivery of major urban innovation projects.

- **Digital creativity:** The capital has a combination of flourishing digital and creative industries, from software development to advertising and visual special effects. There are at least 34,000 digital technology businesses in London, a 26% increase over the past ten years. Since 2010 the capital has experienced a 75% increase in the number of tech companies investing from overseas. London's open data store and Tech City cluster in east London has enabled digital service innovation and new business opportunities. A number of service design companies are established in London such as Engine, PDD, live|work, thinkpublic, Particle, Egglab and the Design Council provide innovation consultancy to a number of industries.

- **World-class research and higher education:** London's universities include some of the world's top academic institutions. Internationally-recognised research and education centres on cities include LSE Cities (focused on the social and environmental impacts of urban design), UCL CASA (focused on spatial data analytics, modelling and visualisation) and the Imperial Digital City Exchange (a collaboration between the Engineering and Business schools focused on digital innovation for cities).

- **Political will:** The Greater London Authority (GLA) and individual London borough councils are adopting innovative approaches to city-making. The GLA's Smart London Plan outlines how the city will embrace new technologies to improve residents' lives. The GLA has promoted the digital economy through a number of initiatives, including investing in the growth of Tech City in east London, establishing a city-wide open data platform (London DataStore), and setting up a Smart London Board to convene experts from industry and academia to look at how technology and data can keep London at the forefront of innovations. The Mayor of London has made a commitment to high quality urban design across both the GLA and Transport for London (TfL). These organisations work collaboratively on issues and externally with stakeholders to provide specialist advice on urban design, heritage, streetscape and landscaping[50].

- **Demonstration opportunities:** London is a site for experimentation with new forms of city-making. As the capital's population grows, public authorities are upgrading infrastructure and integrating different urban systems to deliver public services in new ways. Major urban development projects including the London Olympic Park and King's Cross are providing test beds for demonstrating the application of new technologies and development processes. The Future Cities Catapult is collaborating with partners including Microsoft, Intel and borough councils to test new technologies such as air pollution sensors and new mobile urban navigation platforms for blind and partially-sighted residents at sites across London.

The map of central London aims to show the confluence of capabilities in London driving future cities innovation. It is important to recognise that the city and its innovation activity is an international operation, drawing upon ideas, skills and solutions from, and in turn feeding them to, all parts of the world. Many thousands of people head to London to study and set up business. This map provides a static view of London's capabilities in future cities that are tied to international networks.

