Reading 2050: A Smart and Sustainable City

Book

Published Version

University of Reading

Reading 2050
a smart and sustainable city?

Edited by Tim Dixon and Lorraine Farrelly
School of the Built Environment
University of Reading

Public Lecture Series (2017–2019)

r2050

This book has been developed in partnership with Barton Willmore and Reading UK.

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Growing opportunity

Contents

Foreword

Imagine living in a city that is so smart and sustainable that it is a joy to live there. The advanced technology used throughout this city makes working there just that bit more efficient and enjoyable. The energy used in this city is also largely generated there, and its carbon footprint is a tiny size 5. Public transport is fully integrated and walking and cycling are given priority over cars. This city is no killjoy either, and its heritage, modern architecture, nature parks and connectedness to its rivers invite both inhabitants and visitors to dwell through this city with a surprise around every corner, both during the day and at night.

Now imagine this city is Reading.

I know Reading is not a city, but that is just a matter of time. I also know that Reading is not this smart and sustainable city right now but, with the right vision, it is a deliverable aspiration for the future. Living through a time of major upheaval due to the outbreak of the COVID-19 pandemic, where so much has changed so quickly, the changes we need to make envisaged in this book appear eminently achievable.

This collection of articles, based on the 'Reading 2050 lecture series', all envision Reading as this smart and sustainable city of the future. In fourteen chapters based on the lectures, it considers Reading in 2050 from all angles: the place and its environment, the people and their lifestyle, the economy and future employment.

The University of Reading has been part of the fabric of this place, in one form or the other, since the 1860s. The connectedness between town and gown has always been strong, but my vision for the University is strengthen this relationship further. The contributions to this book by so many colleagues, and the editorship of two of the University's professors, Tim Dixon and Lorraine Farrelly, already shows some aspects of this connectedness.

But there is more we can do together. For the University, that means using our longstanding research expertise, such as that in climate change and environmental sustainability, for the benefit of the people of Reading. It also means creating more access to our education and our facilities. We can also help to connect Reading to many parts of the world, through our students who come from all over the world and through our global partnerships. We need to do all this in partnership, and make sure that the University of Reading is also the University for Reading.

The book you are about to read offers a vision of a smart and sustainable Reading; the University of Reading very much wants to be part of, and help deliver, this amazing city.

Professor Robert Van de Noort
Vice-Chancellor, University of Reading

1 Introduction: The Reading 2050 Public Lecture Series

Tim Dixon and Lorraine Farrelly
School of the Built Environment, University of Reading

The continuing impact of extreme global weather events and the recent coronavirus pandemic have placed our cities and urban areas under huge pressures. Probably for the first time since the second world war these events are testing the sustainability and resilience of our cities and their hard and soft infrastructures to the limits. In an uncertain world we will need to reconcile ourselves to whether cities need to re-densify or de-densify, and what will be the impacts of the pandemic on longer-term patterns of working and living? How can technology improve response times and resilience in urban emergencies without endangering privacy? What sort of communities will we want to belong to when the pandemic is over, but when climate change is still a burning reality? How will our communities and urban environments evolve in response to this crisis and longer-term environmental pressures?

It's now more important than ever therefore that we think about the future and the places that we want to live, work and play in. Take the case of Reading, for example. Based on an ancient bridging point at the confluence of the Thames and Kennet rivers, Reading's history stretches back to Anglo-Saxon times, and perhaps beyond to the Roman occupation. The growing interest in Reading's culture and heritage, founded on a rich and often hidden past, is established on its iconic buildings, such as the medieval Abbey and nearby prison, 'home' to Oscar Wilde for two years. Reading's more recent industrial heritage is also important to remember through the three (or four) Bs of beer, biscuits, bulbs, and bricks (Figure 1.1). Today, Reading is a very different town to the one of years gone by, before the Inner Distribution Road was built and when trolley buses still ran. The Reading-Wokingham urban area (with parts of West Berkshire) now has a population of 318,000 and feels more like a 'city'. Despite continued deprivation in some areas, it has responded to economic cycles with agility, innovation and strong growth, helped by the high number of start-ups and the hi-tech multinationals located here, such as Microsoft and Huawei.

But this progress raises a question: what sort of a place should Reading be in 30 years' time (2050)? This is especially pertinent when we think about the huge environmental challenges that all our towns and cities face now and in the future. After all, Reading has a current ambition to become zero carbon by 2030. So how will it tackle the urban challenges it faces, and how will it use technologies to become a 'smart and sustainable' place to live? These are some of the crucial questions that the Reading 2050 project is focusing on.

The Reading UK 2050 project was established in 2013 by the University of Reading, Barton Willmore and Reading UK CIC (the 'Reading 2050 partners') to deliver a strategic, long-term vision that will support Reading's growth and prosperity, and help ensure we can deliver a legacy of a truly smart and sustainable city, by 2050. Through a series of workshops and sessions with a wide range of organisations and people from across Reading and the Thames Valley region we are developing an economically viable and evolving future vision for Reading in 2050 which links and informs Reading Borough Council's Local Plan and the Reading Climate Change Emergency Strategy (2020–25).

The Reading 2050 Vision was launched in September 2017, and the lecture series which forms the basis of this book helped create a platform not only to discuss and debate how Reading should evolve to a smarter and more sustainable future by 2050, but also to help inform the continuing development of the vision and provide an important channel for public engagement. The series started from the premise that to understand the future of a place the present and the past must also be understood.

The Public Lecture series (hosted by the interdisciplinary School of the Built Environment) ran from October 2017 to October 2019, and was structured around three themes which underpin the Reading 2050 vision:

- Place and Environment
- People and Lifestyle
- Economy and Employment.

The full lecture series is listed on page 6.

Figure 1.1 Reading: the four Bs

Place and environment

LECTURE 1 | 19 October 2017)
Reading 2050 Vision
Professor Tim Dixon (School of Built Environment, University of Reading), Nigel Horton-Baker (Reading UK CIC), Jenni Montgomery (Barton Willmore)

LECTURE 2 | 2 November 2017
Reading's 'Urban Room'
Professor Lorraine Farrelly, Head of Architecture, University of Reading

LECTURE 3 | 16 November 2017
Reading's heritage and history
Matthew Williams, Manager, Reading Museum

LECTURE 4 | 30 November 2017
The future of energy in Reading
Dr Phil Coker, School of the Built Environment, University of Reading

LECTURE 5 | 14 December 2017
The future of transport and mobility in Reading
Scott Witchalls, Peter Brett Associates

LECTURE 6 | 11 January 2018
Climate change and flooding in Reading: current and future risks
Dr Joanna Clarke, Geography and Environmental Science, University of Reading

LECTURE 7 | 25 January 2018
Reading: the 'Great Place' project
Grant Thornton – Reading Borough Council and Dr Sally Lloyd-Evans, Geography and Environmental Science

LECTURE 8 | 8 February 2018
Reading art and culture: past, present and future
Professor Susanne Clausen, Head of Department of Art, University of Reading

People and lifestyle

LECTURE 9 | 28 June 2018
Nature & People in our Urban Future
Natalie Gatpansingh, Nature Nurture

LECTURE 10 | 18 July 2018
The Urban Metabolism of Reading
Dr Eugene Mohareb and Dr Daniela Perrotti, School of the Built Environment

LECTURE 11 | 25 October 2018
Transforming the Museum of English Rural Life: Past, Present and Future
Kate Arnold Foster, MERL

LECTURE 12 | 29 November 2018
Future Health and Quality of Life in Reading
Dr William Bird, Intelligent Health

LECTURE 13 | 31 January 2019
Reading's Climate Change Strategy
Chris Beales (Reading Climate Change Partnership) and Ben Burfoot (Reading Borough Council)

LECTURE 14 | 28 February 2019
Digital Visualisation: Understanding the Past and Revealing the Future
Dr Ian Ewart and Dr Dragana Nikolic, School of the Built Environment

Economy and employment

LECTURE 15 | 28 March 2019
The Future of the Reading Diamond in the Thames Valley
Professor Kathy Pain, School of Real Estate and Planning

LECTURE 16 | 26 April 2019
Smart City Cluster in the Thames Valley
Rob McDonald, Peter Brett and Associates

LECTURE 17 | 23 May 2019
What is the Future of the Tech Economy in Reading?
Nigel Horton-Baker, Reading UK

LECTURE 18 | 20 June 2019)
The Current and Future Role of Thames Valley Berkshire LEP
Tim Smith MBE, Thames Valley Berkshire LEP

LECTURE 19 | 26 September 2019
Future Housing and Population Change in Reading
Simon Macklen and Debbie Mayes, Barton Willmore

LECTURE 20 | 24 October 2019
The Oxford-Cambridge Corridor: Opportunity or Threat for Reading
John Worthington, MBE

The presentations of the majority of these twenty lectures are available at http://www.reading.ac.uk/news-and-events/Events/www.reading.ac.uk/architecture/architecture-public-lectures.aspx. This book draws on the full series to include fourteen chapters based on the relevant lectures.

We are grateful to all of our presenters and experts who provided the chapters for this book. We would also like to thank Professor John Connaughton and Professor Stuart Green of the School of the Built Environment for their help in chairing the sessions, and Caroline Cross (Research Communications Business Partner) for her help in publicising the lecture series.

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School of the Built Environment, University of Reading
www.reading.ac.uk/built-environment/built-environment.aspx

Part 1
place and environment

2 Reading 2050 vision

Tim Dixon School of the Built Environment, University of Reading
Jenni Montgomery Barton Willmore **and Nigel Horton-Baker** Reading UK

Introduction

We live in an urban world. Today a majority of the world's population lives in cities, and this is set to grow to nearly 70% by 2050. In the UK we are already heavily urbanised with about 80% of the population living in cities. In England much of the future growth will come from existing smaller and medium sized urban areas like Reading in the south east of the country. So rapid urbanisation, changing demographics and climate change will all impact on the way that people live, work and play in cities. This means we need to plan for the future to try and overcome the current disconnection between short term planning horizons and longer-term environmental change to 2050.

Many cities around the world have therefore developed visions (or shared expectations) about the future. In the UK, for example, a number of cities developed visions within the UK Government Office for Science (GOfS) Future of Cities Programme (2013–2016), including Newcastle and Milton Keynes. In Canada, Vancouver aims to be the world's greenest city by 2020, with tough targets set for greenhouse gas emissions and a desire to create a city which is resilient to climate change (see also the Rockefeller Foundation 100 Resilient Cities Project). In Denmark, Copenhagen's vision is based on a target to be net zero carbon by 2025, underpinned by a highly successful walking/cycling policy agenda and a strong focus on renewable energy.

These cities are planning to be both 'smart' and 'sustainable'. This means using innovative technology (such as Internet of Things, smart metering, environmental sensors, and smart traffic management systems) to help create a smart future for people living in cities which is also economically, socially and environmentally sustainable. Creating a smart and sustainable city isn't easy, however. It requires a clear strategic vision, a strong link with climate change strategy, active planning, inclusive participation with key stakeholders, and a sense of political reality. In essence, a vision can be thought of a shared perspective of a desirable future and developing a vision and a strategy is essential if we are to realise smart and sustainable ambitions. It is telling that a recent research project we undertook for RICS found that only 47% of UK cities in the survey had an established definition for a smart city. Moreover, high level planning at city level is not common: only 22% of respondents had a smart city action plan and only 22% had a smart city framework (Dixon et al, 2017).

What is a city vision?

The best city visions are something more than simply a branding or re-branding exercise. Although a successful city vision only becomes a success when the vision is realised, best practice visions not only clearly link together strategies, plans and actions, but also integrate the vision clearly with climate change, energy, infrastructure, economy and people. Moreover, successful visions need to be politically viable, analytically sound, and participatory so that stakeholders form part of the inclusive process of formulating the vision. In the UK, for example, Bristol's One City 2050 vision), aims *'to make Bristol a fair, healthy and sustainable city. A city of hope and aspiration, where everyone can share in its success'*. In Canada, Vancouver aims to be the world's greenest city by 2020, with tough targets set for greenhouse gas emissions and a desire to create a city which is resilient to climate change. In Denmark Copenhagen's vision is based on a target to be carbon-neutral by 2025, underpinned by a highly successful walking/cycling policy agenda and a strong focus on renewables.

The UK Government Office of Science Foresight programme on Future Cities has also placed a strong emphasis on the co-creation of city visions (Government Office for Science, 2016), and UK cities have engaged in this process in a variety of ways through scenario development, exhibition spaces, and design challenges. To connect with this work, the University of Reading partnered with Barton Willmore and Reading UK CIC (the economic development company for Reading) to develop a Reading 2050 vision.

Why do we need a vision for Reading 2050?

Although Reading is not yet officially a 'city', it forms part of one of the most economically vibrant and connected urban areas in the UK: Reading, as part of a wider Reading/Wokingham urban area (including Arborfield, Woodley, Theale (West Berkshire), Crowthorne, Earley), has a population of 318,000 (based on 2011 ONS data), and this is set to grow to 362,000 by 2037 (Dixon and Cohen, 2015). This presents big challenges in maintaining its competitive edge and dealing with the important environmental and socio-economic issues arising from its continued economic growth. Developing a Reading 2050 vision which is both 'smart' (making the best use of technology) and 'sustainable' (creating a truly sustainable city) is an important step in supporting longer-term planning and development in Reading.

Understanding Reading's past and its present are vital to understanding Reading as a place. Reading's geographic location at the confluence of the Thames and Kennet rivers, and its location 40 miles west of London explain the ancient origins of its success as a trading centre and centre of commerce and manufacturing. The Reading of today, however, is also very different from the Reading of 40 years ago. Despite its rich history stretching back to the founding of Reading Abbey in 1121, the 'beer, biscuits and bulbs' (and 'bricks'), for which Reading was rightly famous, have long since gone. Moreover, its heritage and culture remain relatively 'invisible' to residents and businesses, despite the fact that Reading is in the top 16% of the country for its overall heritage (according to the RSA's National Heritage Index), and that important Heritage Lottery Funding for Reading Abbey restoration has also recently been won (2016–18).

Reading's strong economic success is based on its physical and virtual networks in an increasingly globalised world (Crampton et al, 2010: Dixon and Montgomery, 2015). It is also a classic example of an 'under-bounded' urban area, where its administrative boundary is smaller than its wider urban footprint. However, vibrant economic activity and a growing population come at a price, and that price is reflected not only in greenhouse gas emissions, but also in outdated and congested infrastructure, pockets areas of deprivation, and a sense that Reading could, and should, be a more liveable place.

Developing the Reading 2050 vision

The starting point for our work was not to develop a masterplan for Reading, but rather a vision. More formally, a vision is a shared expectation about a plausible and desirable future. In futures (or 'foresight') thinking, 'backcasting' is often used to generate a desirable future, and then look backwards from that future to the present in order to strategise and to plan how it could be achieved. In other words, a vision or visions of a desirable future are first defined and then pathways (or roadmaps) to that future are developed (Figure 2.1).

Drawing on previous research which had scoped out retrofit visions for Cardiff and Manchester (Dixon et al, 2014) the Reading 2050 project[1] combined elements of a smart city with those of a sustainable city. This was because Reading already has a long-term aspiration to be 'low carbon' by 2050, but also has a strong technology and green technology focus in its existing economy. Moreover, a 2050 time-horizon provides space to think beyond today's immediate problems and facilitates a greater sense of strategic thinking by identifying desirable as well as undesirable outcomes.

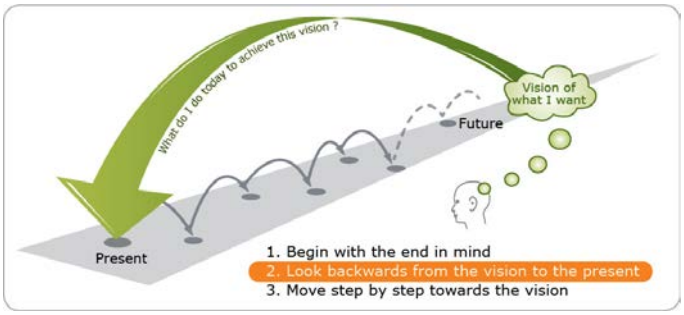

Figure 2.1 Backcasting
(source: Natural Step -– Creative Commons – http://www.naturalstep.ca/backcasting)

A 'smart and sustainable' city can be defined as one (ITU, 2014):

'that leverages the ICT infrastructure to:

- Improve the quality of life of its citizens.
- Ensure tangible economic growth for its citizens.
- Improve the well-being of its citizens.
- Establish an environmentally responsible and sustainable approach to development.
- Streamline and improve physical infrastructure.
- Reinforce resilience to natural and man-made disasters.
- Underpin effective and well-balanced regulatory, compliance and governance mechanisms.'

This definition provided the starting point for developing a vision for Reading 2050, with the Reading/Wokingham urban area as the primary focus. To develop the vision, we ran three workshops and a major public engagement event (Table 2.1 and Figure 2.2). These were supplemented by other events, including:

- Engagement event with young people (*Greys and Greens* event) – (November 2014)
- Linking with Reading Museum's *Where's Reading heading? Happy Museums Project*[2]
- *Drawing the City* event with School of Architecture students (October 2016)

The three workshops focused on three main elements of the vision:

- Identity (people and lifestyle)
- Life (place and environment)
- Work (economy and employment)

1 www.reading2050.co.uk

2 http://www.readingmuseum.org.uk/get-involved/projects-consultation/where-s-reading-heading/

Table 2.1 Examples of visioning events for Reading 2050

Event	Date	Purpose	Attendees	Impact
Initial Vision Workshop	December 2014	Initial meeting and scoping of the vision	56 (business, academia and public/NGOs)	Influenced thinking about a Reading 2050 vision and helped build a network to achieve this using urban foresight methodology
Reading Borough Councillors Workshop	September 2014	Initial meeting and feedback of vision	20 (Reading councillors)	Gained support from the councillors and helped build stronger link with Reading Borough Council to support the vision
Follow-Up Workshop	December 2015	Developing the vision	41 (business, academia and public/NGOs)	Further developed impact by building out the detail of the vision
Urban Design Workshop	January 2016	Picturing and imagining the vision	32 (business, academia and public/NGOs)	Enabled the vision to help influence local/regional design
'Step into Reading' Public Engagement	March 2016	Engaging with the wider public in Reading	350 surveyed (spoke to personally) 3000 leaflets distributed 21,000 engaged on social media	Direct impact by helping engage with public and secure feedback for the vision
Feedback and consultation through Reading Borough Council Local Plan consultation	March–June 2017	Engaging with the wider public in Reading and Reading Borough Council councillors and planning department	Reading citizens and other stakeholders	Direct impact by helping engage with public and secure feedback for the vision
Group Meetings with Reading Borough Council Planning Department	May–June 2017	Engaging with Reading Borough Council councillors and planning department	Reading Borough Council councillors and planning department	Helped finalise the explicit citation of the Reading 2050 vision in the local plan and corporate plan and establish a Reading 2050 Futures Commission
Launch of Reading 2050 Vision (Thames Lido in Reading)	October 2017	Engaging with all key stakeholders	Businesses, local government and community groups (200 attendees) Keynote by Peter Sloman, CEO of Reading BC.	Public engagement and outreach to all stakeholders

Each of the workshops used foresight-based techniques to imagine the future of Reading and they were used to develop three main strands of thinking:

What should a smart and sustainable Reading look like in 2050? (Developing the vision): What should Reading look like in 2050, how will it feel, and what will it be like living there? How do we join smart technologies with sustainable thinking in Reading to set it apart, building on the strengths Reading already has?

How do we achieve a smart and sustainable Reading by 2050? (Developing the roadmaps or pathways to the future): What do we need to do, and by when, to achieve the smart and sustainable vision for Reading? We used structured roadmaps and matrices to identify challenges and opportunities.

'Urban design' scenarios: The workshops scoped out the physical changes which could support the smart and sustainable vision, in the short, medium and long term. Group work examined how

Figure 2.2 Visioning activities for Reading 2050

specific key developments might emerge and what infrastructure changes were needed. We used 'postcards from the future' and other visual aids to summarise the thinking of groups, and these were at the heart of developing the urban design scenarios.

More recently in November 2019 a further workshop was run to refresh the vision in the light of the moves to a net zero Reading by 2030 (declared by Reading Borough Council). During the course of its work, to date, the Reading 2050 programme has engaged with 21000 people and more than 400 businesses with some 15 linked events.

The overall Reading 2050 vision statement that emerged from the series of workshops and participatory engagement was that:

"By 2050, we believe a strong vision will help us to establish Reading as an internationally recognised and economically successful city region. A city where low carbon living[3] is the norm, and the built environment, technology and innovation have combined to create a dynamic, smart and sustainable city with a high quality of life and equal opportunities for all".

3 Reading Borough Council have now set a net zero carbon target for 2030, and so the vision now reflects this ambition.

Figure 2.3 Reading 2050 Vision

By 2050 Reading will therefore be:

- A cosmopolitan city celebrating and supporting its cultural diversity.
- Retrofitted and developed to create a smart, sustainable, high-quality built environment.
- A leading destination offering a vibrant city of arts, culture, architecture and public realm.
- Supported by a comprehensive sustainable transport system that accommodates walking and cycling, as well as rapid transport and zero emission vehicles.
- A city of equal opportunities for all and reducing poverty and deprivation.
- A dynamic, resilient and confident city attracting new businesses and entrepreneurs operating sectorally.
- A leader in smart and green technology and sustainable living solutions.
- A city which has rediscovered and embraced its heritage and landscape.
- Generating a large proportion of its own energy from renewables.

Within this vision, three interrelated urban futures were developed as follows (Figure 2.3):

Green Tech City: A city that builds upon its established technology focus. It celebrates and encourages diversity through business incubation units, 'Ideas Factories' and a city centre University campus through which to exhibit and test cutting edge ideas and approaches, no matter what discipline they are emerging from.

City of Diversity and Culture: A city that builds on the success of the iconic Reading Festival to deliver arts and culture to people of all ages and ethnicities. Reading would facilitate community interaction and opportunity. The city would integrate, enhance and celebrate our heritage, bringing it to life through modern interpretations and uses of space as well as preservation.

City of Rivers and Parks: A city that recognises how water has shaped much of Reading would celebrate its waterways, opening them up to offer recreational spaces such as animated parks, a lido, food production opportunities and city centre waterside living.

Lessons learned and future plans

The Reading 2050 vision research was led by University of Reading (School of the Built Environment) in partnership with Barton Willmore (industry) and Reading UK (the economic development company for Reading). It is therefore characterised as 'academic and business led'. The visioning research, however, also brought together a diverse set of individuals from university/academia (other schools and institutes in the University of Reading); business/industry; government (primarily local); and civil society (NGOs) groups to input into the visioning process. Essentially this can be seen as the quadruple helix model of innovation (Figure 2.4). Importantly, the vision has become strongly linked with the development of the new Reading Borough Council Local Plan (which looks ahead to 2036) and is directly referenced within it as an important longer-term framework for Reading. A similar synergy is highlighted in the Corporate Plan where the council describes its endorsement of the vision and its commitment to integrating the 2050 ambitions into its priorities.

Figure 2.4 Quadruple helix

In the case of the university there was an altruistic desire to help develop the vision, but also a longer-term ambition that in working with the other project partners the development of the vision could lead to further grant applications and funding for research in the field of smart and sustainable cities. Indeed, this has already led to some success. For example, Thames Valley Berkshire European Regional Development funding (£1.7m) has been secured by industry, Reading Borough Council and the University of Reading to develop smart city projects in Reading and the wider Thames Valley Region (including Bracknell, Wokingham and Newbury), which link with the Reading 2050 vision, and Reading Borough Council was the only urban area in south east England to win Heritage Lottery funding for the Great Place project (using Reading 2050 as a project framework). These successes have led to Reading being highlighted as a 'challenger' smart city in the Huawei Smart Cities Index 2017. As the vision is further developed, we hope to establish further funded research projects and a Reading 2050 Futures Commission.

Creating a coherent vision for a city is a challenging process. It requires resources, a coherent plan and clear leadership. Often the visions for cities that have been developed lack credibility because they fail to connect and link with existing plans and strategies, and may be driven from a narrow perspective, or may simply produce intangible, vague or unmeasurable goals. Sometimes multiple visions for cities have also been developed by different groups, leading to confusion, fragmentation and over-complexity; and resistance to change from vested-interest

groups can pose real challenges for co-created visions. Thinking at city scale therefore requires thinking across boundaries and across interest groups and using imaginative and innovative ways of engaging with communities (Dixon and Cohen, 2015). The Reading 2050 project is very much a continuing journey. The experiences of the Reading 2050 project also carry important lessons for interdisciplinary research, and the way in which city visions are co-created through a city foresight approach. These include (Dixon et al, 2018):

- Framings of the problem for transformation: how is the problem framed from the outset? What is the overall ambition or goal of the vision?
- Urban foresight activities – how can these be best developed to include a truly participatory element, and a balance between structured activities and 'blue sky' thinking?
- Ownership and leadership – who is responsible for the leadership of the vision? Who 'owns' the city vision?
- Vision and implementation – how does the city vision link with existing local plans and the aspirations of the city authorities, the public and other stakeholders? To what extent do the city authorities support the vision and its implementation?
- Contrasting partnership ambitions – related to leadership, can the differing ambitions of those creating and leading the vision be reconciled and balanced?
- Structural change and reform (vis a vis environment and design) – what are the wider implications of the vision, for example, in relation to governance structures and city status?
- Interdisciplinary challenges – how can different disciplines and different professionals work with each other, other stakeholders and the public to help develop the vision? Can built environment professionals really think 'longer term' beyond the constraints of the present?

Ultimately, city foresight techniques are not an alternative to longer term planning, and the more strategic masterplan approach adopted in many cities in continental Europe. Nonetheless, if we are to develop the longer term, unconstrained thinking that is required to move to a more sustainable future, futures-based studies offer us a potentially powerful set of tools to help achieve this, and mobilise resources in the best possible way (Dixon and Tewdwr-Jones, 2021).

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Useful links

Reading 2050 Vision: www.reading2050.co.uk

GOfS Future of Cities Programme: https://www.gov.uk/government/collections/future-of-cities

3 Reading's history and heritage

Matthew Williams Museum Manager, Reading Museum

Reading is an ancient place, well over a thousand years old, with evidence of human occupation going back at least 400,000 years. I was asked by Reading 2050 to consider the role that this heritage has to play in our town's future – a question that we are well placed to reflect upon at Reading Museum.

