

UK leading capabilities on sustainable urbanisation

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Executive Summary

This report was prepared for UK Trade & Investment (UKTI) as part of a brief secondment from BRE. The report is intended for UKTI staff with varying levels of knowledge about sustainable urbanisation and the UK's leading capabilities in this area. The report may also be developed into a marketing brochure with key examples and case studies highlighted through images and light text. UKTI staff provided information through interviews and document references that have been incorporated into this report. This document focuses on a brief set out by UKTI requesting information on the following (see Appendix A: for the full brief):

- key perceived UK strengths and commercial offer on sustainable urbanisation (including sub-sectors) across new and existing cities; including comparison of UK offer to other countries
- leading companies and case study examples that could be used to showcase British capabilities
- key enablers (such as standards) and best methods for 'showcasing' British offer
- cities and regions where UKTI should focus its efforts.

The UK is well-positioned to provide expert advice, products and services to cities seeking sustainable urbanisation solutions. British companies bring together diverse professions to develop multi-disciplinary integrated approaches to complex city challenges. Sustainability requires the holistic consideration of social, economic and environmental dimensions of urban challenges to develop solutions that will meet future and current needs. The UK has a track record of applying a systems thinking approach, developing integrated spatial plans and applying these skills at a city-scale.

This report summarises a wide range of reports by UK Government, international organisations, leading consultants and academia regarding the concept of sustainable urbanisation, global challenges and trends affecting cities, and how the UK is positioned to support cities with these challenges. The research was carried out between March and August 2015 and involved desk based research, two stakeholder workshops and multiple individual interviews (see Acknowledgements).

The first section in this report explains the background to sustainable urbanisation and related global challenges. The second section outlines strategic UK capabilities including systems thinking and applying a city systems approach, integrated planning and the ability to work at large scales.

Section three outlines the sub-sector areas of sustainable urbanisation, for which the UK has a range of upstream consultancy and project delivery capabilities. Large multi-disciplinary international consultancies are able to provide a full range of services on their own or through consortia. Companies provide services that can take a project through financing, design & planning, construction and management. This report highlights over 33 case study examples where UK cities, public and private sector organisations have delivered innovative sustainable solutions that are world leading. UKTI officers can use this material to demonstrate the UK's track record and capabilities. There are also international reference projects to give a selection of examples where UK companies are leading abroad.

The fourth section of the report explains strategies (including policy approaches), skills and technologies that the UK has used to lead sustainable urbanisation going back to the Garden City movement from the 19th century and including recent examples such as Government's commitment to open data. These leading strategies, skills and technologies are being adopted internationally but have roots in the UK, providing British companies with first-hand experience for international application.



Section five describes city typologies (megacities, emerging cities, mature cities and declining cities) that have been identified by leading UK academics and could be used to segment the cities market and help focus UKTI's efforts. This section also covers areas of opportunity internationally that have been identified by previously published research and the participants in the stakeholder workshops.

Section six describes funding models such as public private partnerships (PPPs) that are being used to finance major infrastructure projects internationally. It highlights research published by the Organisation for Economic Co-operation and Development and the Royal Institution of Chartered Surveyors. It also discusses some of the challenges with procurement on significant international projects and suggests ways that companies and UKTI could improve current practice.

Section seven outlines a set of recommendations primarily gathered from the expert stakeholder workshops and interviews about how the UKTI can support UK companies to win work in the area of sustainable urbanisation.

And finally, section eight lists a number of experts that could be used to provide thought leadership and additional information to UKTI about leading UK capabilities. The references section at the end of this document provides a large range of specialist and strategic reports for further information.

This report demonstrates that the UK has a track record of delivering sustainable development within the UK and internationally. British companies, academics, government and third sector organisations are providing leadership in key challenge areas that can be used to support urbanisation and city management in developing and developed countries.



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1. An introduction to sustainable urbanisation

'A new global picture of growth is taking shape. This is not about a transfer of economic power from North to South, or West to East. It is about the rise of cities, the concentration of productivity, innovation and creativity that will drive our economic future.'(1)

More people are now living in urban areas than rural areas for the first time in history. The rate of growth of urban areas is estimated at 1.3 million people every week.(2) Africa and Asia are the regions experiencing the most rapid levels of urbanisation. While Europe, Latin America and North America are already highly urbanised. In the UK, over eighty per cent of the population already live in urban areas.(3) A United Nations think-piece on sustainable urbanisation puts this demographic shift into context and highlights the importance of urbanisation in global change:

'Cities have become a major locus of power and politics consequently influencing vision achievement and dictating policy outcomes. They are also a major factor in environmental trends and sustainability processes. Urbanization is thus providing the setting, the underlying base, and also the momentum for global change.'(4)

Sustainable urbanisation is the process of sustainable development in urban areas. The Brundtland Report definition of sustainable development highlights the simultaneous pursuit and balance of economic, social and environmental goals. Adriana Allen's work at University College London has emphasised that sustainable development and urbanisation involve trade-offs between these pillars and this is moderated through political governance. Allen provides a framework for urban sustainability with five dimensions: ecological, social, economic, physical (or built environment) and political. She explains that the first four dimensions are pushing and pulling against the boundaries of what is sustainable and the political dimension acts as a regulating force.(5)

Allan's framework for sustainable urbanisation must be considered within the global challenges and opportunities facing cities. Some of the challenges concentrated in cities are highlighted in Table 1 below.

Table 1 - Global challenges concentrated in cities

Social	<p>Growth: 1.3m people are moving to cities every week.(2)</p> <p>Inequality: Cities concentrate deprivation, inequality and exclusion with unequal access to opportunities and resources.(6)</p> <p>Ageing population: The older population is growing faster than the total population in practically all regions of the world.(7)</p> <p>Culture: Changing citizen expectations on how services are provided is pushing cities toward e-governance and increased online delivery.(8)</p>
Environmental	<p>Energy: 70% of global energy consumption and energy-related carbon emissions come from urban areas.(9)</p> <p>Climate change: Mitigating and adapting to the effects of climate change will have an increasing and significant cost for cities with disproportionate negative effects for low-income and vulnerable populations.(6)</p>



	<p>Resource depletion: Cities consume 75% of natural resources.(10)</p> <p>Waste: Cities generate 1.3 billion tonnes of solid waste annually. In lower income countries, solid waste management is often a city's single biggest budgetary item.(11)</p> <p>Water: One in four cities, containing \$4.8 trillion in economic activity, is water stressed due to geographical and financial limitations.(12)</p> <p>Biodiversity: Urban areas are expanding faster than urban populations drawing heavily on resources and harming biodiversity and ecosystem services.(13)</p> <p>Air pollution: 3.7 million deaths (of people under the age of 60) were caused by outdoor air pollution globally in 2012. Indoor and outdoor air pollution together are one of the largest risks to health worldwide. About half of the urban population being monitored by the WHO is exposed to air pollution that is at least 2.5 times higher than recommended. (14)</p>
Economic	<p>Urban sprawl: Challenges from poorly managed growth have an estimated incremental external cost of US\$400 billion annually in the United States alone.(2)</p> <p>Infrastructure requirements: Ageing infrastructure requires retrofitting or replacement. For OECD countries investment requirements are expected to more than double for electricity and rail and grow by 50% for water supply and treatment. New infrastructure in the developing world will require billions of dollars of investment.(15)</p> <p>Energy demand: The demand for energy will increase by over 30% up to 2035, the demand for electricity in emerging economies will increase global demand by 70%.(16)</p>
Technological	<p>Transparency: There is a growing expectation for transparency of reporting, data and decision-making through the use of technology. This is increasing accountability and putting pressure on politicians.(8)</p> <p>Disruption: Digital companies operating in the sharing economy (e.g. AirBnB and Uber) are disrupting city services and economies and have the potential to create legal challenges for municipalities.(8)</p>

The rapid growth of cities is being seen as an opportunity to address global challenges. This is because these issues are particularly concentrated in cities and because cities have the economic and political resources to affect change. Urban areas now account for around 80% of global economic output.(17) A report by the United Nations, *Prosperity of cities*, states that following the 2008 financial crisis, cities have demonstrated their key role in responding to global challenges:

'these crises did more than highlight the transformative role of cities; they also showed that they are in a better position, at least notionally, to address regional and global crises. ... Cities need to be put in better positions to respond to the challenges of our age, optimizing resources and harnessing the potentialities of the future.'(6)

Many organisations and international institutions recognise the power of agglomeration effects of cities. The close location of universities, talent, jobs, cultural facilities and more combine to produce innovation



and prosperity. There has been some debate about whether urban growth necessarily results in economic benefits. However, research has shown that ‘urbanisation has the potential to promote growth, even if much depends on how conducive the infrastructure and institutional settings are.’⁽¹⁸⁾ There are governments that are concerned about the rapid migration of rural populations to urban areas. A United Nations survey in 2011 found that 82% of developing countries had policies to curb rural-urban migration. China, was one of only 3% of surveyed countries that had a policy in place to encourage rural-urban migration.⁽¹⁸⁾ Given these concerns, particularly among city leaders in Asia and Africa, it is important to highlight integrated urbanisation strategies and programmes that have resulted in positive benefits across city populations.

The challenges faced by mature ageing cities in high income countries are very different to those in emerging markets like India, where basic sanitation infrastructure is lacking. Yet cities globally are driving rapid change to demonstrate their credentials to international investors and become global leaders. The plethora of city indices published by organisations such as PwC, AT Kearney and MORI demonstrate the importance and influence of global city competition. Jones Lang LaSalle and The Business of Cities have produced a recent report reviewing over 200 city indices which rate cities on performance across measures such as quality of life, sustainability and economic performance.⁽¹⁹⁾ The report demonstrates that leading cities like New York, London, Singapore and Paris have learned lessons about sustainable urbanisation that can be shared internationally. It also emphasises that there are some conditions which contribute to success (or lack thereof) which cannot be replicated such as geographical location, climate, and capital city status.

International competition at a city-scale has in some ways meant that the concept of sustainable urbanisation has been overtaken in recent years by ‘smart cities’. Cities are competing nationally and globally to attract multi-national companies and successful businesses to locate in their area and stimulate the local economy. The focus on economic growth is driven by the need to manage cities that provide a high quality of life for all residents and are resilient to social, economic and environmental pressures and shocks. This also has to be done with fewer municipal resources. In simplistic terms a better managed city with a skilled and happy workforce attracts investment and creates a reinforcing cycle of success. Poorly managed growth creates long-term social, economic and environmental problems that detract investors and reinforce stagnation or decline.

Sustainable urbanisation is about developing and managing cities that are good for people, the economy and the environment. The same aim holds true for ‘smart cities’ although there is more emphasis on achieving this through technology and overcoming silo working. A report by the Future Cities Catapult and Government Office for Science Foresight Future of Cities project provides two definitions of smart cities:

‘smart cities’, when used in a narrow sense, refers to the way Information and Communication Technologies (ICT) can improve city functionality, proposing that use of the right hardware, software and technology platforms can solve many or most urban development challenges. However, a broader conceptualisation of smart cities – more commonly considered by academic and policy user groups, rather than corporates - places emphasis on good city governance, empowered city leaders, smart or ‘intelligent citizens’ and investors in tandem with the right technology platform.⁽²⁰⁾

Although UK Trade & Investment requested this report to define the UK’s offer on sustainable urbanisation, the research has included publications and stakeholder interviews that focus on the related concept of smart cities. The terminology is important because it is not understood in the same way by different professionals and countries. This report explains the UK’s strengths across the various definitions and within the sub-sectors that support urban infrastructure.



2. UK leading capabilities

A key challenge for cities around the world is to design city services that operate across departmental silos to improve the efficiency of managing these services and to respond to ‘messy’ urban challenges. These challenges, and associated solutions, do not fall neatly into single policy domains. UK companies offer consultancy and design solutions that integrate multiple aspects of city governance and sustainable urbanisation. They have experience delivering world class solutions for existing cities with ageing infrastructure as well as creating new towns in response to demographic pressures.

This section outlines UK strengths on sustainable urbanisation and its sub-sectors. There are multiple consultancies that can operate at the scale and complexity of city-scale infrastructure and development. A selection of such companies are highlighted through case studies in this report and outlined in Appendix B.

Small and medium-sized enterprises (SMEs) sometimes have a difficult time operating internationally because of the scale of projects relevant to sustainable urbanisation and the risk undertaken in business development and procurement processes. In some cases, large consultancies will work with SMEs in consortia where a particular skillset is required. However, in some areas of sustainable urbanisation, SMEs are leading. For example, the Department of Business Innovation and Skills (BIS) states that ‘UK SMEs hold some dominance in the HEMS [home energy management systems] market, in global visibility at least. Many of them offer relatively innovative products and have developed delivery partnerships with large utilities in the UK and abroad.’(16)

Several examples of SMEs operating internationally were suggested by expert stakeholders, particularly in relation to technology, data and mapping. These businesses and others are featured throughout this report in case studies. Appendix C lists all SMEs included in this report (with some additional entries) and their relevant expertise.

Sections two, three and four of this report highlight where the UK is leading through the work of private and public sector activities. International comparisons across such a wide area as ‘sustainable urbanisation’ is inherently difficult. Competition will vary across sectors and regions. Where possible, published reports stating UK strengths have been quoted and referenced to provide some indication of the UK’s competitive advantage. UKTI staff would be advised to contact the sector leads in appropriate regions for further information.

2.1 Overarching support on sustainable urbanisation

The UK has long been involved in sustainable urbanisation by providing long-term, resilient and sustainable solutions for city infrastructure and systems. Internationally prominent consultancies and engineering firms such as Arup, AECOM and Mott MacDonald, facilitate the collaboration of key disciplines to offer integrated one-stop shops for significant urban development projects. The UK is strong at financing, planning, designing, and project managing large infrastructure projects.

Strategic advice is available through the ‘Big 4’ consultancies which all offer services on urbanisation, smart cities and sustainability. For example, KPMG has a Cities Global Center of Excellence which ‘brings together subject matter experts and industry professionals from around the world to share industry best practices, knowledge and experience. With a focus on emerging and revitalizing cities, our mission is



to advise and support the sustainable development of cities and the effective provision of city services.’(21) Their brochure goes on to list the following specialism support areas:

- planning design and development
- infrastructure, transportation and utilities
- community facilities and municipal services
- city finances and economic management
- city governance, administrative and municipal law.

McKinsey, EY and PwC have similar services and also publish a range of thought-leadership pieces and publications, some of which are referenced in this report.

There is a strong research and innovation culture in the UK that is driven by universities and businesses. This is supported by strong collaboration between universities and the private sector driving new knowledge into the supply chain. This is discussed in greater detail in section 4.8.

The *Future Cities: UK Capabilities for Urban Innovation* report categorises the UK’s capabilities for ‘Future Cities’ into 5 areas (as shown in Table 2).(22) Many of these capabilities are cross-cutting and are equally relevant to the concept of ‘sustainable urbanisation’. The *Future Cities* report provides multiple case studies highlighting UK best practice and strengths.

Future Cities capability	Example industries	Example products and services
Spatial	Landscape Design Urban Planning & Design Architecture & Design	Urban Sustainable Masterplanning Urban Water Management Public Realm Design
Physical	Engineering Construction Utilities Provision	Electric Transportation Infrastructure Waste to Energy Infrastructure Smart Water Infrastructure
Digital	Software Hardware Information Technology Services	Digital Masterplanning City Data Platform Design City Data Analytics
Commercial	Financial & Business Services Property & Real Estate Legal Services & Policy Development	City Vision & Metrics Development City Innovation Governance Design Business Model Development
Social	Service Design Community Services	Service Design Services Urban Design Crowdsourcing Platform

Table 2 - Reproduced from *Future Cities: UK Capabilities for Urban Innovation*, Future Cities Catapult/Arup, 2014

2.2 UK strengths on integrated sustainable urbanisation

The following three UK capabilities were identified through expert stakeholder workshops involving representatives from industry, cities and academia. Additional information from published reports provides further evidence for the observations made by the workshop participants. The UK is strong at the following integrated sustainable urbanisation capabilities:

- City systems approach – systems thinking applied to city challenges
- Integrated / spatial planning



- Applying the above approaches at scale.

2.2.1 City systems approach

In the stakeholder workshops conducted for this report, participants identified 'systems thinking' as a key UK strength. Cities are recognised to be complex systems with 'messy' or 'wicked' problems. A complex system has multiple elements that interact with each other; change over time and produce unpredictable outcomes. An example of a complex urban problem is provided by the Future Cities Catapult report (22):

'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.'

The complexity of transport and infrastructure systems and their relationship in urban economies is further highlighted by the OECD report *Infrastructure to 2030*:

'Looking to the future, [infrastructure] will continue to play a vital role in economic and social development, not least because the networked economy is becoming increasingly important, and society ever more dependent on the smooth running of a growing range of infrastructure services. Moreover, the various infrastructure systems themselves are interacting ever more closely with one another, engendering interdependencies and complementarities, as well as heightened vulnerability, and thereby posing new policy challenges such as interoperability and reliability.'(15)

The UK Government funded a programme of Future City Demonstrator projects to demonstrate the value of integrating city systems. Glasgow was the lead winner of the funding with a £24m grant (see case study below). The other cities in the programme were Bristol, London and Peterborough. These projects were expected to 'enable businesses to test, in practice, new solutions for connecting and integrating individual city systems, and will allow cities to explore new approaches to delivering a good local economy and excellent quality of life, whilst reducing the environmental footprint and increasing resilience to environmental change.'(23) As a result of this programme, the UK now has several proven programmes of integrated city systems.

UK companies are applying systems thinking to urban challenges in what is being called a 'city systems approach'. This is also the focus of much academic research in the UK on cities and associated challenges (see section 4.8 for further information). This is about working across professional disciplines to fully understand the challenge and developing solutions that often require active engagement from multiple city government silos.

2.2.1.1 Case study – Glasgow smart city demonstrator

The Future City Glasgow programme is showcasing how technology can be used creatively to improve life in the city making it smarter, safer and more sustainable. The pioneering programme received a £24m grant from Innovate UK (previously the Technology Strategy Board) to develop and implement a range of smart city applications across city services. Partners in the project include: Glasgow City Council, Glasgow Community & Safety Services, Sustainable Glasgow, health providers, energy suppliers and universities. The programme has received a Geospatial World Excellence Award and a Holyrood Connect Award for the most innovative use of ICT in delivering public services.

Judges in the Geospatial World Excellence Award praised Glasgow for "providing global leadership in demonstrating how older, more established cities can be transformed into Smart Cities of the future" and



added that the "programme was recognised around the world for its emphasis on quality of life outcomes". The Future City Glasgow programme is transforming the way the city operates and has attracted international attention from as far afield as Brazil, India and the United States.

Innovations include projects such as the installation of new intelligent LED street lights on a section of off-road Clyde-side cycle route - the energy efficient lights are fitted with sensors which detect approaching cyclists or pedestrians and increase the lights' brightness as they get closer- lighting up the route ahead. The sensors also monitor data like footfall, air and noise pollution.

A state-of-the-art integrated city operations centre has also been created which brings together the teams monitoring the city's CCTV and traffic cameras. Officers from Police Scotland are also based there and the operations centre proved instrumental in helping to keep the city moving during the successful 2014 Commonwealth Games. A new network of high definition CCTV cameras is also being installed across the city to replace the ageing, existing system. The intelligent street lights can also be controlled remotely from the operations centre.

The programme's Open Glasgow project has also developed a cutting-edge data hub. The site offers easy access to around 400 datasets and contains information on everything from pass rates at individual driving test centres to footfall in retail areas. It is free and easy to access and the information has already been used to develop new products like apps. Glasgow City Council has also pledged to make all of its non-sensitive and non-personal data openly available to increase transparency and empower citizens with a treasure-trove of information which they could use, for example, to make their businesses more successful, create new gadgets or decide where to buy / rent a new home.

Councillor Gordon Matheson, Leader of Glasgow City Council, said: "It is wonderful that the Future City Glasgow programme is attracting such acclaim. These projects are true game-changers offering huge potential for the city of Glasgow, its citizens, academics and businesses. Clever use of technology and data can unlock immense opportunities, not only to enhance quality of life in the city but also to attract high calibre companies looking to recruit skilled staff and invest in the area. I know that the programme works in partnership with the city's universities to share expertise and everyone from school pupils to community groups are also assisting with several of the projects."