Central London's urban innovation hub
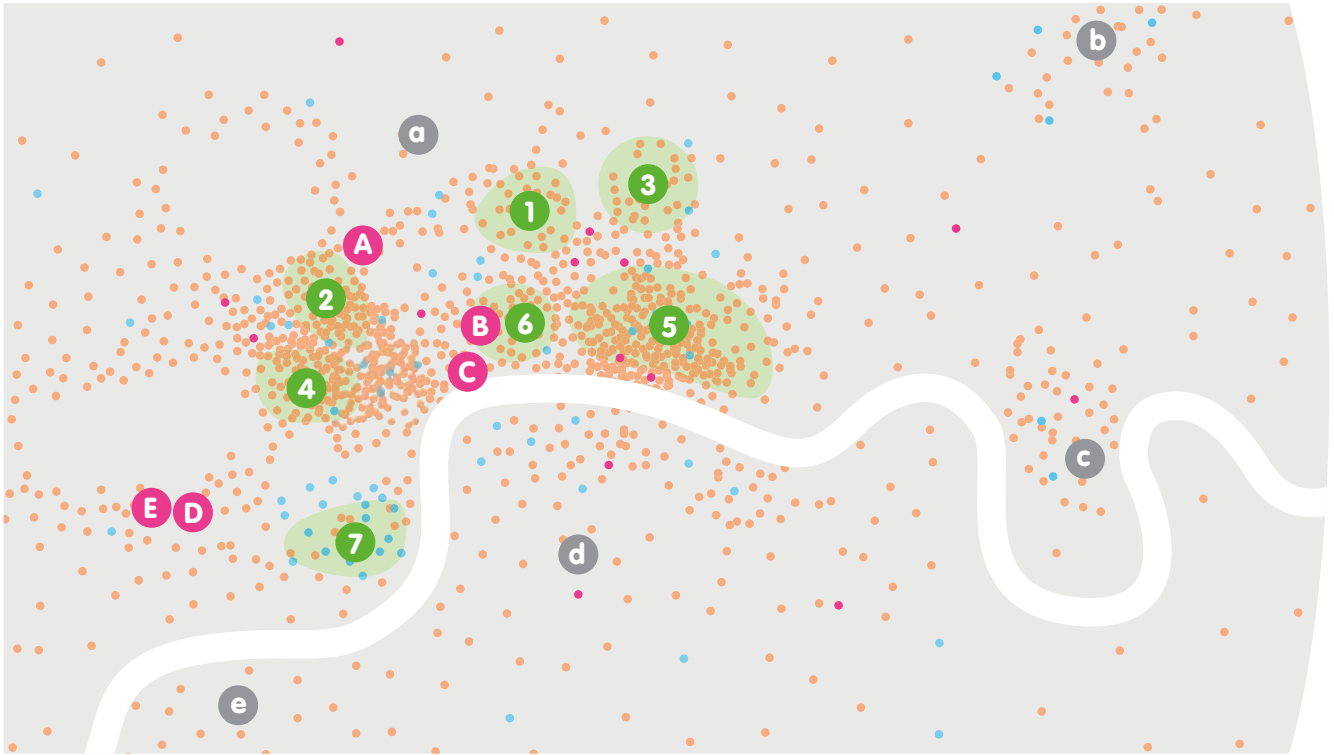
In London, diverse business expertise comes together with world-class universities, urban development opportunities and considerable political will to create a uniquely rich ecosystem for urban innovation.

🟠 **BUSINESSES**

🟢 **CLUSTER**

🔴 **UNIVERSITIES AND RESEARCH INSTITUTES**
Internationally-recognised research centres relevant to future cities innovation include:

A UCL, Bartlett Centre for Advanced Spatial Analysis

B London School of Economics and Political Science, LSE Cities

C King's College, Cities Group

D Imperial College, Digital City Exchange

E Royal College of Art, Helen Hamlyn Centre for Design

🔵 **GOVERNMENT AND CIVIC ORGANISATIONS**

⚪ **DEMONSTRATION SITES**
Major urban development and innovation demonstration sites include:

a King's Cross

b Olympic Park

c Wood Wharf

d Elephant and Castle

e Nine Elms

1 Architecture

Top UK architecture firms are concentrated in central London, with a cluster of big and small firms in the Clerkenwell area. London hosts the head offices of major practices including Foster and Partners, Rogers Stirk and Partners and BDP – all with international portfolios of work. Of the UK's 43,000 architects, 27% work in London.

2 Engineering and Infrastructure

UK engineering and infrastructure firms provide services to cities across the world from their London headquarters. A cluster of civil engineering activity in central London enjoys close links to the property development and business services sectors and civil engineering research and education at UCL and Imperial College. Large global firms including Arup, Atkins and Balfour Beatty are all based in London.

3 Digital and Creative

There are now at least 34,000 digital technology businesses in London. London's vibrant start-up scene links to some major international players with Google's European headquarters to be located in King's Cross and both Intel and Cisco collaborating with London universities to pursue future cities research and development.

4 Property Development

A number of major property developers cluster in Mayfair, West London. Linked strongly with financiers, civil engineers and architects, both UK and international firms have chosen to locate in central London. Major London-based firms include Hammersons, British Land and the European headquarters for Lend Lease.

5 Finance

London is one of the world's top financial centres with extensive expertise in financing urban development and infrastructure projects. Major global banks, investment management firms, and specialist infrastructure funds based in London include HSBC, Amber Infrastructure and Henderson Global Investors.

6 Consulting and legal services

Consulting and legal services are located throughout central London with a cluster of legal activity in Holborn. Law firms such as Bird and Bird and Berwin Leighton Paisner provide legal services on transactions, deal structures and procurement of major development and infrastructure projects. International consulting giants such as Accenture and Deloitte have a major presence in London.