The Museum is Reading's own memory bank of over 400,000 objects and artworks, delivered to the local community is by a small but dedicated team of staff and many fantastic volunteers. Reading Museum has been part of Reading Borough Council (RBC) since 1883, and every year we attract over 110,000 visitors to our galleries, welcome over 15,000 school children, while a further 100,000 people experience our loan boxes of museum objects. The Museum plays a central role in protecting, promoting and helping people understand Reading's past, which helps shape place-making initiatives for its future. It is a place to introduce our town and to facilitate debate about its past, present and future. We are always listening and responding to the views of Reading people on culture and heritage. An example is our consultations in 2014 and 2015 for the 'Reading Abbey Revealed' project (Figure 3.1) when we received 2209 detailed responses that shaped each stage of our grant applications to the Heritage Lottery Fund (HLF).

It may seem odd to some readers that when looking to Reading's future in 40 years' time that we should be thinking about Reading's past, but I think it is vital and hopefully you will think so too! As geographer Nicholas Crane said in his recent book *The Making of the British Landscape* 'to care about a place, you must know its story'.

This essay focuses on the tangible or physical heritage – the streets, buildings and monuments – that are part of everyday life in Reading. However, we mustn't forget that the intangible aspects to a place's heritage such as customs, memories, oral tradition, dialect and informal place-names are all part of the mix that give a place its unique story and identity. In Reading these intangibles include events like the world famous Reading Festival or the Reading Carnival, unofficial place-names like Smelly Alley (its proper name is Union Street!), and local words like 'cheeselog' (Reading's own distinctive word for a woodlouse, and was one of a dozen regional words chosen for inclusion in 12 new poems for National Poetry Day in 2017. The Oxford English Dictionary will also include some of the words for the first time in its next edition).

This image (Figure 3.2) shows the role that digital technology can play in revealing our past, and as part of the Reading Abbey Revealed project, we have virtually rebuilt Reading Abbey. This helps us to demonstrate its vast scale and to interpret what the remains and how it still has an impact on the town today.

Reading is too often been dismissed as being a modern place with little history. This isn't a recent phenomenon. In the 1949 *Murray's Berkshire Architectural Guide*, John Betjeman and John Piper described 'the capital of the county is a much-maligned town'. While they agreed that 'No town in the south of England hides its attractions more successfully from the visitor', they showed that careful exploration would be rewarded. Almost 60 years later we are challenging the persistent impression that we have no history or heritage, often perpetuated by those how have never visited!

Figure 3.1 The Chapter House of Reading Abbey, Reading's most important monument, then in 1778 (left) and now in 2009 (right).

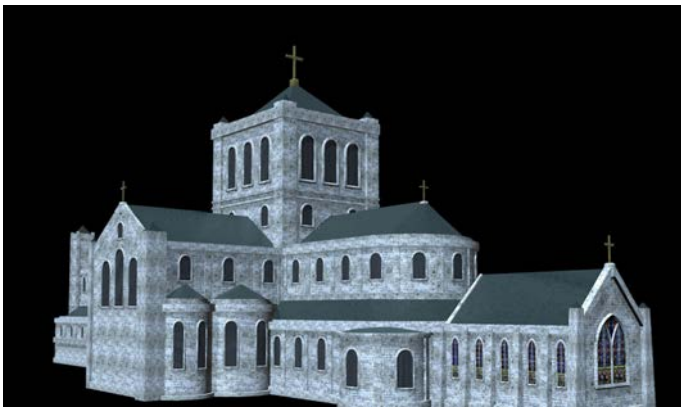

Figure 3.2 Digital image of Reading Abbey

Figure 3.3 The Museum's best-selling 'Reading' mug (only £9.99 from our shop – tea towel is also available!)

In recent years the Museum has been working with partners to present Reading in a new light both inside and outside the town. Over the last ten years ago we have heard a lot of talk about being like Brighton or Oxford...but the real key is to "Be Reading", and this is where our heritage is a unique selling point!

At Reading Museum we are shameless cheer-leaders for Reading's heritage, and have recently blogged on this very subject (www.readingmuseum.org.uk/blog/cheerleading-for-readings-heritage) (Figure 3.3). Presenting the past doesn't mean you can't be modern in your style and methods: we are increasingly embracing digital medium and media in our work, but we also love a traditional gallery!

Reading has plenty of heritage to shout about; it's the burial place of King Henry I of England, it has strong links with Oscar Wilde and Jane Austen, many of Britain's famed nineteenth century architects, such as Soane and Gilbert Scott, designed buildings in the town and many great names of late industrial Britain are synonymous with Reading – the biscuits of Huntley & Palmers, the seeds of Sutton's and the beer of Simonds, its success in modern times as harmonious and diverse town. This is the past that we need to know about if we are to understand modern Reading.

At a national level there has been much work in years to show the wider impact and benefit of heritage. The Historic Environment Forum has been presenting evidence for the impact of heritage and the historic environment in many areas of our lives and showing why heritage should matter as part of any town or cities' future. This work is presented in *Heritage Counts* – the annual audit of England's heritage, first produced in 2002 and published on the Historic England website. Key findings include:

- Adults who live in areas of higher levels of historic environment are likely to have a stronger sense of place.
- Young people and adults who cite a local building or monument as special are likely to have a stronger sense of place.
- £1 of investment in the historic environment generates £1.60 of additional economic activity over a ten year period.
- Investment in the historic environment attracts businesses, one in four businesses' agree that the historic environment is an important factor in deciding where to locate, the same as for road access.
- Investing in heritage brings more visitors to local areas and encourages them to spend more, approximately one in five visitors to areas which have had historic environment investment spend more than before, and one in four businesses has seen the number of customers increase.

These and other benefits are seeing places as diverse as Margate and Oxford embracing their heritage as a vital part of their sense of place and their urban regeneration. Sometimes it's an overlooked site or part of a town, such as Oxford Castle, previously a prison that was never part of the main heritage offer for tourists. While in other places it covers wider areas of their town or city. In Margate the regeneration of its seaside heritage at the Dreamland amusement park and its Old Town is complementing the new Turner Contemporary art gallery. History and heritage are attracting people, changing perceptions and creating places where people want to live, work and visit.

So back to Reading: it was first mentioned as a royal estate in 870 AD when the Viking army spent the winter here between the Rivers Thames and Kennet. It is this strategic location in the heart of southern England, controlling communications to the west close to London, that has made Reading an economic centre ever since. Industries come and go but Reading's geographical links have always made it a great place to live and do business.

This map (Figure 3.4) from Reading's new draft local plan makes the point about how history has shaped our town. We also need to be proactive about respecting and enhancing that heritage as the town continues to change and develop. In the centre is the small medieval heart that from 1121 to 1539 was dominated by Reading

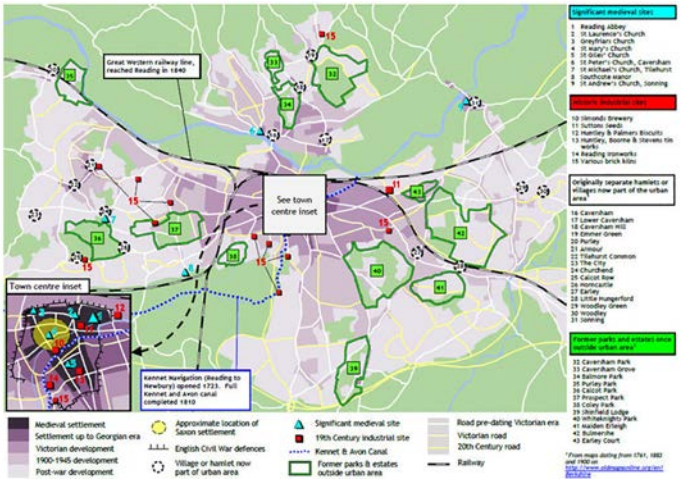

Figure 3.4 Reading's heritage from the draft Local Plan 2017

Abbey; then came canals and railways; major Victorian industries like biscuits and brickworks; world wars; motorways and the digital revolution. Former villages and country estates (like the University's Whiteknights campus) have become part of a larger urban conurbation but one that is still bounded by it rivers and floodplains and connected by strategic transport routes.

All this history means there is a lot of heritage to explore in Reading from six museum collections to 800 listed buildings, but somehow we have convinced ourselves that we 'lost' far more than we have– yet a bit of exploration as John Betjeman suggested shows there is much to see and shout about it. In 2016 the Royal Society for Arts ranked Reading in the UK top 16% of local authorities for historic built environment, 7% for industrial heritage, top 2% for museums, archives and artefacts. We are optimistic that Reading no longer wants to hide its attractions from its residents and visitors!

So, what are we doing? The Museum and RBC are with working partners in three areas to make sure heritage and history are part of Reading's future in 2050 by:

- Protecting and better managing our heritage – monuments, buildings, collections, archives
- Making sure that new development respects and enhances our heritage – with proactive policy and planning
- Ensuring Reading's heritage is no longer a hidden but enjoyed and celebrated by residents, workers and visitors through interpretation, signage, exhibitions, events, festivals, marketing and active participation

This approach is best seen in our work in the historic Abbey Quarter. This is our most ambitious scheme yet, showing what can be done when you have the vision, time and resources. The Quarter, the former precinct of Reading Abbey, one of the largest medieval royal monasteries in northern Europe, stretches from the railway station to the far side of the former prison covering an area of 12.85 hectares of the town centre. We are currently transforming this area into a unique historical and cultural destination – literally putting this internationally important monastic and royal heritage firmly on the heritage map! Today the Quarter contains a wide range of nationally important archaeological monuments, historic buildings and areas and has been defined by a specific policy in the draft Local Plan (May 2017).

In 2009 the ruins of Reading Abbey were closed to the public. This was due to their deteriorating condition being unsafe for the public. The £3.15m 'Reading Abbey Revealed' project was conceived by RBC in 2010 and secured £1.77m of HLF funding in 2015. There are three key parts to the project: conservation, interpretation and activity – that will deliver RBC's vision for the Abbey Quarter to ensure it is an integral part of Reading's contemporary life and is no longer a hidden gem when it reopens in summer 2018. The Museum will be the hub from which residents and visitors can explore and enjoy the Abbey Quarter.

Figure 3.5 Part of the new Abbey Quarter displays at Reading Museum

The project has also been engaging people through internships, learning and volunteering programmes. Our main outreach programme, 'Abbey on Wheels' has been popping up all over the town, connecting less affluent communities and underrepresented groups with their town's heritage, creating a sense of civic pride and helping to narrow the inequality gaps that are found in our town (Figure 3.5).

Beyond the Abbey Quarter the Museum team has been working with local residents to reveal the 'Hidden Histories' of their neighbourhoods. A Happy Museum commission in 2013 saw research by local volunteers resulting in a series of popular history leaflets exploring the surprising heritage of Dee Park, Newtown and Oxford Road. The Oxford Consultants for Social Inclusion have noted that "the project drew on alternative historical narratives of clay excavations, red brick heritage, manufacturing and recent social history to shape remarkable civic stories". In 2015 we looked at the past, present and future development of our town with 'Where's Reading Heading', our own contribution to the Reading 2050 debate. This project sought to provoke debate about how Reading will sustain a growing population and build a successful low carbon economy whilst narrowing the gaps between different sectors in our communities by commissioning a short documentary film, drawing together the views and knowledge of a widespread group of Reading people. This included school students, academics, local politicians, business people, ecologists, architects, and residents (see the Reading Museum You Tube channel https://www.youtube.com/watch?v=jAEmJqqtCAM).

So, where is Reading heading? There are some real opportunities to make the most of Reading's heritage and to continue this work beyond our current projects. These could include:

- Plans to develop and integrate Reading Gaol and the neighbouring site of Huntley & Palmers biscuit factory into the Abbey Quarter.

- The BBC's plans to sell off the historic Caversham Park in the north of the Borough.
- The aspiration of the new Local Plan to improve conservation areas,and remove eyesores and inappropriate developments that detract from the settings of heritage assets.
- Continued improvements to the physical and digital interpretation for heritage sites and collections.
- Bigger and/or better museums with even more on display that explain Reading's heritage stories.
- The British Museum plans to relocate their archaeology store to the new University science park at Shinfield.
- More promotion so you can find and explore the town's heritage, perhaps starting with new 'Welcome to Reading – the resting place of Henry I' – watch this space!

With so much happening, by 2050 Reading will no longer be 'a maligned town', people locally and nationally will be aware of Reading's heritage, and instead Reading will widely be regarded as a vibrant and diverse place, that successfully mixes old and new – a place that people want to visit, work and live in.

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John Betjeman and John Piper (eds) *(1949) Murray's Berkshire Architectural Guide*

Nicholas Crane (2011) *The Making Of The British Landscape: From the Ice Age to the Present*

Historic Environment Forum (2008 to present) *Heritage Counts* annual audits – see historicengland.org.uk/research/heritage-counts/

Oxford Consultants for Social Inclusion (10 May 2016) http://indicesofdeprivation.co.uk/2016/05/10/readings-happy-museum-project/

Reading Borough Council draft local plan www.reading.gov.uk/newlocalplan

Useful websites

Reading Museum: www.readingmuseum.org.uk

Abbey Quarter: www.readingabbeyquarter.org.uk

4 The Urban Room at the School of Architecture, University of Reading

Lorraine Farrelly Head of Architecture, University of Reading

Urban rooms

A key recommendation of the 2014 Farrell Review of Architecture was the development of Urban Rooms as a nexus of built environment debate across the UK. Sir Terry Farrell's Review of Architecture and the Built Environment (2014) or 'FAR', commissioned by Ed Davey, then Minister for the Department for Culture, Media and Sports, had a central idea that urban design is a significant cultural and economic asset for the UK which needs to be further capitalised. The review identified the need for institutions and actors to work more collaboratively, focusing on learning, improving, innovating and creating good quality places. The review made 60 recommendations across five 'place'-based themes. Including Education, Outreach and Skills, Design quality, Cultural Heritage, Economic Benefits and Built Environment Policy.

One of the key recommendations within the Educational theme was for 'Urban Rooms' to be established across the UK to contribute to public education and outreach about urban environments. The Urban Room concept predates the Farrell Review, but the review identified it as a key mechanism for encouraging public understanding and engagement in architecture and the built environment in UK towns and cities, and that it is an idea that should be promoted by the UK Government to develop the quality of placemaking at local and regional level.

Various initiatives already exist in the UK and internationally that have adopted and adapted the Urban Room concept to their local context. These public spaces and interpretation centres, aim not just to inform people about good urban design but also to actively engage a wide range of people in different processes with the aim of delivering better quality places.

The idea is that the urban room should offer possibilities for an exhibition space, a learning space and a community space around the theme of the quality of the Regional Built Environment. Above all, these spaces should encourage a range of groups and individuals across the community to participate in discussion about the future of their towns and cities.

In the UK, examples include 'The Architecture Centre 'in Bristol, the 'City Gallery' in Liverpool, 'Live Works' from the School of Architecture at the University of Sheffield, and Newcastle City Futures. There have been more temporary places such as the 'City Workshop' in Leeds and a 'pop up' Urban Room in Blackburn.

These centres work in different ways depending on the local interest and contributors. For example, the *Architecture Centre* in Bristol, combines exhibitions, events, learning and live projects to inspire better places. The centre hosts Bristol's '*Urban Design Forum*' which provides independent design review for major developments around the city. They offer a smaller-scale monthly design surgery where a RIBA registered architect provides one-to-one impartial advice on design related matters.

The University of Reading has a new School of Architecture which opened in September 2016 to its first cohort of students. One of the ambitions for the new School is that it connects with the region to understand the issues relevant to its context.

This is in response to the idea that many successful Schools of Architecture connect regionally to their location through community groups and other organisations interested in designing built environment projects. In doing so, they are giving their students an understanding of the dynamic backdrop of the surrounding town and city. This context gives them the 'places' to test their architectural ideas and concepts. This idea has been understood by politicians and professionals. This is a comment from the Mayor of Copenhagen who valued his city as a test bed for new ideas of place-making:

"Without the many studies from the School of Architecture, we politicians would not have had the courage to carry out the many projects to increase the cities attractiveness."
(Gehl and Svarre, 2013)

The aims of an urban room are to deliver better quality places and inform the local community about good design, but also to be aware of the concerns regionally associated with the quality of the built environment, placemaking and architecture. A common first principle of urban design as described by Gehl (2010) is to seek to understand the 'context' of a place before seeking to further shape or alter it.

A School of Architecture can be a catalyst for civic identity, using Reading town centre as a laboratory to test ideas and explore possibilities for regeneration and design. The development of an urban room, is a key strategic aim for the School of Architecture at the University of Reading. It is also part of the strategy for the Urban Living Research Group that spans across the School

of Built Environment at the University of Reading. Housing and City research also thriving at the University. Whilst Reading has benefited from the Reading 2050 initiative, which brings together the University, business and local authorities, much needs to be done to capitalise on its potential as a centre for participatory urban research.

As the recent NESTA report *The Geography of Creativity (2016)* has shown, Reading is a nexus of creative industry activity but lacks networking capability and visibility. The University of Reading urban room will address these issues head on, working with the design practice Barton Wilmore on the next steps for the Reading 2050 vision.

The idea of the Urban room is to create a place where the local community can come together to debate, discuss and exhibit ideas around architecture and the built environment regionally. It can act as a catalyst to encourage new thinking and possibilities about development, urban regeneration and placemaking. This can be achieved through a series of events and structured meetings, lectures and discussion.

Public lecture series

To encourage this discussion the School of Architecture hosted a series of public lectures and discussions. The first set of lecture series when the Architecture School opened in 2016 were invited speakers who had links to Reading.

This initial public lecture series, with 3 lectures each addressing and design and place making issue. The new strategic developments around Reading station was presented by Bob Allies, director of Allies and Morrison Architects, who are the Architects for Station Place in Reading. Another speaker was Roger Hawkins from Hawkins Brown architects who talked about design quality in higher education contexts, as his practice are working on key projects on the University of Reading Whiteknights campus.

The school of architecture has hosted a series of events in the last few years to develop a forum for discussion around architecture and the built environment. These talks have been advertised across the local community to encourage discussion and debate.

The physical model

An important aspect to realise and understand a region is to have some tools to help an understanding of scale and space in the townscape. A physical model is a very useful tool to understand 'place' and many urban interpretation centres have a physical model to allow visitors to understand the cityscape. A very good example of this is New London Architecture, a centre in central London at the Building Centre Store Street, which has a large physical model of London and is useful for visitors to London and professionals to understand possibilities for development of the city and tangible visions for its future.

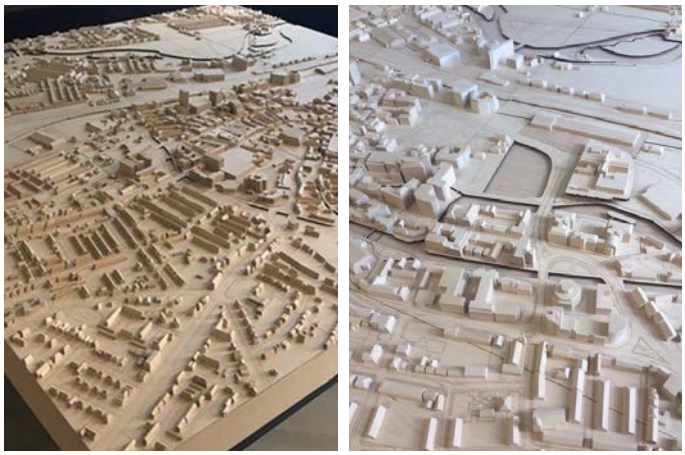

Figure 4.1 Photographs of the Reading town centre physical model at the School of Architecture (Photo Lorraine Farrelly)

The School of Architecture University of Reading received a gift from Broadway Maylan Architects of a hand-made timber model of Reading town centre at 1:1000 scale (Figure 4.1). This model has removable sections of key buildings and sites which allows new proposals to be understood against the context of the existing massing and scale of the surrounding buildings. This model has been used by students as a tool to consider their own schemes against the existing scale of buildings in the town centre.

The exhibition

At the end of its first year of operation in summer 2017, the School of Architecture also had an end of year exhibition, and the public were invited into the University to see ideas that students had developed for regional sites, including local riverside and town locations.

In addition, students worked together on a small experimental structure to test ideas of collaborative making. The idea of this experimental structure will continue every year to allow students to test different construction skills as part of the annual exhibition.

The intention is that this yearly exhibition will engage the public with ideas that students have to develop sites in Reading and the region and engage them in a conversation about the future development of Reading (Figure 4.2 and Figure 4.3).

The second season of the lecture series architecture students were invited to run the series and they defined a title – 'communities of practice'. They have invited a range of speakers to talk about their professional and practice experiences. In addition, in collaboration with Reading 2050 and Professor Tim Dixon, a second School of Built Environment public lecture series was run in parallel with this student public lecture series to bring some key issues that relate to the vision for Reading from understanding climate and heritage to ideas of transport and flooding. This lecture series invited experts and professionals from the

Figure 4.2 The first collaborative built structure by the School of Architecture (Photo: Lorraine Farrelly)

Figure 4.3 The urban room structure (Photo: Jim Stephenson)

University and regional groups and is intended to inform the public of the possibilities of development for the region and understand the context of this development from environmental, economic, planning policy, heritage and design quality perspectives.

The idea of the Urban room will take time to develop, it needs participation from stakeholders which include the local community, the local authority involved in policy and control of planning laws and regulation, professionals working in the built environment, educators and academics and local businesses. If there is involvement and participation from this cross section of the community, the urban room will be a place which could influence the quality of placemaking and development of the region.

For the School of Architecture, the future of our course and professional education is to ensure that curriculum, student experience and research is related to regional development associated with Architecture and the Built Environment and the Urban Room can support that objective.

References

Farrells (2014). *The Farrell Review of Architecture and the Built Environment.* Commissioned by UK Department of Culture, Media and Sport.

Gehl,J. (2010) *Cities for People*. Island Press, Washington

Gehl, J. and Svarre, B. (2013). *How to study public life*. Island Press, Washington

Mateos- Garcia, J., and Bakhshi, H. (2016) *The Geography of Creativity in the UK*. NESTA, London

Useful weblinks

The Farrell Review www.farrellreview.co.uk

Place Alliance www.placealliance.org.uk

Urban Rooms Network www.urbanroomsnetwork.wordpress.com

Reading 2050 vision www.Reading2050.co.uk

Governance of Urban Sustainability Challenges (GUST) www.urbanlivinglabs.net

5 The future of energy in Reading

Phil Coker School of the Built Environment, University of Reading

Introduction

Technology is changing at an eye-watering rate, with multiple trends in recent years surprising the most experienced energy analysts, not least the cost reductions in solar panels and battery systems. Against this background, speculating on a possible energy system for 2050 feels like a fool's errand. Perhaps, though, there is value in projecting from current trends and using this to unpack some future choices we will need to make. In considering the future of energy for an urban area, a reasonable start is to ask what we want energy for anyway and then to review the possible sources that we might get it from. Geography is important, especially if we attach significance to sustainability. This essay considers these issues for Reading, while keeping a wider UK context clearly in mind. To contain the possibilities, I will draw on an assumption that we are targeting true sustainability. In recent decades, human ingenuity has allowed us to dodge many of the constraints that a strict sustainability test would bring and it may well be that we continue in this vein for some time to come. I can only hope, though, that we will be much nearer this goal by 2050.

I often spend time with students thinking through a variety of definitions of sustainability. Through these discussions, I have been drawn to the idea that we should treat the planet as if we intended to carry on living on it for some while longer. *'Some while'* is elusive and we rarely reach absolute agreement on how long is long enough. We mostly agree we should think beyond the typical attention spans of newspaper headlines, political election cycles and business accounting periods. Is ten years enough, or maybe one generation? '*Forever*' seems a stretch given numerous contradictions in making decisions that would stand the test of millennia. Typically, 2050 would fall well within the frame of reference that we converge towards and, so, it seems fit to assess our current decisions against how they might be seen at that point.

One of the most compelling concepts underpinning ambitions for real sustainability is that of the '*circular economy*', as explained and advocated by the Ellen Macarthur Foundation (2012). Businesses following circular economy principles will avoid waste, seeing only resources. Resources can be separated into *biological nutrients* (such as timber or water) that are replenished by our natural environment and *technical nutrients* (such as steel or plastic) which are not naturally replenished, and must therefore be cherished, reused and their stocks perpetually maintained. Proponents argue the need to rely on renewable sources for energy. This philosophy is having a growing influence on business and the principles are increasingly widely recognised. Unfortunately, the logic is not yet dominating our direction on energy, where more immediate concerns regarding security, affordability and even climate change drive government policy. When returning to possible energy sources, below, I will draw on these principles to streamline the options.

What do we want, or need, energy for, anyway?

Many people who pause to think about energy begin to appreciate that it is not actually a thing that we want for its own sake – few of us collect or hoard energy. Rather, energy is a means to an end – it allows us to do other things. We use energy to achieve mobility, comfort, entertainment and a host of other services. There is much further to take such questions and those wishing to explore such matters might look to Shove and Walker (2014) who argue '*energy is used not for its own sake but as part of accomplishing social practices*' and that energy researchers and policy makers need to reinstate '*fundamental questions about what energy is for*'.

Every year, the UK government publish an excellent flow chart (strictly a Sankey diagram) that gives an overview of country level energy use (BEIS, 2016). This can be accessed at: https://www.gov.uk/government/collections/energy-flow-charts and I recommend a browse. The chart shows that by the time energy reaches end users, three dominant flows can be seen: electricity (or power), alongside oil, primarily for transport, and natural gas, primarily for heating.

Electricity. So much treatment of energy gets lost in thinking of electricity – a trap that all too often I blunder into myself. Perhaps this is just an attractive problem to think about. We use electricity for obvious things like lighting, for practical things like washing dishes and washing clothes, for the fun stuff – playing music, video and games, as well as communicating across great distances, or even just from one room to the next. Our appliances have become dramatically more efficient, but the profusion of appliances we use continues to grow.