Source: Glasgow City Council (24)

2.2.2 Integrated / spatial planning

Before any large-scale infrastructure or development projects are initiated, UK companies offer spatial planning (or integrated spatial planning) services to understand the social, economic and environmental drivers, issues and opportunities that must be addressed in the early stages of design. Spatially representing issues and opportunities demonstrates how infrastructure systems will work together and where there may be unintended consequences across systems or spatial inequalities. Spatial planning combines traditional urban planning skills regarding demographic needs and sustainable land use patterns with other disciplines such as ecology, energy, transport, etc. (25) This process helps clients understand how significant developments can be managed in terms of financing and phasing.

Consultants can support clients to make informed choices about infrastructure options and procurement by first considering strategic issues and opportunities. See sections 3.2 and 4.4 for further information about spatial planning.



2.2.2.1 Case study – Integrated planning in Jeddah

The Municipality of Jeddah commissioned Space Syntax (working with Aecom), to produce an integrated suite of planning documents: the Jeddah Plans. The Jeddah Plans co-ordinate Regional, Structural and Local Plans across the Jeddah Governorate to accommodate a population increase of around 3m people over the next 20 years. The Jeddah Sub-Regional Plan studied how this growth could be accommodated within the Governorate. It also studied the impact of urban growth on the existing City to optimise the benefits to existing assets, to reduce sprawl and resolve existing problems.

To understand how Cities work at the regional scale within wider networks of Cities, precedent studies were carried out to look at the relationships in other parts of the world. These included looking at the City regions of Barcelona, Birmingham, the United Arab Emirates, Chicago, Riyadh, and Singapore.

To develop and test the impact of Sub-Regional proposals, an advanced spatial modelling methodology was used to add population and employment growth to the City. This modelling technique was used as a design tool throughout the development process, and to benchmark options against each other.

The major issues being addressed were how committed infrastructure projects affect the spatial hierarchy of the City, how changes to the size of the City increase the pressure on the movement infrastructure of the City, how opportunities for centres emerge based on their new relationship to the wider City, and whether existing parts of the City decline as a result of becoming more difficult to access. Our work helped to develop an approach to accommodate population growth within the Governorate, in a way that would create minimum impact on movement infrastructure, discourage sprawl and strengthen existing parts of the City.

The approach was based on two concepts:

- Urban expansion was proposed in areas which were neither environmentally sensitive, nor would increase pressure on City infrastructure
- Urban intensification was proposed within the parts of the City where developable land had the spatial characteristics to support increased population.

Reproduced with permission from Space Syntax (26)

2.2.3 Scale

UK companies have delivered some of the most significant infrastructure and sustainable urban development projects in the world. London's Crossrail project is one of the largest in Europe at a projected cost of just under £15bn (see case studies in sections 3.3 and 3.5).(27) The Queen Elizabeth Olympic Park is also one of the largest of its kind in Europe and was designed by multiple UK urban design and planning companies. The park includes infrastructure to support biodiversity, wastewater management and public space. A case study in *Future Cities: UK Capabilities for Urban Innovation* highlights how companies working on this project went on to apply similar skills at scale in Saudi Arabia (Atkins) and China (Arup).(22)



3. Sub-sector strengths

In addition to integrated and cross-disciplinary services, the UK has strengths in multiple sub-sector areas of sustainable urbanisation.

3.1 Energy

According to an Intergovernmental Panel on Climate Change report 'urban areas account for between 71% and 76% of CO₂ emissions from global final energy use and between 67 – 76% of global energy use.'⁽⁹⁾ This demonstrates the need to address sustainable forms of energy supply in urban areas. But energy is not only an environmental sustainability issue and economic imperative, it also affects health. The World Health Organisation states that a lack of access to energy for those living in extreme poverty 'dramatically affects and undermines health, limits opportunities for education and development, and can reduce a family's potential to rise up out of poverty.'⁽²⁸⁾

UK companies support cities to achieve a more secure energy supply from early stage evaluation of which generation technologies are appropriate through planning, design and construction of energy generation systems. International companies with offices in the UK, such as Siemens and Schneider Electric, offer energy supply consultancy and technology solutions.

The following excerpt from the BIS report, *Smart City Market: Opportunities for the UK*, explains where the UK is leading on energy:

'The energy industry as a whole is a well-developed part of the UK economy with a total direct contribution of £20.6 billion or 1.6% of GDP in 2011, and the UK's experts in the technology, consulting, engineering, legal and financial aspects of the energy industry are well-regarded globally. Indeed, UK power standards are roughly aligned with the EU market and with several major Commonwealth economies such as Singapore, Hong Kong, India and Pakistan. This makes entry into these markets easier for UK industry and expertise. This is particularly helpful for SMEs who would otherwise struggle with redesign costs to enter other markets with less similar regulatory regimes.'⁽¹⁶⁾

In addition, BIS note that the UK has a strong reputation in skills that are required for innovation in the energy market such as product design, user interface design, and service design.⁽¹⁶⁾ A significant amount of research investment is used in universities and in partnership with industry to develop new intellectual property in this area. For example, the Triangulum project is a Horizon 2020 European wide project involving 23 European partners from urban municipalities, research and industry. Manchester have awarded Siemens the role of 'technology partner' at a value of £4.5m. As part of the project, Manchester will be introducing an autonomous energy grid along the Manchester Corridor with refurbishment of the building's energy management systems along the corridor.⁽²⁹⁾ Consultants are able to use new IP created through research to gain a competitive advantage internationally.

Cities in the UK have been developing decentralised energy generation schemes for decades. One of the oldest examples is Southampton City Council which worked with a private partner to exploit heat from geothermal stores below the city in the early 1980s.⁽³⁰⁾ Cities are working in partnership with the private sector to create sustainable and decentralised energy generation systems through funding models that provide a return to the city and offer cheaper electricity, heating and cooling to residents and public buildings. UK cities such as London, Manchester, Sheffield, Peterborough, Woking, Bristol and more



have led the creation of energy companies through joint ventures, energy service companies (ESCOs) and other models.

Smart grid or smart energy management systems are growing technologies that will play a key role in sustainable urbanisation internationally. BIS define smart energy management technology as ‘technology that makes use of data or information to improve the management of energy. This is sometimes closely tied to, but is distinct from technology which generates renewable or sustainable energy.’(16) These smart systems help energy providers and governments manage rising electricity demand, stability and affordability of energy supply.

The BIS smart cities report outlines the following smart energy management technologies(16):

- home Energy Management Systems (HEMS)
- smart Appliances
- smart metering and Advanced Metering Infrastructure (AMI)
- building Energy Management Systems (BEMS)
- smart grid technology at distribution scale (including Distribution Automation (DA) and Distribution Management Systems (DMS))
- real-time / Dynamic pricing infrastructure
- microgeneration management.

The report highlights that the market for these technologies is estimated at \$500 billion globally up to 2030. The UK is well-placed to deliver these systems with companies like Siemens already paving the way (see case study below).

3.1.1.1 Case study – Low Carbon Network project

Bristol City Council and WPD [Western Power Distribution], with Siemens as technical solution and integration partner, are exploring a highly innovative energy efficiency and storage solution. The SoLa project is trialling a combination of technologies, both to help manage energy use and to overcome network constraints. The key elements of the solution are energy storage in customers’ premises to cope with fluctuating demand; coupled with new variable tariffs and integrated network control to overcome generation or load-related constraints at key times of the day. Also included is a direct connection from rooftop PV panels to a DC power feed.

Storage batteries and DC wiring are being installed in 30 homes and 10 local schools – along with solar panels, energy-efficient DC lighting and ‘smart’ domestic appliances. Using a Siemens smart energy hub, all the equipment will communicate wirelessly with the local substation and ensure that energy bills are reduced and energy wastage eliminated. WPD and Siemens have identified four key potential customer benefits:

- 1) Keeping the lights on: Batteries will provide greater resilience during power outages, ensuring that lighting, computing, telecommunications – and potentially central heating pumps too – all continue to function even during network power cuts.
- 2) Lower energy bills: By controlling energy more effectively, a variable tariff can reward customers for



reducing peak demand and pass on the cost savings to consumers.

3) Greater energy efficiency: The direct current from PV panels can be stored in batteries. Along with an efficient DC/DC converter in place of many smaller and less efficient converters, these can be used to power lights and small electrical appliances.

4) Quicker, cheaper connections: Conventional network reinforcement can not only be costly, but also require significant scheduling. The Bristol solution is one that could be implemented much more quickly and cost-effectively.

Reproduced with permission from Siemens, www.siemens.com/energy-management (31)

3.1.1.2 Case study – Stoke-On-Trent smart energy programme

The [Mandate for Change](#) in Stoke-on-Trent, is a £1bn public private partnership to help regenerate and improve the image of the city to attract outside investment. The scheme was supported by NESTA's creative council's programme.

This was the first such initiative under the 2011 Localism Act with the council creating its own local authority power company. Mohammed Pervez, leader of Stoke-on-Trent city council said "We have the potential to exploit heat, gas and electricity to power operations right across the city. Offering a secure source of energy from natural and waste resources within the city's boundaries will be a real incentive for businesses."

Demand will be met with waste industrial energy redirected by a smart grid to service both businesses and homes. Stoke's energy from Waste initiative run in partnership with Veolia currently generates enough power for 130,000 homes.

Source: The Guardian (32)

3.1.1.3 Case study – Urban scale sustainable heating and cooling

Consultancy Mott MacDonald is pioneering one of the world's largest 20MW heating and cooling networks through an ambitious plan, drawing upon three years of research, to create a mechanism for the storing and sharing of thermal energy via a network of pipes and boreholes throughout the South Kensington Estate, London. It will serve many iconic establishments such as the Science Museum, Natural History Museum and Victoria & Albert Museum, the Royal Albert Hall, Imperial College, the Royal College of Art, the Royal College of Music and the Royal Geographic Society.

During summer, excess heat will be collected from buildings and stored ready for heating in winter, whilst cold air collected during the winter months will be used for cooling via 70 to 80m long boreholes drilled into chalk aquifers. Warm and cold air will be transferred between the aquifers to the buildings via two ring pipes, which will also enable the sharing of hot and cold air to be distributed amongst buildings with differing energy demands.

Engineering consultant Mott MacDonald and project manager Cynergin proceeded with this £25M plan on behalf of the 1851 Group representing all of the South Kensington institutions. Richard Shennan of Mott MacDonald said: "we calculate that the capital investment would be paid back within 10 years and



deliver an £18M financial benefit over the project lifecycle,” and Nick Ray of Cynergin said: “this could provide a template for the greening of the government estate, which is one of the crucial tasks in meeting the UK’s target of cutting CO² emissions 80% by 2050.”

Source: New Civil Engineer (33)

3.1.1.4 Case study – Controlling heating loads and grid balancing

Energy Assets have collaborated with CityWest Homes, provider of housing management services to Westminster City Council, to install its Z-LYNK load switching/energy control technology within hundreds of tower block properties throughout Central London. The project aims to tackle fuel poverty and enhance thermal comfort levels.

The monitoring and controlling technology will work by making use of and improving the energy efficiency of existing storage heaters, providing a cost-effective solution to landlords that will deliver financial and comfort benefits to tenants.

Phil Bellamy-Lee, Chief Executive of Energy Assets, said: “we....look forward to bringing the benefits to its residents. Projects of this kind, developed and implemented by Energy Assets, can ultimately create a platform to deliver load balancing and deferment opportunities to network owners, with storage heating being one of the largest deferrable loads available in the UK. Energy Assets is dedicated to developing innovative technology which will provide benefit to the UK energy market and we are committed to providing solutions which can tackle relevant market issues and help keep the lights on.”

The intention is to expand on this scheme with further social housing, local authority and rental sectors to trial the technology.

Source: Energy Assets Group (34)

3.2 Spatial planning

The Royal Town Planning Institute (RTPI) explains spatial planning in *Thinking Spatially* stating that it ‘goes beyond traditional land use planning to seek to integrate policies for the development and use of land with other policies and programmes which influence the nature of places and how they function.’(25) For example, planners may combine evidence about the low carbon energy generation technologies that can be used in a particular area with data on fuel poverty or the location of large energy users to inform policy and investment.(35)

Planners are trained to bring together the range of actors needed to deliver sustainable development in a particular area, including driving and coordinating community engagement. The role of planning is fundamentally about looking after the public good. This can be manifest through many roles, including shaping policies and proactively working with developers and other stakeholders to deliver economic growth, high quality affordable housing and environmental sustainability. Conservation of heritage and environmentally protected areas is also part of the planning system’s role in looking after the public good. Increasingly, planners are playing an important part in management of climate change adaptation/mitigation and ensuring the built environment promotes health and wellbeing.

The UK holds a very strong reputation internationally for spatial planning. The professional institute for planners, the RTPI is the largest for professional planners in Europe. In addition to section 2.2.2 on



integrated spatial planning, the UK is highly regarded for multiple planning specialisms, including: urban and regional development, New Towns, master planning and urban design, urban regeneration, heritage and conservation, industrial development, transportation and traffic management, environmental assessment and management and sustainable development. British approaches to planning have greatly influenced international practise.

3.2.1.1 Case study – Birmingham East Side development

Eastside, a once deprived area of Birmingham city centre, is currently seeing a multi-million pound investment for regeneration from a broad spectrum of public and private sector organisations. The scheme will enhance the economic and physical growth of Birmingham's business and leisure offerings.

In the late 1990's, Eastside began to attract investment and attention from a range of organisations, helping to create new jobs, businesses, educational and leisure services. Eastside is now considered as the city's learning and technology quarter, presenting the local community with opportunities to learn and enhance employment potential.

Careful urban design will ensure Eastside is incorporated into the surrounding city infrastructure of parks, public spaces, squares and streets, with further regeneration expected if proposals for an HS2 terminal to be located within the quarter were to be given the go-ahead.

Source: Birmingham City Council (36)

3.2.1.2 Case study – Urban Regeneration in Sheffield

Sheffield is a post-industrial city in the North of England with a population of 547,000. The City is England's third largest metropolitan authority and grew rapidly during the industrial revolution. At its peak, in 1951, the population numbered 577,050 due to the steel manufacturing and coal mining industries. There was a fairly catastrophic collapse of the steel industry during the 1970's and 80's due to international competition, which also coincided with a decline in coal mining. However, successive regeneration attempts have resulted in very considerable success for the city and it saw its economic output (measured by Gross Value Added) increase by 60% between 1997 and 2007.

One of England's first Urban Regeneration Companies was set up in Sheffield in 2000. This transformed into 'Creative Sheffield', an Economic Development Company which had responsibility for economic strategy, elements of masterplanning, urban design, marketing and promotion of the city. This was a truly innovate organisation, the first of its kind in the UK to be endowed with any real influence over investment.

Creative Sheffield sought to build a reputation for scientific and cultural innovation, and to draw high tech and creative industries into the city. It supported the development of a 'Creative Industries Quarter', for artistic, media and design companies. It also made connections between the innovation functions of Sheffield's two universities and sought to generate additional routes to market for research, supporting the creation of a 'digital campus' for the city.

The creation of a large out of town shopping mall in the 1990's, called Meadowhall, generated jobs and grew the economy, but created economic challenge for an already ailing town centre. The city also did not have a properly functioning 'urban heart' in its city centre, as it was developed quite quickly during industrial expansion. The City Centre Masterplan created a new link between the central station and the



town centre, re-routing roads and creating a high quality design and pedestrian-friendly route between the two. Indoor and outdoor green spaces were created, including the Wintergarden, a year-round green space. Sheaf Square outside the station is a world class public space with a massive stainless steel sculpture 'Cutting Edge', reflecting the industrial heritage of the city and literally reflecting its visitors.

Park Hill is a massive housing project just on the edge of the city centre. It became very run down and largely abandoned during the 1980s and 90s. It was 'listed' by English Heritage (the Governments watchdog for heritage design) as an outstanding design of modernist architecture. This gave legal protection meaning the building could not be demolished. A partnership between the City Council, other regeneration agencies and a private company specialising in regeneration (Urban Splash) eventually delivered a solution and Park Hill is currently undergoing total refurbishment and is considered a desirable and even fashionable place to live as a result.

Reproduced with permission from Chris Murray (37)

3.3 Building Information Modelling (BIM)

Building Information Modelling (BIM) facilitates more detailed knowledge of physical and functional characteristics of places and therefore creates benefits through more efficient design, construction and management of those places. It is not limited to buildings – BIM models are used for infrastructure and can be scaled up to cover an entire city. The UK is leading many aspects of the development of BIM. The UK Government requires 'collaborative 3D BIM (with all project and asset information, documentation and data being electronic) on its projects by 2016.'⁽⁹⁾ This is part of a larger plan to move the UK construction sector toward eventual adoption of BIM Level 3. This will involve:

'the interconnected digital design of different elements in a built environment and will extend BIM into the operation of assets over their lifetime. It will support the accelerated delivery of smart cities, services and grids.'⁽³⁸⁾

When the detailed knowledge of BIM level 3 is combined with data from sensors deployed in the urban environment, cities will have very powerful information for decision-making and improved management of urban systems. The UK has led on infrastructure and BIM with case study examples of the Crossrail and Thames Tideway projects.

3.3.1.1 Case study – BIM saves time and money on motorway junction project

Skanska has used building information modelling (BIM) on a £128.5 million project to improve junction 19 of the M1 motorway. The project will use sophisticated computer technology to develop a very detailed computer model of the project.

The 3D model shows three levels of the motorways, alignments, structures, street furniture, temporary access routes, drainage and more. By bringing the design proposals to life in a 3D model, design teams can work collaboratively and make immediate changes to the model to test approaches. It has meant that design proposals of how this major intersection could be re-modelled have been brought to life.

Using BIM during the design process flagged up several problems and solutions were identified and refined before in a virtual environment before construction commenced. This early identification of issues and solutions removes risk throughout the design and construction process, resulting in cost and time reductions for the project.



Source: Skanska (39)

3.3.1.2 Case study – Crossrail: the first European major transport project to use BIM

The first surveying work for Crossrail began in the mid-nineties and since that time this major infrastructure project has been leading cutting edge approaches to design and industry standards.

There are 25 main design contracts, 30 advanced works contracts and over 60 logistics and main works construction contracts working on the Crossrail project. Detailed design work started in 2008 with a contractual requirement to work in a collaborative 3D environment.

Crossrail define BIM as ‘the process of generating, building and managing data through the life of the project by using model-based technologies linked to a database of project information.’(40)

This is the first BIM environment for a European transportation infrastructure project of this scale. Crossrail is using BIM for the benefits it can bring to the construction of the railway (in terms of long-term cost savings) and the opportunity to drive innovation in the wider construction industry.

The key benefits of using BIM are listed by Crossrail as follows:

- ‘Reduction of risks from greater visibility into design and construction interfaces and activity
- Improved safety through increased construction awareness from easy review of complex details or processes on site
- Reduced errors from using a trusted “single source of truth” approach to data management, for example ensuring only the most appropriate version of models, drawings and documentation is used
- Improved collaboration through linked data sets and integrated 3D models that create a “virtual” Crossrail before the physical Crossrail is constructed, allowing design and construction refinement
- Reduced information loss between project phases, ensuring we capture and hand over full asset information into the Operations and Maintenance phases
- Improved project delivery leveraging technology advances including data interoperability and mobility.’

Source: Crossrail (40)

3.4 Green building and retrofitting

The environmental footprint of buildings is significant; they account for 37% of carbon emissions in the UK.(41) They are also responsible for a significant amount of water use, consumption of natural resources through construction materials and impact on biodiversity through habitat destruction. Buildings also impact on occupants through the quality of the indoor environment and design. These challenges can be mitigated through best practice design measures and use of sustainable materials and technologies. When well-designed, buildings can have a positive impact on people and the environment, resulting in multiple economic benefits for owners and occupiers.



Building Research Establishment's assessment method for sustainable buildings, BREEAM, is the world's first and most widely used method. BRE launched BREEAM Communities, a standard for large-scale masterplanning projects, in 2008. The BREEAM Infrastructure scheme is now in the pilot stages with early adopters including High Speed Rail 2, Crossrail and Thames Tideway Tunnel. UK consultants, architects and engineers become qualified as BREEAM assessors and use this qualification to win work internationally.

BREEAM has been used in over 60 countries and is available for buildings, communities (and soon infrastructure) at a range of life-cycle stages. Given the prominence of BREEAM in the UK non-residential sector, the UK has very strong capabilities at designing and constructing environmentally sustainable buildings. Engineers, architects and other design professionals have created some of the world's most sustainable buildings including innovative design measures and technologies across the following building sustainability areas: energy, water, waste, transport, health and wellbeing (indoor environment and community-scale design), pollution, materials, ecology and management processes.