7 Government and civic

As the UK capital, London's government quarter is home to government organisations such as the Department of Business Innovation and Skills and UK Trade and Investment that play important roles in stimulating innovation for future cities. Local government bodies including the Greater London Authority and Transport for London have successfully led innovative approaches to delivery of city infrastructure and services.

LONDON AND BEYOND

Beyond central London there are a multitude of other organisations contributing to the city's innovation capability. The British Standards Institute is establishing globally-recognised smart city standards, the Building Research Establishment is leading innovation in green building and Siemens have selected London for their cities research and development base at The Crystal centre. A vibrant community of not-for-profit organisations are at the cutting edge of urban innovation. The Centre for Cities, NESTA and C40 are all based in London – leading research and advocacy that is influencing cities around the world.

CONCLUSION

CONCLUSION

The UK has a diverse range of capabilities that are relevant to innovation for the world's future cities. This conclusion summarises and reflects on the UK's strengths and weaknesses in the future cities sector and the opportunities for UK businesses, researchers and city governments to operate in a growing global market for urban solutions.

UK strengths for the world's future cities

- *Multidisciplinary approach:* Businesses are establishing collaborative cross-disciplinary teams to provide products and services for the world's cities. Engineers, urban designers, data scientists and sociologists are collaborating in the design of urban masterplans. Software developers, product designers and architects are creating new apps for urban navigation. Not only are firms working together in unexpected collaborations, UK universities, research centres, businesses and the public sector are using each others' strengths to accelerate urban innovation.

- *Project delivery:* The UK has capabilities across a range of industries required to deliver urban projects including financial and business services, engineering, project management, and construction services. In particular, the UK has the commercial expertise to manage large-scale urban projects, from London's Olympics to sustainable regeneration in Doha.

- *Urban planning and reinvention:* The UK is one of the world's most urbanised countries. The country has a well-established land-use planning system and its planning capabilities are used worldwide. With its rich urban heritage, the UK has developed expertise in transforming brownfield sites, retrofitting low carbon solutions and using existing infrastructure in new combinations to address contemporary challenges.

- *Digital creativity:* The UK's diverse creative services combined with its fast-growing digital sector are producing innovative digital services for cities. Together the two sectors cover a range of complementary capabilities from product and graphic design, to software and media development and advanced manufacturing.

- *Urban data, visualisation and modelling:* Universities and a vibrant start-up community of spatial data analysts are leading the uptake of newly available open datasets to create innovative visualisations and modelling techniques that help to improve the management and planning of cities.

- *Human-centred design:* Designing for the 'end user' is gaining prominence across diverse industries. Businesses and city councils are using new tools and methods to engage citizens in the design of places and public services. Centring the design of cities on people is crucial to making cities attractive and well-functioning places.

- *Standards setting:* Industry associations and government organisations have developed world-leading standards for urban design, open data, low-carbon, public service delivery and community governance. Standards such as BREEAM for green buildings and the BSI's Smart City standards have encouraged UK businesses to develop new services and products ahead of competition in overseas markets.

Next steps for UK urban innovation

Despite the strengths of the UK ecosystem for urban innovation and some unique capabilities in specialised areas, there is further work to do in developing UK capabilities across the business, research and civic areas and the interconnections between these areas. Particular challenges for urban innovation in the UK include the following:

- **Commercialising innovation:** It is hard for UK businesses to access venture capital financing for innovative technology projects. British engineers struggle to find funding and business advice despite having some of the leading engineering research facilities[51]. In construction there is a relatively little spent on R&D spending by UK firms and similarly in utility companies, where innovation is often restricted by regulatory frameworks and outdated business models that do not account for the life cycle of new technologies.

- **Skill shortages:** The UK lacks skills in manufacturing and engineering. There is a lack of local building craft skills which limits the control of architects over the end result of their designs. The engineering industry faces a shortfall of 36,800 qualified engineers by 2050[52]. A clear strategy is also needed for the development of skills in ICT and engineering to support the country's economic vision.

- **Political centralisation:** Despite central government policies to promote urban governance, the functional remit and resources of city administrations in the UK are limited. This restricts the implementation of city-wide initiatives that require coordination across different levels of government as well as different departments.