Transport varies from the mundane to the exciting. Commuting to work is rarely a joy, though driving to the shops or the cinema might be. The energy to move us still comes mostly from oil, whether that be fuelling our cars, buses, planes or even ferries.

Figure 5.1 Solar PV panels on the Estates & Facilities Building, University of Reading

The UK's railways continue to see partial conversion from diesel to electric. Electrification of main line rail services through Reading completed just recently. Now this trend looks to be coming to our roads too, with the growth of electric vehicles explored further below.

Heat is somewhat harder for many of us to get excited about. We expect our buildings to be kept warm in winter, and increasingly to also be kept cool in summer. Wherever mains gas is available, this has been the fuel of choice for heating over recent decades. We have seen efforts towards greater efficiency, both through insulating our buildings and improving our appliances / heating systems. However, there is significant unrealised potential here and we remain largely dependent on fossil fuel for our comfort and health.

What are our sustainable sources of energy?

With little space here to review the full profusion of possible energy sources, I will quickly narrow down to the front-running options. Global concerns about climate change point to the need to decarbonise our energy system, meaning our policymakers are widely considering some mix of renewables, nuclear power, or fossil fuel use with carbon capture and storage (CCS). Here 'renewables' covers wind, solar, wave or tidal energy, as well as biomass (from wood or other crops), and to an extent energy from waste. Despite their low carbon credentials, I would argue that we should look beyond some of these options if they do not pass our stricter sustainability test. CCS, coupled with coal or gas, continues to deplete a limited fuel reserve and introduces a further challenge of finding somewhere to lock captured carbon dioxide out of harm's way. Nuclear fission similarly depletes stocks of fissile uranium and generates another waste storage challenge. In both cases, reasonable estimates suggest we could continue for decades without creating insurmountable problems and humanity looks likely to draw intensively on nuclear, CCS, or both, in transitioning to a sustainable future. Relying on such 'bridging' solutions troubles me, though. These bridging solutions can absorb limited financial and political resources and even crowd out preferable, long-term options.

My research and this essay are framed against the hope of moving directly and rapidly to a fully sustainable future and my greatest confidence lies in renewables. There are many reasons that could lead us along another path, not least the urgent pressure of climate change and widespread doubts that a sufficient, renewable based energy supply will prove reliable, affordable and achievable in the time required. I am optimistic, though. In his recent book 'The Switch', Goodall (2016) explores the remarkable developments with solar power and related technologies. I find myself compelled by his argument that the world is moving more rapidly than most realise towards a solar based energy system.

Where would this leave the UK, if the world's energy is to be drawn predominantly from today's incoming solar energy (rather than the sun's energy from hundreds of millions of years ago fossilised in our coal and oil reserves)? We inhabit a temperate latitude and enjoy a changeable maritime climate, where plentiful sunshine is hardly a reliable commodity. As it happens, we already rely on

the atmosphere to carry solar energy from equatorial regions to our shores; temperature gradients drive our winds and the UK offshore wind energy industry is world leading. Biomass, too, provides a means of storing summertime solar energy in a form that we can readily access in the winter. Care is needed, though, as this can represent a very inefficient way to use the solar resource and our ancestors have already demonstrated the dramatic deforestation that can arise from the over-reliance of a growing population.

Extending this thinking to the local level raises further challenges. Localism can bring numerous benefits and help point the way to much more sustainable lifestyles. Yet, our appetite for energy is ravenous and likely well beyond the capacity of our local resources. Wind energy is not well suited to urban areas; even if a greater share of us should grow to love the sight of wind turbines, the more reliable, higher speed winds blow in hilly, coastal and offshore locations. Solar energy brings some promise and provokes less human concern, but this becomes a game of land area trade-offs. The areas of farmland needed to generate sufficient electricity for Reading would be better given to food production. I do hope we will see evermore rooftop solar generation, as seen in Figure 5.1, but this can only make a modest contribution to our voracious needs.

Thought, here, must also be given to timing. This was the problem that led me to begin research at Reading, when back in 2004 I found myself wondering how useful variable renewable generation could actually prove. Since then, colleagues in our Meteorology department have helped me better understand the long-term behaviour of our wind and solar resources (e.g. Cannon, et al., 2015, Drew, et al., 2015). We have a plentiful wind resource, especially offshore, but we can occasionally see several days at a time with low winds. Solar generation tends to complement wind well, but annual variability is its Achilles' heel for the UK's purposes. We receive far more sunshine in the middle of summer and, yet, our greatest need for energy lies with keeping our buildings bright and warm in the middle of winter. Figure 5.2 contrasts the annual variability in solar generation with that of

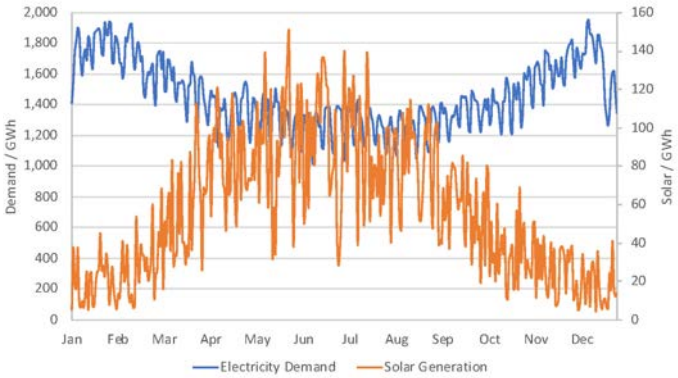

Figure 5.2 GB Electricity Demand & Solar Generation, 2017. Data from National Grid. Note secondary access exaggerates solar generation for ready comparison

GB electricity demand. This graph focusses on electricity and considerably under-represents the increase in winter heating demand that would be shown by gas use. I will return below to the potential for battery storage, but seasonal balancing of solar supply would represent the very worst deployment of batteries, requiring truly enormous battery capacity that would only be used once a year.

Caution is needed to ensure that the benefits of local energy and '*microgeneration*' do not blind us to its limits. Many of the 'local' energy schemes that we currently see in new developments rely on natural gas. These simply substitute importing electricity to our urban areas through cables with importing gas through pipes. Whilst electricity may best be generated in remote locations, importing gas perpetuates the depletion of fossil fuels, emits carbon dioxide and, for the greater part, means importing fuel from abroad. These concerns for local supply remain while we obsess about electricity, but thought to heat harvesting, below, brings more local promise.

The only certainty is change

Through recent months, the prospect of increasing electrification of transport has seen a dramatic surge in attention and credibility across the energy industry and across political and media debate. Improved battery technologies have reduced costs and increased the range of passenger cars. Concerns over air pollution are encouraging legislators to set increasingly ambitious targets for electric drive or zero emissions technologies. Sales of electric vehicles (EVs) are still low but growing rapidly while the rest of the car market is struggling.

Switching our transport needs from oil to electricity brings a host of benefits, opportunities and challenges. Our electricity networks have limited capacity and our congested streets restrict the ability of network companies to upgrade their cables, even if the cost is palatable. Charging cars overnight, at home, can take advantage of times when network demand is low, but may not be an option for those without their own off-street parking. There are calls for more public charging options, but the real need is elusive – do we want city centre, street-side chargers, charging at super-markets, at work, or simply a like for like replacement with rapid chargers where we currently have petrol pumps? Each represents sizable financial investment and significant power network upgrade needs, while technology is changing rapidly and the user case with it.

I have been drawn to the growth of EVs, because of the potential complementarity with renewable generation. Large numbers of EVs would mean vast, mobile, energy storage. We can charge when the sun is shining, or the wind blowing and could even use our vehicle batteries to power our homes when natural energy supplies are less plentiful. If we get this right, then it will help accelerate the deployment of renewable generation and the transition to sustainability.

Taking advantage of EV batteries is just one aspect of a rapid and diverse, if perhaps bewildering, stampede towards a smart(er) energy system. As dominant UK energy use has shifted from our industrial heartlands to our urban centres, so technological change is giving energy users numerous ways to take a more active role in the system. Various market mechanisms incentivise energy users to move their demand away from peak times and to offer fine tuning services back to the energy system. Simultaneously, companies are developing new technologies and business models to help users offer services in the most effective way and take best financial advantage. More homes and businesses are generating their own electricity on site and even considering installation of battery systems to further the possible benefits.

Returning to the matter of local energy resources, the one form of energy that does abound in our urban areas is heat, albeit at low temperatures. We can use heat pumps, typically driven by electricity, to move heat from our surroundings into our buildings. There are some tricks to building design and some complexities to operation, but heat pumps are in growing use and will make increasing sense as we decarbonise our power system. Energy density plays a role, with ground source heat pumps typically performing better than air source, and water source heat pumps performing better still. For Reading, this '*city of rivers and parks*', our waterways open up new opportunities, though care is needed to understand and avoid environmental risks. Whilst we should look to hydro-electric schemes, such as that proposed by Reading Hydro (2018), the greater benefit still could come from heat harvesting.

Such alternatives raise a question for the role of our gas network, perhaps the greatest unknown for our future energy system. Some of our natural gas is used for cooking, but the greater share by far is to heat our buildings. There are imperatives to move away from fossil fuels and opportunities to significantly reduce our heating needs through improved building insulation and air tightness. Some studies suggest we should shut down our gas networks, but, even if we do reduce our heating needs, it must be expected that we will still need substantial energy input from somewhere. Options could include:

- Fully electrifying our heating, where possible taking advantage of heat pumps to reduce the strain on our power networks.
- Increasing our use of district heating networks – piping hot water from centralised heating plant to our homes and offices.
- Burning more biomass (wood fuel and similar) either directly in buildings, or preferably in cleaner, centralised plants to feed heat networks.

All bring sizable challenges, especially for our distribution infrastructure. Heat networks are best suited to new developments and much harder to realise for established districts. Electricity networks would need substantial upgrade if required to supply our transport and heating needs, bringing a cost burden and planning headaches. Alternatively, given its energy carrying capabilities and the historical investment it represents, there are proposals to repurpose our gas networks:

- Some biogas (derived from biomass or waste) is already injected into our gas system and the potential here is far from fully utilised at present.
- Our natural gas supply could even be replaced with hydrogen, a clean fuel that produces only water when burned in air or used to generate electricity in fuel cells. The city of Leeds is currently considering proposals to convert their city-wide gas system to a hydrogen network. (Northern Gas Networks, et al., 2016)
- The future of heat is a growing focus of research at the University. It seems likely that most, if not all, of these solutions will see increasing uptake somewhere and we need to better understand the local circumstances that can and should influence such choices. Meanwhile, the Reading 2050 initiative provides an ideal platform for collective conversations to explore local preferences.

Some final thoughts

There are promising signs that a remarkable transition to a solar based global energy system could now be underway. For me, this is a matter of some personal optimism, though not yet one of confidence. The economic, technological and political drivers are highly complex and highly uncertain. Yet, such a solar based system, complemented by other renewables suited to local circumstances, appears the most credible, truly sustainable option that I can envisage. Dependence on variable renewables would bring challenges, but the solutions are within grasp, many of which must increasingly be delivered in our urban areas.

Simultaneously, we look to be on the cusp of widespread electrification of surface transport, now being seen with passenger cars. This will bring sweeping implications for the way that we think about energy. Home charging appears preferable wherever practical. The consequent increase in private electricity use will bring a new incentive for vehicle owners to explore innovative, flexible supply arrangements. The potential for active control of charging, or even powering the grid from our car batteries, could be highly complementary to increasing the levels of renewable generation in our power system.

Our centralised command and control based energy system is morphing into a dynamic and dispersed ecosystem. Technology within our urban areas looks set to have a far greater role in responding to variable supply, balancing discretionary energy needs moment by moment and storing energy locally. The emergence of a diversity of smart energy technologies and business models is bringing economic opportunities that could be well suited to Reading's skills base. However, this is a turbulent market place, with rapidly changing technologies, a lack of political clarity and numerous social uncertainties. Foremost could be the level of user engagement – whether enough energy users are

ready to respond actively to a variable price signal, or whether we will leave this to remote, invisible, automated services.

Perhaps the greatest and least certain question for the future of energy lies with the primitive concern of how we will keep warm. We have the technological ability to deliver buildings that maintain a comfortable internal temperature with no additional heat input, but such buildings can be met with suspicion in our damp and changeable climate. Certainly, we can improve our buildings to greatly reduce the energy input for heating, but we seem frustratingly slow in achieving this for a range of very human reasons. This leaves a great dependency on energy input to keep ourselves warm. Here, reducing our dependence on fossil fuel is very much a local challenge. We should harvest local heat where we can but moving energy through networks remains imperative. We just need to decide whether these should convey sustainable gas, hydrogen, hot water or ever more electricity

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6 The future of transport and mobility in Reading

Scott Witchalls Director Urban Places and Smart Cities, Stantec

Introduction

The future of transport has become a real talking point in the last couple of years, but the focus has, in the main, been on emerging technologies; electric vehicles, self-driving cars, drones, flying cars, hyperloops, space tourism – the list goes on. These are all exciting developments in their own right, but they don't make up a strategy, and they completely ignore the human factors in transport, forgetting that the level and type movement is a result of the environment we create, and is about people's lifestyle and choice. If we want the future of transport and mobility in Reading to be one that is inclusive, environmentally sensitive and efficient, then we need to plan around that vision, and set in place the policy levers, governance and infrastructure to be able to achieve such a vision. We need to firstly understand what has shaped Reading in a planning and transport context, and then to establish what might need to change in incremental steps to work towards the type of place Reading wants to be by 2050.

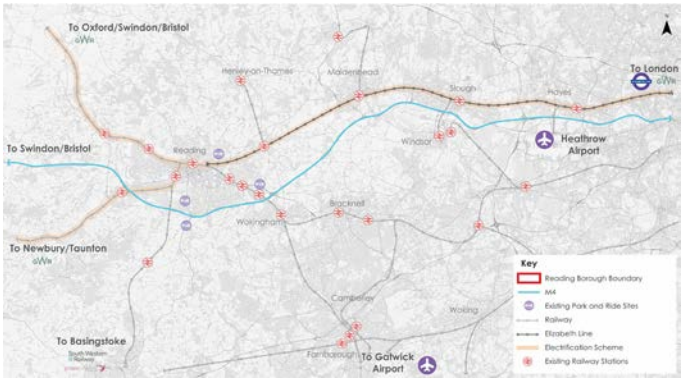
Access and movement in Reading

Like many other towns and cities, Reading has been a successful place to live and trade in for many years because of its connectivity. This was historically driven since Saxon times by the easy access to London and the west by the Rivers Thames and Kennet. Road infrastructure later followed similar routes, and most notably step changes in accessibility came with the Great Western Railway in 1840/41 and the M4 motorway in 1971.

Reading became a key trading hub, and its proximity to Heathrow airport has since made it an ideal location for global inward investment spurning the Thames Valley wide information and communication technology boom of the 1980s and 90s, finally transitioning the area from a manufacturing hub to a diverse knowledge based economy and regional retail growth hub.

Population and employment growth have been driven by this excellent strategic connectivity and high-quality surrounding environment over the years, which has bolstered the agglomeration effect of the knowledge economy in the area.

Reading ranks highly from an economic perspective having the 11th highest employment rate, the third highest average weekly earnings and a labour force where 24% of all jobs are within knowledge intensive business services, the highest percentage in the UK (Centre for Cities, 2017).

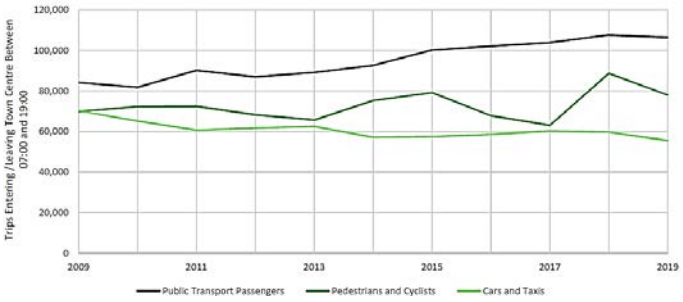


However, this growth has relied mainly on road based travel in the last 50 years and the town has both benefitted from and been blighted by a road system conceived in the 1970s including the opening of the M4 and typical 70s and 80s dual carriageways and grade separated junctions that, in places, dominate and sever the town centre. This 'road based' strategy has led to more car dependent development, particularly housing and out of town employment and retail parks across the Thames Valley as a whole, which has resulted in substantial growth in car trips and congestion. A high proportion of people drive to and from work and schools in particular, with the average annual delay to drivers in Reading now more than twice England's average at 26 hours of delay per commuter per year (Department for Transport, 2018).

This is no surprise since many of the developments around Reading are inaccessible by public transport, and too remote from other facilities and services for walking or cycling to be practical.

The challenge and considerations

Reading is now facing a critical challenge if it is to continue to be as successful in the future but do so in a more inclusive and sustainable way. It must reverse the private car-dependent hinterland philosophy that has prevailed and move towards a more sustainable travel and lifestyle model. This, in turn, will naturally help tackle the increasing problems of congestion, poor air quality, and climate impact. However, Reading is starting from a sound base. In comparison with many other towns, Reading has excellent bus and rail provision and large numbers of people walk and cycle to the town centre.



Reading station is one of the best connected rail hubs in the country, and will be a key focus for movement of large numbers of people well into the future, with stations at Tilehurst, Reading West, Green Park, Twyford, Earley, Winnersh Triangle and Winnersh, catering for more local trips within the Reading area.

Although the population and economy have grown, trips into the town centre by car have reduced, and pedestrian, cycle and public transport trips have increased (Reading Borough Council, 2019).

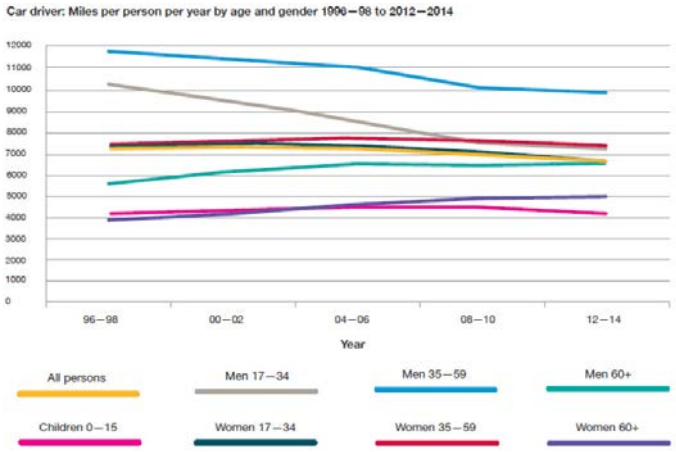
This is largely due to the implementation of a series of sustainable transport measures over the past 15 years or so set out in consecutive Local Transport Plans (Reading Borough Council (various)), including amongst other things, a cap on central parking numbers, investment in bus priority and quality bus corridors, a modern bus fleet, high quality traffic management and information systems, major rail and station upgrades, park and ride sites and walking and cycling schemes. These have all improved passenger transport and travel reliability, quality, information and connectivity.

In spite of this success, the majority of trips in the Greater Reading area are made by car and it is relatively easy to cater for this by building in more road capacity – but this will be self-defeating and lead to yet more car dependent land use plans. So, the future of transport needs to cater for all the area wide and cross Reading movements as well as the flows of people to and from the centre without building any new roads.

Changing behaviour

There is some evidence of a decline in reliance on private car access and use, particularly amongst the younger male population as demonstrated by the chart below. (Peter Brett Associates and Independent Transport Commission, 2018). There may be an opportunity to capitalise on this trend to help achieve incremental change working towards a non-car dependent vision for movement in Reading.

The research report starts to explore the many factors influencing and affecting travel behaviour and the trends emerging from recent years. These are all existing potential disruptors that mean we can start to think differently about how we plan the future of Reading, on the basis that the need to travel will be reduced, and that societal changes and different priorities will emerge.



For example, amongst younger generations, climate concerns, the cost of learning, driving, and running a car, other ways to gain freedom and independence, and a move towards city living reduce the desire or need for a car. Therefore, the future of transport in Reading will need to capitalise on the trends that may help deliver the objectives of Reading 2050, particularly those that will lead to reductions in car trip demand.

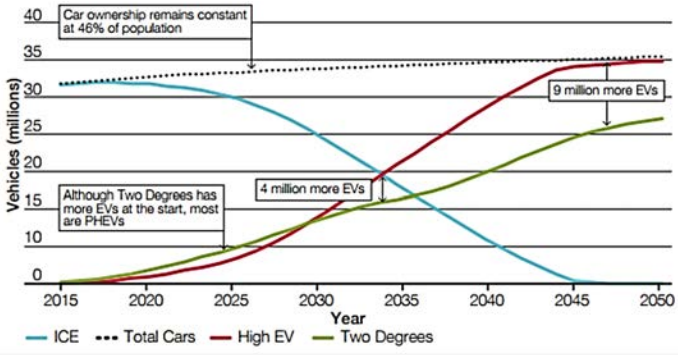
Climate emergency

One of the key disruptors from a policy perspective is that Reading, and all adjacent authorities, have declared Climate Emergencies setting a carbon neutral emissions target by 2030. Transport is the biggest single contributor to CO_2 and emissions levels haven't reduced in the last 25 years despite improvements in engine technology and reducing exhaust emissions, mainly because of the scale of traffic growth and increasing demand for larger SUVs. To achieve such a substantial reduction in transport CO_2 emissions, something radical will need to be done over the next 10 years. It will still however be critical to manage and facilitate people movement to ensure the continued success of Reading, but this will also need to be targeted towards the 2050 Vision desired outcomes.

The role of emerging technologies

To meet the climate emergency target and vision objectives, the strategy will need to embrace emerging technologies, focusing on all those areas that could help reduce CO_2 emissions either directly, through cleaner vehicles, or indirectly, by introducing measures that reduce vehicle use. The types of technology we will see in the future of transport and mobility in Reading are briefly explored below.

Electric vehicles offer significant potential to reduce the carbon footprint of travel and transport significantly. This, of course, presupposes that the electricity used to charge the batteries is sourced from renewable energy rather than coal or gas power plants, and it should not be forgotten that the production of



National Grid Future Energy Scenarios - July 2017

the vehicles themselves has a carbon footprint along with the challenges of the environmental harm of battery production and disposal, so they are not actually zero emission vehicles at all. The UK Government has now placed a ban on the sale of all petrol, diesel and hybrid cars by 2035. This is clearly a significant and positive step, but we are starting from a very low base. Less than 2% of cars are electric and it will take around 25 years before almost all cars on the roads are electric due to the life cycle of a typical car. We are also some years away from a practical electric heavy goods vehicle, and these may rely on hydrogen power as a more practical approach. The chart below, prepared by National Grid shows how, even under a high EV growth scenario, around half of the cars on the road will still be petrol or diesel powered in 2034. However, we can say with some certainty that practically all cars will be electric (or some other form of ultra-low emission fuel) by 2050.

This will lead to a gradual then complete reduction in tailpipe emissions leading to significantly improved air quality by removal of harmful gases from our environment. However, around 85% of fine particulate pollution which is also very harmful to health, comes from wear and tear on tyres, brakes and road surfaces, and such particles are lifted back into the air through vehicle movement (Timmers and Achten, 2016). If this is not addressed, these non-exhaust emissions will be dominant in road transport. Reducing single/low occupancy road travel will thus be required to achieve further improvements in air quality. Similarly, if EVs are used in the say way we use cars today, congestion problems will only get worse, so they are only part of the future mobility strategy. There is also a concern about access to charging infrastructure and potential inequalities in the price paid for electricity. Many of the early adopters of EVs are higher earners and have easy access to a charging point at their home, so pay mostly for electricity at the usual domestic rate unless they are travelling long distances and need to top-up at a commercial charge point. For those without driveways or able to run cables from their houses to the street, commercial street chargers will need to be used. These can cost much more than domestic electricity. Those on lower incomes tend to live in higher density properties (terraces and blocks of flats) with remote parking or areas without private driveway access, so the majority of commercial street charge users could pay more for their electricity but be on lower incomes (Riggall and Witchalls, 2018). Through the provision of EV charging points, there is also an impact on public realm and street clutter in the form of obtrusive posts and cables. Technology is developing in this area to replace cables with wireless, inductive charging systems hidden in the road, and that could well be the norm by 2050.

Data and communications technology will form the backbone of all our transport operating and information systems enabling a real time understanding of travel options, cost, capacity, congestion and air quality enabling us to choose the most effective way to travel for any purpose at any time of day. Data sources will include people as they move around (through wearable technology and mobile devices), vehicle to vehicle communications, live camera feeds, weather, parking, air quality and noise sensors etc, along with the millions of Internet of Things (IoT) devices that will be deployed in the coming years.

Communications, virtual and holographic technology will be so advanced that it will be possible to hold meetings, conferences, lectures and social gatherings in virtual environments, as well as seamlessly working from home or in the commonplace work sharing hubs.

Digital railways will enable trains to operate at higher frequencies and with fewer delays due to advanced safety, control and signalling systems. Train capacities and seat availability will be sent in real time to passengers before leaving their homes and whilst waiting to board. The purpose of railway hubs and their access infrastructure will become more important and should be a focal point for more intensive development areas and activities

Demand Responsive Transport (DRT) has been around for many years at a small scale and is theoretically ideal for less accessible areas where scheduled bus services are not viable. With DRT, customers simply request a pick-up from a designated point close to their home and the service, typically using smaller mini-bus type vehicles with no fixed route, drops them close to their destination. However, historic operating costs (vehicle, driver and back office systems) have meant that DRT has never really managed to offer a service on a suitable scale for Reading. With emerging vehicle technologies, automated payment systems and virtual control rooms, this will all change in the future and DRT will become more of a norm, closely associated with the deployment of autonomous vehicles and Mobility as a Service described below.

Autonomous Vehicles or driverless vehicles are perhaps the most futuristic of concepts being tested currently across the globe. The focus in the car industry beyond EVs is on the development of connected and autonomous vehicles. Most of those being trialled still look similar to the combustion engine cars they will replace, based on the model of a 'driver' sitting up front, and are clearly targeted at the market that currently has access to and regularly uses a car. This is mainly because at level 3 or 4 of

autonomy, there is still a requirement for a human to intervene and take over control when necessary. When manufacturers achieve level 5 of autonomy, there will be no need for human intervention at all so we will see genuine driverless cars on the roads.