Of the 22.2 million homes in England, 39% were built before 1944 and 42% were built between 1945 and 1980.⁽¹⁰⁾ Older homes are highly valued and therefore the UK refurbishment industry has significant experience with bringing old buildings up to modern standards of safety and energy efficiency. UK companies provide services at a strategic level, advising cities on which housing stock is in the poorest condition, down to individual building trades installing insulation.

3.4.1.1 Case study – Battersea Power Station and BREEAM Domestic Refurbishment

Battersea Power Station Development Company is using the BREEAM Domestic Refurbishment assessment method on 248 to improve the sustainability and environmental performance of phase two of the major construction programme. The Power Station (a Grade II listed building) is at the heart of a new 40-acre mixed-use site that will feature office and retail space, around 200 shops and restaurants, a state-of-the-art performance venue, cinema, hotel and riverside park. Construction of phase one comprising 866 apartments and leisure facilities including a gym and spa is already underway. Phase two involves the conversion of the power station itself into commercial and residential space. The commercial element of the scheme has also been registered under BREEAM Offices and Retail.

Reproduced with permission from Building4change (42)

3.4.1.2 Case study – The Crystal, Sustainable Cities Initiative

The Crystal is a building with multiple functions: part event space, part sustainable cities exhibition, part office and part exemplar high-tech sustainable building. Located on the Thames on London's Royal Docks, the building is certified to BREEAM Outstanding and LEED Platinum, making it one of the most sustainable buildings in the world. The building is all-electric and uses solar power and a ground source heat pump to generate its own energy. It showcases state-of-the-art technologies in efficient building management using 3,500 data points to ensure all electrical and mechanical systems function effectively. The Crystal has rainwater harvesting, black water treatment, solar heating, automated building management systems, a community garden, electric car charging points and a green roof. Building tours can be booked via the website at www.thecrystal.org.

The exhibition space has interactive exhibits, films, and animations, allowing visitors to explore city



trends, urban planning, smart buildings, safety and security, energy, water, healthy lifestyles, environment, and mobility. Throughout the exhibition, visitors will find international case studies sharing innovative ideas, and the 'Future Life' theatre which displays visions of how cities might look in 2050. The exhibition space is regularly open to the public with further information available on the website.

Source: <http://www.thecrystal.org/>

3.4.1.3 Case study – Castleward regeneration and BREEAM Communities

Castleward is a 12.1 hectare brownfield regeneration site in Derby currently undergoing redevelopment to create a new community of sustainable homes and businesses. This £100 million project is located between Derby Midland Station and the city centre. The development is a joint venture between Derby City Council and a private partner, Compendium Living, a company jointly owned by housing developer Lovell Partnerships and social housing provider The Riverside Group.

The project spans five phases over 15-20 years. Work on phase one started in November 2012 and includes 163 homes, 16,500sq ft of commercial space, a boulevard and a new urban park over five acres of land. The plan is to create around 800 new homes and 34,500 square feet of commercial space. The development enhances links to surrounding green space and providing a strong connection between the city centre and public transport connections.

Paul Bayliss, leader of Derby City Council, said: "Achieving the BREEAM certificate is a positive step and is an accreditation to be proud of. It shows that creating innovative, sustainable homes and businesses is a priority for us."

Kate Reid, HCA Area Manager for Midlands North, said "This achievement shows that Castleward is set to be a distinctive place that will enhance the quality of life in Derby."

Reproduced with permission from BRE (43)

3.5 Transport

A 2014 survey by Urban Land Institute and Ernst & Young found that 78% of respondents named improved public transit infrastructure as a top priority for infrastructure investment.(44) The importance of functioning transportation is significant for individuals and cities. The EY *Routes to Prosperity* report highlights the importance of infrastructure for urban growth and prosperity:

'Transport infrastructure is a major driver of economic growth and competitiveness. Therefore, it is the backbone to any effective smart city strategy. In fact, IMF [International Monetary Fund] estimates suggest that for every dollar of investment in infrastructure, output increases by nearly three. This is no more apparent than at the city level, where growth and development challenges mean urban transport infrastructure will need to support increasing demand for mobility and drive competitiveness.'(45)

The UK has a sustained programme of adapting asset management; renewing track, signals, power and stations as we continue to modernise our railways. Today in the UK, rail is a success story, more trains run every day than ever before, safety, punctuality and passenger satisfaction levels have risen to record levels with enhanced sustainability and running costs reduced substantially.



British companies have capabilities in designing, financing, delivering and managing transport assets of all types as well as expertise in 'Turn-key solutions': design, build, and manage. They are experienced at working to standards such as *PAS 55-1: 2008: Asset Management* which has become internationally accepted as the industry standard for quality asset management.(46) In January 2014, the ISO 55000 series of Asset Management standards were published, officially making the British Standard Institute's approach the chosen international standard.

Sustainable transport solutions are integrated across travel modes and build in resilience and connectivity. Using rail stations and other transport hubs as catalysts for regeneration is an example that the UK can showcase in several places (London King's Cross and Birmingham's Eastside for example).

3.5.1.1 Case study – Crossrail

The Crossrail project involves the construction of 21km of new twin-bore tunnels under central London. There will be nine stations and new rolling train stock, each carrying 1,500 passengers with 24 trains per hour during peak services. Services are expected to start in 2018. The expected cost is just under £15bn -- the largest construction project in Europe (with wider economic benefits estimated at over £40bn).(27)

UKTI reports that there are expected to be at least 75,000 opportunities for businesses in delivering Crossrail, generating enough work to support the equivalent of 55,000 full time jobs all over the UK. Firms from around the country and of all sizes are winning business:

- 43% of suppliers winning work are outside London and the South East
- 62% are outside London
- 58% are small and medium sized businesses.

Crossrail has already tendered over £6.5bn worth of contracts, with 97% of contractors based in the UK. The project has also created 450 apprentices beating its original target of 400. This project will ensure the UK has a workforce to deliver Crossrail as well as a pipeline of skills for other future projects.(47)

3.5.1.2 Case study – Heathrow Terminal 2b

Balfour Beatty led the Heathrow Terminal 2b rebuild integrating design, construction, ground engineering, and specialist mechanical and electrical expertise to create a single point of service

The £592 million project has made Terminal 2b one of the largest airside projects in Heathrow's history. The project successfully completed Phase 1 in 2009, with Phase 2 currently underway with 10 more aircraft stands under construction to help relieve congestion.

The project aims to save 40% more carbon than the previous terminal building, and help create a more sustainable Heathrow.

Source: Balfour Beatty (48)



3.5.1.3 Case study – PRT Pods at Heathrow Airport (Terminal 5)

Heathrow was the first airport to procure Personal Rapid Transport vehicles. ‘The unique Heathrow pod system – which started life as a Bristol University project – was developed by UK company Ultra and BAA and consists of 21 low energy, battery powered, driverless, zero emission vehicles capable of carrying four passengers and their luggage along a dedicated 3.8km guide way.’(49) The system will eliminate 50,000 bus journeys on the roads around Heathrow each year. The pods use 70 per cent less energy than it takes to power a car, and 50% less than a bus.

The pods run between the T5 Business Car Park and the terminal carrying over 800 passengers per day. Because the pods have are quite small they fit well in the limited space available at the airport. They were commissioned by Heathrow Airport’s operator BAA and consist of 21 pods and three stations.

Source: Ultra Global PRT (49)

3.5.1.4 Case study – Croydon Trams

The London Borough of Croydon is the centre of a tram service provided by London Tramlink, part of Transport for London. The tram ‘network consists of 39 stops along 28 km of track, on a mixture of street track shared with other traffic, dedicated track in public roads, and off-street track consisting of new rights-of-way, former railway lines, and one section of alignment (not track) shared with a third rail electrified Network Rail line.’(50) This tram network is the first to be built in England since 1959.

An impact study published in 2002, two years after the tram service opened, found that travellers had changed their choice of transport to this more sustainable mode. Transport for London and the Department for Transport conducted before and after studies to measure the behaviour change supported by the tram service. Passengers were primarily changing from bus journeys to the tram, however 7,000 car journeys were shifted to the tram providing benefits through reduced vehicle emissions, traffic and car parking demand.(51)

3.6 Intelligent transport

Smart or intelligent transport encompasses a range of technologies that drive better outcomes for sustainability, from social, economic and environmental perspectives. EY’s Routes to Prosperity report highlights the role of smart transport as:

‘Smart transport infrastructure and enablement of smart mobility are top of the growth and competitiveness agenda. Technology enabled assets and systems offer governments significant economic leverage through outsized gains in productivity and economic activity, reflecting network effects and other boosts to competitiveness.

Smart transport infrastructure can also help address the need for sustainability and inclusiveness in urban design and development as populations increase, inequality persists and environmental pressures build.’(45)



The UK has been a leader in intelligent transport technologies and test facilities. Intelligent transport systems includes a range of technologies at different scales, including the following reported by BIS in *The Smart City Market: Opportunities for the UK* (16):

- **‘Transport Information Application developments** (to reduce congestion, improve quality of life, reduce emission from traffic, improve safety and optimise traffic flow). These are used by technology companies and transport integrators to provide information to city management which enable better management of transport systems in cities.
- **Intelligent traffic features** (to reduce congestion, improve quality of life, reduce emission from traffic, improve safety and optimise traffic flow)
- **Digital City features** (to reduce congestion, reduce emission from traffic, improve safety and security and optimise traffic flow).’

The BIS report also highlights where the UK is leading in the smart transport sector:

- early stage concepts and system integration
- traffic management services (eg. through experience gained in the 2012 Olympics)
- designing, managing and retrofitting underground transport systems (eg. the London Underground)
- bridging the gap between universities and industry, enabling faster development of research ideas.

The report also highlights that the UK has a number of important smart transport initiatives including: the London Congestion Charging Zone (see case study in 3.9); the Regent Street Consolidation Centre (moving stock to electric vehicles for local delivery); the FREVUE (Validating Freight Electric Vehicles in Urban Europe) project with Arup, Land Securities and The Crown Estate; and the Efficient Consumer Response (ECR) project (run by The Institute of Grocery Distribution to improve logistics).

Similar to energy, transport is another area where significant research investment helps create innovative solutions and IP that are exploitable globally. For example, the Transport Research Laboratory’s software and other innovations support UK consultancies and other companies in the supply chain.

The Transport Systems Catapult is working to create transport systems that are intelligent and integrated, working across multiple forms of transport. Their current projects, summarised from their website (52), include:

- **Departure Planning Information (DPI)**: This project allows airports to share real-time data on flight departures and improving airspace efficiency to minimise delays and reduce emissions. The DPI project is now in place at Heathrow, Gatwick, London City, Stansted, Manchester, Edinburgh, Glasgow and Aberdeen airports, with Luton airport scheduled to take part shortly. The partners are the Civil Aviation Authority (CAA) and the National Air Traffic Services (NATS).
- **LUTZ pathfinder**: This pathfinder project is testing driverless pods in Milton Keynes for automated and on-demand transport. It involves RDM, a firm based in Coventry, providing the electric-powered two-seater pods. These will be equipped with sensor and navigation technology to be provided by the University of Oxford’s Mobile Robotics Group initially. An open platform capability will allow other Autonomous Control System suppliers to use the pods for test purposes in future.
- **Innovation in Rail Franchising**: The group is tracking innovations to ensure continued and increased investment in innovation solutions for the railway sector. Members of the Innovation in



Rail Franchising group involve: Department for Transport, Future Railway, the Rail Safety Standards Board and the National Skills Academy for Rail Engineering.

- **Manchester smart table:** This technology is an interactive touch-screen table that uses transport data from Manchester city centre to demonstrate the potential of future urban planning in a user-friendly way. The software for the table uses historical data from 2010 and projected figures for the years 2020 and 2030. It allows users to test out different interventions to the transport system such as increased interconnectedness of transport modes, road closures or the creation of Park & Ride schemes to understand how these might affect traffic. Partners include InnoZ and IXDS.
- **Solutions for Integrated Seamless Transport Across Land and Sea (SISTALS):** This project is examining how smarter systems can be used to improve the tracking of goods from their starting point to their final destination. Partners include Chronos and Aimes,
- **Sentiment Mapping for Transport Systems:** This project is using social media and crowd-based applications to understand how these could benefit transport providers and customers. A demonstration version is live in the catapult's Innovation Centre and pilot projects are being planned. Partners include Commonplace and the Royal College of Art.

3.6.1.1 Case study – Driverless vehicles

[Innovate UK](#) invested £10 million in 3 projects to test driverless cars in the real world. The projects in Bristol, Milton Keynes, Coventry and London Borough of Greenwich are part of the Introducing Driverless Cars to UK Roads competition. The projects started in January 2015 and will investigate how driverless cars can be integrated into everyday life in the UK.

The **Venturer** project in Bristol will investigate the legal and insurance aspects of driverless cars and analyse public reactions to the vehicles. Lee Woodcock, VENTURER project lead and technology director for Atkins' Highways & Transportation business said "This programme will help keep the UK at the forefront of this transformational technology, helping to deepen our understanding of the impact on road users and wider society and open up new opportunities for our economy and society."

The **UK Autodrive** project in Milton Keynes and Coventry will evaluate passenger cars with increasing levels of autonomy as well as lightweight self-driving pods in pedestrianized spaces. Tim Armitage, UK Autodrive Project Director, Arup said "Our plan with the practical demonstration phases is to start testing with single vehicles on closed roads, and to build up to a point where all road users, as well as legislators, the police and insurance companies, are confident about how driverless pods and fully and partially autonomous cars can operate safely on UK roads."

The **GATEway** project in Greenwich will trial three types of zero emission automated vehicles in a technology-agnostic testing environment. The project will look at how autonomous vehicles can be integrated into existing transportation hubs and provide insights into how users respond to the vehicles. Dr Nick Reed, Principal of Human Factors and Vehicle Automation at TRL and technical lead of the GATEway project said: "We have the perfect location in which to demonstrate automated transport systems and our vision is to bring international recognition to Greenwich, London and the UK through this project, establishing the UK as the global centre of excellence for the testing and development of automated vehicles."

Driverless cars represent significant research and innovation opportunities for the built environment and their wide ranging use will have far-reaching impacts on how we design and develop urban



environments and infrastructure projects.

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3.6.1.2 Case study – Adaptive Traffic Management

TRL is leader in the field of Adaptive Traffic Management through its research, development and creation of advanced solutions that are used all around the world. Its Traffic Management portfolio includes SCOOT, MOVA and TRANSYT Online. TRL are the researchers and developers of:

SCOOT - SCOOT (Split Cycle Offset Optimisation Technique) is a proven effective and efficient tool for managing traffic across a signalised road network and is now used in over 250 towns and cities in the UK. In London alone, 50% of the traffic lights, circa 3,500 junctions, are controlled by [SCOOT](#). Overseas users include Brazil, Chile, Dubai, Thailand, Canada and the USA

MOVA - TRL's [MOVA](#) is one of the most comprehensively deployed adaptive traffic management solutions for isolated intersections, mandated by the UK's Highway Agency for use on the HA Trunk Route Network with over 3,000 deployments to date. MOVA is designed to cater for the full range of traffic conditions, from very low flows through to a junction that is overloaded.

TRANSYT Online - [TRANSYT Online](#), one of TRL's latest solutions, connects TRANSYT model outputs (plans) with controllers on street through automatic updating and deployment of signal timing plans against received traffic flows from on street data.

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3.6.1.3 Case study – Intelligent Mobility, Imtech Traffic & Infra

Imtech Traffic & Infra (Imtech T&I), working with Kirklees Council, has successfully reduced congestion at a previous 'pinch point', providing access to Huddersfield town centre, by providing site assessment, supervision and subsequently commissioning SCOOT Multi-node software.

The junction at Waterloo was identified as the 14th most congested traffic signal junction in West Yorkshire and was proposed as a "pinch point scheme." The Waterloo site was allocated £1.5million of government funding to carry out works to alleviate the congestion at this location. The scheme would have meant long term works to widen carriageways bringing confusion and delay to pedestrians, cyclists and motorists alike.

Tasked at looking at the problem from a different angle, Imtech T&I's 'Infra Solutions' team and Dave Caborn of Kirklees Council found another way to 'get the most out of the current infrastructure' and save over £1 Million of government funding.

Multi-node SCOOT enables closely situated junction timings to be linked through software and communications networks. As traffic moves through the junction's detection, the timings at each node are locked together in synchronisation, as opposed to independently calculating phase timings, thus enabling the end user to clear the junctions efficiently, reducing idle time and delays to a minimum.

Having developed and tested the software for use in-house, Imtech T&I demonstrated the operation of the system to Kirklees Council who gave the all clear to roll the solution out on site. The Multi-node



junction is also co-ordinated with two closely associated Puffin Crossings and provides bus priority utilising the West Yorkshire central bus priority interface.

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3.6.1.4 Case study – Manchester’s Customer Smart Programme

EY is the delivery partner for Transport for Greater Manchester’s (TfGM) largest programmes. The most transformational is the “Customer Smart” Programme which will change TfGM into a world class, customer-centric, service delivery organisation with the most advanced Smart Ticketing solution as a key enabler.

This would enable TfGM to provide services, either themselves or through large, multi-year contracts, in order to deliver a world class transport experience throughout Greater Manchester. This transformation is technology enabled, but also delivers:

- The seamless ability for passengers to use contactless ‘smart ticketing’ across public transport in Manchester;
- Multi-modal, multi-operator, and modal ticket products that are persuasive, understandable, easy to use, competitively priced and promote public transport; and,
- A new operating model with efficient infrastructure (including ‘back office’ and ‘on network’ hardware) and processes within Transport for Greater Manchester and transport partners for managing smart ticketing and allocating revenues to operators.

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3.7 Water

As cities grow in population, so does the demand for water. This is not only because there are more people demanding water, but also because urbanisation and economic development increases the number of people drawing from municipal water sources.(12) A comprehensive study of urban water supplies internationally has estimated that approximately 25% of urban dwellers are living in water stress.(12) Access to clean water, even more so than energy, is imperative for health. In developing countries, water and waste infrastructure will be a priority.

The UK provides a range of water management services. The UK water industry draws on decades of experience in developing integrated water-resource management solutions and techniques. Its 20 water utilities invest £5.85 billion in assets each year and £5.17 billion in services, employing 45,700 people and creating 86,000 indirect jobs. Supporting the UK water industry is a world-class regulatory framework. This has driven an efficient, innovative sector that can operate to the highest levels of environmental protection, quality maintenance and customer protection.(57)

According to a 2013 BIS report: ‘The European water utilities industry is forecast to be valued at \$277.9 billion in 2015. At present the UK has approximately 15% to 16% share of this market. The UK has the single largest individual market value.’(16)

UK expertise can offer support internationally on the following specialisms:

- Water sourcing
- Quality water delivery
- Treated water for reuse



- Water, wastewater and desalination process engineering
- Balancing water usage
- The digital utility
- Flood resilience
- Advisory services
- Research, innovation and training.

The Institute of Water, the UK's professional membership body for anybody working in the water sector, showcases leading work in their annual awards. Previous award winners included the following innovative companies and research networks (with many more showcased on their website <https://www.instituteofwater.org.uk/>):

- **Ferret leak location system:** an innovative hydraulic solution for finding leaks in water pipes. The system significantly reduces the amount of time and number of excavations required to pinpoint and repair leaks, minimising disruption to customer's property.
- **Radio Data Networks:** the UK's largest provider of licensed radio links and smart sensors for applications such as sewer monitoring. Sensors are used to measure sewer levels, storm tanks and CSO [combined sewer overflows] overflows. The systems usually provide 5-minute data from both the wastewater networks such as sewers and CSO overflows and within sewage works and pumping stations. They report local activity such as high wet well levels, the operation of a storm bypass channel or the level in storm tanks.
- **STREAM:** the Industrial Doctorate Centre for the Water Sector. The STREAM programme involves a consortium of five universities and combines multi-disciplinary expertise to train engineers and scientists with the skills, knowledge and confidence to tackle the challenges faced by the water sector today.

3.7.1.1 Case study – Identifying clean water sources in Sierra Leone

Ioniq Global's unique satellite technology was used in Sierra Leone to identify clean water sources. Sierra Leone has a history of health problems associated with the rainy season, including cholera which causes many infant fatalities every year. The Ioniq Global technology recognises the genetic footprint of a resource by way of its frequency. The technology found four sources of sustainable clean water in the area around the national capital, Freetown. A strategic underground system was successfully drilled, and local residents and government officials were delighted. The company has also carried out invaluable work in drought-affected areas in countries such as Cyprus, Thailand and the Middle East.