- **Privatised utilities:** Delivering innovation to a city's infrastructure in the UK is dependent on the private utility companies who own and operate the infrastructure. The way these companies are organised is largely unrelated to place or city, so there is little incentive for them to cooperate with city governments in finding ways to reduce energy or water usage. New business models are needed to motivate these companies to innovate and consider how they could use existing infrastructure in new combinations.

The Future Cities Catapult and the Technology Strategy Board have also identified number of barriers to the uptake of urban innovations – both within UK cities and abroad. Findings from their survey of 50 cities around the world and 450 business executives suggest the market is still weak. Survey respondents said:

- The wrong things are being innovated. Cities say that business has focused too much on the 'smart' digital agenda, which doesn't always reflect the complexity of city functioning or the voices of citizens.

- Cities aren't buying. Businesses say that cities are siloed and their administrations are not good at taking joined-up and long-term decisions. Added to this, there is an inability to pilot, test or prove the business case for city-scale solutions.

- New markets haven't coalesced. There are significant financial, legal and procurement obstacles, ongoing uncertainties, plus a lack of evidence, trust and collaboration which are needed if organisations are to work together to tackle integrated city challenges[53].

These indicate challenges to the formation of a successful market, rather than weaknesses of UK capabilities for serving these markets. However, without a well-functioning market, the significant capacity for urban innovation will remain untapped.

The Future Cities Catapult has an important role to play in both building UK innovation capacity for future cities, accelerating the innovation process and enabling the market for products and services to be bought and sold. It has identified three immediate focus areas:

- **Prototyping:** Spotting, supporting and improving city-changing ideas, new urban products and services.

- **Proving:** Through our Cities Lab, pilot projects and new platforms for system-wide urban innovation via Big Data.

- **Scaling:** Through helping deploy innovations in major urban projects, accessing finance, removing barriers and creating the wider market-place.

Together with the diverse range of businesses, university research centres, city governments, civic organisations and public bodies illustrated in this report, the Future Cities Catapult will continue to help build UK capabilities for meeting the needs of the world's future cities.

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THE FUTURE CITIES CATAPULT

The Future Cities Catapult is a global centre of excellence on urban innovation, a place where cities, businesses and universities together develop the solutions cities need for a strong economy, resilient environment and an improved quality of life.

We're interested particularly in the challenge of urban integration: helping cities take a more joined-up approach to the way they plan and operate. Too often we do things in cities that fight against each other: we make life easier for the motorist but reduce air quality, separate living from working and create congestion. What makes more sense is for city systems to work together for mutual benefit.

The Future Cities Catapult bridges the gap between cities, business and academia to get more people than ever working together to solve complex city challenges. Imagine analysts talking to scientists talking to environmentalists talking to designers talking to financiers, all figuring out how to tackle city challenges. This is the way collaborative innovation will make a real difference in the future.

Based in central London, our innovation centre is home to our world-class team of master-planners, data scientists, anthropologists and futures specialists. An independent space where experts from across disciplines can collaborate: cities, companies and universities working alongside financiers and lawyers to remove barriers to innovation, developing solutions to the future needs of the world's cities.

At the heart of our innovation centre is the Cities Lab, a world-leading facility where live city data, analysis and visualisation are used to test and validate solutions to city challenges. Alongside our futures and barrier removal programmes, our work helps cities around the world take a more joined-up approach to the way they function, and become better places to live as a result.

www.futurecities.catapult.org.uk

ARUP

Arup is the creative force at the heart of many of the world's most prominent projects in the built environment and across industry. We offer a broad range of professional services that combine to make a real difference to our clients and the communities in which we work.

From 90 offices in 38 countries our 11,000 planners, designers, engineers and consultants deliver innovative projects across the world with creativity and passion.

Founded in 1946 with an enduring set of values, our unique trust ownership fosters a distinctive culture and an intellectual independence that encourages collaborative working. This is reflected in everything we do, allowing us to develop meaningful ideas, help shape agendas and deliver results that frequently surpass the expectations of our clients.

The people at Arup are driven to find a better way and to deliver better solutions for our clients.

We shape a better world.

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