Since autonomous vehicles are also connected to each other (virtually), they are constantly sharing data about their environment and what they are doing, or about to do. For this reason, we should see a significant reduction in accidents and injuries associated with road traffic, and an increase in capacity, as vehicles will be able to drive much closer together. Computer algorithms will make use of the extensive live network data available and will manage vehicle flows, priorities and routes taken. This has the additional aesthetic benefit of removing the need for any traffic lights or road signs.

However, the major benefit of autonomous vehicles will be in the development and deployment of shared vehicles that can carry more people and fulfil a multitude of purposes. A single vehicle could theoretically operate all day 'daisy chaining' a series of trips thereby removing the need for the multiple cars, buses and vans that would otherwise be needed. They will become self- charging, self-parking and be able to finitely control vehicle paths reducing road-space requirements.

This will lead to a reduced requirement for car parks and an ability to repurpose our road-space for the better.

A significant benefit in terms of passenger transport is one of fairly large savings in operating cost if the need for a driver is removed, meaning that additional services could operate for the same cost, and that staff could focus on customer care and supporting the elderly or infirm, for example.

In other sectors, autonomous personal flight is being developed and trialled, and this is likely to become a more popular option amongst the wealthy, initially for shorter distance travel, but will naturally develop into larger capacity vehicles with longer ranges. This will require some further management and legislation to ensure our skies do not become as polluted as our roads with low altitude vehicles (in terms of nuisance, noise and visual impact).

Bikes and E-bikes will be a mainstay of future movement in Reading especially as traffic levels reduce and more roadspace becomes available. Barriers to safe cycle trips will need to be systematically removed and new safe, green routes created.

Micro-mobility such as scooters were historically viewed as toys for children until larger more robust models suitable for adults were developed and have since become Increasingly popular for commuting in some dense urban areas, particularly in parks, cycle lanes and other traffic free environments. New forms of motorised and non-motorised personal transit are in constant development and could become a key means of getting around over short to medium distances in our towns and cities, but new legislation is needed to clarify their legality for road and cycleway use.

Drones have seen significant growth and technological development over the past few years for both commercial and domestic use. Applications such as aerial photography through to crop spraying, emergency service use and parcel delivery are planned. However, there are concerns regarding privacy, noise pollution and visual impacts which have yet to be addressed (Witchalls, 2018). NASA research (Christian and Cabell, 2017) also suggests that drone noise is more annoying to people than that of cars. However, in the right environment and used in a controlled manner, drones should become a key part of the future of transport for services such as last mile logistics along controlled flight corridors, and for use by emergency services delivering medical supplies or tackling crime. Drones for personal flight are also likely to be deployed in certain environments but these will need airspace controls as described above under autonomous vehicles.

Freight, logistics and waste make up a significant proportion of essential movement in our towns and cities. With the development of electric and autonomous vehicles, we should see a future where automated deliveries and waste collection become the norm, with modular vehicles able to mix seamlessly with people can be undertaken. We may also see the development of underground waste and delivery systems where surface space is at a premium in our highest quality environments.

Mobility as a Service (MaaS) is a concept that embraces the sharing economy, travel data availability, payment systems and multiple travel options to potentially provide the most efficient and cost-effective way of meeting area wide travel needs, removing the need to own a car at all. It is a concept being trialled in numerous cities and established in Helsinki, which now has over 70,000 registered users of its Whim service able to pay for a monthly travel package giving them access to trains, buses, taxis, car hire/clubs, bike and scooter hire. This will become the norm in the future in the same way that we currently buy data, call and text packages for our mobile devices.

A 'places first' agenda

Clearly technology will have a vital role to play in the future of transport for Reading, but we need to be careful not to rely solely on technology to solve all of the existing and emerging challenges, it will be good land use and street planning that will determine how we live, work and play in the future. There was a wave of town centre pedestrianisation projects across the UK in the late 1980s, driven by a desire to create more welcoming, high street environments. These traffic closures were often greeted with objections from traders and car drivers.

One such example was Reading's main shopping street, Broad Street. This polluted road that used to be dominated by cars, then buses, was transformed into the environment that feels much more like the type of place Reading should be in the future, including the addition of more green space to further enhance the quality and environment.

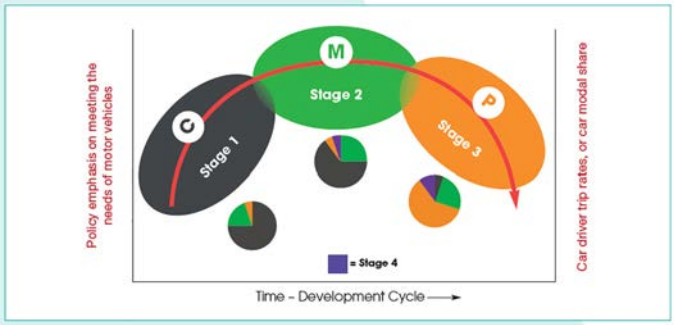
One can image the adoption of a similar approach to greening other streets in Reading to create less car dominant environments, perhaps moving towards much larger car-free areas over time, as articulated in the example below on Southampton Street looking north towards The Oracle shopping centre and Mill Lane flyover.

Broad Street, Reading before and after pedestrianisation

Source: Peter Brett Associates & Doyle Design

Such changes are always controversial but similar examples of the removal of dominant road infrastructure to create better public realm in places such as Birmingham and Liverpool have ultimately proved incredibly successful and popular. We know that a 'healthy and accessible streets' approach not only encourages more people to walk and cycle improving physical health, but that access to green and open spaces is good for mental health.

Research into this strategic shift in thinking has been undertaken by Peter Jones at University College London (diagram below), setting out how we need to transition from a car dependent growth agenda that naturally leads to increased car use (Stage 1) to a Place based agenda (Stage 3) that focuses on low car dependency and use as an outcome. We must then map out the steps required to achieve this vision of place. This moves us away from a 'predict and provide' to a 'decide and provide' approach.



Source: CREATE, Urban Mobility: Preparing for the Future, Learning from the Past - Peter Jones, UCL

Mistakes are however already being made in our desire to roll-out technology without considering the consequences. We are rightly seeing a push towards more use of electric vehicles (EVs) to tackle the problem of poor air quality in our congested areas, but this will do nothing to tackle the underlying problem of congestion and in the provision of on street EV charging points, we are creating a poorer quality public realm and also a barrier to safe and efficient movement, particularly for movement and visually impaired people in some streets.

We should be adapting and using technology more effectively to remove street clutter rather than increase it. There is a need to rethink how we can provide for EV's without damaging the environment in other ways, such as through the provision of Societal Service Stations.

Policy and legislation

The declaration of a climate emergency and growing understanding and support of the need to protect the environment provide the impetus to introduce measures that could have an immediate impact in reducing CO_2 emissions and help create the foundations for our 2050 vision. However, this is likely to need to be bolstered be a series of policy and legislative measures as a catalyst for behaviour change and uncontrolled car use. Like many other towns and Cities, Reading is constrained by its existing street pattern and buildings that cannot easily be moved, so better use of existing infrastructure has to be explored. This might need to be through legislation such as:

- Congestion charging similar to that in place in London where every vehicle driving into an area at certain peak times is charged. This not only leads to a reduction in car trips, but can also generate significant revenue to invest in better public transport and lead to improvements in safety and air quality.
- Work Place Parking Levy where every business is charged a fee for the parking spaces available to staff, as has been introduced in Nottingham.
- Low Emission or Clean Air Zones where vehicles that do not meet stringent emissions standards are charged to enter the area.
- Traffic Restrictions where certain roads can only be used by public transport vehicles, or restricted to pedestrians and cyclists only (car-free zones)
- High Occupancy Vehicle Lanes where only those vehicles carrying two or more people can access the lane

Concept future street image with narrow roads for autonomous pods and extensive public realm and landscaping (Stantec)

When will the future arrive?

Reading's roadmap to future mobility will combine the above place-led approach, technologies, legislation and planning in different cycles and to varying degrees as we move towards 2050. The timeline below gives one scenario of how this future could pan out.

- **By 2025** – Electric vehicles will make up around 10% of cars on the road and there will have been a significant improvement in air quality. The Elizabeth line will be fully open and operational connecting Reading directly with the City of London and beyond to the east. A new Green Park station will provide rail access to this major business park and housing community in South Reading. The first autonomous public transport vehicles will be running in Readings bus lanes on the A33 and Kings Road into central Reading
- **By 2030** – Electric vehicles will make up over 20% of cars on the road and there will have been a further improvement in air quality. A congestion charging scheme will have been introduced to reduce car trips and fund new cycleways, Reading Mobility as a Service (RMaaS) and a Demand Responsive Transit Network. Central Reading will have seen further pedestrianisation with autonomous shuttles connecting cross-town trips. Advances in communication and data will mean that half of all business trips are no longer necessary and are held in virtual environments.
- **By 2040** – Electric vehicles will make up around 80% of cars on the road, but the majority of central Reading will be a car-free area with autonomous only shuttles. There is a comprehensive new traffic- free cycle network across the whole of Reading, and poor air quality and safety concerns are a thing of the past. Congestion charging has been removed.
- **By 2050** – Reading has a fully autonomous road network in place with a variety of shared vehicle types and sizes available to all through RMaaS. The wider transport network will be linked by a range of travel options connecting to and serving a series of healthy, place led, car free community hubs at district local and town centres. Drones provide essential emergency and delivery services. There are no traffic lights.

Summary

In summary, the future of transport in Reading has to be based on a vision and place led approach, rather than one that is dependent on any particular means of travel or technology. We know that historic car dependent growth has led to unacceptable levels of congestion, carbon impacts, poor air quality and isolated or inaccessible communities, so we must ensure that we create the type of environment we want rather than one which is entirely dictated by available technologies.

The future transport architecture must focus on minimalistic clean, carbon neutral movement in keeping with the 2050 Vision themes of place and environment, people and lifestyle and economy and employment as an enabler to create a city of green tech, rivers and parks, and culture and diversity

There are three major disruptors emerging that we need to capitalise on now to lay the foundations for this future. These are:

- sharing economy
- climate emergency
- connected autonomous vehicles.

We should image a future Reading where private car trips have been all but eliminated. Walking, cycling and personal micro-mobility will have become the norm for shorter distance trips along safe, green corridors without traffic conflict. Communications technology in our homes and workspaces will have developed to such a degree that virtual meeting spaces and office environments have removed the need to travel for many businesses.

Good land use planning and investment will have ensured there is easy access to jobs, leisure, shopping, entertainment and culture without the need to travel long distances. Where travel by motorised means or in larger numbers is necessitated, the majority of trips will be through the shared travel service, Reading Mobility as a Service (RMaaS), and these will be in connected, autonomous electric powered vehicles using entirely renewable energy, and by seamless transfer to rail or motorway networks for more distant trips.

The move away from car ownership to 'on demand' mobility services which use AI and big data in a connected world to predict demand, supply and network conditions will ensure quality, reliability and consistency of service. Autonomous vehicles will meet the needs of all communities by providing a 'turn up and go' service on demand with a 24/7 provision. The substantial efficiencies gained by using a single vehicle for multiple trips with no redundancy making the most efficient use of roadspace means that we will not need to have built any new roads or car parks, but will have removed significant areas of road and parking to create new green amenity spaces and street culture.

Our main and local centres will be pollution free and will have become a focus of social and cultural activity with extensive natural green congregation spaces and play areas. There will be no street clutter, since connected autonomous vehicles will not need any signage or traffic signal control. Reading will have introduced measures to prevent the pollution of the skies with uncontrolled drones and flying cars – these will have their place, but only for controlled and managed deliveries and emergency services.

In the transition stages, we will see a wave of electric vehicles and the first autonomous public transport vehicles will be running along the bus lanes throughout Reading along with the introduction of RMaaS and congestion charging.

For all of this to happen, bold decisions will need to be made about priorities and transitional stages. Many people are currently car dependent or choose cars as their main means of transport. To achieve the future vision outlined, we will need to provide individuals with a better, cheaper, healthier and cleaner way to meet their travel needs as time progresses. This will be achieved by a combination of technology, legislation, behaviour change, design and governance. We should all look forwards to a future Reading with much healthier, greener environments where technology plays a key role and where cars no longer dominate the streets or the way we travel.

The views expressed in this essay are those of the author, and do not in any way reflect any commitments or policies of Reading Borough Council or the surrounding authorities.

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7 Climate change and the zero carbon challenge in Reading

Chris Beales Former Chair of Reading Climate Change Partnership
Ben Burfoot Reading Borough Council

Climate change (Chris Beales)

The reading 2050 lecture offered Ben and me a very welcome opportunity to talk about our plans to help Reading prepare for the challenges of Climate Change. It was timely as well, with 2019 promising to be a very busy year for the Partnership. Even more so now that the Council has declared a Climate Emergency for Reading (on 26 February 2019).

As a quick introduction: The Reading Climate Change Partnership (RCCP) was set up in 2009, with the aim of providing strategic direction for the town on Climate Change. The board has 11 members, representing the Council, businesses, community, health, Environment Agency and the University. One of our core responsibilities is the Reading Climate Change Strategy, which – like most big plans – is updated every few years. Our current strategy runs through to 2020 so this summer we will be starting consultation on the next iteration, which will guide the town from 2020–2025.

The Strategy, and all material that we produce in the RCCP, will be available on our new website: www.ReadingCAN.org.uk. And note that ReadingCAN is an abbreviation of the *Reading Climate Action Network*, which is going to be a vital network of people and organisations committed to delivering and developing our Strategy; as well as running events to try and engage the wider population of the town.

There is a lot of ambition in all of this and it is worth reflecting that we are still picking ourselves up from quite a low point in the RCCP. We were heavily impacted by a loss of resources and focus through austerity and the recent political climate. Happily, we have turned a corner now and, as the current Chair, I am excited to see us grow ... hopefully just in time to face the full scale of this Climate Change challenge.

What is this climate change challenge?

There has been a lot in the news about climate change recently. Something that has continued since our lecture, for example with the global protests by the Extinction Rebellion campaign and the school strikes. Beyond the political news, there are ever more articles about extreme weather events, for example the recent devastating cyclones in Mozambique. The link between these extreme events and climate change is the sharp-end of the climate change issue. These can rapidly affect our lives and livelihoods (see https://chrisbeales.net/environment/extreme-events) and they are a pressing reason to take Climate Change seriously, and get prepared for it.

In the autumn of 2018 a couple of important reports were published. The Intergovernmental Panel on Climate Change (IPCC) produced Special Report 15 (SR15) on the impacts of 1.5 degrees Celsius of global warming, with a sobering look at the consequences. It is clear from this report that if we allow the planet to warm more than this, we will face profound changes from: increasing flooding, heat waves and sea level rise; to the loss of all coral reefs; and an increasing likelihood of an annual disappearance of the Arctic ice cap.

In November the latest UK climate projections were also published. This updated science uses the latest climate models to predict how temperature, rainfall and other weather variables will change over the rest of this century. The broad message is unchanged: we need to prepare for wetter winters and drier summers; the likelihoods of more extreme heat waves and more extreme rainfall events increase. And the magnitude of these increases is very much dependent on the extent of global warming. Which, in turn, depends on the choice we make as the human race, as to whether or not we curb our carbon emissions.

The following graph (Figure 7.1) from SR15 shows how rapidly global carbon emissions have to be reduced to zero, if we are to limit global warming to 1.5 degrees C. This means reducing

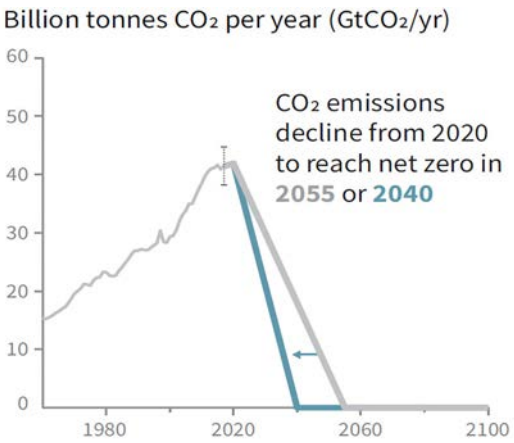


Figure 7.1 Global emissions challenge

to zero our burning of coal, oil and gas, for every country in the world; as well stopping deforestation...and potentially reversing it massively if we wish to buy ourselves more time (i.e. to 2055). Given the current global trend of increasing emissions – and the notable lack of political interest in Climate Change from some key global leaders – the chances of us meeting the scale and speed of this challenge are not great. Therefore, we need to get serious about planning to live with the consequences of more extreme climate change.

The need for an adaptation plan for Reading

In the final part of my lecture, I introduced some of the concepts behind Climate Change Adaptation Planning. There are a few examples of Adaptation planning, which are inspiring. They offer an important degree of confidence for those cities that have worked through how they will build up the infrastructure and capability to face the new extremes of weather we expect to see with the changing climate. The Thames Estuary 2100 Plan is a good example of this, and will make sure that London is protected from rising sea levels.

As Chair of the RCCP, I have made it an important part of my Vision to deliver the first Adaptation Plan for our town. This first plan will take a broad brush approach. It will describe the big picture risks we face, and highlight some key adaptation options. As a first pass, it will not be perfect. However, it will help guide future projects to tackle the unanswered questions. I hope that this will be the start of an evolving Adaptation Planning process, for Reading, similar to that envisaged nationally in the Climate Change Act 2008.

As I write this, I am very pleased to note that work has just started on this first Reading Adaptation Plan. We can expect to see this delivered in the autumn this year, and when complete, it will be available on the www.ReadingCAN.org.uk website.

Achieving a zero carbon Reading (Ben Burfoot)

Astronauts in the international space station see the sun rise sixteen times per day. As they look upon the vast dark shape of the Earth beneath them, its surface hurtling past at 17,000mph, the first thing they see at sunrise is a thin blue line. A tiny glimmering sheen along the Earth's edge. In seconds the sun bursts through and a new 40 minute space station day begins. That thin blue line shows just how slim, in planetary terms our atmosphere is. That atmosphere protects all the life on earth from the harshness of space.

In just two hundred years, which is a mere moment in geological time, the human population has risen from 1bn to 7.5bn. Since 1961 the population density has increased from 24 to 60 people average per km2 of land area.

The global consensus on climate change has varied through time and between nation states but as each new report from the International Panel on Climate Change (IPCC) is published, the level of certainty grows that we are facing inexorable changes and that the change is caused by anthropogenic factors (e.g. the combustion of fossil fuels).

In 2015, in Paris, at the 21st Convention of the Parties the Countries of the world agreed to act to limit the global temperature rise to +2 degrees Celsius with an additional commitment, via a 'ratchet agreement' to increase efforts to achieve limit temperature rise to an average of 1.5°C.

The United States of America under the Trump Administration, has not been supportive of action on climate change and there have been reports of their actions to discredit climate science. At the time of writing the USA has formally begun the year long process of exiting the Paris Accord. China, the only country with greater emissions than the USA, by comparison recognises the issue and has targets for carbon intensity and peak CO_2 emissions by 2030 and is on track to exceed its 2020 targets by a considerable margin. Its critics argue that it is not doing enough to reduce its emissions however, especially considering its prominence as the no1 emitter.

The IPCC IR15 Special Report report outlines the difference between a 1.5°C change and a 2°C change in terms of impacts. The report states that threats to ecosystems would be reduced, for example there would be a chance to save 10 to 30% of coral reefs under a 1.5°C rather than lose them entirely.

Following the IPCC report a letter was written to the COP24 Katowice conference by the mayors of the world's major cities stating that the transition to zero carbon must be achieved in cities within two decades. This means 2038. For western cities and for developed economies that are further along the reduction pathway, there is an argument to say that this should happen sooner.

'Running the numbers for Reading'

When Reading signed up to a UK100 target of 100% clean energy by 2050 some modelling was carried out to assess whether this was physically and conceivably possible in terms of delivery. The model made a number of assumptions about which measures, if rolled out to their conceivable maximum, would be required and the extent of any 'gap' that would need to filled through innovation. The model did not make specific assumptions about current policy position or financial barriers but assumed measures would be universally rolled out and that those measures deliver what is currently understood to be achievable.

In order to achieve zero carbon non-fossil based fuel and energy solutions substantial changes to infrastructure will be needed.

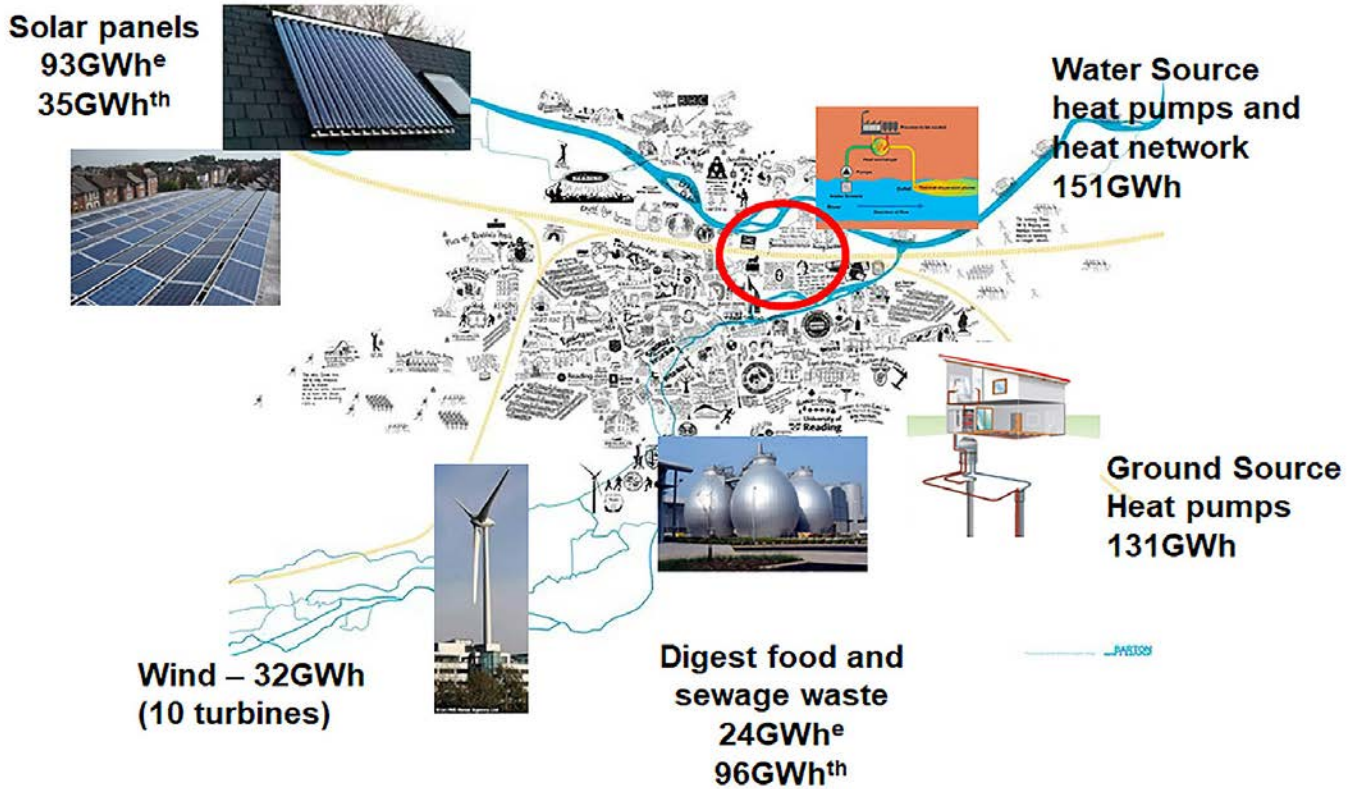


Figure 7.2 Renewable potential of Reading

Reducing energy demand

The model looks at reducing the energy demand by retrofitting buildings and then by maximising the supply of renewable energy for that demand. The size of any gap can then be assessed. This will need to be addressed by innovation and balancing approaches (offsetting).

The modelling assumed that by installing retrofit measures on all properties, with different housing types (Pre 1919, post 1919 private and social housing) a 52% reduction in gas consumption could be achieved. The likelihood of being able to achieve this is considered to be very low without significant regulatory and/or fiscal intervention, however.

With respect to electricity it was assumed that a 59% reduction would be achieved through improvements to technology for small power uses and appliances within the home. Assumptions were not made in respect of reductions to current electric powered heating. This consumption was therefore by default also assumed to average 59%.

Clean power

Once the reductions were taken into account, a series of assumptions were made on the potential for renewable energy installations. Estimates were made of how many houses and commercial roofs could accommodate solar. It was concluded that 226MWp or a little over 10 times the current amount could be possible for Solar PV mounted primarily on roofs. The assumption included 25% of houses with Solar PV. Assumptions about the amount of rooftop solar were also made using a broad resolution sample from satellite imaging and applying to industrial areas of Reading (Figure 7.2).

The model assumed 10 wind turbines the size of the current turbine at Green Park although no practical assessments of the suitability of land for these was carried out.

Heat

It was assumed that heat needs to be powered as far as possible from non-fossil sources and that hydrogen and/or biomethane delivered through gas grid will not be available in any significant proportion by 2030. On this basis we have taken the approach of delivering as much ground and river sourced heat as possible and using electricity to power the pumps. This approach harnesses the local renewable energy from the sun which is stored in the ground and water courses over the course of the year. This offers around three units of heat for every unit of electricity used to run the heat pumps.

The model sought to match the dense heat-loads in the town centre with electrically powered water source heat pumps utilising heat from the river. The assumptions were that 25% of the available heat in the rivers could be utilised (the load factor).

For ground and water source heat pumps, it was found that up to one half of the boroughs heat after demand reduction could potentially be met from these sources with most of the remainder coming from local biogas and solar thermal sources.

Note – Air Source Heat Pumps were felt to lack the Coefficient of Performance of ground and water sourced heat pumps and as such were not modelled in this scenario. In practice ASHP will likely form an important heat source for the borough although there are practical reasons why this technology should not be relied on. They typically use more power to derive the same heat output, especially when the weather is at its coldest. There are also some concerns about localised cool impacts which could occur.