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3.7.1.2 Case study – Flood alert system, GaugeMap

A company that specialises in unlocking the power of data has developed an alert system that gives a real-time picture of river levels and the potential for flooding at more than 2400 locations across England and Wales.



Shropshire-based [Shoothill](#) developed its [GaugeMap](#) with the help of a £97,000 award from Innovate UK. The map is a visualisation of river levels at 2,481 Environment Agency river gauges.

Anyone can view the map online for an overall picture of national river levels or search for levels and river flow at individual measuring stations. Twitter users can also follow individual gauges and receive two alerts a day.

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3.7.1.3 Case study – Drone technology and water quality in Swaledale

Drones, or Unmanned Air Vehicles, were trialled by Morrison Utility Services (MUS) in investigative work in April 2015 whilst contracting for Yorkshire Water, in a bid to improve water quality for 400 customers in Gunnerside, Angram and West Stonesdale.

The £4.8 million investment will see replacement of Yorkshire Water's West Stonesdale water treatment works with a new clean water pipeline and two new pumping stations, also benefiting the community by providing water from a more reliable source, reducing the risk of bursts, water supply interruptions and leakage by up to 1 million litres a day.

The work will be overseen by MUS, which will be making use of drones due to the engineering challenges presented by the terrain, such as having to tackle four River Swale and 13 other water course crossings. The use of Google Earth or viewing from the highways for taking aerial images, extracting the terrain slope, aspect and ruggedness were not feasible, and so the drones proved helpful in reaching inaccessible areas, minimising risks to employees. Drone usage has allowed practical designing of the new pipeline. Mike West, MUS Construction Manager believes that drones 'can play an extremely beneficial role in future projects'.

Source: Institute of Water (59)

3.7.1.4 Case study – Energy savings in Welsh Water

Perceptive Engineering Ltd, a developer of leading-edge predictive control and diagnostics tools for the water industry, was commissioned by Welsh Water to conduct a detailed assessment of process performance at a site in South Wales and uncover opportunities for improvement. Building on similar projects undertaken for Northumbrian Water, Yorkshire Water and United Utilities, the audit suggested that there was significant potential for energy saving – 17 percent in aeration energy – without compromising the quality of final treated water. As a result, a data driven, model predictive control scheme was implemented and Welsh Water's engineers installed ammonia probes. Within a few months, electrical blower energy was reduced by more than 25 percent, ammonia control became significantly more robust and the risk of compliance failure fell. Other improvements included a better control of manifold pressure and a dramatic reduction in the number of blower trips.

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3.7.1.5 Case study – Leeds invests in innovation to tackle flood risk

Two movable weirs powered by giant air bags are to be installed as part of a £23m flood defence scheme in Leeds. The innovative weirs will replace existing fixed weirs at Crown Point and Knostrop on the River Aire as part of a major flood defence scheme designed to protect 3,000 homes and 500 businesses against a 1-in-75 year flood. There are currently no formal flood defences along the River Aire and the works will extend over a 4.3km stretch of river from the mainline railway station to just below Knolstrop Weir.

The existing weirs hold the river level artificially high to allow navigation on the river. The proposed movable weirs will allow river levels to drop by up to 1.0m under flood conditions. It is the first time that this type of movable weir has been used in the UK.

The contract for the works has been awarded to a BAM Nuttall/Mott MacDonald joint venture by Leeds City Council. It is due to be completed by March 2017. The city's entire Flood Alleviation Scheme is estimated to cost around £45m and is being funded through a partnership supported by Defra and the Treasury, Leeds City Council and local businesses.

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3.8 Waste

Waste management services are an essential aspect of healthy and sustainable cities. 'While service levels, environmental impacts and costs vary dramatically, solid waste management is arguably the most important municipal service and serves as a prerequisite for other municipal action.'⁽¹¹⁾ If left uncollected, solid waste has significant local impacts on the environment and health, causing ailments such as diarrhoea, respiratory illness and dengue fever. It also has global impacts, contributing harmful gases into the atmosphere and contributing to climate change. These impacts create cost implications across local and national government. In low-income countries solid waste is often the single largest budget item for cities.⁽¹¹⁾

The UK has a proven track-record of implementing waste reduction, reuse and recycling measures across residential, public and private sectors. The waste industry in the UK is extensive and the country has numerous experts working within the consulting, operational and engineering sectors. These experts work on national and international projects providing highly regarded services. According to BIS 'UK companies have created solutions to optimise waste collection and management and are well placed to advise and supply a broad spectrum of innovative technologies and expertise in: waste collection systems and services; material recycling facilities; mechanical biological treatment (MBT); composting and anaerobic digestion; landfill engineering; and waste to energy.'⁽¹⁶⁾

The UK is home to a successful and growing waste to energy industry. The UK excels in both the extraction and production processes necessary to turn waste into energy. Its extraction capability is borne out of a long history of underground mining and a waste management history steeped in landfill disposal.

As a result of significant investment both by the private and public sector in R&D, the UK is providing a global lead on low carbon solutions and the development of innovative emission-reduction technologies. The UK has become an international player in the waste to energy market by introducing new Advanced Thermal Treatment technologies, developing its world-leading expertise in methane gas conversion and targeting niche areas for Anaerobic Digestion development.



3.8.1.1 Case study – Integrated waste management in inner-city London

VolkerFitzpatrick have collaborated with Veolia Environmental Services, the specialist technology contractors, and Southwark Council, to launch the Southwark Integrated Waste Management Facility (IMWF) in South London.

The large inner-city facility is the first of its kind in the UK, consisting of an 85,000 tonnes per annum materials recovery facility (MRF), able to process a wide range of materials such as glass and tetra paks, and an 87,500 tonnes per annum mechanical biological treatment (MBT) plant, producing recyclables and solid recovered fuels from residual waste, as well as a publically-accessible waste transfer station and a household reuse and recycling centre.

Southwark IMWF forms part of Southwark Council and Veolia Environmental Services 25-year private finance initiative (PFI) plan to improve recycling rates and reduce Southwark's waste-imposed environment impact.

Source: VolkerFitzpatrick (61)

3.9 Pollution and remediation

Air pollution is the introduction into the atmosphere of chemicals, particulate matter, or biological materials that cause harm or discomfort to humans or other living organisms, or damage the natural environment. The UK has developed a broad spectrum of air pollution control capability – expertise developed at home but sought after globally. The UK industry is particularly strong in:

- research and development
- emission controls
- catalysts for industry
- removal and destruction of greenhouse gas emissions
- odour, dust and noise-abatement technologies
- consultancy and support services.

The UK's diversity of contamination problems and sites, coupled with a scarcity of available development land, has led to the growth of niche specialist and multidisciplinary consultancies, technology providers, contractors, equipment suppliers and laboratories. In turn, they can call upon a large pool of well-educated and highly skilled professionals to work efficiently and safely in solving industrial problems. They are complemented by expert legal, financial and insurance firms, and a network of high-quality academic institutions and industry bodies that deliver first-class research and professional development.

UK companies take a leading role in the development of innovative solutions to the clean-up and regeneration of contaminated land, with sustainability at the heart of their approach. UK firms have gained considerable expertise through undertaking major, often iconic, urban regeneration projects across the UK, helping to breathe new life into the country's towns and cities (for example, the Olympic Park required considerable remediation). All of these initiatives have turned previously developed and derelict land into new mixed-use developments, helping to deliver renewed economic prosperity.



3.9.1.1 Case study – Congestion Charging Zone in London

The Central London congestion charge was introduced in February 2003, originally at a daily rate of £5 per vehicle.(62) There are multiple purposes for the congestion charging zone, including:

- alleviating congestion
- increasing the reliability of car journey times through London
- improving the efficiency of the delivery of goods and services
- overhauling the bus services
- and generating income to aid the delivery of the Mayor’s Transport Strategy.(63)

Driving through the congestion zone Monday to Friday between the times of 7am and 6pm now costs £11.50.(64) There was an approximate 30 percent reduction in traffic congestion in the few years immediately after the implementation of the scheme. In 2007 and 2008 it was found that levels were similar to those before the scheme.(62) Further analysis suggested that perhaps the increased incidence of temporary interventions such as road works in these years could have contributed to fluctuations in congestion rates.

Up to 50% of the increase in bus use between 2002 and 2003 was attributed to the introduction of the congestion charge, which also contributed to increased reliability of bus services.(62) The number of personal injury claims from road traffic incidents within Central London decreased by between 40 and 70 reports in 2008 from previous years.

Transport for London estimates that in the first few years following congestion charge implementation the following reductions were achieved:

- 8 percent in road traffic emissions of nitrogen oxides (NOX)
- 7 percent in emissions of fine particulate matter (PM10)
- 16 percent in emissions of carbon dioxide (CO2).(62)

Since the current Mayor of London, Boris Johnson, has been in office, there has been a 20 per cent reduction of (NOx) emissions, and a 15 per cent reduction in PM10. The Mayor is currently overseeing several further pollution-minimising initiatives which are working alongside the congestion charge, to reach EU NO2 limits by 2020.(65)

3.9.1.2 Case study – Olympic Park site remediation

The former Lower Lee Valley site in East London once famous for “Hackney Fridge Mountain”, a twenty foot heap of disused appliances, has in recent years been transformed to what is now the Olympic Park, home to the 2012 Olympic Games and one of Europe’s biggest urban parks with a green assemblage of meadows, lawns, wetlands, woodlands and wildlife habitat.

This once brownfield site housed a mixture of industrial buildings and low income housing. Some of this land was highly contaminated, unfit for construction work to begin, and therefore required extensive remediation work to be overseen by the engineering consultancy, Atkins, within a tight two year period.

Investigative work to determine the type and extent of soil contaminants began with the demolition of



200 buildings. Assessment of the ground to place in 3,500 drilled exploratory holes across the site. The discovery of contaminated soil and groundwater, in the form of chemicals, glue and various industrial landfill debris led to the development and implementation of a remediation plan, devised and implemented by Atkins.

The ambition for London 2012 Olympic and Paralympic Games to be the “greenest” and most sustainable Games ever meant that it was a priority for 90% of the soil and material to be reused or recycled on-site. A couple of “soil hospitals” were set up to facilitate and manage the various diagnosing, treatment and reutilising remediation methods to be used, such as soil washing, chemical and geotechnical stabilization, and bioremediation. The unprecedented ‘bioremediation’ method was used for the very first time in the UK underneath the Olympic Stadium. Contaminants were eliminated by introducing the naturally-occurring Archaea microorganism into boreholes within the affected ground, degrading the ammonia and other offending substances.

The extent of contamination meant that this was the largest ever soil washing task in the UK, with around 1.7 million cubic metres being reused, equating to over 80% of the soil and exceeding the acceptable 50% threshold of favourability. This success carried throughout the project, with a resulting 90% of overall demolition material, and a total of 98% of materials being recycled and reused.

The efficiency of the remediation techniques used meant that construction was able to begin ahead of schedule, and the Olympic Stadium and Aquatics Centre were built earlier than originally planned. This Atkins-led project proved that such large scale remediation work is possible and will be used as a blueprint for similar work in the future, setting higher standards for industry.

Source: Atkins (66)

3.10 Health

Health and urbanisation is a topic of growing interest due to the pace of urbanisation and the potential adverse health impacts this may produce. However, there is a lot of evidence highlighting the positive impact that denser urban living can have with benefits such as active transport and access to services. The quality of new infrastructure and the ability for existing infrastructure to adapt to changing pressures will have a big impact on whether urbanisation is beneficial or problematic from a health perspective.

3.10.1 Changing nature of healthcare globally

Health systems globally are struggling to keep up with the growing demand for healthcare services due to the rise of non-communicable diseases and chronic health conditions like heart disease, obesity, chronic obstructive pulmonary disease and stroke. The World Health Organisation (WHO) highlights the growing challenge of meeting healthcare needs in the 21st century:

‘The changing nature of the challenges faced by 21st-century societies drives new approaches to governance; health is only one challenge and is not always given priority. Most of these challenges, however, have significant health effects, which have not been considered sufficiently so far. The challenges include systemic shocks, such as natural disasters and disease outbreaks, as well as longer-term processes, such as urbanization, epidemiological and demographic transitions, food insecurity, climate change and widening economic disparities.’(67)

In the context of sustainable urbanisation, the responsibility for delivering services and a healthy urban environment goes beyond central health departments and healthcare services.



'the failure in many countries to achieve real, sustained involvement of other actors in health and equity suggests that clearer understanding of health and governance is needed to move forward. This will require joint recognition of systemic risks and wicked problems and working together through both whole-of-government and whole-of-society approaches, accepting the need to build convergence to reach better outcomes.'(67)

These challenges mean that built environment professionals and city officials across multiple services need to consider how their practice and policies impact health and wellbeing.

3.10.2 Integrated planning for healthy cities

The healthcare challenge links back to the UK strength of integrated planning, systems thinking and applying a city systems approach.(68) Consultants, planners and design teams in the UK are beginning to advise clients on the co-benefits of planning new urban development and infrastructure to meet a range of social, environmental and economic imperatives, including health.

The importance of integrated spatial planning for health is emphasised by an RTPI Planning Horizons report, *Promoting Healthy Cities: Why planning is critical to a healthy urban future*. The report warns that 'a lack of adequate planning for urbanisation can result in sprawling environments, poorly connected places, limited access to services, housing and opportunities, exacerbating inequality, social exclusion and poor health.'(69) Conversely, when cities are planned well they 'expand the possibilities for economic growth, innovation and social development, and improve people's access to work, education, healthcare, housing and other services.'(69)

The WHO Healthy Cities movement started in Europe in the 1980s and continues to emphasise cross-sector collaboration and integrated planning for health outcomes. A UK example of integration is Scotland's 2008 *Good Places, Better Health* plan, highlighted in the RTPI report as encouraging a 'systems-based rationale for action to reduce health inequities and the links with other governmental strategies related to this domain.'(69)

The BRE is engaged in ongoing research on the built environment impact on health and wellbeing following on from its three-year Future Cities research programme. Part of this research has established the underlying methodology for a Healthy Cities Index which is now being further developed with a range of partners in the UK and internationally.

Architects and design firms such as HOK, HLM, BDP and Perkins + Will offer specialist healthcare design services. Perkins + Will, a global architecture and design firm operating out of London for the last two years, are providing a design service that goes beyond healthcare buildings and looks at the wider impact of the facilities on the community. They are working on 'Health Districts' in Shanghai, the US, the Middle East and Australia (see case study below for further information).

UK companies are leading on health infrastructure delivery (such as Mott MacDonald's HLSP) and strategic healthcare planning (such as WYG). Healthcare UK cautioned that there can be challenges with international procurement of hospital facilities as ministries of health may commission a hospital without doing a thorough analysis of local needs. The PPP model for healthcare infrastructure may not contain a lot on sustainability but rather focuses on reducing costs and efficient management.

3.10.3 Traditional health exports

The primary focus for exporting UK knowledge on health has been about more traditional areas regarding healthcare management, digital health, specialist facilities, clinical services, education and training. The National Health Service is internationally renowned as a cost-effective system for providing universal healthcare. Healthcare UK's brochure for clinical services cites a 2014 Commonwealth Fund study that



rated the NHS as ‘the best health system out of eleven countries studied’. Many countries, from low to high income, can learn from NHS approaches to managing population health and primary care.

An article by The Economist in 2013 highlighted two specific attributes of the NHS appreciated by other countries: 1) the disassociation between earnings and access to healthcare and 2) the general practitioner (GP) as gatekeeper system. The article states that ‘GP-based primary care is becoming popular in India, which has pledged to increase its government health spending from a paltry 1% in 2011-12, to near double that by 2016-17.’(70) It went on to highlight several examples of NHS approaches being used internationally including: a GP from Birmingham setting up 150 primary care practices in India; the Chinese government studying the National Institute for Health and Care Excellence (NICE) approach to evaluating the cost-effectiveness of medicines and treatments; and London hospitals such as Moorfields and Great Ormond Street setting up private branches abroad.(70)

Healthcare UK highlighted where Britain is leading internationally in terms of delivering clinical services (such as the Moorfields and Great Ormond Street examples above) and through education and training. Universities such as Imperial, University College London, King’s College London, University of Salford and Buckinghamshire New University have strong export offers on health education.

There is an opportunity for the UK to do more on hospital management and finances. The International Hospitals Group (IHG) is leading in this area and facilities management companies such as Carillion offer services from financing and construction through to management. For example, Al Futtaim Carillion, Carillion’s joint venture business in the United Arab Emirates, is in the final stages of completing the £112 million Al Jalila Speciality Children’s Hospital for the Dubai Health Authority.(71)

3.10.4 Ageing population

The ageing population has created challenges for healthcare providers and a growing focus on enabling people to stay in their homes longer and create smarter ways of caring for older people. There is also an emphasis on designing buildings and communities that are appropriate for all ages and more vulnerable people, such as the elderly and those suffering from dementia.

The Assisted Living Technologies market has been strongly supported by the UK Government. BIS highlights that the UK is one of the fastest growing markets for Assisted Living Technologies in Europe. Their 2013 report on smart cities states:

‘Comprehensive deployment of pilot projects and government funding and the elder population growth are some of the reasons behind this market growth. This helps place the UK at the leading edge of the sector, addressing the challenges associated with an ageing population through the development of the next generation of assisted living products and services.’(16)

The More Independent case study below demonstrates one example of this technology being developed and piloted in the UK.

3.10.4.1 Case study – Health District in Adelaide, Australia

This new precinct in Adelaide, Australia will create a global centre for health, innovation and learning, a regional hub for business, a local destination for commerce and combined with the Flinders University Campus will be a great place to live, work and learn. As part of the health, education and technology ecosystem of Adelaide, the new area will establish a new destination in the city, containing an urban village that builds on the existing activity of the area. The precinct will promote permeability and healthy movement by integrating transport and community objectives to create seamless connectivity between



regional centres, and local destinations. This connectivity will promote multi-modal transport focused on movement that achieves the human-oriented linkages, pedestrian and bicycle mobility, on which innovation grows while balancing necessary regional movement along roadways. Roadways are a central defining factor in the quality of a place; this infrastructure of mobility must support the vision of the precinct.

Source: Perkins + Will (72)

3.10.4.2 Case study – Holistic healthcare provision at Bromley by Bow

The Bromley by Bow Centre's mission is to "help create a cohesive, healthy, successful and vibrant community, and to remove the label 'deprived' from Bromley by Bow". The Centre is an internationally renowned charity which has been working to transform its community over 30 years. The focus is on supporting vulnerable young people, adults and families who may have difficulty accessing traditional support services.

As one of the country's very first healthy living centres, along with a GP surgery, they offer the community a wide range of health services that meet their needs, providing a bespoke health and holistic provision that exceeds local and national targets.

The centre runs several employment and health and well-being initiatives, such as the Capital Talent programme which supports 16-35 year olds into work, training and apprenticeships and employment. The My Life programme is an Adult Health and Wellbeing programme delivering services to people with physical, mental, sensory, learning and complex disabilities and health conditions.(73)

Source: Bromley By Bow Centre (74)

3.10.4.3 Case study – More Independent

Mi, More Independent, is a Government-funded initiative, bringing together tools, technology and support enabling people to take control of their health, wellbeing and lifestyle. The Life Enhancing Technologies is a range of gadgets that monitor health, and allow ongoing communication with family and carers, providing security and independence.

Additional benefits of Mi, some of which are aimed at those with health needs, are that it allows people to minimise their time spent visiting healthcare facilities, and more time spent being supported in the home, giving control and peace of mind to individuals and their families.

Mi was funded by Innovate UK, and is being trialled across four different regions within the UK, one of which is Liverpool, home to the Smart House which demonstrates Mi's range of tools and life-enhancing capabilities to prospective users.