The 'gap'

Initial calculations showed that although heat could be sourced primarily from local renewable energy sources, this would also create additional electrical demand to run the systems. Together with the extra electricity demand to power an estimated 30% of the transport fleet by 2030, the gap opens somewhat to some 260GWh of electricity and 164GWh of heat (later projections show that the heat gap could be reduced but the electricity gap would open further). To put this in perspective some 31 solar farms the size of the system currently installed at Pingewood (Figure 7.3) to the South of Reading would be required to fill the gap. (Note – in practice solar panels installations of this nature would not provide power at the correct of day and year to power the town and fill the gap).

Local carbon offset (allowable solutions)

The Councils planning service embedded zero carbon planning into their planning policies (the Local Plan, adopted in November 2019). This policy requires developers of larger developments (>10 houses or 1000m^2 of commercial) to meet 'zero carbon'.

Figure 7.3 Pingewood Solar Farm

In practice they are required to perform 35% better than the regulatory standard set out in the building control regulations 2013 and the remainder is used to offset emissions locally using a rate of £60 tonne p.a. In practice, the model assumed a zero emission for new build and therefore energy savings in the offset process must be additional to those already assumed.

Low and zero carbon energy from the grid

For the UK, wind energy is abundant, and the UK now has the highest capacity of off-shore wind farms in the world, meaning that renewable energy is a higher proportion of the energy mix on windy days. On this basis a strategy of seeking to store energy from low carbon times on the grid and use the power during higher carbon 'peak' periods would enable a reduction in carbon. This doesn't eliminate carbon but balanced against a flow of energy onto the grid at other times it could represent a valid strategy for a net zero Reading.

Smart city approaches

Smart city approaches are exiting and innovative. Examples are; the ability to feed power into the grid from electric vehicles, the 'demand management' of systems (avoiding peak price and carbon on the grid), the use of 'big data' to machine learn and the 'internet of things' (IoT). Notwithstanding the above comments about low carbon grid electricity, and the wider use of the term, these technologies were seen primarily as enablers critical to interconnect systems. They were not therefore considered in the model to create carbon emissions or energy reductions.

Net zero assumptions

There is no accepted definition of carbon neutral or zero carbon for cities in the UK and various local government organisations have considered this differently. The modelled approach carried out by the Council seeks to calculate the emissions without the use of offsetting other than where this is within the borough directly (as per allowable solutions). It has not yet been decided how the gap will be met, and approaches such as 'sleeving' where renewable generation capacity is installed somewhere on the grid to directly offset the consumption in Reading. In order for this type of sleeving approach to be valid, power should ideally be generated and consumed at the same time. This is not always the case and therefore it would be best if specific local projects can be invested in where generation specifically feeds the same part of the network that the consumption is made and also that local storage and power balancing approaches allow some control of when power is consumed on site.

Whilst consistent with the GHG Protocol (Green House Gas) approach of considering emissions at source, it should be noted that Reading's carbon dioxide emissions are not limited to the 'scope 1' (direct) emissions of the borough and 'scope 2'

emissions relating to the power consumed, but many would argue that they should also include the 'scope 3' or embodied emissions in all the products and services that we consume no matter where in the world these are emitted.

Economic benefits

Reading spends over £150m p.a. on energy rising to over £200m when vehicle fuel is taken into account. By creating inward investment to retrofit the town at scale and install renewable energy, a substantial part of this revenue finance could be diverted from paying energy bills to funding schemes to save energy and generate our own. This in turn would create substantial jobs, help to protect the town from the volatility of energy markets and bring money into the local economy. It would of course also enable Reading to reduce its impact on global climate change, help to equip us to adapt to changes and enable us to sell those services outwards.

Conclusions

Overall it is concluded that if a major step change is made that involves all sectors in Reading and driven by high level of ambition from partners then significant progress could be taken towards becoming zero carbon in terms of Readings scope 1 and 2 emissions. This would have the effect of boosting the local economy and would put Reading at the forefront of the global battle to control climate change.

To achieve this, however, would require significant policy developments and partners stepping forwards to lead by example in the early years to create scalable solutions.

The roadmap outlined does not focus on scope 3 emissions, ecological impact or adapting to climate change and these factors should also be developed in the towns climate change strategy going forwards.

Chris Beales was Chair of Reading Climate Change Partnership from April 2018–April 2020.

Part 2
people and lifestyle

8 Transforming the Museum of English Rural Life: past, present and future

Kate Arnold-Forster Director, Museum of English Rural Life;
Director, University Museums and Special Collections Services, University of Reading

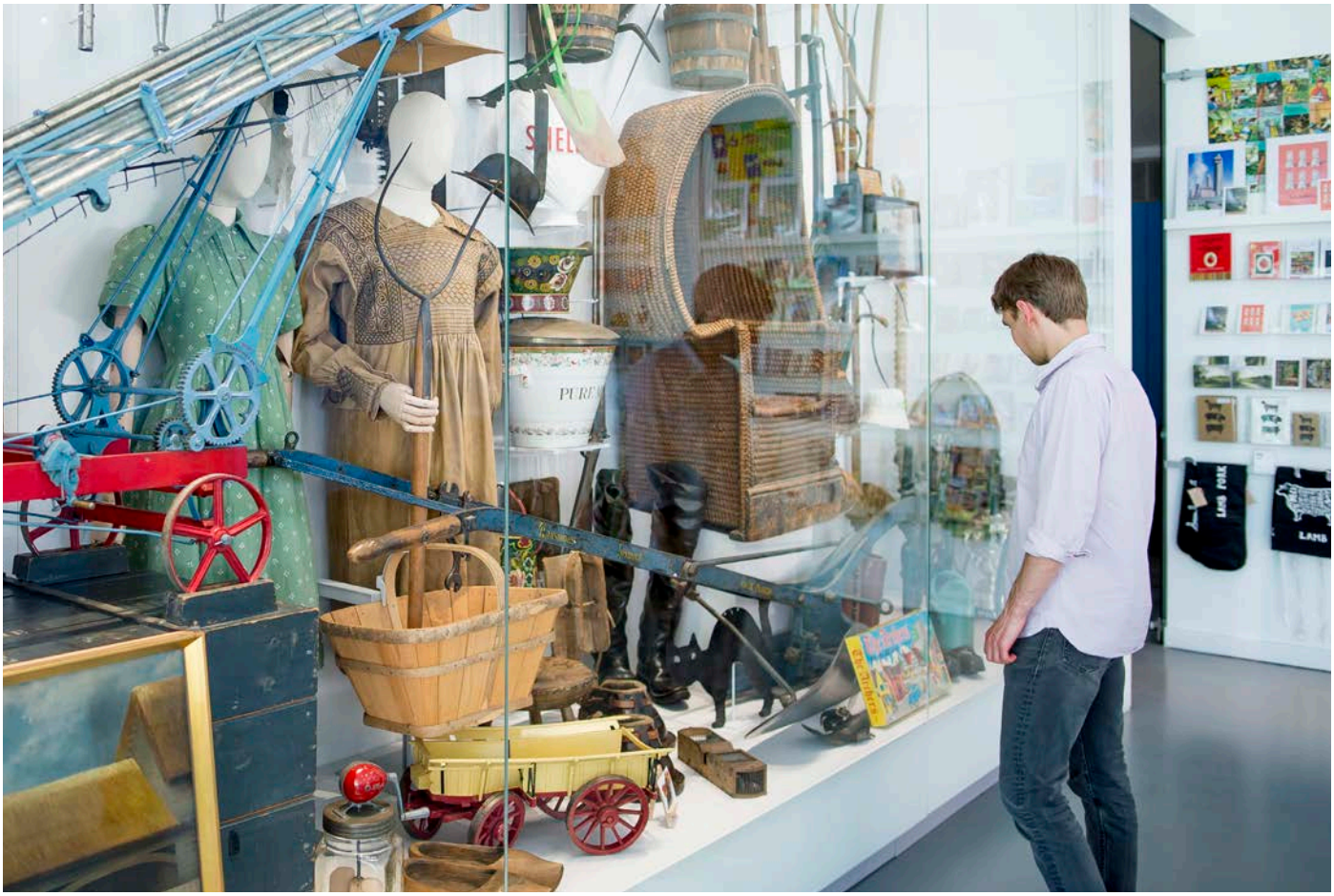
I have worked in museums in various capacities for more than three decades, as a volunteer, curator, consultant and director; I still find it hard to believe my good fortune that this has led to my present role at the Museum of English Rural Life (The MERL). Of course, I am likely to be biased, but I know that I am not alone in recognising The MERL's wider significance within the world of museums – it is not just as a wonderful cultural resource for Reading, but a pioneering institution that has helped influence and shape how many other museums have played a part in preserving the social, economic, scientific and technological records of England's rural past.

Most of us involved in museums and heritage today would probably acknowledge that we have been part of an extraordinarily dynamic period of regeneration in the sector. Over a relatively short period the emergence of new thinking about how we interpret and make use of our collections has transformed the cultural and heritage landscape. During my working life a huge number of museum and heritage projects, including many in Reading, have benefited from significant investment from the National Heritage Lottery Fund (formerly HLF) and other sponsors and benefactors. Museums and heritage sites at all levels have undergone physical renewal but have also seen a step change in how they engage with visitors. The importance of diversifying audiences, extending access have become key drivers for our funding and how we develop our resilience and long-term strategies.

The MERL has been especially fortunate to have had not one, but two, major capital redevelopments in recent years. Access to funding opportunities have made it possible to modernise and adapt, addressing both longstanding needs to house and care for collections with a view to their conservation and in response to new ideas about heritage learning and the value of cultural participation. For more than 40 years the Museum of English Rural Life was housed in what had become a crumbling time-expired temporary building on the University's Whiteknights campus. Some may still remember its former home (now demolished) and, indeed, still look back on it fondly. But it was desperately in need to redevelopment – conditions for housing the collections were terrible and, although in some respects a wonderful example of 1970s hessian- inspired museum displays, these were long past their best.

My predecessors had done much to push forward with plans for redevelopment but often, it seemed, in the face of resistance. It took the best part of twenty years to gather the momentum, external resources and University backing that led to the MERL's move to its present location on Redlands Road in 2005. Yet once rehoused, it was only a few more years before once again, we began to consider how to reposition the Museum through a project that we called 'Our Country Lives'. In 2016 the Museum of English Rural Life reopened following a major capital redevelopment, creating ten new galleries, learning spaces and the redisplay of more than 25,000 objects. Underpinning this transformation has been a fundamental examination of the Museum's purpose and its relevance to new and diverse audiences in contemporary Reading and beyond.

When we started to consider redeveloping The MERL, we set ourselves the challenge of reimagining how a museum about the everyday working life of the countryside in a pre-mechanised age could engage young, diverse and urban audiences whose own life experiences would have little to do with the history of rural England. Our ambition was also to ensure that previously inaccessible objects, such as Michael O'Connell's magnificent wall-hanging depicting rural Kent, commissioned for the Festival



of Britain in 1951, could be displayed and interpreted and in a setting where new interventions from artists and creative practitioners could sit set happily alongside the handmade technologies of the rural past.

The change of outlook for the Museum has been profound, both in its physical presentation and in how it has sought to ensure that it is at the heart of Reading's ambitions to transform its cultural offer, including looking ahead to 2050 (Figure 8.1). Leading a successful application to become an Arts Council National Portfolio Organisation for the first time in 2018 has helped realise this ambition through the creation of Museums Partnership Reading, a consortium with Reading Museum, with £1M funding from 2018–22. This new Arts Council funding is providing unprecedented opportunities for audiences to access heritage that connect people with their personal histories and identities; improve well-being; and foster a sense of place.

The Museum is finding new recognition locally for our innovative public and schools programming (including our under-fives outdoor learning session and our increasingly popular 'lates' for over-18s); nationally (for the creative reinvention of our interpretation through arts projects and residencies); and internationally for our ability to use humour to deepen engagement (through innovative social media activity and unprecedented growth in our online audiences).

We have also begun to realise a subtler goal in helping audiences find relevance in our galleries, enhance their wellbeing and enjoy individual perspectives through our engagement programmes and activity. We have invested in building strong relationships with our community partners, particularly enabling adult groups to help develop and participate in challenging new cultural experiences in our garden and through regular supported access to our spaces. Our focus centres largely on co-developed projects and promoting our facilities and expertise to benefit a wide range of communities. These include providing supported placements to promote new skills, including caring for the museum chickens, front of house and researching new community displays, for students with learning difficulties from Reading College and the sustained engagement with Elizabeth Fry House through projects and volunteering opportunities that support women who have experienced the criminal justice system. Our aim to deepen and extend engagement means that many groups have successfully progressed to directing their own activities, such as a weekly knitting circle and self-led sessions by the local Mencap group. Our garden has become a setting where the local Nepalese community and Young People with Dementia, among others, cultivate their own growing spaces. An MPR partnership with the University's Clinical Trials Unit and the Royal Berkshire Hospital, as part of the Reading Great Places Cultural Commissioning programme, is establishing a model for measuring the impact of our health and wellbeing work with older people, aiming to demonstrate the therapeutic value of our reminiscence, dance and gardening work to health commissioners.

We have sought to widen the appeal of the Museum by fostering art and creative practice, ensuring that we aspire to supporting residencies and interventions of the highest quality that resonate with the themes of the collections and open it up to new forms of interpretation. Artist, Christine Mackey's Home Grown Housing created a hen house built by the local 'men's shed' collective, now a permanent garden feature and Deirdre O'Mahoney used the collection to examine how the use of legumes as livestock fodder help combat climate breakdown. Her film, Speculative Optimism, premiered in our open stores has since been screened in arts festivals worldwide. The Wellcome Trust also supported

production of a series of films depicting pigs at play made by artist Andrea Roe and an exhibition of the wonderful sculptures and monumental photographs of artist Maria McKinney.

The Museum of the Intangible was a recent project that explored the potential for historical objects to stimulate creative investigations of their lost histories: Artist-led commissions, digital vodcasts of folk tales, a twitter-based microproject and a choreographed performance by dancer Hannah James, in a pair of clogs made for her by a traditional maker and destined to find a home back at MERL. Award-winning contemporary artist Steven Claydon asked complex questions of colonialism, cultural appropriation, and institutional authority in his 2018 exhibition for Reading International at the Museum, 'The Outside In'. He described his experience 'as a rare opportunity... these opportunities do not present themselves very often and the privilege of working with the institution and the experience and expertise of the staff has taught me much and allowed my work to develop and grow into the crevices of the collection.' All this in a year that also saw the Museum host two English Folk Dance and Song Society musicians in residence and an AHRC-funded poet-in-residence.

But perhaps our recent transformation is best demonstrated by the Museum's digital achievement through the unexpected success of a single tweet of a photograph of a ram, captioned 'look at this absolute unit' in April 2018. In under a month our followers grew by 250% and the Museum enjoyed a worldwide Twitter 'moment'. At its peak this tweet trended ahead of Beyoncé and the Superbowl, capturing the attention of the international media.

Like many museums, the MERL has had a social media presence for more than ten years, but closure during its recent redevelopment and the support of a joint ACE project with Reading Museum to develop our digital resilience, offered the perfect opportunity to explore how communicating digitally could attract a new kind of audience engagement, reaching far beyond Reading: On the one hand 'the absolute unit' was an unanticipated surprise, but on the other, part of a carefully planned and conceived campaign. Based on the proposition that through social media the Museum's voice could share a different, engaging and entertaining insights into the world of the Museum's collections, we found ways to harness Twitter's power to interact, have fun and be part of an online conversation that has brought us a sustained and still-growing audience and new-found prominence as social media innovators.

The original 'absolute unit' tweet was part of a new content stream experimenting with memes, aiming to make the museum relevant beyond our traditional audiences – those who would never consider Reading as a cultural destination, people from rural communities with low levels of cultural participation as well as young and urban audiences with the potential to enjoy heritage and cultural engagement through social media. We wondered whether this 'moment' might have been our one and only moment of fame, but perhaps against all expectations, our success with the Twitter has continued. A further viral tweet of an 18th illustration of a chicken wearing trousers, unearthed in the archives was re-tweeted by J.K. Rowling and was the subject of further national press coverage, followed by another featuring a duck that led us to attracting 100,000 followers by the beginning of 2019, outstripping many larger institutions. Our Twitter online conversations with followers from across the world have helped redefine the Museum; we have found a new way to communicate about what those of us who work here have always known about its unique and wonderful capacity to engage, inspire, inform and even entertain.

Chronologically, there is a neat and rather satisfying alignment between the history of the Museum of English Rural Life and the theme of this lecture series. The museum was founded in 1951 so by 2050 will be approaching its centenary. Looking ahead to 2050, it is intriguing to consider The MERL in a changing social, cultural and economic context and speculate on its place in Reading's wider cultural landscape. Predicting precisely how new models of engagement and participation will evolve between now and then and how it will sustain its relevance to its many communities and stakeholders in Reading might be difficult, but there are perhaps some important clues and indications to the future to be found through examining the impact of the Museum's recent redevelopment: In particular, how new community programmes and digital engagement is transforming MERL's capacity to reach and engage with local and global audiences and to enrich lives locally and globally.

Useful weblinks

University of Reading University Museums and Collections Portal: https://collections.reading.ac.uk/

@TheMERL (Twitter): https://merl.reading.ac.uk/

9 Nature and people in our urban future

Natalie Ganpatsingh Director, Nature Nurture CIC

As we look to the future of Reading and explore how can we develop a smart city, we can easily become focused on the new, but looking at how we lived 200,000 years ago alongside harnessing the power of technology may hold the key.

Reading boasts a formidable array of green spaces and waterways, abundant in wildlife and delivering a range of ecosystem services, from food production, flood mitigation and air quality to providing recreational and sport opportunities. I have always been fascinated by our relationship with the natural environment, but it is only more recently that I discovered the evidence base around the importance of spending time in nature to our health. At last this is recognised in the environment sector, with conservation organisations shifting their focus to connecting people with nature as well as supporting wildlife. In terms of government policy, Defra's 25 Year Plan for the Environment features a key strand on 'Connecting people with the environment to improve health and wellbeing' (DEFRA, 2018) and Sport England's Active Nation strategy (Sport England, 2016) has shifted to embrace the role of green space and outdoor recreation as well as traditional sport, in keeping us active.

I grew up in Reading and I was lucky to have a nature-rich childhood which enabled hours of physical activity, self-led play and learning experiences, risk taking, resilience building and a strong sense of place and belonging. We were allowed to roam; to play in the natural environment, unsupervised, whatever the weather. Thanks mum, dad and the 1970s.

Surveying childhood today, it seems that sedentary indoor activities, often screen-based, are the order of the day, both at home and school. A 'Dirt is Good' campaign survey in 2016 suggested that three-quarters of UK children spend less time outdoors than prison inmates (Carrington, 2016) A report by Dr. William Bird, published by Natural England and the Royal Society for the Protection of Birds highlighted the shrinking roaming distance of children over just four generations from 6 miles to 300 feet (Bird, 2007) Stress, anxiety, depression and obesity are on the rise and we are in danger of leaving behind the original NHS; the Natural Health Service. The way we are living is not serving our health with just over 70% (40 million) of global deaths in 2015 caused by non-communicable diseases (BMJ, 2016). That is to say, non-infectious diseases, many of which are lifestyle related. The state of nature is pretty alarming too, with a recent World Wildlife Report (WWF, 2018) stating that global wildlife populations have fallen by 60% in just over four decades.

In our rush to modernise, many have assumed that we have evolved to urban-based living, but our bodies and brains have the same fundamental needs as they had 100,000 years ago – as Dr. William Bird, Director of Reading-based Intelligent Health Ltd. states, "Our bodies are meant to be active and we're designed to be connected with nature."

Despite the guidance for new homes emphasising active lifestyles, less social isolation and more green spaces, a 2018 report by Transport for New Homes (Transport for New Homes, 2018) surveyed 20 new housing developments across the UK and found many were built around the car, with residents driving for almost every journey. How can we work towards a vision of Reading 2050 that supports active travel, contact with nature and an environment rich in biodiversity? Birmingham may have the answer, as I'll explain later on.

Reading like so many towns and cities, is expanding rapidly. It has been predicted that by the year 2050, 70% of the human population will live in cities (UN, 2020). We must ensure that housing developments include natural features and active travel routes through our green spaces and waterways. I propose that we take account of this primordial and vital connection we have with nature when we design the built environment and that we all seek out nature in our everyday lives and play a role as stewards, as this will support us in the here and now and secure our interdependent future. I urge our policy makers and planners to move beyond considering nature as an aesthetically pleasing enhancement to the urban setting, but rather a core and integrated component from the outset, for the sake of both people and wildlife.

In the late 80s I studied Philosophy and Social Anthropology at The University of Kent. I learnt about the limitations of an anthropocentric belief system, with its utilitarian attitude towards nature and I explored biocentric and animistic cultures deeply connected with nature where people saw themselves as part of an intricate web of interdependent life (Marshall, 1996) rather than seeking dominion over nature. My questioning of our so called advanced civilised living, prompted me to seek out indigenous communities living closely with nature and I travelled to the Belizean jungle where I worked as an expedition artist, documenting life with a Mayan community, sketching jungle wildlife and painting murals. I marvelled at children's inventiveness and self-directed play, using the natural materials around them. Their adept use of machetes from so young and their use of sustainable building materials, sourced from the jungle.

After several months away from home, the pressures of earning a living brought me back to Reading where I settled in the west and lost sight of the wild.

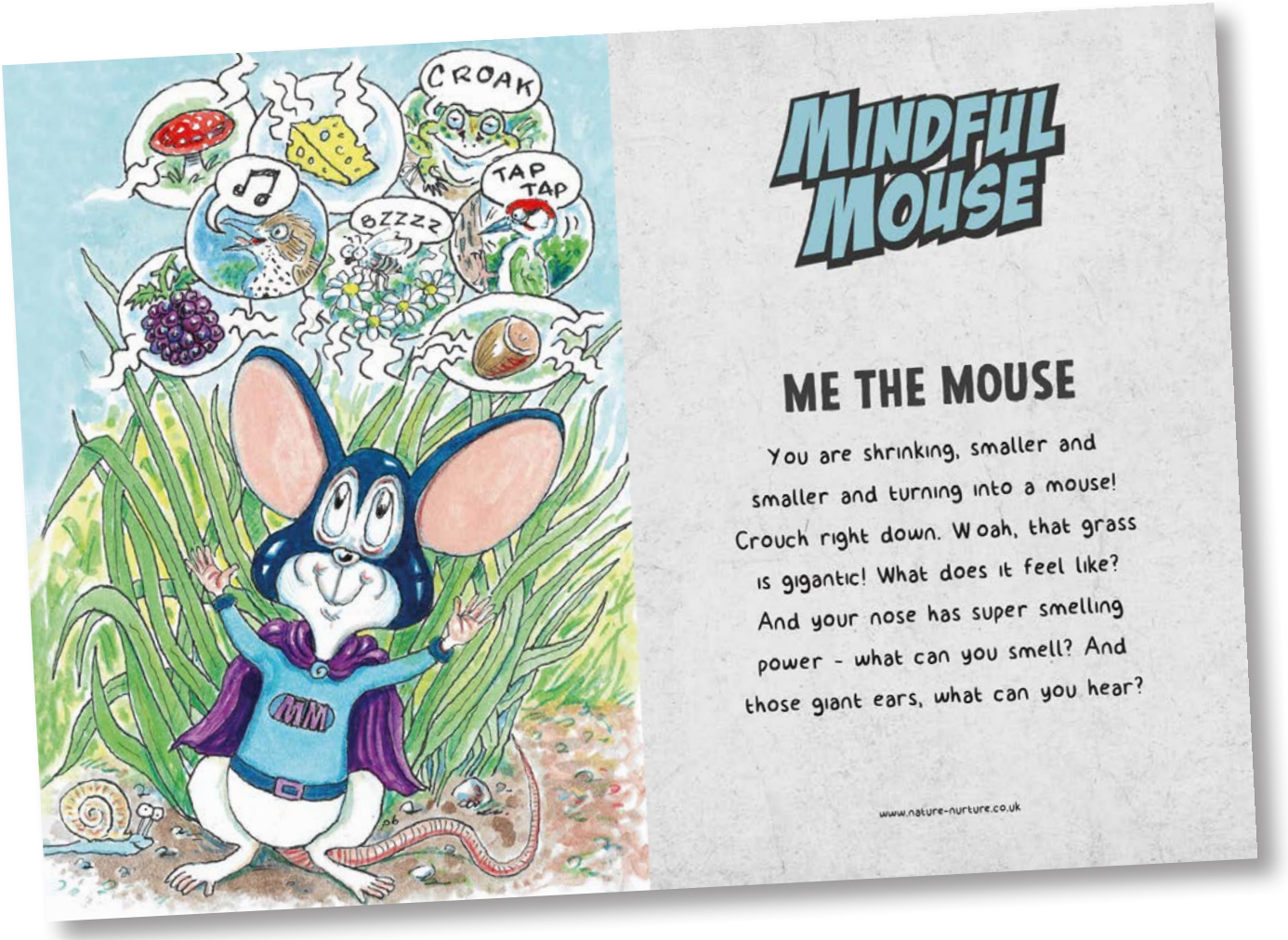
Fast forward 15 years of urban living and I reached a turning point in my career. Pondering my future, I walked to Prospect Park, but unlike my normal tarmaced route, I took a walk on the wild side, through the Rookery where I had never ventured before. I meandered past oaks and field maples towards the tap tapping of the woodpeckers and saw the early summer light shining through the beech leaves and a carpet of bluebells. My mood uplifted and my pace quickened. How could I have lived in West Reading so long and not discovered such a beautiful place of adventure? It then struck me that save for a few dog walkers, nobody was there. This space that offered so much scope for play and learning, relaxing, walking, running and cycling right in the heart of our town was devoid of people. I then began exploring more of Reading's parks and woodlands; beginning with our gems in the west;

Top The Wild West Project, illustrated by Natalie Ganpatsingh

Above Crique Sarco mural, Belize, by Natalie Ganpatsingh

Blundells Copse, McCilroy and Arthur Newbery Parks with their magnificent woodlands, streams and meadows and spectacular views across Reading. It was at this point that I knew what I had to do; set up an organisation with a mission: Connect the people of Reading with their nature and heritage. So, Nature Nurture was born nine years ago. In 2016 we achieved a Pride of Reading Award in recognition of our success in engaging people with nature.

After training as a Forest School leader I amassed a team of local environmental educators and creatives with a shared vision. I began writing grant applications and the funding came in, enabling us to run workshops and events in Reading's wild spaces. We realised that connecting urban communities



with nature genuinely fulfilled an array of positive outcomes; increasing physical activity, supporting mental health, increasing wellbeing, strengthening communities, tackling social isolation and increasing pro-environmental behaviour. We discovered that there were Friends of Parks, Food4Families community food growing projects and numerous grassroots conservation groups across Reading, all eager to recruit more volunteers and that by joining forces we could engage communities in getting active outdoors, meeting people and helping to look after their local green spaces. We have worked across Reading, providing an array of nature-inspired activities, including our popular Family Wild Days which attract between 200 and 500 people, with activities including pond dipping, bug hunting, den building, storytelling and foraging. All simple activities, requiring minimal instruction or specialist equipment, enabling families to participate in free, wholesome nature-based activities, together. Thanks to our partnership with Catalyst Housing Ltd, we have been able to focus on Dee Park and the adjacent ancient woodland of Lousehill Copse with a range of nature-based health interventions including Family Wild Days, Forest School and outdoor theatre. The Conservation Volunteers recently invited us to collaborate on a project that seeks to improve habitats for priority species whilst engaging the local community. We have been able to help boost health and wellbeing and community pride whilst nurturing custodians of nature. Teachers from four neighbouring schools have attended 'Wild Teaching' training sessions in the copse and now regularly take learning out of the classroom and into the wild. Managers from Vodafone took part in Nature Nurture's 'Greenspace Challenge' and not only fulfilled their Corporate Social Responsibility objectives, but reaped the health and wellbeing benefits of being active in nature. A project with older people in Earley combined socialising, tea and cake with conservation activities. It's a win-win for people and nature and a model we would like to replicate across Reading.

I have been able to take this urban nature connection approach further afield through my work with Dr. William Bird's company Intelligent Health. Their flagship programme 'Beat the Street', first piloted in Reading, uses smart card technology and gamification to encourage mass participation in physical activity across towns and cities. My role is to help people maintain physical activity in urban nature and I have built on my re-wilding Reading experience to create trails, learning resources and nature-based health interventions with communities in Wolverhampton, Hounslow and Colchester.

Rather than urge people to leave technology behind, we recognise its potential to serve as a conduit between humans and nature. Our Nesta funded Interactive Soundmap for Tomorrow's Reading was our first step into technology, swiftly followed by our Talking Trees project with the Woodland Trust. We collaborated with Reading's maker community to build Raspberry Pi computers into bird boxes with motion sensors triggering audio beside Tower Bridge for London Tree Week. In 2017 we were selected as one of the 50 Gamechangers in the Thames Valley design and technology community.

Our most recent nature tech venture is our collaboration with the developers of YourTour which turns your mobile into a personal interactive tour guide via immersive audio. Our trail in Colchester is being built on this user-friendly platform and brings to life the wildlife and history of an underused urban green space, with outcomes around improving health and wellbeing and encouraging volunteering. Our next joint venture is the 'Wild

Left Nature Nurture's Mindful Mouse®
illustrated by Phil Baber

Right Nature Nurture's Talking Trees,
commissioned by The Woodland Trust

Workout', which will encourage families and schools to participate in a series of accessible and fun physical activity circuit stations, through friendly animal characters that guide you along the way and 'appear' in school grounds, heritage sites and parks through augmented reality. Hi-tech and hi-nature ways of experiencing the world do not need to be mutually exclusive and if we are to capture a contemporary audience, we need to stay abreast of evolving technologies.

Back to the built environment and my mention of Birmingham – what can we learn from our friends in the West Midlands? Well they are the UK's first Biophilic City. The term 'Biophilia' was used by Harvard Professor E.O. Wilson (Wilson, 1986) and proposed that the tendency of humans to focus on and to affiliate with nature and other life-forms has, in part, a genetic basis. Dr.Timothy Beatley applied this to the urban environment in his book 'Biophilic Cities: Integrating Nature into Urban Design and Planning' (12) and proposed that any vision of a sustainable future must focus on nature. For too long we have perceived environmental considerations as slowing down or at odds with progress, "The choice between city and nature is a false choice and an unnecessary and outdated dichotomy. Biophilic cities and biophilic urbanism transcend this dichotomy and present a compelling new vision for a rapidly urbanizing world." As a biophilic city, Birmingham is pioneering a comprehensive, integrated approach to environmental and health-related problems and any planning applications have to go through a rigorous natural capital assessment to evaluate their ecological impact.

Another inspirational modern city is Bogotá, Colombia, which is built around keeping kids active, sociable and outdoors. Mayor Enrique Peñalosa, sees children as an indicator species, "In Bogotá, our goal was to make a city for all the children. The measure of a good city is one where a child on a tricycle or bicycle can safely go anywhere. If a city is good for children, it will be good for everybody else." I am delighted that Reading Borough Council enables 'Play Streets', giving children the chance to play safely in their street without danger from traffic. Residents can apply for up to 3 hours a day per fortnight. However, this should not be a one off, but an everyday possibility. We need to design our towns and cities less around cars and more around walking, cycling, biodiversity and children's play with plenty of off-road options and green corridors. I contributed to Arup's 'Cities Alive – Designing for urban childhoods report' (Arup, 2016) which proposes that "Seeing a city from children's perspective shines a light on how the urban environment could be improved, both now and for future generations."

So, back to the future of Reading; I recognise the need for new homes, schools, businesses and transport routes but I believe that by learning from Birmingham and Bogota's approach, we can make better decisions and build a smart city that supports healthy living and biodiversity. We need to recognise the interdependence of humans and wildlife and our innate need for connecting with nature and each other, embracing technology in the process.

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10 Measuring Reading's resource consumption – an application of urban metabolism

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Introduction

Resource efficiency in our urban areas will be central to humanity's long-term mission to a sustainable relationship to our planetary support systems. Our parallel goal for economic growth can be made more sustainable through this lens using material flow management (Niza, Rosado and Ferrdo, 2009). Looking at the urban level, a greater understanding of the urban resource flows, or urban metabolism, enables a quantitative approach for gauging resource efficiency, understanding where anomalies in resource demands exist, and lessons that can be learned from these.

With over 50% of the world's population now living in urban areas and these urban areas representing 70% of global GDP, cities are focal points of resource consumption (Barles, 2009; Niza et al., 2009; Mckinsey Global Institute, 2011); they must be targeted to achieve greater resource efficiency in our economies. Understanding the material flows of cities enables new insight on resource intensity and how this can be reduced (Voskamp et al., 2017). However, the rise of globalisation has led to resource flows becoming increasingly global. The majority of consumption within cities is now comprised of imported finished and intermediary products instead of raw materials (Barles, 2009; Niza, Rosado and Ferrdo, 2009). These new commodity chains highlight that resource consumption within cities and waste produced can have environmental impacts beyond the administrative boundary (Kennedy et al., 2014).

Whilst urban metabolism studies of cities are rare due to inadequate data availability (Niza et al., 2009), the development of material flow analysis (MFA) in the 1990s has provided a framework to understand the sustainable development of cities (Kennedy, Pincetl and Bunje, 2011). Since then, urban metabolism studies have been completed for several major European cities including Paris and the surrounding region (Barles, 2009), Amsterdam (Voskamp et al., 2017) and Lisbon (Niza, Rosado and Ferrdo, 2009). These studies provide context to explain how cities' characteristics can affect its resource requirements.

For instance, Voskamp et al., (2017) discuss the influence of the Port of Amsterdam on the city's material balance. Given the large volumes of material flows, mainly fossil fuels, entering and leaving the city through the port, calculating which of these flows are a throughput (trade-related flows that simply pass through the city without being consumed or processed) gives great insight into the city's imports, exports and stocks (Voskamp et al., 2017). Without this differentiation, the material consumption within Amsterdam could be distorted and considerably higher than the true value. An accurate reflection can be used to establish how much of Amsterdam's resource consumption could be met through local sourcing.

Kennedy, Pincetl and Bunje (2011) discusses the potential applications of urban metabolism including; greenhouse gas accounting, mathematical modelling for policy analysis, urban design and as an indicator for sustainability. Their section on mathematical modelling is particularly relevant to this report and discloses how these models can be used to quantify the stocks and flows in metabolism.

A particular gap that exists in the research is the role of medium-sized cities in realising improvements in resource efficiency (Bahers, Barles and Durand 2018); many existing major MFA studies (such as those discussed above) have focused on large cities, particularly mega cities (Kennedy et al., 2015). However, residents of these megacities do not represent the majority of the population. For example, 61% of the population lives in urban areas between 100,000 and 500,000 residents (ONS, 2014). This increases to 67% if you also include urban areas between 500,000 to 999,999. Only 20% of the population lives in urban areas greater a million residents. If the UK is to be successful in realising a more sustainable economy, these medium-sized cities will require dramatic changes in their resource consumption.

This chapter discusses the results of an MFA of one such medium-sized European urban area: Reading, UK. The motivation of this is to determine in which ways urban areas such as Reading's differ from their larger counter parts. We explore the trends in resource demands over the 5-year study period (2010 - 2015), with further insight on where Reading's sustainability challenges lie. Finally, we explore spatial variations in resource consumption to gain insight into the local drivers of resource consumption.

Background

Within this study the MFA method will be applied to the municipality of Reading. Reading is a large town made up of 16 wards and 2 constituencies, situated along the Thames River in the South-East county of Berkshire (Figure 10.1). An important technology and commercial centre within the Thames Valley region, Reading is ranked as the UK's top economic area for economic success and wellbeing (PriceWaterhouseCoopers, 2018), and home to the University of Reading and major national sports teams.

Figure 10.1 Location of Reading in the UK, the South-East region and the municipality boundaries

The following table provides key social and economic statistics for Reading in both of the base years studied (see Table 10.1). There has been a 4% increase in population from 2010 to 2015, and therefore an increase in the population density by 186 per km² (Office for National Statistics, 2017). In terms of Gross Value Added (GVA), Reading's economy grew by £1,042M in the five years between the base years (Office for National Statistics, 2017). Also, the table shows there is a difference in the climate of the two years studied. In 2015, the daily average temperature was 1.44°C hotter than 2010, and the year saw 30.2mm more precipitation than 2010 (University of Reading, 2017).

Table 10.1 Reading: Key statistics, 2010 and 2015

Indicator	Unit	2010	2015
Population	Number	154,296	160,825
Land area	m²	40,398,188	40,398,188
Population density	Per km²	3,857	4,043
Gross Value Added (GVA)1	£ million	5637	6679
Average daily temperature	°C	9.75	11.19
Annual precipitation	mm	544.6	574.8

[1]GVA is Gross Domestic Product (GDP) excluding taxes and subsidies on products.

As shown in Table 10.2, the largest land use in Reading is suburban, covering 55.87% of total land area, followed by urban areas covering 20.19%, given a combined total of 76.06% of land used for urban processes. The land uses that can be considered more natural (neutral grassland, improved grassland, broadleaf woodland, and arable and horticulture) together only amount to 24% of land use. This presents Reading as a predominantly urban environment, with most space characterised as developed areas serving to host urban resource consumption activities (Figure 10.2).

Table 10.2 The area and percentage of each land use type in Reading (Ordnance Survey, 2017)

Land use	Area (m2)	Percentage (%)
Arable and Horticulture	540,772	1.34
Broadleaf Woodland	1,304,317	3.23
Freshwater	621,688	1.54
Improved grassland	7,148,004	17.69
Neutral Grassland	54,367	0.13
Urban	8,158,319	20.19
Suburban	22,570,721	55.87
Total Area	40,398,188	100

Areas defined by the Biodiversity Broad Habitat Classification (Jackson, 2000).

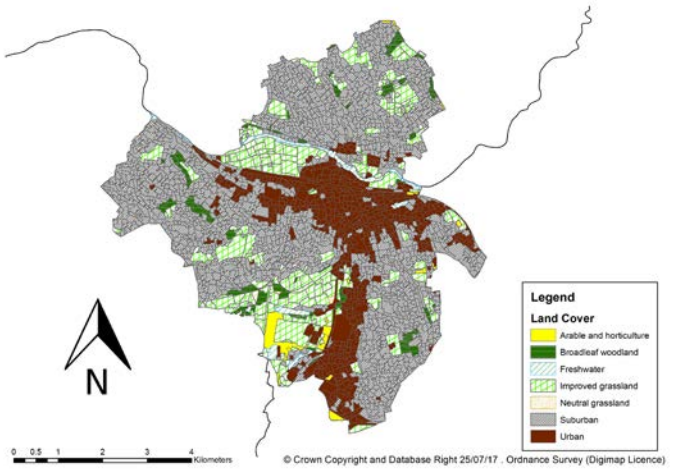

Figure 10.2 Land use map of Reading (Ordnance Survey, 2017)

Research method

Reading resource flow data were examined for the years 2010 and 2015. These years were chosen as 2015 was the most recent substantial data source available at the time of the study (2017–18), given that data are often released after two years and 2010 provides a five year difference – long enough to be able to see any potential comparative change. Three recent major UM studies for European cities all refer to the Eurostat (2001) method for MFA

(Barles, 2009; Niza et al., 2009; Voskamp et al., 2017), though they highlight that it was originally designed for use at the national level and subsequently adapted at the regional and urban level as in these studies by Hammer et al. (2003).

Using the original MFA would leave out flows that are significant within Reading, such as water and renewable energy. At the national level, the magnitude of water flows is deemed too large so is left out as it could alter other results (Eurostat, 2001). However, at a local level, all flows become vital to be able to understand a city's overall material balance (Voskamp et al., 2017). Renewable energy is also quantified since increasing the proportion of locally generated renewables in Reading is a key target for the town moving forward. Consequently, similar to Voskamp's et al. (2017), the Eurostat method used in this research has been modified to include these important flows within Reading that would not be included under the original Eurostat MFA. Figure 10.3 illustrates the flows that are examined in this modified MFA, with a list of data sources provided in Table 10.3.

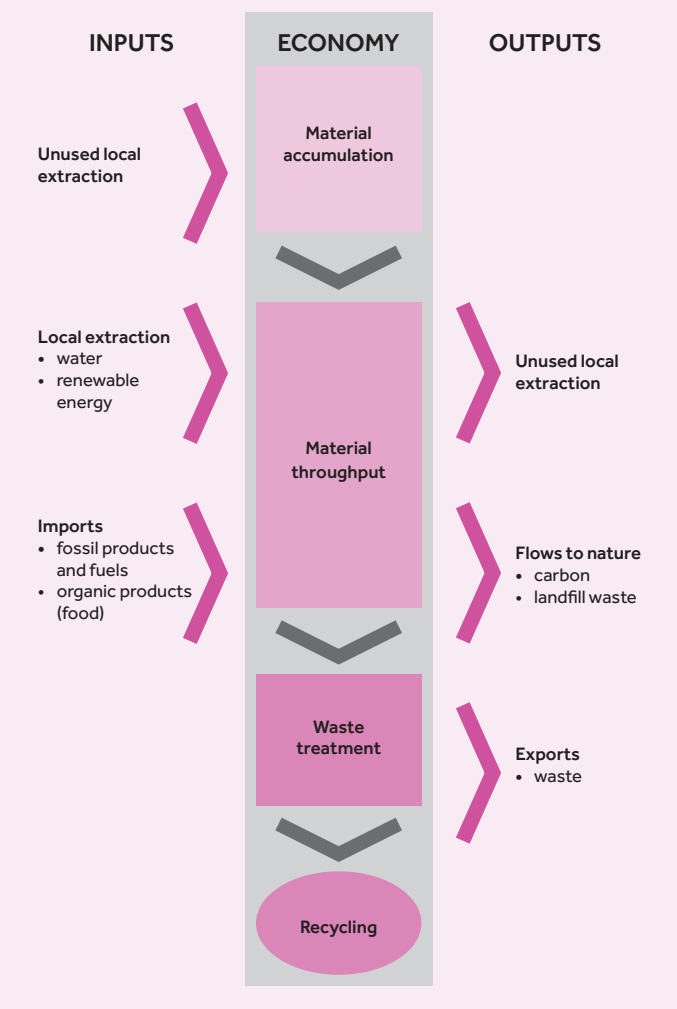

Figure 10.3 MFA flow diagram

Table 10.3 Table of data sources

Flow	Data sources and remarks
Local Abstraction	
Renewables	Average daily solar radiation and totalled quarterly data. University of Reading – Meteorology Observatory climate data extractor; WasteDataFlow – Waste management: Reading Final reprocessor report 2010 and 2015.
Water	Annual abstraction data. Environmental Agency Water Balance components report for Thames Water 2016 (EA, 2017a)
Imports	
Fossil fuels	Total annual consumption. Department for Business, Energy & Industrial Strategy: Regional and local authority electricity consumption statistics: 2005 to 2015; Regional and local authority gas consumption statistics: 2005 to 2015; Road transport energy consumption at regional and local authority level 2005 – 2015.
Organic products	Totalled weekly data. Department for Environment, Food & Rural Affairs – Family food datasets
Flows to nature	
Waste to landfill	Totally quarterly data. WasteDataFlow – Waste management: Reading Q100 PI Summary (UA) 2015 and 2010 (Wastedataflow, 2016).
Carbon	Derived from Fossil fuel data (see entry above). Department of Energy and Climate Change (DECC) Greenhouse gas reporting – Conversion factors 2015 (DECC, 2015).
Water	Annual data on leakage of different types. Thames Water – Final water Resources Management Plan 2015 – 2040 – Main Report (Thames Water, 2014a).
Exports	
Waste	Totalled quarterly data. WasteDataFlow – Waste management: Reading Q100 PI Summary (UA) 2015 and 2010 (Wastedataflow, 2016).

Results and discussion

The complete MFA table of the data collected in this study is presented below in Table 10.4. Some observations include improvements in renewable energy capacity, declines in municipal solid waste, domestic and transportation energy demand/GHGs, as well as food consumption (though this figure may be due to changes in quantification methods used by the source). Trends in water consumption are not observable as 2010 data were not available. Leakage quantities do suggest improvements in non-revenue water at the level of the supply infrastructure (excluding buildings), which is a further positive development.

Table 10.4 MFA results

Resource classification	Unit	2010	2015
INPUTS			
Local extraction			
Renewables	**ktoe**	**0.71**	**0.77**
Solar PV	ktoe	0.42	0.44
Waste-to-energy	ktoe	0.29	0.33
Water	**kt**	**–**	**16731.81**
Groundwater abstraction	kt	–	11712.27
Surface water abstraction	kt	–	5019.54
Imports			
Fossil Fuels	**ktoe**	**131.71**	**124.10**
Total domestic consumption	ktoe	92.90	86.41
Electricity	ktoe	23.59	22.70
Gas	ktoe	69.31	63.71
Total mobile energy	ktoe	38.81	37.69
Diesel	ktoe	19.81	21.83
Petrol	ktoe	19.00	15.86
Organic products			
Total food	kt	118.46	71.63
DMI	**kt**		**17161.72**
OUTPUTS			
Flows to nature			
Waste tolandfill	kt	20.27	18.15
Household	kt	17.66	15.94
Non-household	kt	2.61	2.21
Carbon	**kt CO_2**	**391.77**	**363.12**
Total domestic emissions	kt CO_2	281.19	257,44
Electricity	kt CO_2	132.29	121.04
Gas	kt CO_2	148.90	136.40
Total mobile energy emissions	kt CO_2	110.58	105.68
Diesel	kt CO_2	57.62	61.52
Petrol	kt CO_2	52.96	44.16
Water	**kt**	**4881.25**	**4671.39**
Total building leakage	kt	3336.27	3651.78
Non-household leakage	kt	54.22	45.61
Measured non-household uspl	kt	51.10	40.89
Unmeasured non-household uspl	kt	3.12	4.72
Household leakage	kt	891.75	953.05
Measured household uspl	kt	388.19	265.78
Unmeasured household uspl	kt	503.56	687.26
Void properties uspl	kt	10.91	28.31
Total mains and trunk mains leakage (Distribution losses)	kt	2469.47	2624.81
Total supply leakage	kt	1544.98	1019.61
Distribution system operational use	kt	–	64.98
Raw water losses and operational use	kt	–	94.36
Treatment works losses and operational use	kt	1544.98	860.26
Exports			
Waste			
Total municipal waste collected	kt	70.81	73.87
Total Household waste collected	kt	63.01	65.27
Household waste sent for dry recycling	kt	15.21	13.02
Household waste sent for composting	kt	6.17	7.04
Household waste used for energy recovery	kt	23.31	28.32
Household reusable waste	kt	0.65	0.90
DMC		**360.69**	**16973.30**

Table 10.4 notes

ktoe = thousand tonnes of oil equivalent; uspl = underground supply pipe leakage

Direct Material Input (DMI) is the sum of all local extraction and imports. 2015 is substantially bigger than 2010 given the inclusion of water extraction data for 2015 that was not available for 2010.

Domestic Material Consumption (DMC) is DMI minus exports. This is a partial DMC as processed waste flows are the only exports included in this MFA.

Energy

The MFA shows that energy imports have decreased over the 5-year period by 5,8%. Domestic energy consumption has consistently been the greater flow compared to mobile energy consumption, with it being 70.53% and 69.63% of total consumption in 2010 and 2015, respectively. Commercial and industrial energy consumption data were not available. Domestic energy consumption is presented in Figure 10.4, comparing areas where electricity and gas consumption are highest on an average "per meter" basis. There are areas where information has not been disclosed but some areas of little or no gas consumption can be explained through much higher electricity consumption compared to the rest of Reading.

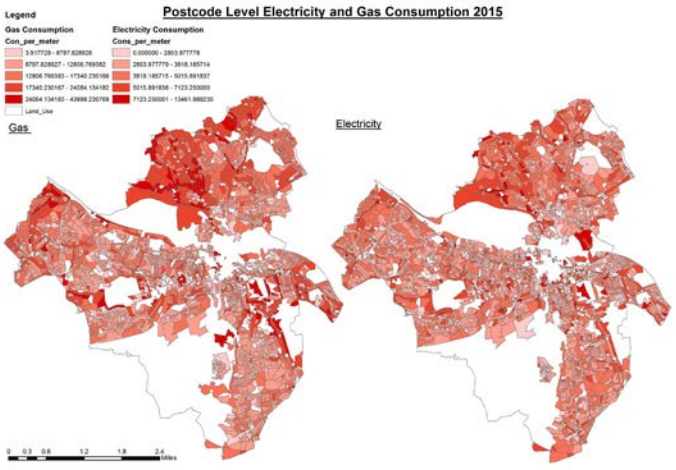

Figure 10.4 Postcode level electricity and gas consumption, Reading, 2015 (BEIS, 2017)

Furthermore, the MFA demonstrates that only a very small proportion of Reading's energy consumption is generated from local renewable sources. In 2015, renewables generated only 3.4% of domestic electricity consumption in Reading (of course this excludes the consumption of other non-residential urban functions). This underscores the challenge of Reading achieving its target to generate 8% of its energy consumption by 2020 (RCCP, 2013). However, wind and biogas generation data were not available and would increase this figure so that it is closer to the stated target.

Water

The results from the MFA show that 2015 local water utility abstraction in Reading totalled 16731.81kt, with 70% of this derived from groundwater, and 30% from surface water. Water flows make up nearly 99% of inputs and therefore dominate the composition of the total resource input (DMI). Despite not obtaining the abstraction figures for 2010, it can be assumed that the share of water abstraction would be of a similar magnitude to 2015. With regards to water flow outputs between 2010 and 2015, total building leakage increased by 9.46% despite Thames Water efforts to reduce water inefficiencies (Thames Water, 2016), while total supply leakage decreased by 34%, although 2010 figures do not include data for raw water losses, distribution system losses and operational use. The different leakage components accumulative proportion of the total domestic material consumption equates to 91.12% in 2010 and 90.99% in 2015, representing a very slight decrease in the MFA. This would support the idea that there is progress in the attempt to achieve the objective of reducing leakage (RCCP, 2013). Figure 10.5 visualises the relative sizes of inputs and outputs of water flows in Reading.

Following on from this, there are water input and output flows not included within the MFA. To have a complete representation in the MFA of Reading, the rainfall flow must be included in the Local Extraction category (Inputs), and the wastewater, infiltration to groundwater and run-off into sewers must be included in the Flows to Nature category (Outputs). The volume of rainfall in Reading has been calculated using annual precipitation (University of Reading, 2015) across the total area of Reading and then converted into kilo tonnes. In 2010, this flow was 21784kt and 22992kt in 2015, indicating 2015 was a significantly wetter year. The rainfall flow would therefore be larger than all other flows combined in both years. This highlights the importance of rainfall as part of the material balance due to its significant magnitude. Through improved communication with local water utilities such as Thames water, more research will lead to more available and abundant data for water flows within urban systems. This in turn will provided a better detailed and disaggregated understanding of how water flows are created and their impacts. The size of the rainfall flow means it cannot be included in the MFA as data on wastewater outputs (from both stormwater and drinking water) were not available, so its inclusion without the outputs would cause the MFA to be imbalanced.

From 2010 to 2015, water consumption decreased in Reading (Thames Water, 2014a). This reduction in water consumption may be due to the wetter climate of 2015 in comparison to 2010, with less water needing to be consumed for outdoor activities such as gardening (Sim et al., 2005).