Source: More Independent (75)

3.11 Education

In the forward to Government's 2013 strategy document on exporting education, the Rt Hon David Willetts, Minister for Universities and Science from 2010-2014, wrote: 'There are few sectors of the UK



economy with the capacity to grow and generate export earnings as impressive as education. ... Our universities, colleges, awarding organisations and schools are recognised globally for their excellence.’(76) The *International education: global growth and prosperity* report highlights UK strengths in education in the following areas:

- **Brand recognition:** UK educational institutions have internationally known brands. The recognition of Oxford and Cambridge universities benefits other educational institutions in the UK. Independent schools, awarding organisations and external degree programmes have taken advantage of this and set up foreign institutions.
- **Professional institutions:** The UK’s professional institutions are used globally as a model for accrediting new professionals and continuous professional development activities. The qualifications set by UK institutions are internationally recognised. For example, The Institute of Chartered Accountants in England and Wales and the Association of Chartered Certified Accountants work across international networks with accredited trainers and students.
- **Independence:** Many educational institutions operate independently from government and are therefore in a good position to compete internationally.
- **Research excellence:** The report states that the UK has ‘14% of the most highly cited scientific articles, second only to the US. After accounting for its size, the UK research base is the most productive of the major economies in terms of volume and excellence.
- **University business interaction:** As discussed previously, UK universities work closely with business to commercialise research findings. The report cites the World Economic Forum Global Competitiveness Report which placed the UK ‘second in the world for university business interaction, ahead of the US. Between 2003 and 2011, 40 university spin-outs were floated on the stock exchange with an initial public offering (IPO) value of £1.79 billion and 25 were acquired for over £3 billion.’

The Education UK brochure, *UK Education & Training Capability: An Overview*, highlights over 60 case studies of British education exports. For example, an education solutions provider called Frog worked as a key partner for the Malaysian Ministry of Education on its 1BestariNet project:

‘the world’s first project to connect an entire nation through a single, cloud-based learning platform. Establishing Malaysia as a model of excellence in internet enabled learning, 1BestariNet provides all 10,000 state schools and 10 million users with 4G connectivity to Frog’s virtual learning platform, FrogLearn.’(77)

This is just one example to demonstrate the innovative solutions linked to the education sector provided by UK companies.

The UK is also undertaking a range of research programmes on sustainable urbanisation (see section 4.8).

3.11.1.1 Case study – Tech city stars – developing local talent in London

The Mayor’s Fund for London has announced its support of ‘Tech City Stars’, a new programme to connect young Londoners from the local boroughs of Hackney, Islington and Tower Hamlets with the burgeoning digital technology industry cluster around London’s Old Street. Tech City Stars is led by employers and will equip local youngsters, who live in an area where some 40% of 16-24 year olds are out of work or not in formal education, with a digital apprenticeship at NVQ 3 and a route to employment.



Ultimately, the aim of Tech City Stars is to be a launch pad for the technology leaders of the future and the chosen talent pool for growing technology companies. Recruiting young Londoners and providing them with fast-track education and in-work technology training will help to drive the competitive advantage of firms in Tech City.

Reproduced with permission from the Greater London Authority.(78)

3.11.1.2 Case study – BRE Academy shares British expertise and standards internationally

The BRE Academy provides a link between industry and world leading research for knowledge translation. The Academy runs courses internationally through multiple media (online and face-to-face), and in partnership with other institutions to fulfil training needs for new and experienced professionals. The subjects covered through BRE Academy courses are of interest to construction professionals and cover the following areas: BIM, BREEAM, design, energy, fire, health & safety, renewables, security, specification, sustainability, waste and more.

The Academy offers a range of externally validated qualifications (BTEC Level 4 & 5, Pearson EDI Level 3 & 4, City & Guilds Level 3 & 4, Foundation Degrees, Postgraduate Diplomas, MScs) and its own qualifications such as BREEAM assessor. BRE has run courses throughout Europe, China and the Middle East. This creates a route for British standards to be used internationally and helps potential clients understand the value of expertise offered by UK companies.

<https://www.bre.co.uk/academy/index.jsp>



4. UK leading strategies, skills and technologies

In addition to the sub-sectors of sustainable urbanisation, there are a number of areas where the UK is leading sustainable urbanisation through national policies and strategies, specialist skills and development of innovative technologies. This section was compiled from expert stakeholders input on UK strengths. These strategies, skills and technologies apply to some of the sub-sectors above and help give the UK an advantage over global competitors.

4.1 Leadership, policy and capacity building

4.1.1 Climate change policy

The UK government was the first in the world to set legally binding carbon emission reduction targets in the 2008 Climate Change Act.⁽⁷⁹⁾ The target requires an 80 per cent reduction by 2050. The carbon budget period from 2023 to 2027 involves a 50 per cent reduction in emissions, relative to 1990.

The UK is using the following actions to achieve these goals: setting national policy and strategy across government departments; increasing energy efficiency through public and private sector initiatives; investing in low-carbon technologies; publicly reporting carbon emissions across public and private sectors; and internally taking action in Government.⁽⁷⁹⁾ These national activities have filtered through to action in local authorities and the private sector.

4.1.2 Policy and capacity building

UK consultants offer services spanning a range of sustainable urbanisation policy and capacity building issues. For example, Mott MacDonald offer the following governance consulting: civil service reform, decentralisation and devolution at various levels, developing public private partnerships, and improving governance and accountability.

An example of Mott MacDonald's recent work in this area is the 'Capacity building for economic management and policy co-ordination' project in Malawi.

'This project was designed to build capacity for economic management and policy co-ordination in the Government's core institutions – the Ministry of Finance (MOF), the Ministry of Economic Planning and Development (MEP&D) and the Office of the Vice President (OVP). We provided human resource development, long- and short-term technical assistance to enhance macro-economic analysis for policy making, strengthened development capacity through training and supported the EU Ministry of Finance National Authorising Officer (NAO).

Detailed advice was provided at a policy level on issues of structure and staffing, design and management of nationwide monitoring and developing an ambitious strategy for growth. Training needs were assessed and prioritised and a wide range of training was organised and monitored. A strategic plan was developed with the MOF, the economic faculty was strengthened and the central statistical office assisted in introducing new methods and tools.'⁽⁸⁰⁾



4.2 Technical solutions for low carbon infrastructure

HM Treasury has published a report outlining recommendations to reduce carbon emissions throughout the infrastructure planning, delivery and operational process in the UK. This report highlights several examples where UK companies have incorporated low-carbon design and technical solutions in infrastructure projects across water and transport infrastructure.(81) The following case studies are quoted from the report:

'Anglian Water – Covenham to Boston water transfer scheme: MMB, the design and construction joint venture between consultant Mott MacDonald and contractor JN Bentley, achieved a 12,000t (57 per cent) reduction in capital carbon and associated £13 million cost saving by building less and building clever on this 60km pipeline from Covenham reservoir and water treatment works to Boston, Lincolnshire.'

'M25 Widening: 5 per cent cost saving delivered through 115,000 t carbon reduction on £1 billion highway upgrade. Connect Plus, a joint venture between Skanska, Balfour Beatty, Atkins and Egis Projects, realised a 115,000t reduction in capital carbon and cut the outturn cost by £53 million through building clever and building efficiently during the widening of a 63km length of the M25 motorway.'

'A21 Stocks Green Bypass embankment stabilisation: Innovative earthworks solution saves 30 per cent cost and 40 per cent carbon. Design and build joint venture Mott MacDonald-Balfour Beatty used electro-osmosis in combination with soil nailing and improved drainage to stabilise a failing dual carriageway embankment in Kent. ... Carbon emissions were 70 per cent lower than using a traditional granular fill and 40 per cent lower than a standard soil nail solution. Stocks Green was the first use of electro-osmosis on a UK highway'

'London 2012 Olympic Park – structures, bridges and highways: Capital carbon was cut by a quarter across the Olympic park infrastructure projects between the initial and construction design stages. Consultant Arup with contractor Balfour Beatty achieved this through building less and building clever, making widespread use of lightweight structures and temporary solutions with shorter life expectancies that used less material.'

4.3 Economics

4.3.1 Natural capital

Various British economists and environmentalists have shown the economic value of nature in a concept known as natural capital. This is defined as 'the world's stock of natural resources which creates a long term supply of goods or services. It is an extension of the economic notion of capital (resources which enable the production of more resources) to goods and services provided by the natural environment.'(82)

The concept is being used in infrastructure and development projects to demonstrate impact on the three dimensions of sustainability (economic, social and environmental). For example, Skanska's Senior Sustainability Manager, Chris Hayes, presented their approach to Natural Capital at Ecobuild 2014 on a regeneration project north of Doncaster called Bentley Works. The company is using a quantitative and qualitative approach to measuring impact.(83)

4.3.2 Climate change

The *Stern Review on the Economics of Climate Change* was published in 2006 and is one of the most widely known economic reports on climate change. The report was led by Lord Nicholas Stern, Chairman of the Grantham Research Institute on Climate Change at LSE. The main message is that the benefits of early action on climate change will outweigh the costs.(84)



Several ‘mini-Stern reviews’ have been carried out in the UK to help city-regions understand the impact of low carbon interventions and their payback period. This work was completed by the Climate Smart Cities programme which is based at the University of Leeds and has funding from multiple sources.(85) The programme involved reviews in Leeds, Sheffield, The Humber, and Birmingham. Internationally they have also done reviews in India, Peru, Malaysia, and Indonesia. The methodology involves partnership working with international agencies and local stakeholders to understand current and predicted energy/water use and methods for reducing use alongside the associated costs and benefits. An example of the findings from this work is the Leeds City Region report. This showed that the region spends 10% of its GDP on energy costs. The report recommends investing 1% of GDP a year for ten years in low carbon energy which would pay off in four years and yield benefits through job creation, reduced fuel poverty, lower fuel bills and other local economic benefits.(86)

4.3.3 Circular economy

The circular economy is a concept that seeks to de-couple economic growth and resource consumption. It requires a systems science approach to optimise the flow of resources and materials across design, production and consumption.(87) The Ellen MacArthur Foundation has been highly influential in pulling together leading UK scientists and economists to prove the business case for a circular economy. The Foundation works across education institution and business to help society move toward a circular economy. This is underpinned by analysis from their knowledge partner, McKinsey and Company, outlining the macroeconomic case for the transition.

4.4 Approaches to planning and regeneration

4.4.1 Supporting community-led initiatives

The origins of community participation in planning and development are closely linked to the concept of developing sustainable communities. Ebenezer Howard’s Garden City movement used extensive community engagement. Government’s New Deal for Communities launched in the late 1990s heavily relied on community involvement. The Planning and Compulsory Purchase Act 2004 requires the early engagement of communities in the preparation of local plans and the Localism Act 2011 requires community consultation on large development projects. Communities in the UK can now also create Neighbourhood Plans to set out the type of development and design that they desire in their community.

There are many examples where communities in the UK have led local developments and initiatives for sustainable development. For example, the Southey Owlerton regeneration project in Sheffield was led by the local community:

‘Through a series of neighbourhood planning exercises which treated local communities as the planning and design client, local residents not only helped to plan improvements to local parks, improvement of housing stock and provision of new community facilities, they also helped to formulate a single masterplan to bring all this together. People were asked to think about the future of the whole of their area, not just their own neighbourhood. The responsibilities of local residents extended to being part of bidding for local and national funds and then allocating budgets.’(37)

Government’s Urban Community Energy Fund (2014) provided grants for communities to start their own decentralised power stations. Many communities were ahead of the curve and had already used local volunteers to finance and deliver community-scale energy generation. The Brighton Energy Co-operative was started by a local resident and ‘has succeeded in performing three share issues, raising £700,000 from the community and continues to install solar PV across Brighton – adding to its five existing sites in the city which already total 500kWp.’(88)



4.4.2 Greenbelts

The concept of greenbelts originated in the Garden City movement in the late 19th century. The first greenbelts were designated in London and Sheffield and by the middle of the 20th century were firmly supported by national planning policy.(89) The purpose of a green belt is to be a barrier to urban sprawl by protecting land around urban areas from further development. The Campaign for the Protection of Rural England and Natural England have recently campaigned for greenbelts to be more accessible to city dwellers as space to enjoy the natural environment.

Local authorities in England are responsible for setting boundaries for green belt designations and protecting them from new development. This is set out in the National Planning Policy Framework which also explains that local planning authorities should define these boundaries within local plans, which can be updated as appropriate. The most recent statistics for the size of the green belt estimate the coverage at 1,638,610 hectares, around 13% of the land area of England.(90)

4.4.3 Garden Cities and New Towns

As described above, the Garden City movement originated with Ebenezer Howard and is described in his influential book from 1898, *To-morrow: A Peaceful Path to Real Reform*. The key concept was 'based on a vision of combining the 'advantages of the most energetic and active town life, with all the beauty and delight of the country' in a high-quality sustainable community.'(91) The two garden cities realised by Howard's concept are Letchworth Garden City and Welwyn Garden City in Hertfordshire county near London.

The Town and Country Planning Association (TCPA) was founded by Howard to take forward the Garden City principles and 'is Britain's oldest charity concerned with planning, housing and the environment.'(92) The TCPA has campaigned for 21st century Garden Cities which apply the original principles set out by Howard in a modern context. A recent TCPA report on lessons learned from New Towns and Garden Cities explains that the former are closely linked to the latter:

'The New Towns were essentially an evolution of the Garden City concept, upscaled in size of population and strategic economic purpose, and with very different methods of delivery, reflecting the specific political and social contexts in which they were developed.'(91)

Both Garden City and New Town concepts have been influential internationally as examples of comprehensively planned new communities. There are 32 new towns in England, developed in the post-war period in response to requirements for urban renewal in England's city centres and designed to be sustainable compact towns. There were three phases of New Town development from 1946 to 1970, with examples including Milton Keynes and Peterborough.

The TCPA's campaign for 21st century Garden Cities emphasises the fundamental principles as including: land value capture, community engagement, community ownership of land, mixed tenure and affordable homes, local jobs, beautiful and environmentally sustainable design, cultural facilities and integrated transport.(91)

4.5 Financial models and risk management

UK consultancies have significant experience with public private partnerships (PPP) and other financing mechanisms for large-scale infrastructure (see section 6 for more information). In relation to financing energy infrastructure, BIS state the following (which is also relevant to other infrastructure projects):

'London's financial sector is now a world centre for banking, investment and venture capital. The industry will need to develop novel finance packages to fund the innovative business models that smart energy management will enable. The UK is already a key player in green finance, and is host



to organisations such as the Green Investment Bank, the London Energy Efficiency Fund, the Climate Bonds Initiative, and Climate Change Capital.’(16)

An example of support provided by a UK company is Mott MacDonald’s work in Turkey. They were commissioned as the lenders’ Technical Adviser Services and lenders’ Environmental Adviser Services in relation to the financing of an Integrated Health Campus in Turkey at an approximate project value of €440m. This is a PPP project run by Turkey’s Ministry of Health with support from the World Bank. Mott MacDonald explain their role as follows:

‘[Mott MacDonald] will undertake due diligence on behalf of the lenders to assess the capabilities and experience of the consortium stakeholders as well as the consortium’s design, planning and construction, facilities and lifecycle management proposals. Once ensured that the contractual arrangements and agreed risk allocation are in line with international PPP best practice standards and the requirements set out by lenders, Motts will provide construction and operational monitoring services on the project.’(93)

4.6 Standards

A recent RICS report on future trends, *Our changing world: let’s be prepared*, notes the importance of standards. Expert workshops for the report found that professionals in the built environment ‘noted the importance of standardisation not only in working environments and professionalism, but also with respect to benchmarking projects.’(94) This included infrastructure and other construction projects.

There are multiple standards relevant to sustainable urbanisation and smart cities, such as:

- The UN Sustainable Development Goals
- ISO 37120:2014 Sustainable development of communities – Indicators for city services and quality of life
- PAS 180:2014 Smart Cities Terminology
- PAS 181:2014 Smart Cities Framework
- PAS 182:2014 Smart Cities Data Concept Model
- PD8101:2014 Smart cities – Guide to the role of the planning and development process

The United Nations has recently published the new Sustainable Development Goals which will build on the Millennium Development Goals as a framework for countries to use in setting priorities, policies and investment. There are 17 goals and 169 targets that integrate the cross-cutting nature of sustainable development requirements. Goal 11 ‘Make cities and human settlements inclusive, safe, resilient and sustainable’ is particularly relevant for this report.(95) The UK and multiple other countries are involved in developing these goals.

ISO is the International Organization for Standardization and it is independent, non-governmental and the largest voluntary standard developer. ISO 37120: 2014 is being used internationally to help cities compare their performance on key indicators.(96)

The British Standards Institute (BSI) received funding from the Department of Business Innovation and Skills to create a Smart City Framework (PAS 181) that encourages cities to develop new systems and integrated governance arrangements. The Smart City Framework focuses on ‘the enabling processes by which innovative use of technology and data, coupled with organizational change, can help deliver the diverse visions for future UK cities in more efficient, effective and sustainable ways.’(97) The BSI Smart



Cities standards approach the term ‘smart cities’ from a wide definition: ‘effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens’.(98)

The British Standards on Smart Cities offer a great opportunity for UK companies to sell capabilities and demonstrate a track record internationally. Expert stakeholders noted that the UK is working to have these accepted as international standards through ISO. It was also noted that there is interest in China in applying the PAS Smart City standards and that BSI and China have a common recognition of standards. Workshop participants suggested that this recognition of standards could be expanded to other countries to facilitate greater export of British products and services.

There are UK companies and organisations helping to develop the standards further to demonstrate their value. The Cambridge Centre for Smart Infrastructure and Construction (CSIC), represented by Jennifer Schooling at the expert stakeholder workshop, is trialling the PAS 182 standard on an engineering project at London Bridge Station involving multiple sensors in different locations. This project involves Network Rail and Costain. The CSIC is jointly funded by the Engineering and Physical Sciences Research Council (EPSRC), Innovate UK and private sector partners.

Existing sustainable building standards provide a competitive edge for UK companies. The UK’s most widely used standard for buildings and masterplans is BREEAM (Building Research Establishment Environmental Assessment Method). Multiple building types and community-scale developments can be assessed through several life-cycle stages (including design stage for new buildings, in-use assessment of existing buildings and refurbishment of older buildings). BRE has trained and qualified over 2,000 assessors from many built environment professions and companies. Assessors usually work for companies that are providing other consultancy services on the development such as design and engineering. This model means BREEAM standards help British suppliers export upstream consultancy services and can help pull through suppliers further down the supply chain. See section 3.4 for more information).

4.7 Data and Information Technology

4.7.1 Efficient city services through technology

The Future City Demonstrator programme run by Innovate UK, previously the Technology Strategy Board, raised awareness of technology driven solutions that improve the efficiency of city services (see section 2.2.1). These technologies could be about smart and efficient lighting, transport or other infrastructure. It can also be about improving the relationship between people in cities and the city council or service providers.

For example, a London-based company called mySociety has created an app for councils to manage notifications from the public about road issues. The app is called FixMyStreet and the London Borough of Barnet was an early adopter.(99) Barnet used the app to help people avoid slow customer service processes and feel that they were directly accessing up-to-date information. People in Barnet can report problems like potholes, broken lights and fly-tipping. This changes the relationship with citizens and the council into being more positive and transparent. Many councils in the UK now use this app or similar products. The app is built with an open source code that anybody can download from mySociety.org and use wherever they live in the world.

4.7.2 Open data

The Open Data Institute (ODI) was founded in 2012 by Sir Tim Berners-Lee and professor Nigel Shadbolt to help government and business identify and use valuable public data.(100) Since then, the institute has worked in the UK and internationally for organisations such as: the European Commission, World Bank,



United Nations Development Programme, the Department for Environment, Food and Rural Affairs (DEFRA), Mexican Government, Arup, the British Broadcasting Corporation (BBC), Thomson Reuters, and the Met Office.(101)

Cities are increasingly looking to use data to enhance city services (as highlighted previously in this report). The ODI is working across the public and private sector to help start-ups and other organisations to get value out of open data. Their June 2015 report, *Open data means business: UK innovation across sectors and regions*, highlights the value of this new sector: 'The open data companies we studied have an annual turnover of over £92bn, and over 500k employees between them'.(102) The report highlights the following companies using open data that are particularly relevant to cities:

Doorda is a leading open data site which offers free instant access to reported crime, road accidents, restaurant hygiene scores, property prices and more. It covers the whole of the UK and the site is updated daily. Users can explore their local neighbourhood using official government open data. The company provides that is free to access as well as commercial solutions.

Shoothill creates online mapping and data visualisation solutions. An example project involved integrating flood risk data from the Environment Agency in web-based street maps.

OpenSensors.io provide sensor technologies and allow clients to decide whether to publish data with an open data license or keep it for private use. They provide the components needed for real time data access, security, storage, data analytics and machine learning.

Swirrl were asked by The Department for Communities and Local Government (DCLG) to create a linked open data site that is easily accessible and understandable. OpenDataCommunities.org contains a large number of datasets that can be fully browsed and queried. Users can create applications with the data using a tool on the site. They also have good visualisations (like the local authority dashboard) which provide an easy way to access the data for non-technical users.