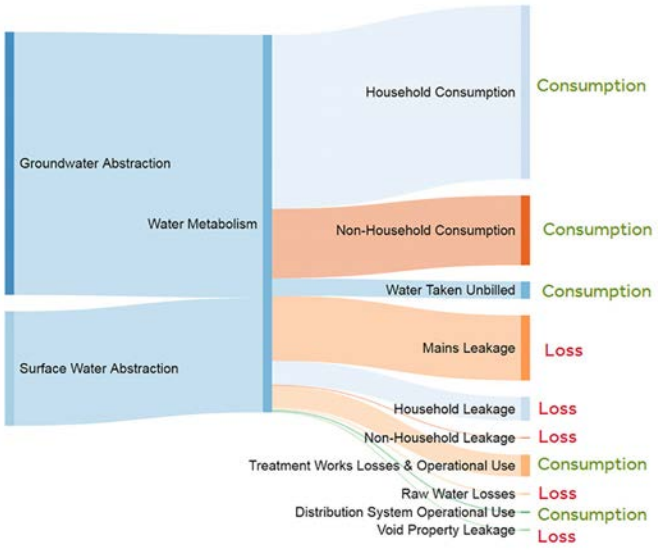

Figure 10.5 Estimated relative size of domestic water flows in Reading's metabolism (scaled using data from Thames Water 2014a)

Figure 10.6a) portrays the spatial variation in annual water consumption for different housing typology. This gives a good indication as to which typology use the most water, with detached and terraced housing having two and four lower super output areas (LSOAs) with the highest water consumption (between 50 and 60 ML) respectively. Furthermore, Figure 10.6a) indicates where there is greater concentrations of different housing types; areas of lowest water consumption would indicate a relatively low concentration of that housing type in that area. The total annual water consumption per LSOA for all four housing typologies is shown in Figure 10.6b), with the lowest areas of water consumption appearing to be in the East of Reading.

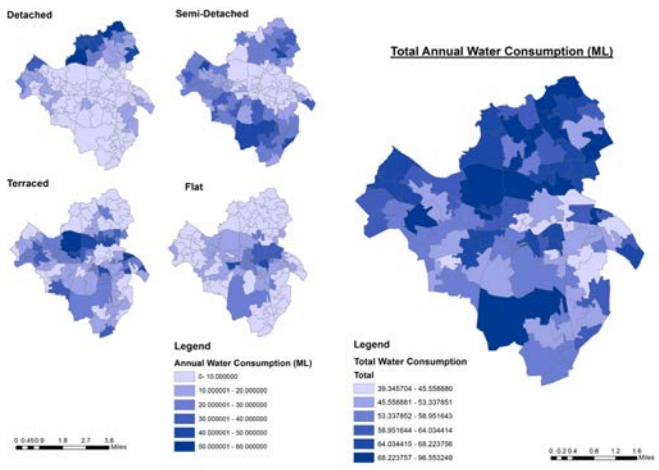

Figure 10.6 a) Water consumption per housing type (left), and b) Total annual water consumption (right) by LSOA (ML)

Waste

Flows of processed waste are included in the Exports category of MFA since there are no waste treatment plants located within Reading's administrative boundary and hence all waste is exported in other municipalities for treatment. These flows are the only export data obtained for the MFA; neither data on wastewater exported and treated outside Reading nor were estimates on exports of other (organic or inorganic) materials available. The municipality of Reading collected 3.06kt more waste in 2015 than in 2010. This can be assumed to be in response to population growth (ONS, 2017a) and the increased material consumption that comes with it. From 2010 to 2015, household waste sent for composting increased by 14% (from 9.8% to 10.8% of total household waste), household waste sent for energy recovery increased by 22% (from 37% to 43% of total household waste) and reusable waste increased (from 1.0% to 1.4% of total household waste). Despite these improvements in more sustainable waste flows, dry recycling decreased by 14% (by 24% to 20% of total household waste), casting doubt on the realisation of the recycling rates target of 42% by 2020 (RCCP, 2013).

Waste flows to landfill (households and non-households) are included in the Flows to Nature category since, differently from exports, no economic value is attached non-recycled waste following the MFA method (regardless if the landfill is located within or outside the town's boundary). The total amount of these flows also decreased by 2.12kt in this time, indicating a reduction on negative impacts to the environment resulting from hazardous landfill. On identification of the locations the waste is sent to and the distanced needed to transport waste to each of these locations (re3, 2016), it was calculated that emissions totalling 139.86tCO_2 was produced taking waste away from Reading. This creates a negative feedback effect that is extremely minimal in terms of the scale of the waste transported. Also, as the waste is transported outside the municipality, the majority of these emissions will be produced outside of Reading, reducing their visibility as a part of the metabolism of Reading.

Carbon

The carbon emission output flows accounted in ktCO_2in the Flows to Nature category (again, no economic value attached in MFA) are those produced from the fossil fuel flows described in the import category of the MFA. In terms of emissions from electricity, gas, diesel and petrol, these totalled 391.77 in 2010 and 363.12 in 2015 representing a reduction of 28.65 ktCO_2. In this time diesel was the only fossil fuel to increase its carbon emissions. Reading's target of reducing carbon emissions by 34% of 2005 levels by 2020 would mean emissions would equal 643.4 kt CO_2 (RCCP, 2013). According to the Department for Business, Energy & Industrial Strategy (GOV, 2015) the total emissions produced by all sectors of Reading's economy total 595.7 ktCO_2, indicating the Borough's carbon target has already been met. There is slight variation between total transport emissions in this publication and that of diesel and petrol in 2015 resulted from the MFA calculations, with the Department for Business, Energy & Industrial Strategy stating emissions of 114.8 ktCO_2 against 105.68 ktCO_2 in the MFA. This may be due to the inclusion in the MFA of emissions produced from other fuel types for transport such as biofuels.

Conclusion

In conclusion, despite the restriction of not being able to map certain flows, such as wastewater, the modified MFA still indicates the main flows within Reading. Even though water imports appear to dominate Reading's metabolism, it should be noted that the magnitude of water flows is systematically much higher than all other flows when the same mass metric (kton) is used, reason for which Eurostat (2001) recommends accounting for these flows separately. As for the Borough's sustainability targets, it is important to emphasise that locally generated renewable sources were only a small component of the MFA. However, there is scope for Reading Borough Council to increase local extraction in terms of renewables, especially biomass and solar. This could be a good policy when combined with efforts to improve energy efficiency, in a sustainable energy transition perspective. In addition, carbon emissions from domestic gas consumption have reduced, but this can be linked to a decrease in the heating demand (and related gas and electricity consumption) due to higher average daily winter temperatures in 2015. As waste was the only export recognised in this MFA is gives a partial indication of the exports within Reading. Besides Exports, lack of data on Imports of minerals and materials other than food (e.g. construction materials) as well as on other key flows such as wastewater (both from stormwater and drinking water) significantly limit the scope for calculating resource-use aggregate indicators such as DMI and DMC, which are one of the main added values of working with MFA. This points to the need for more complete datasets in order to yield meaningful results from an urban metabolism scan and unravels the data-availability challenges that characterise medium-sized cities compared to big cities (the latter representing the traditional focus of urban metabolism studies).

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Part 3
economy and employment

11 Developing a Smart City Cluster in Thames Valley Berkshire

Rob McDonald Director Future Transport and Smart Cities, Stantec UK

Technology – an exciting future

We are entering the fourth industrial revolution, one where artificial intelligence and cyber / physical systems transform our world, how we live and how we work. Some see only opportunity, whilst others see the end of our economies as we know them as automation takes our jobs and further concentrates wealth in a small handful of people around the world. Evidence of the previous three industrial revolutions, Steam in the 1780s, the division of labour, electricity and mass production in the 1870s, and electronics in the 1960s, has each resulted in a growth in wealth and in opportunities for people, although at each stage the transition has been very disruptive to some industries. The difference that we see with the fourth industrial revolution is the speed of change and the breadth of industries that are likely to be impacted as well as the sheer scale of transformative opportunity.

The United Kingdom's Industrial Strategy (Figure 11.1) is investing in keeping the UK at the forefront of this revolution. It has four main pillars focusing on technology to address the aging population, the future of mobility, providing clean growth and leading in the areas of artificial intelligence and big data. Supporting these are a wide range of technologies and services from the development of Electric Vehicles and batteries, to green energy and mobility services, and from AI and robotics to cyber security, with multiple links between these and the four pillars and between the four pillars. This reflects the need to ensure that there are no silos restricting our future visions.

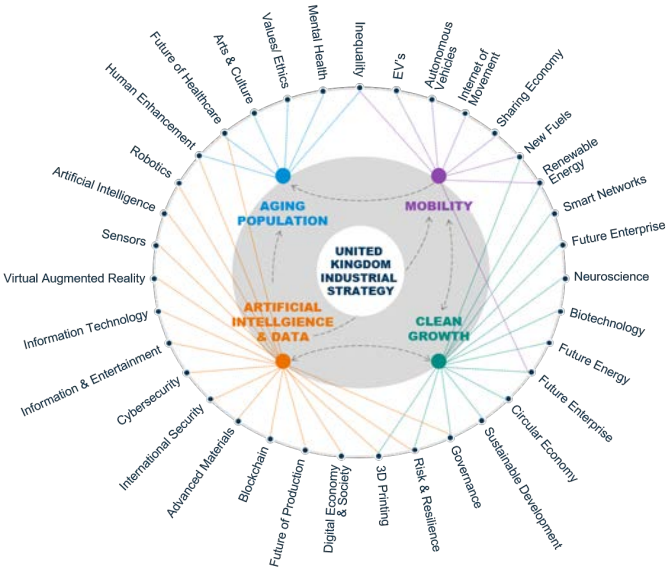

Figure 11.1 UK Industrial strategy

The rate of technology growth can be seen in the predictions, for example, in the growth of the number of connected devices, the Internet of Things (IoT). 14.4bn global devices in 2014 has grown to around 38bn devices today with Ofcom projecting around 150bn devices in by 2024.

In 2015 the World Economic Forum sought the views of 800 technology experts across industry to identify tipping points and predict the future. By 2025 the report identified that 10% of people would be wearing clothes connected to the internet, the first 3D printed car would be in production and 5% of consumer goods would be printed in 3D, over 50% of internet traffic to homes would be for devices and appliances, and we would have the first AI machine on the board of directors. Whether all or some of these become true it is a good indicator of the scale of change coming.

We can see our homes and offices of the future changing, designed by AI based on personal data habits, one that is built in a fully automated factory using bio-mimic materials layered through 3D printing, that is constructed on site using robots, and when finished, will allow spaces to change inside the building to adapt to different uses throughout the days. We see new green and ethical supply chains, a circular economy for materials, and new levels of energy efficiency delivered through a smart network based on green generation with energy storage balancing out the variability in supply from renewables.

In transport we see the move away from car ownership to on demand mobility services which use AI and big data in a connected world to ensure a very high quality of service, predicting demand, supply and network conditions. We also see increased sharing being enabled by this technological revolution.

The above examples are just the tip of the iceberg in terms of coming changes and the challenge for local authorities is to respond to this changing world and make the difficult decisions that best utilise technological advances to meet the needs of people in delivering their services whilst avoiding the pitfalls of investing in the wrong technologies.

The climate crisis – a challenge for today

Whilst we have a bright technological future with rapid innovation and technological change, there is also a significant amount of inertia where large scale manufacturing is required (e.g. the Car industry) and in our built environment where we expect about 80% of homes in 2050 to have already have been built.

There is no doubt that Climate Change is real and it is too late to avoid large climatic changes that we will need to adapt to whilst also cutting carbon so that we avoid catastrophic levels of climate change as we reach the end of the century.

Technological change is very much part of the solution and we have seen huge reductions in carbon in the production of electricity over the last decade and this is continuing, however, this has masked a failure in all other industries to cut carbon. The IPCC have told us that we need to make very deep cuts into greenhouse gas emissions including cutting carbon emissions by around a half by 2030 if we are to keep global temperatures to a manageable level by the end of the century. It is clear that technology alone is not going to achieve this in this timescale and that we need to significantly reduce our carbon footprint, whether in response to legislation or through behavioural change. The need to change behaviour is particularly important as it is easy for behavioural change to undermine attempts to reduce carbon and we only have to look at the growth of SUV ownership and the increase in average temperatures of our homes in the UK to see how efficiency benefits can be substantially reduced / offset by individuals making lifestyle choices rather than recognising the need to reduce carbon.

As local authorities in Berkshire have made their Climate Emergency declarations it is clear that a cross-sector, cross authority, and collaborative approach working with the public and industry, is critical to developing tackling the climate crisis. This is a smart city approach.

Thames Valley Berkshire – developing a smart city cluster

Walt Disney once said that "*the way to get started is to quit talking and begin doing*" and it is this approach that has been taken in developing the Thames Valley Berkshire Smart City Cluster. The need to be a smart city was not clearly understood and hence Stantec (at the time Peter Brett Associates) and the University of Reading led a bid for £10m Innovate UK funding for an Internet of Things project (IoT being an element of Smart Cities). Thames Valley Berkshire Local Enterprise were one of a number of public and private sector partners including Reading Borough Council who supported in being the required public sector lead for the project. Whilst ultimately, we were unsuccessful, CityVerve in Manchester won the funding, we scored very highly and the LEP confirmed that they would be happy to see an application for LEP funding on the same lines. Core elements were taken from the £13m application (with partner contribution) to create a much smaller £1.8m application to be a catalyst for developing a smart city cluster across the four local authorities involved in the Innovate UK bid, Reading, Wokingham, West Berks and Bracknell Forest. In 2018, the LEP awarded Reading with £1.73m.

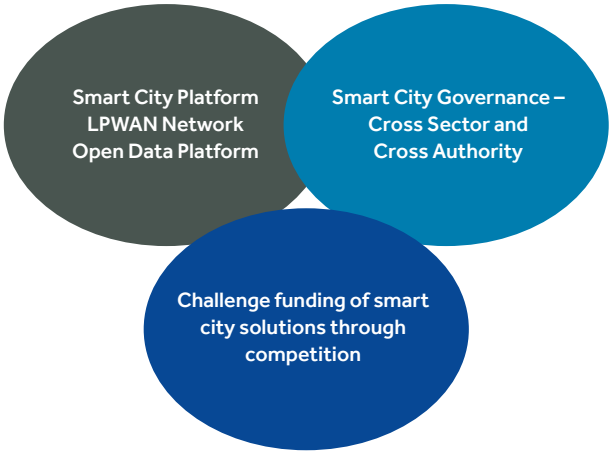

Figure 11.2 Smart City Cluster

Developing and getting the business case approved to enable the funding to be released was an interesting process. Typically, the LEP awards funding for capital schemes with formal cost benefit analysis approaches, but our scheme was different and took some discussion with the auditors. A key element was that we did not want to identify what all the money would be spent on as a key element of the project was engagement with the local authorities to identify the real-world challenges that they wished to tackle through a smart IoT approach. Ultimately we compromised on detailing about a third of the spend (an IoT communications platform) with about two thirds identified for funding innovation calls in the area of transport, energy, the environment and assisted living, where a supporting investment strategy report was produced to set out the process of how we would spend the money.

There are three main pillars to the smart city project: Smart City Governance, Smart City Platform and the Challenge Funding of Smart City Solutions through competition (Figure 11.2). The project is due to substantially complete in May 2020 and hence this paper reflects current progress.

Smart City Governance

The Smart City Governance part of the project had the aim of raising awareness of what smart cities means within the authorities and setting the challenges for enterprises to meet such that technology was not developed for technology's sake but instead was developed to meet real need. This was a key part of the project and around the first nine months of the two year project was spent on this. We ran a series of cross-sector and cross authority workshops to brief on smart cities and to

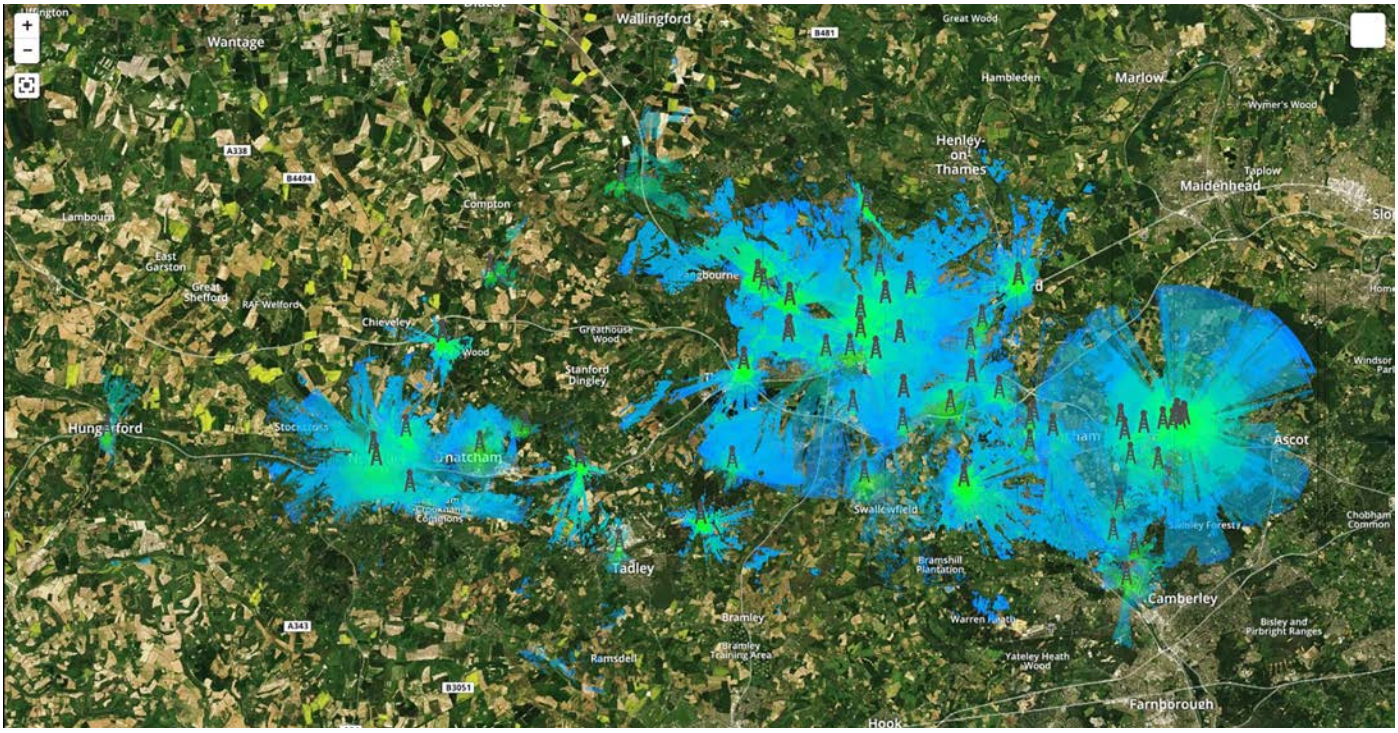

Figure 11.3 LoRaWAN in Thames Valley

identify key sector challenges and then cross-sector workshops within each authority to refine the focus of the project to specific challenges. The Thames Valley Berkshire Chief Executive was also briefed directly on the project. The outcome of this process was a greater awareness of smart cities across the authorities, and 9 separate challenges that reflected the local authorities' priorities to meet real need.

The project is being governed by a cross authority steering group which is chaired by Reading Borough Council (fund holder), with each of the four authorities represented, the LEP, a technical representative appointed by the LEP, currently the chair of the Institute of Directors (IOD), and supported by Stantec as project managers on behalf of Reading. All key decisions have been discussed and agreed by consensus by the steering group and the approach has ensured that funding and engagement is shared across the authorities.

Smart City Platform

The Smart City Platform is an Internet of Things communications system based on LoRaWAN (Figure 11.3). LoRaWAN is a low powered wide area network ideal for sending small packages of data over relatively long distances and is based on an established global open standard with data transferred over the Things Network. it was chosen because of this open standard and also as it was the network being promoted by the Digital Catapult. Sensors for things such as temperature, humidity, moisture, movement, etc. can be placed either inside or outside of buildings and connect directly to a base station that can be up to 10 miles away. This means, for example, a homeowner does not need Wi-Fi for an assisted living service. Whilst distances can be long over open ground, good coverage within an urban area requires a higher intensity of base stations which need to be located as high as possible. The scheme is rolling out 85 base stations over the four authority areas to cover just under 100% of the population. Deployment has focused on gaining permissions for installation on tall buildings in the first instance which is time-consuming. The rest of the units are then being deployed on tall poles and traffic signal junctions to provide infill and resilience which can be much more simply deployed as they sit within Highway land.

Challenge fund calls

Nine challenges were defined by the local authorities though their cross-sector workshops, two for each of the four authorities and an open call. Through discussion at the steering group, grant funds of £100,000 for each were identified with a requirement that there should also be in-kind contribution from the applicants in terms of effort. A key aspect of the calls and the level of funding was to enable a meaningful pilot to be run in the real world as part of the project to maximise the chances of the funding leading to a successful product or service.

Funding was allocated through two rounds of competition calls with grants being awarded to the successful applicants through a written and interview process with an independent panel

evaluating all of the applications. It was advertised through engagement with the IoT community and in particular the Thames Valley IoT meet up group. The aim was to have solutions built on the LoRaWAN network but this was not a requirement of the calls as we were looking for the best solutions to the challenges and did not wish to force a particular technology. As a Thames Valley Berkshire LEP funded project with a key aim to support business and promote economic growth and world leading solutions, applicants were required to be based in Berkshire or be a collaboration with the lead collaborator based in Berkshire.

The nine challenges are currently being delivered are:

- **Reducing falls in the elderly** – Falls Prevention System aims to help the over 65's keep their independence, freedom and control for longer, by using non-intrusive technology to help prevent falls in the home. [West Berkshire – Thingitude, IoT Stars and Tendertec]
- **Help vulnerable people to travel independently** – InDependAbility is an initiative to enable greater use of public transport by vulnerable members of the local community in Bracknell Forest. There are a number of local dedicated transport services, but these usually require advance booking and can incur significant costs to Bracknell Forest Council, local charities and the user. This project offers an IoT solution to relieve pressure on these services by encouraging greater use of the local scheduled buses. This will be done by providing vulnerable individuals with live availability of buses together with an assessment of how busy they are and whether wheelchair spaces are occupied. [Bracknell – Ethos]
- **Reduce Isolation in the elderly** – The Joy solution supports the identification and capturing of individuals that are lonely and socially isolated and through Joy matches them to suitable local services, activities and their community to improve their health and wellbeing. The technology captures data around wellbeing information, the quality and feedback about the services utilised and outcomes achieved. It is seen as great way to get people to access local activities easily through technology and also to learn more about what's on in their local area. It can be used by the individuals themselves, their families and statutory services including social prescribers to link individuals to activities. [Wokingham – Berkshire Age UK, Pungo]
- **Monitor household condition for energy and health** – The solution consists of a suite of environmental sensors, IoT data collection and storage platform, and intelligent algorithms for detecting issues with heating and fuel poverty. [Reading – Think Engineer]
- **Open call** – MyWay is a mobile phone map app that helps women university students walk home safely at night, both from university campus and Reading town centre. A network of sensors will monitor lighting levels, people movement and noise level. Noise will be analysed to distinguish between happy sounds and alarming sounds. [Reading – Coraledge]
- **Promoting arts and culture in Wokingham** – Creating a new app to promote cultural events and activities across the Borough, utilising all existing content as well as introducing new features to drive future engagement. The solution will use market segmentation to tailor content to different users and target audiences. [Wokingham – Volume]
- **Climate emergency – open call** – The Measurable.Energy (ME) Platform is a commercial sector energy control and analytics system for Small Power (SP): electricity used by building occupants via power sockets and large building devices accounts for ~40% of total building energy. The ME Platform, featuring ME 'Smart' Power Sockets, automatically eliminates wasted SP energy, reducing power, cost, and emissions. [Reading – Measurable]
- **Using chatbots to improve council services** – Through chatbots, voice assistants and data analytics the project will answer FAQs around the clock. Including, self-serve issue recording, ordering new things like recycle bags, and reporting streetlights, potholes and other issues. [Wokingham – SSPS]
- **Climate emergency – promote sustainability in schools** – The Eco Rewards Scheme is a trial incentive scheme for schools in Bracknell Forest to encourage staff, students and their families to choose greener options when travelling to reduce their carbon footprint, pollution and local congestion. Participants will record their journey choices by tapping branded smart tokens on special readers placed along specific routes to participating schools and via online forms. The card readers send data over the private Internet of Things network provided through the Smart City Cluster project for analysis and to show CO_2 savings. Participants will be rewarded with points and could receive prizes, cash-back and retailer discounts. [Bracknell Forest – Eco Rewards]

Summary and next steps

To date the project has been successful in raising awareness of the wider smart cities agenda within the local authorities through demonstrating the potential of IoT to deliver council services and through encouraging cross-sector working to develop challenges. The project is now funding 9 very promising projects which are in the process of demonstrating the benefits of a smart city approach and we will be holding showcase events of the Local Authorities and the wider community at the end of the project. Deployment of the IoT communications network is progressing well and there is a proposal to extend the network to the other two authorities in Berkshire, Slough and the Royal Borough of Windsor and Maidenhead. There is a strong cross authority desire to build the smart city brand and the current £4.8m Adept funded Thames Valley Berkshire Live Lab is an outcome of the cluster collaborating with O2 to develop a smart transport project built around big data and insights.

12 What Reading's history teaches us about its ability to harness green technology to drive its future

Nigel Horton-Baker and Alex Brannen Reading UK

The Reading 2050 Vision outlines an aspiration to be an internationally recognised smart and sustainable economy with green technology businesses and innovation at the heart of its development by 2050.

How Reading gets there and what factors underpin our future success is to a significant degree driven by where we have come from and the factors that have developed over time that have contributed to our economic success. Put simply, understanding Reading's history is crucial to plotting its future.

History teaches us that those economies and businesses that move with the time and adapt are more resilient in times of recession and are arguably better placed to face the future. Agglomeration – businesses relocating to follow other successful businesses – is also a key mark of success for thriving economies. As the capital of the Thames Valley economy, Reading has demonstrated consistent resilience, adaptation and clustering and used them to its advantage. Will this continue and what will the next cycle of technological change mean for Reading and its economy, businesses and the town itself? This paper explores some of the historic trends which point the way to the possible futures and relationships between the City of the future and our economy and businesses.

Location, location, location has been a consistent and crucial factor in Reading's attraction of businesses in every era. As a settlement on a major river that has become the centre of successive transport connections to other major economic centres nationally and now internationally, Reading has always presented a strong case for the location of trading and business activity.

Dating back to time of Henry I, Reading was a seat of government and the throne in the biggest Abbey in Europe. Waterpower and transport were key to moving raw materials and turning them into finished goods while the town thrived, trading in animals and agricultural products. It was a major stopping off point as well between London and the West Country, supporting the hospitality sector; inns, pubs, hotels, places to eat and be entertained.