TransportAPI pulls together transport data from multiple sources (including timetables, routes, and live running and performance history) about multiple transport modes allowing for the creation of new transport-related products and services.

4.7.3 Gaming

Gaming programming techniques are being use in software technologies that are not for leisure purposes. For example, Coventry's Serious Games Institute creates 'serious games' that are used for learning in multiple sectors. Their upcoming conference website states:

'Serious games have seen an exponential growth as means to help students enhance competences, skills and overall learning experience. In particular, the advent of serious games in Higher Education is perceived as a novel approach for promoting student-centred approaches to teaching and learning through the interactive, immersive and motivational game dynamics included in such games.'(103)

The University of Bolton's Centre for Educational Technology, Interoperability and Standards has recently announced its partnership in the RAGE (Realising an Applied Game Eco-system) project. This is a €9m EU funded Horizon 2020 project that will help increase knowledge in Europe's applied games industry. The press release states:

'The EU based industry for non-leisure games – Applied Games – is an emerging business with multiple uses in industry, education, health and the public administration sectors. As such, it is still



fragmented and needs critical mass to compete globally. Nevertheless its growth potential is widely recognised and even suggested to exceed the growth potential of the leisure games market.’(104)

Improbable is a company based in East London using gaming and other programming techniques. They are building a virtual world that would test city growth and management options based on the combined knowledge of physicists, economists, software developers and others. Their website states:

‘Improbable is developing an operating environment that makes building simulated worlds possible. Worlds which can be run in real time, simulating the behaviours and interactions of millions of entities. Spaces with their own rules and properties that a multitude of people can simultaneously change, explore and visualise in as many different ways as developers can imagine.

Simulated worlds provide unique insight to those asking questions of complex systems. As well as enabling completely new experiences in gaming, simulated worlds can solve significant problems in areas as diverse as defence, energy, city efficiency, health, and finance.’(105)

4.8 Research and innovation

Research activity related to urban systems and technologies is growing and increasingly drawing on multi-disciplinary working within and across academic departments and universities. The complexity of city systems has emerged as a key theme in these research activities. A Future Cities Catapult report, *Connecting Research With Cities: Mapping the UK's research landscape on urban systems and technologies*, compiled by the Urban Systems Laboratory at Imperial College London highlights a large number of research programmes and institutions across the UK.(106) A selection of these include:

- **Liveable Cities** (liveablecities.org.uk/) a collaboration between Birmingham, Lancaster, Southampton and University College London which seeks to create an integrated city analysis methodology.
- **Centre for Sustainable Development** at the University of Cambridge (www-csd.eng.cam.ac.uk/) looking at the social and environmental aspects of urban infrastructure and services.
- **Urban Big Data Centre** at the University of Glasgow (urbanbigdatacenter.wordpress.com/8-2/) researching methods and technologies to manage, link and analyse big data.
- **Intel Collaborative Research Institute in Sustainable Connected Cities** (www.cities.io/) a collaboration between Imperial, UCL and Intel using computer science and human centred design techniques to create new urban systems and services.
- **LSE Cities** at the London School of Economics and Political Science (www.lse.ac.uk/LSECities/home.aspx) researching city governance and how the design of cities impacts society, culture and the environment.
- **Centre for Applied Spatial Analysis (CASA)** at University College London (www.casa.ucl.ac.uk) focused on simulation, spatial data and visualization.

There are many more programmes and new initiatives continue to emerge. Powered by UCL, The UK Collaboration for Research in Infrastructure and Cities (UKCRIC) secured in principle up to £138 million of funding of infrastructure research, drawing upon knowledge, tools and methods from a variety of disciplines.

Brian Collins, Professor of Engineering Policy at UCL, STEaPP, is leading the project, initially bringing together 13 UK partners, from major university-based infrastructure, civil and construction engineering research groups, helping to obtain the funding.



UKCRIC has presented four different scenarios for funding allocation, which have to be confirmed. These include investment in capital equipment and facilities, a national 'observatory' and living laboratories for testing of potential systems, a multi-level modelling and simulation environment that will allow high-performance speculative computational experimentation, and a Coordination Node (CN) for coordination of UKCRIC activities and industry collaboration.

With dynamic global development, it is important that transport, water, waste, energy and ICT systems are able to support the functioning and welfare of society, hence infrastructure research is paramount in delivering viable systems. The UKCRIC initiative will help to cement growth in the UK's research capabilities and subsequent societal impact.(107)

Innovation and joint research and development with academia and business has been encouraged and supported through BIS and its innovation agency, Innovate UK. Innovate UK's Five Point Plan sets out a roadmap for how the agency will help maximise innovation activities to support economic growth in the UK. This includes working with the national catapults (such as the Future Cities Catapult, Digital Economy Catapult, Transport Systems Catapult and others), investing in innovation excellence and working with the research community.(108)



5. City typologies and export markets

Different types of cities will have different needs from UK companies on the journey to low-carbon and sustainable cities. There are several city typologies with similar growth patterns and infrastructure requirements that can help UKTI staff understand which services may be most appropriate in a given city or region.

5.1 City typologies

An LSE Cities report *Cities and the New Climate Economy: The Transformative Role of Global Urban Growth*, describes three broad types of city typologies globally: emerging cities, megacities, and mature cities. These consist of just under 500 cities which will contribute to over 60% of global income growth, and more than 50% of energy-related greenhouse gas emissions growth from 2012 to 2030.(2) Sections 5.1.1, 5.1.2 and 5.1.3 are summarised from the report to give UKTI a picture of these city typologies. More detailed information is available in the LSE report.

An additional city typology, declining cities, is also described in this section, although very few cities will fall into this category. Figure 1 shows these four city typologies with some key defining characteristics.

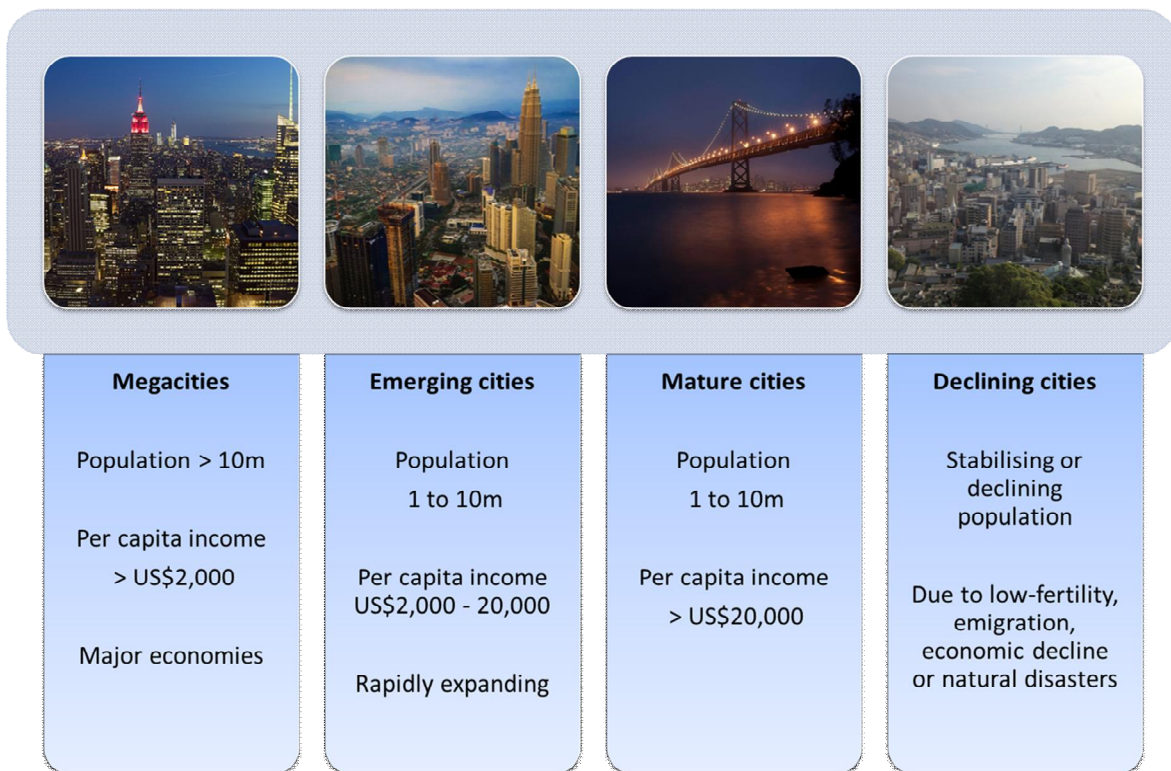


Figure 1 - City typologies, left three from reference (2) and far right from reference (109) . Photos (L to R): NYC by Nicolas Vollmer, Kuala Lumpur by Luke Ma, San Francisco by Dawn Ellner, and Nagasaki by Kouki Kuriyama.



5.1.1 Megacities

Megacities are defined as dominant economies that hold populations of over 10 million and per capita income of more than US\$2,000 (£1300).(2) In 2014 there were a total of 33 global megacities including: Delhi, Beijing, Shanghai, Bangkok, Rio de Janeiro, Mexico City, Jakarta, London, New York and Tokyo. However, only one in eight of the global urban population reside in megacities.

The megacities group is characterised by the LSE research as attracting population growth in the city core and periphery and having services based economies (financial, business and other). These cities benefit from agglomeration effects and are international leaders in innovation. These cities have significant carbon footprints and there is high potential to implement reduction strategies and technologies here.

5.1.2 Emerging Cities

Emerging Cities are defined as rapidly expanding medium to large, middle income cities, with populations of between 1 million and 10 million, and per capita incomes between US\$2,000 and 20,000 (£1300 to 13000).(2) Many are found in China, India, and other significantly growing economies. The following characteristics of 'Emerging cities' are noted in the LSE Cities report (2):

- There are just under 300 emerging cities globally, such as Kunming, Ulaanbaatar, Pune, Puebla and Kuala Lumpur.
- Rapid urbanisation during the coming two decades is expected within these cities, accounting for a greater proportion of global economic growth (15%) and carbon emissions than any other city type.
- An example of the growth in 'Emerging Cities' is Chennai in India – estimated to grow by nearly 4 million by 2030 and 14 cities in China will grow by 1 million or more.
- The majority of these emerging cities are likely to be high-growth industrial economies, which will need heavy infrastructural investments. The industry will be valued at US\$11.2 trillion in these emerging cities by 2030, accounting for 44-49% of their economies.
- Other sectors are also set to grow such as transport, storage, information and communications (by 5.9%), financial and business services (by 6.3%), consumer services (by 6.1%) and public services (by 5.4%).

5.1.3 Mature Cities

Mature Cities are defined as medium to large cities with populations between 1 million and 10 million, and are higher income cities with per capita income levels in excess of US\$20,000 (£13000).(2) These are the core regional economic networks in countries within North America, Western Europe and OECD countries elsewhere. Globally there are 144 Mature Cities, such as Hiroshima, Stuttgart, and Minneapolis. During the coming two decades, it is expected that population growth will be comparably low, accounting for just 4% of global urban population growth. However shifts in urban challenges and opportunities are still expected to occur, resulting from the rise and decline of populations, and will still hold importance in the global economy.

The following characteristics of Mature Cities are noted in the LSE Cities report (2):

- The contribution of mature cities to global economic growth will be significant, with a resulting 26% of global GDP and 15.5% of global energy-related carbon emissions, accounting for the greatest per capita emissions of any city typology. Although carbon emissions in mature cities are high, growth in mature cities is expected to be comparatively low at 4.3%.



- Examples of mature cities include economically inactive cities such as Turin, Detroit and Cleveland, as well as the key leaders in innovation such as San Francisco, Stockholm, Copenhagen, Portland, Singapore.
- Between 2012 and 2030 Hong Kong and Seattle's economies are expected to grow beyond 70%, whereas over the same period the maturity of Cleveland has given annual growth projections of less than 1.5%, and Turin's expected growth at a mere 0.4%, due to rising worldwide competition, especially from emerging cities.
- Although varying between cities, generally high growth rates are expected of all significant sectors within mature cities, such as annual transport, storage, information and communications (3%), financial and business services at (2.8%), consumer services (2.4%) and public services (1.7%).

5.1.4 Declining cities

The 2014 United Nations *World Urbanization Prospects* report describes declining cities as those that are experiencing stabilising or declining populations, in particular in low-fertility countries of Asia and Europe. Examples of declining cities are Nagasaki in Japan, and Busan in South Korea. Some cities in Russia and Ukraine experienced population decline between 2000 and 2014. Capital cities are also not immune to dwindling numbers: Bratislava, Slovakia; Riga, Latvia; Sarajevo, Bosnia and Herzegovina; and Yerevan, Armenia have all seen a reduction in population, resulting from emigration, economic decline and natural disasters, as seen in a New Orleans following Hurricane Katrina in 2005.(109)

The UN *Prosperity of Cities* report highlights that declining cities are often a result of economic 'decay':

'population declines in a number of cities in Eastern Europe and the United States of America are strongly associated with economic decay. The loss of economic momentum in Cleveland, Detroit and Buffalo (homes to the USA's declining automobile, steel and heavy industries, respectively) and the deterioration of inner city conditions (deserted residential areas and crumbling infrastructure) have all gone hand in hand with population declines.'(6)

In the UK, some cities have not moved into a post-industrialisation knowledge-based economy and may not be able to for circumstances such as location and quality of life to attract skilled workers. In these cities 'a programme of managed contraction with environmental improvements, as was undertaken in East Germany, may be necessary, together with increased connectivity to larger, more dynamic cities.'(110)

5.2 International opportunities for UK companies

The biggest sustainable urbanisation projects identified by the expert stakeholder workshops appear to be in Asia (especially China), South America, the Middle East, Africa and India. This section lists opportunities identified through UKTI, workshop participants and desk-based research by regions.

RICS report that the Oxford Economics and Global Construction Perspectives have forecast 70% growth in construction output by 2025 to US\$15tn, with seven countries accounting for 72% of the growth, including: China, India, Indonesia, Russia and Mexico.(94) Furthermore, the report states that China and India are estimated to contribute a third of global construction output.

5.2.1 Asia

The UKTI report, *Smart Cities Of The Future In Asia: The Opportunities For UK Business*, outlines a number of opportunities across themes including: buildings & environment, digital media, education, energy, health and transport.(111) Given that this report was published in 2012, it was not reviewed in detail for this report but may provide useful insights about the Asian market.



The Environmental Industries Commission is the UK membership organisation for businesses operating across environmental markets (water, waste, pollution, renewable energy, etc.). They have identified the Chinese market as a strong opportunity for UK businesses with the following statement on their website:

- 'The global environmental technology and services market is worth \$5.4trillion, and China is well on the way to becoming the biggest country market, with \$473billion committed to environmental protection over the next four years.
- We believe the UK environmental industry should be a major player in the Chinese market. To support this, we have negotiated a formal Memorandum of Understanding with the Chinese Society for Environmental Sciences (CSES), a body which is part of the Chinese Ministry of the Environment. This MoU sets up a process for EIC members to engage directly with senior Chinese officials to develop commercial opportunities to provide environmental technologies and services in China.'(76)

Waste: The UKTI Water and Environment Unit list the Asia Pacific region as dominant because of the gradual industrialization and rapidly increasing waste management requirements across developing economies such as China. Asia Pacific is expected to present significant market potential because of its growing waste volume generation and increasing treatment needs due to the current low availability of waste treatment installations.

Water: BIS report that huge growth in the smart water sector is predicted in Asia and China in particular. They note that this high growth is 'due to their low starting point in using technology and the huge scale of development anticipated in China's tier 2 and 3 level cities.'(16) Emphasis is on wastewater treatment and improving drinking water supplies throughout China. China are encouraging foreign investment in city utilities to improve efficiencies and reduce costs.(16)

Energy: The smart grid market in China is expected to grow to \$15 billion by 2016 and by 2020 China will be the single largest market for smart metering and smart grid investment.(16) The Japanese market for home energy management systems is expected to reach \$2.3 billion by 2016. China is undertaking significant improvements to its energy supply system, moving away from nuclear power toward renewables.(16)

Health: Healthcare UK, listed China and Hong Kong as focus areas.

Transport: The UKTI rail team is targeting high value rail opportunities in Southeast Asia, Vietnam, Taiwan, Hong Kong, and Thailand. The Ministry of Transport estimates that there will be over 200 million vehicles in China by 2020, which means that China requires a more intensive use of smart transport technologies to optimize the traffic network and achieve lower-carbon emissions.(16)

5.2.2 South America

In Brazil there are many opportunities but a strong indigenous supply capability. UK companies will need to establish a presence in the market or form strategic alliances with Brazilian companies to win business. A BIS report states: 'The Brazilian Government is keen to attract investment in PPPs and sees this as a stimulus to the country achieving the infrastructure development needed over the next two decades. Brazil's legal framework for Brazilian PPPs provides opportunities for UK environment and water companies and their professional advisers and lenders.'(16)

Affordable and liveable housing provision is a key challenge throughout all of Latin American, with the average liveable space in the regions cities of just 15 square meters per person.(112) Throughout the region, infrastructure needs including homes, sewage, water, gas, and electricity, will add up to



investment requirements of almost \$400 billion in five of the largest cities and more than \$3 trillion in Latin America.(112)

Water: BIS state: 'A 2011 report by UKTI reported that increased government funding and changes in policy by the Brazilian Government in the water industry has encouraged companies in Brazil's water and sanitation sector to look at partnering opportunities on applicable technologies and products as a way of bringing in technology whilst minimising risk and capital investment.'(16)

Waste: Brazil has significant waste management issues with reliance on informal waste collectors for disposal and recycling. BIS summarise UKTI advice on helping Brazil overcome their waste challenges: 'For UK companies seeking to do business in Brazil, UKTI advises that these companies should focus on exporting expertise and technology that is not available in Brazil. For lower-end solutions, UK firms should consider some form of joint venture, partnering with NGOs for design consulting advice.'(16)

Health: Healthcare UK, listed Brazil as a focus area.

Transport: The UKTI rail team is targeting high value rail opportunities in Colombia.

5.2.3 Middle East

Health: Healthcare UK, listed Saudi, UAE, Kuwait, and Oman as focus areas.

Waste: The Water and Environment Unit at UKTI reported on international opportunities in the Waste sector: 'Revenue in the Middle East and Africa (MEA) region is expected to grow due to large investments in Northern African and Middle Eastern countries.' BIS also highlights this market as a significant opportunity for UK companies: 'The Gulf market offers more opportunities than the markets in developed regions. The scale of the projects in the Gulf States creates substantial prospects.'(16)

Transport: Qatar, Abu Dhabi and Dubai have invested significantly in intelligent transport in recent years and are likely to continue investment in this area.(97)

5.2.4 Africa

Africa has a significant appetite for innovation and is able to completely skip some of the centralised infrastructure that can be slow to develop. Expert stakeholder workshop participants raised a concern about working in Africa. Clients are requiring that the individual specialists live in the country where the work is taking place throughout the duration of the project. This is a barrier to winning projects in these countries because even the large consultancies cannot afford to have their most senior experts on one client project for several years.

5.2.5 India

In India the 100 Smart Cities commitment could be a good opportunity for UK companies but ultimately will depend on secure financing and clarity on the international accessible value on tenders relating to individual city development.

Energy: India's smart grid market is set to reach \$1.9 billion by 2015. They are ranked as the third largest market for smart grids with an expected installation of 130 million smart meters by 2021. BIS note that they are predicted to leapfrog technology as they develop their smart energy grid as there is a current lack of energy infrastructure supplying households. (16)

Waste: Waste management is a significantly underdeveloped sector in India. BIS report that 'open dumping is prolific and the environmental and human health impacts associated with this are endemic' They also note that there are significant opportunities for UK business to offer waste management services to India.(16)



5.2.6 North America

North America was not identified by stakeholder workshop participants, but does have high value opportunities as identified by UKTI.

Transport: The BIS 2013 smart cities report identifies increasing investment for smart transport systems. 'The U.S. Department of Transportation's (US DOT's) Intelligent Transportation System (ITS) Program aims to bring connectivity to transportation through the application of advanced wireless technologies that enable transformative change. Increasingly, funding investments by the Federal Government in the U.S are targeted at major initiatives that have the potential for significant payoff in improving safety, mobility and productivity. The main focus has been on the integration between vehicles and infrastructure and between modes of transportation.'(16)



6. Finance and procurement

6.1 Funding options

Infrastructure improvements and development represent a significant cost to developed and developing countries. The OECD *Infrastructure to 2030* reports (volumes 1 and 2) highlight the importance of functioning infrastructure to local economies stating that it is ‘a means for ensuring the delivery of goods and services that promote prosperity and growth and contribute to quality of life, including the social well-being, health and safety of citizens, and the quality of their environments.’⁽¹⁵⁾ The report emphasises that the long-term performance of OECD countries and the global economy is largely dependent on adequate infrastructure to support and sustain growth.

A large portion of investment in infrastructure will take place in rapidly developing countries such as China, India and Brazil. A recent RICS report discusses the growing role of BRICS countries and new funding mechanisms:

‘The New Development Bank (NDB) to be based in Shanghai could play a leading role in increasing the influence of these nations by acting as a competitor to the International Monetary Fund (IMF) and World Bank, providing capital for infrastructure projects to developing countries.’⁽⁹⁴⁾

OECD countries will also need to heavily invest in upgrading and replacing ageing infrastructure to maintain international competitiveness: ‘through to 2030, annual infrastructure investment requirements for electricity, road and rail transport, telecommunications and water are likely to average around 3.5% of world gross domestic product (GDP).’⁽¹⁵⁾

The OECD report outlines forms of financing for infrastructure and suggests that beyond additional financing measures a combination of approaches will be necessary, including: more efficient and intelligent use of infrastructure, demand management, and changes to regulation and planning. Public sector finances are unlikely to be able to cover the rising cost of infrastructure maintenance and development. Public-private partnership models (PPPs) and private sector capital from pension funds and insurance companies offer potential finance options. Ernst & Young report that ‘infrastructure funds and pension funds are expected to invest more in infrastructure, as investors focus on alternative assets for diversification or potentially higher returns.’⁽¹¹³⁾

Public-private partnerships include a range of business structures and partnership arrangements such as private finance initiative (PFI), joint ventures and outsourcing arrangements.⁽¹¹⁴⁾ Since the term PPP is used to encompass such a diverse range of initiatives, it can be difficult to evaluate internationally. The Royal Institution of Chartered Surveyors, University of Ulster and University of Aberdeen undertook such an analysis and reported on the findings in *The Future of Private Finance Initiatives and Public Private Partnership*. This report explains how PPPs have been implemented in multiple countries and the associated benefits for infrastructure delivery in terms of value for money (efficiency, risk transfer and whole life cost). However, it cautions that PPPs ‘are not a panacea for the global infrastructure investment challenge, nor are they a replacement for publicly funded procurement.’⁽¹¹⁴⁾ Traditional procurement models have limitations that PPPs can help overcome, particularly through bespoke PPP models that adopt lessons learned from earlier approaches.



6.2 Procurement

The expert stakeholder workshop noted some significant challenges with the procurement processes of countries in rapidly urbanising countries. Clients can be too prescriptive about the solutions they want for urban challenges. UKTI and UK companies could help the client to re-define the question so that it addresses broader sustainability issues and is more focused on specifying an outcome rather than detailed solutions. One example was given of a procurement brief in Singapore for a public transport system. The outcome-orientated brief requested that the provider create a public transport system that meant that all residents would live within a ten minute walk of a transport node and a thirty minute commute to work. This clearly specified the outcome rather than the solution. A similar procurement style has been used by the City of Gothenburg in Sweden where city officials have challenged housing developers to create new business models that would allow them to deliver affordable housing on a large new regeneration project near the city-centre.(115)

Some workshop participants noted that cities are seeking to differentiate their offer and compete globally which can result in the procurement of unsustainable infrastructure projects (such as extremely large motorways). These projects are designed to showcase the city's wealth and economic growth rather than meet local needs in a sustainable way.

This challenge was also noted on some water or waste infrastructure projects in developing countries. In reference to the suggestion that UKTI could help constructively challenge client's procurement briefs, one participant urged the workshop participants to not be too judgemental about the long-term sustainability issues of certain projects. Given the significant public health issues with lacking sanitation and waste infrastructure, there may be times where the most sustainable solution for the country is to prioritise these projects regardless of other environmental considerations. All participants thought it would be useful for UKTI to facilitate a conversation with city leadership to understand why they want what they want.

Some significant risks were raised during the stakeholder workshops regarding barriers to working internationally. If companies bid for a small piece of work that is intended as a pre-study or feasibility analysis there is a risk that they will not win the larger piece of work that follows. This means that the company may be giving away information in the shorter piece that is later exploited by another company. This creates a certain risk aversion for these smaller pieces of work. However, this risk can be balanced by the potential opportunity to demonstrate to the client the potential for the project gaining the credibility needed to win the larger project.



7. Recommendations

This section of the report outlines several ways that UKTI can support and promote UK businesses leading on sustainable urbanisation and its sub-sectors. The recommendations were gathered through the expert stakeholder workshops. UKTI plays an important role in showcasing British expertise and export offers on sustainable urbanisation. The best method for marketing the UK's services will, of course, depend on the client's needs and may benefit from the integrated 'sustainable urbanisation/smart cities' approach or may require a more specific sector-led response.

7.1 Showcase British expertise at international events

In planning the UK Pavilion at the Smart City Expo World Congress 2014 in Barcelona, the UKTI Smart Cities Team took advice from key stakeholders that using UK cities themselves to promote UK smart capability would be the most successful approach. By profiling smart projects and programmes taking place in the cities represented, this provided an almost impartial practical means for showing what the UK could deliver. It would be helpful if this could be adopted more widely. Cities and businesses benefited from sharing their experiences and won new work at the expo.

7.2 Highlight UK success stories and lessons learned

Workshop participants suggested responding to potential clients with examples of where the UK has solved a similar problem in the UK and internationally. Case study examples in this document can be used for that purpose. Participants also emphasised the importance of respecting local knowledge and not assuming that a UK approach to sustainable urbanisation will be appropriate in all countries and locations. The list of case studies on page 6 provides information on the range of topics covered in this document.

7.3 Promote UK education and training

The UK is very strong at educating foreign students in a wide variety of sustainable urbanisation professions. These students usually return to their home country with a strong opinion of UK expertise and become advocates of British companies. The BRE Academy runs courses on sustainability issues internationally (including China, Mexico and the Middle East) and serves as a good gateway to British services through the specification of standards like BREEAM. Companies like Space Syntax have teamed up with local education providers in China to train local designers on the use of the Space Syntax software and methodology (see Appendix C). This often results in Chinese companies requesting work from the UK Space Syntax team to provide more detailed expertise.

7.4 Segment the city market

If UKTI were to create a marketing brochure or publication it would be useful to segment the market in terms of mature cities and new cities. A series of relevant case studies could be used to showcase the role of UK companies and cities in achieving sustainable outcomes on major infrastructure and development projects. Bespoke versions of a brochure template with relevant themes and case studies could be used to respond to specific client needs.



8. Leading experts

UKTI requested suggestions for leading experts who could contribute to thought leadership on sustainable urbanisation. The following individuals are leading in their subject areas and can represent the UK's strengths on sustainable urbanisation. The biographical information is quoted or paraphrased from organisation websites or LinkedIn (links provided) or sourced directly from the individuals listed.

Amanda Clack

Amanda Clack MSc BSc FRICS FAPM CCMi FIC CMC Affiliate ICAEW FRSA. Amanda is the President Elect for the Royal Institution of Chartered Surveyors (RICS), the world's largest global professional body in land, property and the built environment: operate as an ambassador and leader. Amanda will become RICS President in 2016. Amanda is the RICS Global Lead on Infrastructure.

She is a Partner at EY where she is the Head of Infrastructure (Advisory).

With 29 years consulting experience in business transformation, change management and programme management (delivery, governance and assurance). Amanda is a senior property professional qualified specialist in real estate, infrastructure and construction.

Formerly Amanda was a Partner in PwC, where she led the consulting business across the south-east of England with mid-market FTSE250 clients that have both a UK and global footprint. Amanda established the Portfolio and Programme Management Competency for PwC and was the Partner responsible for the 3rd and 4th PPM Global Surveys Reports.

Amanda is an experienced public speaker.

Alan Couzens

Alan is currently head of the Government's major infrastructure tracking and performance team, including the ongoing Infrastructure Cost programme, launched in 2010. He is responsible for reporting to Ministers on delivery of the Government's priority infrastructure programme and National Infrastructure Plan. He also provide ongoing commercial support across the Government's priority infrastructure projects and programmes. He has previously been a Commercial Advisor to High Speed Two (HS2), Project Director of Partnerships UK (providing commercial and transaction support to a range of PFI and joint venture PPPs), Associate Director of CBRE and Director at Landmark. He is a Fellow of the Institute of Civil Engineers.

<https://www.linkedin.com/pub/alan-couzens/2a/b03/b74>

Beth West

Beth is currently Commercial Director for High Speed Two (HS2) and a member of the Governing Body of the National College for High Speed Rail. Beth is responsible for directing HS2 Ltd's work on issues including: land and property, policy approach, integrity of procurements, contracts, partners and stakeholders, development and implementation of modelling and analysis, and a project investment model. She is also the lead commercial spokesperson. She was previously Head of Commercial Thames Tunnel at Thames Water, Commercial Director for Tube Lines, Head of Commercial Procurement at London Underground for Transport for London, Head of Commercial Advisory & Risk at London Underground for Transport for London, and has held numerous other roles in the sector.

<https://www.linkedin.com/pub/beth-west/0/579/44a>



Professor Brian Collins

Professor Brian S Collins CB, FEng, FBCS, CITP, FIET, C Eng, FIOP, FICE, FRSA, RCDS, MA, DPhil
Over the past 30 years, Prof Brian S Collins has held senior leadership posts in UK government, corporate, philanthropic, and academic institutions, all centred around the interface of science and engineering knowledge and expertise with public policy.

Between 2006 and 2011, Brian served as Chief Scientific Advisor (CSA) to two government Departments (Transport 2006-11; Business Innovation and Skills 2009-11. Brian was also a member of the cross-government Chief Scientific Advisers Council (convened by the Government Chief Scientific Advisor), which has responsibility for issues including (but not limited to): national infrastructure; adaptation and mitigation to climate change; national reaction to extreme events; engineering, systems and technology innovation; the role of space in the UK economy; cybersecurity; and energy conservation in transport.

Brian's CSA service followed from a distinguished career as both a leading scientist within the UK's military and intelligence research community (1987-91 Director of Science and Technology at Government Communications Head Quarters; 1973-85 Royal Signals and Radar Intelligence, leaving as Deputy Director), and information and communication technology leader within the corporate and philanthropic worlds (1999-2002 Global CIO at Clifford Chance; 1994-1997 IT Director for the Wellcome Trust).

Brian is Director of the International Centre for Infrastructure Futures (ICIF) and is Co-Investigator of the Liveable Cities project. He regularly speaks at international events on cities, infrastructure, digital economy, cybersecurity, complexity and governance.

<https://www.ucl.ac.uk/steapp/people/collins>

Chris Murray

Chris took up post as Director of the Core Cities Group in 2006. Prior to this he has had a long association with economic development, regeneration, culture and public policy.

A member of the Egan Task Force on Skills, during 2005 Chris was seconded to the Office of the Deputy Prime Minister to establish the Academy for Sustainable Communities, a national regeneration skills agency based in Leeds. In 2002 he was appointed as a Director of the Commission for Architecture and the Built Environment. Before this Chris worked in local government for 10 years, establishing the UK's first local authority cultural planning unit in Milton Keynes, responsible for economic, cultural and some urban development in the new town and outlying rural areas.

He has worked in education, community work and as a psychiatric social worker. Chris holds qualifications in art and design, teaching, business and marketing and European cultural planning.

Outside of Core Cities, Chris is also Chair of leading social enterprise company Fusion21, an intelligent procurement organisation that recycles profits into training unemployed people and helping them into work.

He writes and presents extensively on a number of subjects connected with his work and broad interests, and has published one book and contributed to a number of others. He was Lead Advisor to the Arts Council of England on regeneration and sustainable communities, ran a working group for the Department of Culture Media and Sport on the future of the Creative Economy, and was for several years a Trustee of a public arts charity.

<http://www.corecities.com/about-us/people/central-staff/director-chris-murray>



Corinne Swain

Corinne Swain, OBE, MA(Cantab), MPhil, FRTPI is a former Director and Head of Planning at Arup, and now holds an Arup Fellowship focussing on knowledge sharing and research. She has established a strong personal reputation on strategic policy issues and planning procedures, at the interface between economics, demographics, transport, environment and urban design from a career spanning nearly 40 years. She has been a member of government advisory committees on planning research, transport, property and professional standards, has recently contributed to the government's Land Use Futures Foresight project, and is currently a member of the Mayor's Outer London Commission.

Corinne is currently one of 8 lead experts steering the UK Government's Foresight Future of Cities project. Also member of the Mayor's Outer London Commission, the National Planning Forum, the TCPA Policy Council and the RTPI English Policy Panel.

She has extensive experience in facilitating debates, including on sustainable design and construction for BRE in late 2011, on Sustainable Cities for the Cambridge Programme on Sustainable Leadership in 2009, and on climate change at the national Sustainable Communities Summit in 2008.

Between 1999 and 2010, she chaired 11 examinations in public to test draft regional spatial strategies throughout England on behalf of the Planning Inspectorate. She sought to capture this experience and that of other regional practitioners by co-authoring a book, English Regional Planning 2000-2010: Lessons for the Future, published in July 2012.

<http://www.birmingham.ac.uk/research/impact/policy-commissions/future-urban-living/commissioners/corinne-swain.aspx>

Isabel Dedring

Isabel Dedring is currently Deputy Mayor, Transport at the Greater London Authority. She spent five years at Transport for London as Director, Policy Unit and before that as Chief of Staff to the Transport Commissioner. Isabel has also worked for McKinsey and Ernst and Young. She has degrees in law from Harvard and is a qualified lawyer in the US. She is fluent in German, Russian and French.

Isabel was previously Environmental Advisor at GLA and according to Wikipedia oversaw the following policies and projects: Re:New (a home retrofit programme to cut energy bills and carbon emissions); the Mayor's Electric Vehicle Delivery Plan; new investment in green infrastructure a £114m London Green Fund (using public sector investment to catalyse private investment in London's low carbon economy); Low Carbon Zones (10 communities across London committed to deliver 20.12% carbon reductions by 2012); Re:Fit (a public sector building retrofit programme); and four statutory environment strategies (energy, waste, adaptation, air quality).(116)

<https://www.london.gov.uk/mayor-assembly/mayor/isabel-dedring>

Paul Morrell

Paul was Government's Chief Construction Advisor from 2009-12. He was previously a Senior Partner at Davis Langdon (now AECOM). 'He was a founder member of the British Council for Offices, a Fellow of the Royal Institution of Chartered Surveyors and Honorary Fellow of the Royal Institute of British Architects. He also served as a commissioner on the UK's Commission for Architecture and the Built Environment (2000–2008; also serving as deputy chairman). In the 2007 Building Awards, he received the Award for Outstanding Contribution to the Construction Industry. He was appointed OBE for services to architecture and the built environment in the 2009 New Year Honours list.'(117)

'Paul led the UK Government, Innovation and Growth Team, that produced an influential report, Low Carbon Construction published in November 2010. He was also the instigator of the Government



Construction Strategy (published in May 2011) which, echoing the earlier Latham and Egan Reports, told the sector to work more collaboratively and to use information technology – notably building information modelling (BIM) – to support the design, construction and long-term operation and maintenance of its built assets.’(117)

<https://www.linkedin.com/pub/paul-morrell/13/ab9/842>

Peter Bonfield

Dr Peter Bonfield OBE FREng is Chief Executive of the BRE Group. A materials engineer with a PhD in wind energy and the design of turbine blades, Peter is passionate about the role that building science can play in finding solutions to the challenges that the built environment faces in delivering buildings, homes and communities that work for people, the environment and the economy. From 2006 until 2012 he was on part-time secondment to the Olympic Delivery Authority (ODA), where he co-created the sustainable development strategy and took the lead on the sustainable procurement of construction products.

He is a Visiting Professor at Bath University, where he has also been awarded an Honorary Doctorate in Engineering. In July 2014 he was also awarded Honorary Doctor of Science by Loughborough University. He is a Fellow of the Institution of Civil Engineers (FICE), a Fellow of The Institution of Engineering and Technology (FIET), a Fellow of the Institute of Materials, Minerals and Mining (FIOMMM), a Fellow of the Chartered Institute of Building (FCIOB) and a Fellow of the Institution of Agricultural Engineers (IAgrE). He has been a Chartered Engineer for over 20 years. Peter is Chairman of the Health, Safety and Environment committee for AIRTO - the Association for Independent Research and Technology Organisations. He is a Vice President and Trustee of the Institution of Engineering and Technology.

In May 2012 Peter received the prestigious Peter Stone Award from the Chartered Association of Building Engineers (CABE) in recognition of his outstanding contribution to building engineering and the built environment. CABE also awarded him Honorary Fellowship in 2013. He was awarded an OBE for services to research and innovation in the construction industry in June 2012. The following month he was elected as Fellow of the Royal Academy of Engineering in recognition of his leadership on innovative built environment research.

In 2013 former Environment Secretary Owen Paterson asked him to chair Grown in Britain, an initiative aimed at creating a sustainable future for UK woodlands and forests. In 2014 Paterson appointed him to lead a government-wide drive to improve public procurement of food. Bonfield's recommendations to Government were published in July 2014.

<https://www.bre.co.uk/page.jsp?id=1732>

Professor Ricky Burdett

Ricky Burdett is Professor of Urban Studies at the London School of Economics and Political Science, and director of LSE Cities and the Urban Age Programme. He is a member of the UK Government's Independent Airports Commission and a member of Council of the Royal College of Art in London. Burdett was Visiting Professor in Urban Planning and Design at the Graduate School of Design, Harvard University in 2014 and Global Distinguished Professor at New York University from 2010 to 2014. He has been involved in regeneration projects across Europe and was Chief Adviser on Architecture and Urbanism for the London 2012 Olympics (where he was involved in the selection of designers for many of the Olympic venues) and architectural adviser to the Mayor of London from 2001 to 2006. Burdett was also a member of the Urban Task Force which produced a major report for the UK government on the future of English cities. He is editor of *The Endless City* (2007), *Living in the Endless City* (2011) and *Innovation in Europe's Cities* (2015). Burdett acts as an adviser to national, regional and local governments on urban issues, and has worked with private companies and architectural practices on the



development and framing of urban projects. He was involved in the design competitions for Tate Modern, the Laban Centre, BBC projects in Broadcasting House, White City and Glasgow; the Royal Opera House Open-up project, NM Rothschild & Sons Headquarters in the City of London, the Golden Mede development at Waddesdon, the MAXXI Centre in Rome, the new Integrated transport system in Jeddah and the redevelopment of Penn Plaza in New York City.

<http://www.lse.ac.uk/sociology/whoswho/academic/Burdett.aspx>

Tim Stonor

Tim Stonor is an architect and urban planner who has devoted his career to the analysis and design of human behaviour patterns – the ways in which people move, interact and transact in buildings and urban places. He is an internationally recognised expert in the design of spatial layouts and, in particular, the role of space in the generation of social, economic and environmental value.

As Managing Director, Tim is responsible for the strategic direction of Space Syntax globally. This role has four key parts: high level advocacy to governments, private corporations and other stakeholders; new business generation; quality maintenance as a member of Space Syntax's Project Review Panel; and development of the Space Syntax Academy, to train students and professional practitioners in the Space Syntax approach.

<http://www.spacesyntax.com/contact/person/uk/staff/tim-stonor/>



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Additional interviews

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Appendix A: Brief from UKTI for this report

The following questions were posed as the subject matter of this report:

- What do UK companies offer in terms of overarching support on sustainable urbanisation?
- What are the key perceived UK strengths on sustainable urbanisation, including in each sub-sector (technology, BIM, green buildings, intelligent transport, water and waste related innovations, energy, environmental, health, education)?
- What are the UK's strengths for responding to the different requirements of new and existing cities?
- Which companies are leading (including SMEs)?
- Which projects could be provided as UK case studies under the wider topic of sustainable urbanisation or sub-sectors?
- Where is the UK leading in comparison with other countries?
- Are there any key enablers such as standards, procurement and funding options?
- Are there any cities or regions where UKTI and UK companies should be focusing their effort?
- How can we best 'showcase' the UK's offer on sustainable urbanisation to cities abroad?
- Are there a few leading figures who might be candidates to contribute to thought leadership around sustainable urbanisation?



Appendix B: International design, engineering & infrastructure companies

Table 3 provides examples of UK companies that are working internationally and provide services in relation to infrastructure and city development. This table does not represent a comprehensive list of all UK companies operating in this area. Figures on gross revenue were obtained from company websites and annual reports. Additional information on sectors of operation and selected projects were also obtained from company websites.

Table 3 - Example of UK design, engineering & infrastructure companies operating internationally

Sustainable urbanisation companies	Headline facts (based on 2014)	Sectors	Selected projects
AECOM	<p>A global provider of architecture, design, engineering, and construction services for public and private clients.</p> <p>Gross revenue: USD19bn</p> <p>Staff: 100,000 worldwide</p>	<p>Buildings & Places Civil & Infrastructure Industrial National Governments Oil, Gas & Chemical Power</p> <p>Core services: Architecture and Landscape Architecture Building and Equipment Maintenance Civil and Building Engineering Construction Management Cost Consulting Environmental Planning and Remediation Facilities Management Program Management Urban Planning and Design</p>	<ul style="list-style-type: none"> London Cycle Super Highway: feasibility, detailed design and supervision work on routes planned by Transport for London (TfL) and the Mayor to encourage more people to commute by bike. Al Raha Beach: detailed infrastructure planning, design and construction on this comprehensive, mixed-use development. China World Trade Centre: technical study and detailed traffic engineering design for all three phases.
Balfour Beatty	<p>Finance, develop, build and maintain complex infrastructure such as transportation, power and utility systems, and social and commercial buildings.</p> <p>Gross revenue: £8.4bn</p> <p>Staff: 36,000 worldwide</p>	<p>Infrastructure investments Construction services Outsourced maintenance Upgrade & management</p> <p>Markets Roads Rail Airports Energy generation, transmission and distribution Renewable energy Gas Water networks Water treatment & supply Healthcare Education Social housing Defence housing Judicial & institutional</p>	<ul style="list-style-type: none"> HKSAR Highways (Hong Kong): design and construction of a 1.6 kilometre dual 2-lane sea viaduct, and building nine smaller approach viaducts Olympic Stadium transformation: transformation of the stadium into an all-round multi-use venue Sydney Water (Australia's largest water utility provider): working collaboratively to renew and improve water networks London Power Tunnels: install high voltage electricity cables for National Grid's London Power Tunnels project to ensure the city can access the renewable energy sources of the future.
Amec Foster Wheeler	<p>Provider to the world's infrastructure,</p>	<p>Operates across the whole of the oil and gas industry – from production through to refining,</p>	<ul style="list-style-type: none"> The Rt. Hon. Herb Gray Parkway (the largest highway investment project in Ontario's history):



	<p>manufacturing and process industries.</p> <p>Gross revenue: £5.5bn</p> <p>Staff: 40,000 worldwide</p>	<p>processing and distribution of derivative products – and in the mining, clean energy and environment and infrastructure markets.</p>	<p>providing geotechnical engineering and environmental design</p> <ul style="list-style-type: none"> Stormwater Management Enhancement Districts (Philadelphia): leading consultants of a diverse team of planners and engineers on innovative planning for green stormwater infrastructure Calgary city asset management and decision support tool: managing the streambank and riparian areas. Multi-disciplinary teams developed an innovative GIS based catalogue and design support tool to meet Calgary's needs.
Laing O'Rourke	<p>Internationally focussed engineering enterprise operating an integrated business model comprising the full range of engineering, construction and asset management services.</p> <p>Gross revenue: £4.4bn</p> <p>Staff: 15,312 worldwide</p>	<p>Engineering expertise</p> <p>Building construction</p> <p>Infrastructure construction</p> <p>Investment and development</p> <p>Modular manufacturing</p> <p>Support services</p> <p>Sectors:</p> <p>Buildings</p> <p>Transport</p> <p>Power</p> <p>Water & utilities</p> <p>Mining & natural resources</p> <p>Oil & gas</p>	<ul style="list-style-type: none"> Chatswood Transport Interchange (Sydney): design and construct contractor. Blacktown Hospital Clinical Services Building (Sydney): responsible for the design and construction of facilities to improve access to services Hong Kong Metro Rail Expansion Express Rail Link, Victoria Harbour to Shenzhen: overseeing the underground construction of the Southern and Northern sections of the interchange
Arcadis (EC Harris)	<p>Natural and built asset design & consultancy firm</p> <p>Gross revenue: £3bn</p> <p>Staff: 28,139</p>	<p>Infrastructure</p> <p>Water</p> <p>Environment</p> <p>Buildings</p>	<ul style="list-style-type: none"> 2015 Sustainable Cities Index Thames Tunnel: providing cost consultancy, contract administration and procurement support to the enabling and investigation works. The Harbour (Edinburgh): The RCTL division of Arcadis has been commissioned to oversee the master planning process Improving Mogden Sewage Treatment Works (London): commercial management, enabling Thames Water to manage their risks and costs.



<p>Atkins</p>	<p>Design, engineering and project management consultancy</p> <p>Gross revenue: £1.75bn</p> <p>Staff: 17,489 worldwide</p>	<p>Aerospace Aviation Buildings Defence Education Energy Environment Government Healthcare Information Communications Marine & Coastal Mass Transit Nuclear Oil & Gas Power Rail Renewables Roads & Bridges Security Tourism & Leisure Urban development Water</p>	<ul style="list-style-type: none"> • Doha Metro Gold Line (Qatar): lead designers on transportation and infrastructure improvements across the city, critical for the 2022 World Cup and central to Qatar's 2030 vision. • Dubai Downtown West and Business Bay masterplan: ensuring long-term environmental, social and economic resilience. The master plan is targeting public spaces and individual buildings. • Meixi Lake Eco City: masterplan embodies the spirit and objectives of an ecological city, maximising opportunities through transport infrastructure
<p>Mott MacDonald</p>	<p>Global engineering management and development consultants</p> <p>Gross revenue: £1.2bn</p> <p>Staff: 16,000 worldwide Employee-owned</p>	<p>Buildings Digital Infrastructure Education Environment Health International development Industry Oil and gas Transport Urban development Water</p>	<ul style="list-style-type: none"> • Crossrail (London): multidisciplinary consultant for the central tunnels, three new stations, railway systems and rolling stock. • Green Infrastructure (New York): preventing sewage from overflowing into waterways when snow or rainfall is heavy with approximately 550 bioswales in Brooklyn. • Delhi Metro (India): involved in Delhi Metro for over ten years, now working on phase three as detailed design consultant. • Governance structure for public transport infrastructure (Amsterdam): process manager for the programme and administrative implementation of the governance structure.
<p>Arup</p>	<p>Independent firm of designers, planners, engineers, consultants and technical specialists working across the built environment.</p> <p>Gross revenue: £1bn</p> <p>Staff: 11,000 Trust-owned</p>	<p>Arts & Culture Aviation Commercial Property Education Energy Government Healthcare Highways Hotels & leisure Maritime Mining Rail Residential Resources & Waste Retail Science and industry Sport Water</p>	<ul style="list-style-type: none"> • Dubai Airport, Terminal 3: managed the operational processes from the construction project to a fully operational environment • Changxindian low carbon community (Beijing's first sustainable community): prepared sustainable guidelines and low carbon zoning codes to guide design requirements for site planning, engineering, buildings, landscape ecology, water, waste and energy. • Butler Park 'n' Ride Train and



		Management Consulting Planning	Bus Station (Perth): providing structural engineering services.
Buro Happold	International consulting engineers providing innovative and holistic skills across the built environment Gross revenue: £112m Staff: 1,600	Aviation Civic Commercial office Commercial residential Culture Education – schools & colleges Energy Healthcare Higher education Hospitality Rail Retail Scientific Sports & Entertainment Transport Waste Water	<ul style="list-style-type: none"> • Mobile Nano Smart Grid: providing research, energy, environment, urban development, and cost analysis consultancy. • Sabah Al Ahmad Sea City: offering masterplanning, coastal design, and transportation services. • KAMA Tri-City Integrated Masterplan: commissioned to offer multi-disciplinary engineering services for infrastructure, transport, housing, social facilities and the general public realm.
Carillion	Integrated support services companies, with extensive construction capabilities, a substantial portfolio of Public Private Partnership projects and a sector-leading ability to deliver sustainable solutions.	Facilities management and property services Specialist Business Infrastructure Energy Advice	<ul style="list-style-type: none"> • London Overground rail operations: involved in a range of services including M&E and building fabric maintenance, grounds maintenance, and minor upgrade works. • Olympic Park (London): commissioned to design and build five buildings on the park, including the world's largest broadcast centre. • Aldar (Abu Dhabi): involved in the construction of this visually spectacular building • Heathrow Airport, Terminal 5 C: implemented its Design to Cost process to aid in the construction of the terminal.
Ramboll	Consulting engineers, designers and management creating sustainable and long-term solutions for customers and society.	Buildings Transport Environment and Health Energy Oil and gas Telecom Management consultancy Water	<ul style="list-style-type: none"> • M25 widening: responsible for designing the upgrade of the junctions and gantry design. Environmental engineers and scientists oversaw the environmental management and design, and also produced a whole life carbon report. • Stockholm water purification: managing the sewerage system transformation process. • Traffic plan for Jyllinge, (Denmark): drawn up the traffic



plan for the development of central Jyllinge and its surrounding residential areas.

- Upgrading pre-treatment of waste in Oslo (to allow processing organic waste into biogas and biofertiliser): working with the City of Oslo, looking into the areas needed for improvement.



Appendix C: Example SMEs across sustainable urbanisation sub-sectors

Table 4 shows example SMEs operating in the sub-sectors of sustainable urbanisation and related services. This is not a comprehensive list of all UK SMEs offering services related to sustainable urbanisation. The table lists a company name, website and a description of the company (text in single quotes is sourced from the company website).

Table 4 - Example SMEs operating in sustainable urbanisation sub-sectors

Sector	Company name	Description from company website
Decontamination and remediation	Soilutions http://www.soilutions.co.uk/	'We specialise in removing contamination issues, whether that involves the remediation of contaminated soil and groundwater, responding to oil spills, or treating invasive weed species, we've got the experience to deal with them and the commitment and quality to provide a great service. We've remediated all sizes of sites and helped many clients, trust us when we say that no site too small, and no site too big.'
	RAW www.raw-group.com	Raw is one of the leading specialists in inland oil spill response and remediation, operating internationally
Education	Frog Education http://www.frogeducation.com/	<p>'Our technology is having a massive impact on the lives of millions of children in Malaysia. Through the Malaysian Ministry of Education and the 1BestariNet project, 10,000 schools and 10 million users now have access to a single coverage 4G network, with our new learning platform FrogLearn the glue that makes online teaching and learning possible.</p> <p>Our ground-breaking learning platform is being used across the whole of Malaysia. It doesn't matter if students are urban or rural, they all have access to the same, high quality resources and content, giving equal delivery of education to every Malaysian child.</p> <p>Built from the ground up, FrogLearn gives teachers the ability to assign and keep track of students work, create resources and connect with educators all through technology. This has revolutionised the whole teaching and learning process, making it more efficient anytime, anywhere.'</p>



Lighting	<p>EnLight http://www.enlight.co.uk/</p>	<p>Provides energy efficient smart street lighting. System can be retrofitted into existing street lamps. Products use sensors to detect daylight and operate lighting according to needs.</p> <p>'It is this multidisciplinary approach, drawing on specialisms in software, hardware and electronics, that enabled us to develop EnLight, a multi-award winning solution that takes a holistic approach to light and energy management. EnLight delivers instant savings in energy and maintenance costs and transforms existing light infrastructure into a living communications network from which value added services can be delivered. EnLight is much more than just lighting control. EnLight is the platform for a more intelligent world.</p> <p>EnLight is a brand of Select Innovations Limited, a privately owned company operating in the UK since 2000.'</p>
Open data	<p>Doorda http://www.doorda.com/</p>	<p>An open data site which offers free instant access to reported crime, road accidents, restaurant hygiene scores, property prices and more. It covers the whole of the UK and the site is updated daily. Users can explore their local neighbourhood using official government open data. The company provides that is free to access as well as commercial solutions.</p>
	<p>Swirrl http://www.swirrl.com/</p>	<p>Swirrl were asked by The Department for Communities and Local Government (DCLG) to create a linked open data site that is easily accessible and understandable.</p> <p>OpenDataCommunities.org contains a large number of datasets that can be fully browsed and queried. Users can create applications with the data using a tool on the site. They also have good visualisations (like the local authority dashboard) which provide an easy way to access the data for non-technical users.</p>
	<p>mySociety https://www.mysociety.org/</p>	<p>This is a not-for-profit organisation that creates tools that enable people to have more control over institutions and decision-makers. Their website highlights the following projects:</p> <p>'FixMyStreet: The original problem reporting website</p> <p>TheyWorkForYou: Keeping tabs on the UK's</p>



		<p>parliament</p> <p>WriteToThem: Email your MP, the easy way</p> <p>WhatDoTheyKnow: A freedom of information service for the UK</p> <p>There website has reusable codebases to allow any country to adapt the projects above internationally. They also have data and mapping tools, including 'Mapumental' a map that shows time.</p>
<p>Mapping and visualisation</p>	<p>Shoothill</p> <p>http://www.shoothill.com/</p>	<p>Creates online mapping and data visualisation solutions. An example project involved integrating flood risk data from the Environment Agency in web-based street maps.</p>
<p>Masterplanning & design</p>	<p>Space Syntax</p> <p>http://www.spacesyntax.com/</p>	<p>Space Syntax was represented at the expert stakeholder workshop. During the workshop the planner representing AECOM discussed partnering with Space Syntax on international projects. Space Syntax is running training courses on their methodology and software in China. This creates future educated clients who then want to buy services.</p> <p>'Space Syntax provides expertise in urban planning, transport, building design, social interaction and spatial economics.</p> <p>Our creative approach combines global experience with an original technology that forecasts the impacts of planning, transport, economic and design decisions on people and property for all scales of development. Operating for more than 25 years, we are:</p> <ul style="list-style-type: none"> • Committed ...to improving the economic, social and environmental performance of the built environment • Trusted ...by a distinguished client base of forward-thinking public, private and community organisations • Expert ...in modelling the impacts of planning, transport, economic and design decisions on human behaviour patterns. <p>Science-based and human-focused, Space Syntax brings creative, innovative rigour to the process of</p>



		making cities, urban places and buildings.'
Modelling cities and complex environments	<p>Improbable</p> <p>http://improbable.io/</p>	<p>'Improbable is developing an operating environment that makes building simulated worlds possible. Worlds which can be run in real time, simulating the behaviours and interactions of millions of entities. Spaces with their own rules and properties that a multitude of people can simultaneously change, explore and visualise in as many different ways as developers can imagine.</p> <p>Simulated worlds provide unique insight to those asking questions of complex systems. As well as enabling completely new experiences in gaming, simulated worlds can solve significant problems in areas as diverse as defence, energy, city efficiency, health, and finance.'</p>
Sensors	<p>OpenSensors.io</p> <p>https://opensensors.io/</p>	<p>Provides sensor technologies and allows clients to decide whether to publish data with an open data license or keep it for private use. They provide the components needed for real time data access, security, storage, data analytics and machine learning.</p>
Transport	<p>Igeolise</p> <p>http://www.igeolise.com/</p>	<p>Igeolise a company that specialises in travel times for multiple modes of transport including walking, cycling, driving and public transport. There two products are TravelTime and MinuteMapr available as APIs and the latter as an app.</p> <p>'Vision is a big word for just 6 letters – but ours is to replace every 'within X miles' (or kilometres) search box with travel time. Globally.</p> <p>Clearly we've got a long way to go – but we've already built some amazing technology, won some blue-chip customers, launched in several countries, and gathered lots of proof about how travel time boosts our client's conversion rates.'</p>
	<p>TransportAPI</p> <p>http://www.transportapi.com/</p>	<p>Pulls together transport data from multiple sources (including timetables, routes, and live running and performance history) about multiple transport modes allowing for the creation of new transport-related products and services.</p>



	<p>Ultra Global</p> <p>http://www.ultraglobalprt.com/</p>	<p>'Ultra provides environmentally sustainable 21st century transport solutions. The Ultra team comprises a balance of technical and operational experience and are recognized leaders in the transport systems industry.'</p>
	<p>Centre for Aviation Transport and the Environment</p> <p>www.cate.mmu.ac.uk</p>	<p>CATE is an internationally recognised centre of expertise concerned with the environmental impacts arising from transport and mobility. Research is conducted for governmental, UN Agency and industry customers on issues as diverse as: emissions measurements and modelling' modelling of global climate impacts; biofuels; airport environmental capacity and its management; community noise disturbance; carbon management and climate change adaptation strategies.</p>
<p>Waste, energy & utilities</p>	<p>Eunomia</p> <p>http://www.eunomia.co.uk/</p>	<p>'Eunomia is an independent consultancy dedicated to helping our clients to achieve better environmental and commercial outcomes. With offices in Bristol and London, we work throughout the UK, other EU Member States and beyond.</p> <p>Eunomia combines the highest levels of analytical and operational expertise with a high degree of professional competence and efficiency to respond quickly and effectively to our clients' needs. We are appointed advisors to many types of private, public and third sector organisations.</p> <p>Our clients include:</p> <ul style="list-style-type: none"> • Waste management, energy generation and technology companies, utilities and financial institutions; • UK central government, local authorities and regional bodies; • The European Commission, other European institutions and foreign governments; and • Charities and third sector organisations with a remit covering environmental issues.'
<p>Water</p>	<p>Ferrett</p> <p>http://www.ferret-technology.com/</p>	<p>'The Ferret leak location system is an award winning device that delivers an innovative hydraulic solution for finding leaks in water pipes. The system significantly reduces the amount of time and number</p>



		of excavations required to pinpoint and repair leaks, minimising disruption to customer's property.'
	<p>i²O</p> <p>http://www.i2owater.com/</p>	<p>'i²O is the world's leading developer of Smart Pressure Management solutions for water distribution networks. The company has installed over 1850 systems in 22 countries around the world – with average leakage savings running at over 20% and totalling over 235 million litres of water every day, reductions in burst frequency of up to 40%, as well as an average of 20% reduction in the energy consumed by pumping water into the network.</p> <p>i²O Water has won a host of awards for innovation, its technology and business growth. The company headquarters is in the UK, at Southampton Science Park and it employs 70 people at its offices in Southampton, Malaysia, Spain and Colombia.'</p>
Wayfinding	<p>Air Design</p> <p>http://www.airdesign.co.uk/work/</p>	<p>Air Design's expertise lies in branding, communications, interior design and digital.</p> <p>The company has a niche specialism in wayfinding strategy and navigation system design, creating signage systems for large, complex places.</p> <p>These skills benefit Air Design's clients in the public sector, government, real estate, retail, transport and corporate sectors.</p> <p>Working internationally with offices in London, Moscow and Shanghai.</p>
	<p>City ID</p> <p>http://www.city-id.com/</p>	<p>City ID develop unique design, information and wayfinding solutions to integrate people, movement and places.</p> <p>City-ID are urbanists, planners and designers with a global reputation for improving the legibility and experience of cities and transport systems.</p>



Nine things you might not know about BRE



BRE is a world leading research, consultancy, training and testing organisation delivering sustainability and innovation across the built environment and beyond.



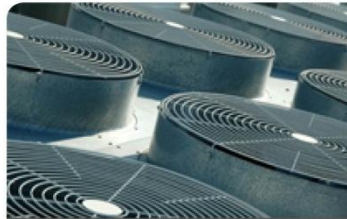
BRE has a unique range of testing facilities, including a structures lab that can contain a four-storey flat, an extreme speed wind tunnel, a burn hall that can accommodate 10MW intensity fires, and an anechoic chamber.



BRE was set up by government in 1921 and became an independent company in 1997.



BRE employs a team of leading research scientists, engineers, architects, surveyors and psychologists who have expertise in virtually every aspect of the built environment.



The BRE Innovation Park Network currently has parks at different stages of development in England, Wales, Scotland, China, Brazil, Canada and the USA. These provide opportunities for collaboration across the world.



Over 20 years ago BRE developed the world's first environmental scheme for buildings, BREEAM. To date over 1 million buildings have been registered around the world.



BRE is owned by the BRE Trust, a registered charity. The profits made by BRE are used by the BRE Trust to conduct research projects that benefit society.



BRE is entirely independent of Government, commercial sector or vested interests of any kind. We are only influenced by the facts.



In 1940, BRE built the first model of the Mohne Dam used by Barnes Wallis in planning the Dambusters' Raid. It is now a Scheduled Historic Monument.