The Industrial Revolution was a major game changer for Reading, led by innovation in power, transport and methods of production. Reading's location, access to water and raw materials remained constant but technology increased the speed and scale of production of goods and services. Reading demonstrated this by becoming a major centre for the mass production of beer, bulbs and biscuits. Names such as Sutton Seeds, Huntley and Palmer Biscuits and Simonds IPA and Courage Beers still resonate around the town.

The landscape changed as well with the coming of the factory and the chimneys. Jobs and employment proliferated with typically local jobs for local residents, which lasted through to the 1960s and 70s at which point technological change surfaced again and breweries, seeds, biscuits companies and jobs became a victim of automation, mass production and economies of scale and globalisation.

While the manufacturing of the past was dying in the UK and moving oversees, a new manufacturing and service sector was emerging to service a growing economy, globalisation and increasing consumer demand. Technology was at the heart of the change and becoming increasingly more pervasive in all aspect of our lives. Reading's title as the computer capital of the UK came about really by virtue again of its location. Post-war, the American giants wanted to expand globally and saw the UK as a stepping-stone to Europe. In the late 1980s and 90s giants like Microsoft, Hewlett Packard and Oracle Corporation landed at Heathrow and turned left along the railway to where there was plenty of land to build monolithic HQs.

The Greater Thames Valley, including Surrey and Hampshire, partly as a result of the war effort had also become the home of Government research labs – Porton Down, AWE, Greenham Common, Farnborough Aerospace. They were there to develop superior fighting power technology that would win the War but they subsequently became a catalyst for innovation primarily around defence but increasingly working with the tech companies to develop everyday solutions that would meet the needs of an ever growing and aspirational civilian market. In parallel, Reading University was expanding and establishing its credentials as a research led university developing spin out technology and partnerships with industry

This interest and demand from the wealthy US computing hardware sector soon attracted the investment and property world. The Prudential financial services corporate was just one of the first to stake a claim in Reading, building a greenfield business


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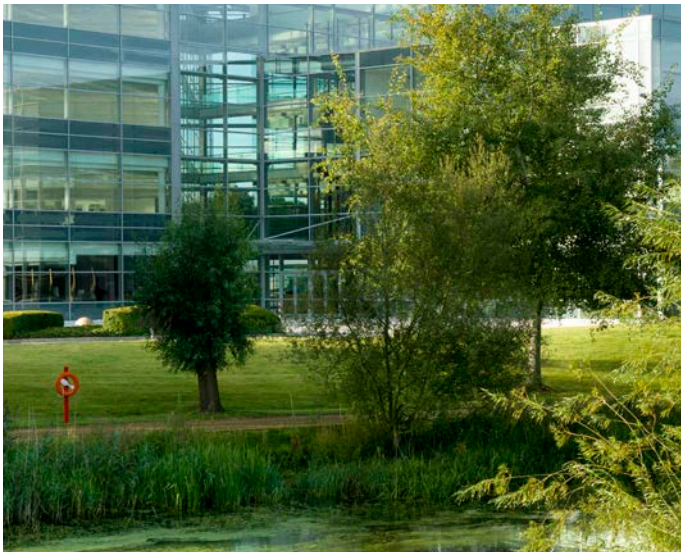



P
Paddington

park in South Reading known as Green Park. Further financial investors and insurance providers were then attracted to Reading given its ease of access to Heathrow and the City of London. Agglomeration theory then began to take hold as computer companies followed computer companies to the Greater Reading area demanding further real estate investment. The town itself grew, as did the demand for retail and town centre services outside a growing commuter train station. Major real estate investment and development companies have also followed such as Stanhope, M+G, Mapletree, and Hammerson to name a few. Further business parks emerged close to the motorways network and the opening of the M4 as well as new covered shopping malls in the town centre such as the Oracle and Broad Street Mall.

By the end of the century IT (ITC), Insurance (Finance) and Investment (Real Estate) – the 3is – were truly the sectors of employment driving Reading's economy and raising its quality of life.

Reading soon became the second home of the financial services sector outside the City – we now have five of the top global management and accountancy companies – PWC, KPMG, Grant Thornton, EY and Deloitte. Reading in the 1990s began to take on an international image. It was at the heart of the whole Thames Valley explosion in technology making us the UK's Silicon Valley.

Reading economic base was now more dependent on external markets, global manufacturing plants and its functions in Reading were more about sales, marketing and HQ. The landscape was now becoming filled with giant offices not factories. These were now global companies, globally linked by air transport, developing product and services for global markets; IT comms, finance, with money fuelling our physical growth in real estate from global sources. These new industries no longer provided the scale of local jobs for local people, however. Reading became a net in-commuter town attracting highly skilled young professionals. In 2019, Reading now has 50% of its workforce with a degree or above qualification. A recent Sunday Times survey ranked Reading as the number one city for first time buyers which relates to the higher wage economy among young professionals, who buy houses based on dual income and no kids.

The net result of this technologically-driven economic success has however seen two major challenges that the 2050 Vision needs to address. These challenges or 'problems of success' are firstly related to our modes of transport. We have seen the rapid growth in car travel on a road network that is built on a medieval footprint with little room for dual carriageways. River boat travel has clearly declined except for leisure but we are left with a town cut through by three river courses including the Thames which is now a barrier, with too few crossings to disperse traffic from the centre.

The Blade from Reading Abbey
(source: By David Merrett from Daventry, England – The Blade, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=12741710)

Secondly, Reading is faced by increasing polarisation between those educated on high salaries able to afford housing and those not in work facing generational unemployment, poor educational achievement and health issues, living in deprived communities and a spiral that is taking them further away not closer to the opportunities and wealth created by the new technology and related sectors.

Location has worked in favour of Reading's economic success in the past but in the future it may depend on decisions beyond our control. Will Heathrow retain its global importance through expansion and a third runway? Will the City of London lose its global financial status as a result of BREXIT? Reading could suddenly become a less desirable location for global tech business. The opening of the Elizabeth line service and the Western rail link to Heathrow from Slough are real and critical to maintain a positive momentum around connection to these two key influencers to our economy.

From a place that embraced new technology in our manufacturing industries we are a place that has become important for technology companies that operate their headquarters, sales and marketing and some research functions while moving or retaining their manufacturing overseas to lower cost areas of the World. This has reversed the impact on the labour force by creating a bigger demand for imported highly skilled employees more so than jobs for local people. The direct benefit of the technology

know-how on our town and communities can be seen though the development of start-up high growth tech companies often by former employees of the tech giants along with academics and students from our University we should encourage this but the gap remains in real benefit to local people of the products and service they generate but only touch Reading people when they touch everyone else in the market place world-wide.

In Reading, the 'Smart City Cluster' initiative led by Reading Borough Council is beginning to examine the relationship and opportunities to directly solve local problems in our communities through technology solutions developed by local tech businesses.

The presence of major tech companies and a research led university has stimulated an entrepreneurial culture with Reading having the largest number of start-ups outside of London per annum. Technology starts ups often spin out of major corporates through employed people wanting to develop their ideas or academics wanting to take their ideas and commercialise them outside of academia.

Reading's physical environment has changed enormously from the south of the town to the centre bringing high rise offices full of tech and service sector companies and now high-rise residential units.

The tech economy of Reading in the future

What this chapter has highlighted is that the evolution of the Reading economy notably:

- Its key geographical location factors.
- Its ability to respond to and embrace technological change.
- Its ambition to accommodate economic growth and regeneration.

This has led to a dynamic City like economy, attracting a multi-cultural population and highly skilled workforce.

Historically the tech sectors have responded to market forces, technological change and locational advantage. There is no reason to think that this would continue though the outcome may be unknown.

The Reading 2050 Vision puts a lot of emphasis on becoming a green tech city, defined as a city that uses technology to its advantage in all aspects of life but especially green environmental technologies for tackling the major challenges that are facing us. How can we use technology to combat the impacts of these challenges? Can we grasp the opportunities of climate change, achieve a carbon neutral or zero carbon situation, adopt green transportation, become energy safe, develop green buildings and retrofit the old?

How can we make innovation and new technologies accessible to everyone to improve their quality of life? Will we find the answers and the technologies in our local economy that can address these issues and bring us the benefit, or will we simply need to seek help from companies elsewhere and import ideas products and technology from around the World?

Will our technology businesses evolve to meet our future needs locally as well as globally? Research, innovation and technology will be vital to tackling the issues our cities face. The launch of the Reading 2050 vision I believe gives us a catalyst to try and manage our futures for the better while all around the World is in turmoil. What we are learning through the 'Smart Cities Cluster' project is the opportunity to tap into local tech business to solve local issues, the most pressing for Reading, as everywhere, being climate change but also social needs of an ageing population. Investment in our expanding low/no carbon public transport infrastructure and local Reading Bus Company Our mass rapid transport network is expanding, benefitting from the increase in park and ride and dedicated bus lanes, moving through the technological 'gears; embracing, gas and now battery power, plus internet access and the internet of things on board.

The Curious Lounge is a skills and event hub offering a vibrant programme of exceptional speakers, events and training around technical, creative, digital and life skills just a two minute walk from Reading train station. A relaxed members-only cafe, comfortable meeting and training rooms create a great environment to work and meet, with super-fast Wi-Fi throughout, and an event space that holds 100 people with full AV meeting the needs of local people, and entrepreneurs hand in hand with major companies.

Our ambition for a city centre-based tech start up business ecosystem that works in partnership with the Curious Lounge, Thames Valley Science Park the University and attracts, supports and helps local entrepreneurs to network flourish and realise there potential and work on local issues, alongside academics and students.

What sectors could help achieve these ambitions to support its local resident population? It is clear that we are now recognised as a leading UK tech hub. Reading has eight times the density of UK tech businesses set alongside a world class research led university specialising in climate change, energy and the built environment.

The current trend has been in digital tech with Reading being designated the UK digital tech hub by Tech Nation because of the levels of digital businesses and people in employment in the sector in Reading.

Modern business practices in these digital tech companies are different. Working practices are 24/7, more mobile and flexible, less dependent on large office structures and paper. What does this mean for some of our large headquarters in the future? Could they change to meet our demand for housing?

The growth in digital tech has also affected traditionally non-tech sectors, most noticeably retail. Major chains, shopping malls

and high streets have been hit hard by online shopping. Levelling the taxation playing field may slow the pace of change but we will see the biggest change in our town centre, certainly in the ones that will survive and prosper with less retail floor space but more offices, residential, community facilities and more leisure hospitality and experiential activities taking place.

Historically the tech sectors have responded to market forces, technological change and locational advantage. There is no reason to think that this would continue though the outcome may be unknown.

At this stage in the evolution of the 2050 Vision there are three sectors worth noting that could be the game changer in Reading, helping match global technology to local needs both through multinationals, start-up entrepreneurs and high growth companies. These are:

- **Lifestyle 'tech by design' – smart digital applications, IOT, Augmented Reality**
  - The 'Smart Cities' project and Curious Lounge have pointed the way to embrasing the numerous parts of the sector, The Department of computer sciences at the University and, Thames Valley Science Park has expertise in augmented reality (AR) and next generation computing as well as supporting entrepreneurs and innovation alongside Henley Business School.
  - Companies in Reading like AI Eptica Uk are developing automated conversations technology; automated intelligence gathering, automated customer relations; augmented agents; customer email social media, chats; live person customer conversation powered by Artificial Intelligence. Other companies include Ultima: Intelligent, secure, automated business and workspace solutions, Volume AI Home to Lucy their BUIG Brain Chatbot. Volume is leaders in experiential AI, helping business transition their traditional online, digital and social touchpoints to conversational interfaces Noble Prog in Thames Valley Park is an Augmented Reality training centre.
  - Reading now has an annual Festival of Digital Disruption a programme developed by Connect to Thames Valley Tech and hosted this year the Curious Lounge. In 2019 Reading also hosted The Internet of Things UK Conference 2019. Three years ago we hosted 'Interface' 2016 a meet the buyer event where major arts organisations in London met the tech solutions world in Reading to commission tech solutions.
- **Life sciences tech – health wellbeing**
  - Already we have Bayer at Green Park: core competencies in the Life Science fields of health care and agriculture. Its products and services are designed to benefit people and improve their quality of life. IQVIA a merger between IMS Health and **Quintiles** in the town centre dedicated to a broad range of solutions that harness advances in healthcare information, technology, analytics and human ingenuity to drive healthcare forward.Quintiles, PRA health services committed to reinventing research and making healthcare integrate seamlessly into real patients' real lives. We provide the end-to-end drug development services to make it happen.
  - TV Science Park medical research companies include a Proton Beam company researching cures for Cancer.
- **Life enhancing tech – ensuring we are carbon free and save our planet**
  - These technologies will help create sustainable places to live work and enjoy, we need to attract the 'green; technology sector companies focusing on energy, waste, and low carbon living solutions. The University hosts the World-renowned Walker Institute for Climate Change focusing on food and water security, biodiversity loss, extreme weather, and disasters. Reading Buses are an industry leader in advanced low carbon bus technology and encourage innovation programmes, the BMI global IT innovation centre for roofing structures recently relocate to Reading.

Conclusion

In conclusion I believe the future for Readings tech sector is good. It's evolving, building on strengths and the power of agglomeration has not rescinded. However, while we cannot be complacent it cannot be growth at all costs.

The same USPs that have influenced Reading's successful development over centuries will play a factor in shaping Reading's future. But we are also able to take some level of control of that future. Reading's 2050 Vision places smart and sustainable development at the heart of the city's future. Through 'green tech' and building on our economic strengths in particular; the three technologies for life;

- life 'style' tech
- life 'sciences' tech, and
- life 'enhancing' tech.

We can ensure that our future is not solely driven by the market. We can have a say in what that future looks like, wise in the knowledge of what has influenced where we are now and how those themes will play out in the future.

13 The future of Reading in the Greater South East in a changing economic landscape

Kathy Pain School of Real Estate and Planning, University of Reading

Introduction

This paper considers what will be the likely future challenges and opportunities for Reading as a business services cluster in the Greater South East of England, in a changing economic landscape.

Reading's rise from English county town, known historically for its "three Bs" (beer, biscuits and bulbs), to an internationally networked business hub with significance for UK overall productivity, was first noted before the 2008 global financial crisis. A major 2003–06 EUR 2.4 million study of densely urbanised regions in seven North-West European countries led by Sir Peter Hall and this author,[1] identified an intense growth process associated with globalization occurring in an arc to the West of London in England's Greater South East. This encompassed cities and towns such as Reading, that were growing at a similar rate to London economically, which were interconnected functionally in a complex web of business and commuting links. Reading stood out in this sub-regional economic geography[2] as a cluster of specialised business services found in global financial centres like the City of London and high-technology industries that were taking advantage of Reading's excellent motorway and high-speed rail connections and its proximity to Heathrow airport.

However, Reading's huge success must not be taken for granted. Recent research at the University of Reading[3] highlights the sustainability challenges for densely developed, functionally interconnected city regions, such as the UK's Greater South East.[4] The global study explains that these challenges demand coordinated decision-making to support future investment in 'good density', which is defined as a well-managed increase in urban built-up density.[5]

The report provides the evidence that well-designed and compact cities have benefits for real estate investment and are also critically important for healthy communities and the environment. It sets out key characteristics of 'good density', including land use arrangements within cities and regions, availability of capital investment, jobs and talent, and green and blue infrastructure such as trees, ponds and waterways.

In this paper, I explore the challenges and opportunities for Reading. I address the question how Reading became so prosperous and how smart urban planning can keep it that way. I argue that securing Reading's resilience to 2050 and beyond, must take 'good density' into account.

Reading's success in a changing economic context

The legacy of Reading's three, and some would argue four, 'Bs' – beer, biscuits, bulbs (and bricks), reflects fundamental principles that make a city economically successful. The starting point for understanding a city's economic success is its people and their work and enterprise. A city is a concentration of people and work, and it is the work done in a city that makes the city economically vibrant. Each city is characterised by its buildings, but it is the work done in a city and the enterprise of its people, that produces the goods and services that create and define the city's economy and prosperity. Reading scores high in this regard.

Reading was one of the three cities in the UK with the highest weekly workplace wages in 2017 and 2018.[6] 78.4% of Reading's resident population was in work in 2017,[7] and it was one of ten cities with the lowest claimant count in the whole of the UK (1.5 %).[8]

Critical for the sustained performance of a city's economy, is the renewal of its work to reflect changing demand for goods and services over time. Demand is not static, especially in a world of dynamic changes associated with globalization. Cutting edge knowledge based technologies, products and services generated through innovation and 'new work' deploying new skills and expertise, need to be developed to replace declining technologies, products and services, and a city's 'old work'.

1 The research, financed by the European Regional Development Fund and national and regional government bodies in seven North West European countries, is published in Hall and Pain (2006).

2 Pain (2008).

3 Pain, et al. (2018). The research was commissioned by the Urban Land Institute (ULI) and the New Climate Economy Global Commission special initiative, the Coalition for Urban Transitions.

4 The term the 'Greater South East' here refers to the South East England 'Global Mega-City Region' studied by Hall and Pain (2006).

5 Pain, et al. (2018).

6 Centre for Cities (2019, p.56).

7 https://www.centreforcities.org/city-by-city/

8 Centre for Cities (2019, p. 48).

In terms of educational achievements, which are important for employability in new knowledge-intensive business enterprises, Reading stands out as a smaller English city with a high percentage of residents (50%) with high-level (NVQ4 and above) qualifications[9] and just 4.4% of residents of working age with no formal qualifications.[10] Referring to Department for Education 2016 data, the UK 2017 Industrial Strategy referred to Reading as an example of regional variation in having 57% of students achieving A*–C GCSEs at age 15 going on to study Maths at level 3, compared with only 10% in Barnsley, South Yorkshire.[11]

Reading 'new work' and economic renewal

Enterprise has been at the forefront of Reading economic renewal, replacing legacy work in the production of beer, biscuits, bulbs, and bricks, with new knowledge-intensive work, which now underpins growing prosperous sectors of the contemporary global economy. Reading's economic strength in business services has developed between 2009 and 2015 in digital, high-tech and creative sectors that have come to be a new driving force in world economic growth. A recent UK study found that between 2011 and 2015, highly skilled (and highly paid) digital jobs grew twice as fast as other jobs.[12]

Reading's number of businesses per 10,000 population in 2017 was second in the UK only to that of London (Reading 478 businesses vs London 583 businesses per 10,000 population).[13] Reading was the fifth best city performer in England for Gross Value Added (GVA)[14] per worker (sixth best performer in the UK),[15] and one of four "top 10" English cities with the highest GVA per worker which also rank in the "top 10" in their industrial share in private sector knowledge-intensive service jobs – London, Milton Keynes, Reading, and Swindon (one of five cities in the UK).[16]

Furthermore, Reading's economic importance extends beyond the Greater South East of England in a UK context, on account of its role as a base for value-adding companies with links in extensive international and national business networks that are vital for overall UK productivity.

Global context matters increasingly for Reading and for UK-wide economic prosperity. Cities are business and work clusters but, in global times, their economic success is much influenced by their external relations; they are not successful alone.

Reading international business links

Reading is advantaged by its historic legacy of business entrepreneurship and vision that looked beyond its local boundary. Like London, Reading's success is linked to its external connections to other economically successful cities that are engaged in 'new work' in geographically extensive business networks generating flows of information, capital, and specialised knowledge transfer promoting innovation and economic renewal. Smart urban planning requires a consciousness of Reading's links with the wider world.

London's role as a leading world city in global 'knowledge economy' sectors that generate value-added for producers, service suppliers and governments – finance, accounting, legal, IT, consulting and marketing – has undoubtedly had spill-over benefits for Reading (Figure 13.1).

The world according to GaWC 2018

Alpha ++	London New York	**Beta +**	Ho Chi Minh City Boston Cairo Hamburg Düsseldorf Tel Aviv Atlanta Athens Doha Lima Bangalore Dallas Copenhagen Hanoi Perth Chengdu Bucharest Auckland Vancouver Hangzhou
Alpha +	Hong Kong Beijing Singapore Shanghai Sydney Paris Dubai Tokyo		
Alpha	Milan Chicago Moscow Toronto Sao Paulo Frankfurt Los Angeles Madrid Mexico City		

Figure 13.1 London – 'Alpha ++ World City' in the Global Knowledge Economy. Source: Globalization & World Cities Research Network, 2018: https://www.lboro.ac.uk/gawc/world2018.html

Despite the development of new technologies that allow work to happen anywhere, including when people are in transit between locations, global business functions in these 'new economy' sectors remain concentrated in offices that are densely clustered in London. Close physical proximity remains critical for high-value face-to-face interactions and for transactions involving global specialists from multiple companies.

Nonetheless, in tandem with London's rising global success since the late twentieth century, Reading has become the prominent Greater South East regional centre for innovative knowledge-intensive international companies seeking access to skilled people and with excellent UK national rail and motorway network and global air links.

9 Ibid, pp. 52–53.
10 Ibid, p. 54.
11 HM Government (2017, p.98).
12 https://technation.io/insights/report-2018/
13 Centre for Cities (2019, p. 38).
14 GVA is a measure of goods and services produced.
15 Centre for Cities (2019, p. 42).
16 Ibid, p. 40.

Reading's position in a changing Greater South East economic landscape

A report by Breach and Piazza in 2018,[17] made the point that even though financial services productivity is low in a number of UK cities outside London, the productiveness of the sector makes it important in those cities. Their analysis using Office for National Statistics 2017 data, showed that financial services give Reading strong links to London which, along with New York, is one of the world's top two international financial centres.

In the Greater South East England context, Reading is the largest town in the Thames Valley with a population of 328,060 in 2017.[18] Its 'primary urban area' (220 km sq.) represents the geography of its economic activity, spills over the Reading Borough Council administrative boundary to include Wokingham.[19] A Reading local economic assessment conducted in 2010 by the University of Reading, found that a larger geography including Reading, Wokingham and Bracknell, and four wards of West Berkshire, comprises a Greater South East economic 'Diamond'.[20]

Despite being physically separated from London, Reading is highly networked functionally with London and with other cities within and beyond the South East of England due the companies that cluster within and around it which are part of wider UK and international business networks and its excellent access in transportation infrastructure networks.

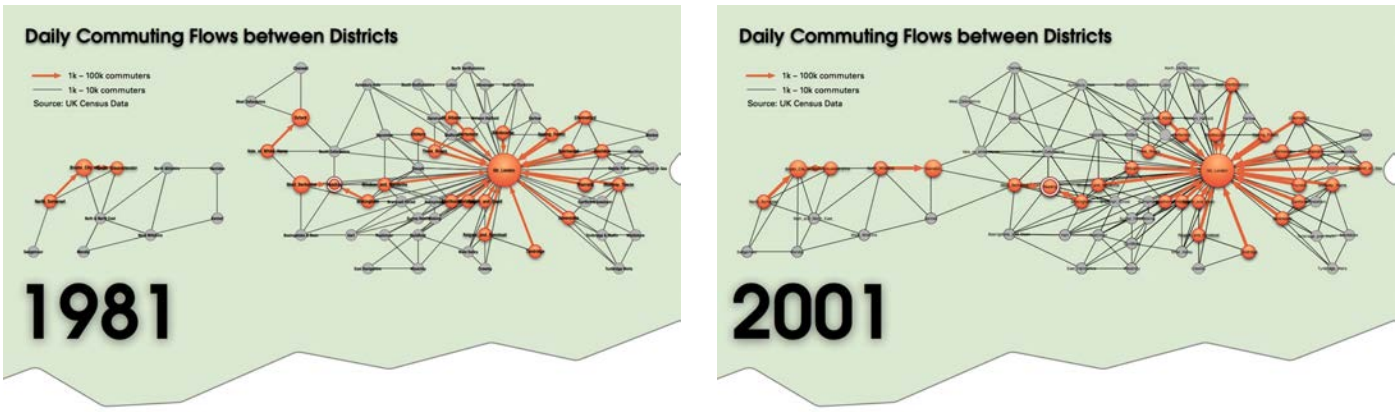
Networked Reading

The North West Europe study[21] that first noted the distinctive role of Reading in the Greater South East, used a multi-methods approach to analyse interlinkages between towns and cities defined by daily travel to work (commuting), and by business travel and virtual communication flows – email, phone and video-conferencing – in knowledge-intensive firms, in eight densely developed North West European city regions.

Intense overall commuting flows by car between physically separate urban centres were found in all of the city regions studied, including the Greater South East of England. Public transport systems were found to be inefficient in serving dynamic cross-cutting accessibility needs in multi-centre city regions. A striking difference between the city regions however, was that despite their modest size compared with London, eight urban centres in a western arc around London were functionally interlinked by high value flows of information and knowledge transfer in specialized business networks. This regional functional interlinking phenomenon associated with knowledge-intensive services, was not found to be so prominent in the other North West European city regions studied.

Reading's attractiveness as an employment centre gives it an extensive functional travel to work area.[22] A University of Reading study conducted in 2010, found increasing inter-linkages and complexity of daily commuting flows within the Reading 'Diamond' functional economic area (Figure 13.2). However, importantly, quantitative and qualitative interview data from all eight North West European city regions, showed that within the Greater South East, Reading also plays a particularly prominent role in providing the base for regional offices many of which are part of important international business networks in a range of knowledge-intensive sectors.[23]

Figure 13.2 Reading functional area defined by daily commuting 1981–2001. Source: *The Reading Diamond Local Economic Assessment*, Crampton, et al., 2010.



17 Breach and Piazza (2018): https://www.centreforcities.org/publication/london-links/

18 https://www.centreforcities.org/city-by-city/

19 Ibid.

20 Crampton *et al.* (2010).

21 Hall and Pain (2006).

22 Ibid.

23 Ibid.

Reading regional knowledge services hub

Reading's role as a multi-sector business services cluster is distinctive and of particular note because this characteristic is confined to the City of London. Furthermore, Reading is also a growing centre for knowledge-intensive high-technology industries that are also clustered along the Thames Valley to the West of London. Together, these firms with an international presence, connect Reading to flows in cross-border business networks rich in high-value new ideas, products and solutions generated by smart people within and beyond its immediate functional economic area.

Reading's prosperity today illustrates an economic growth process which has its root in the town's historic development. Reading's centuries long economic prominence as the county town of Berkshire important for agricultural processing and the production of beer, biscuits, bulbs and bricks, gave rise to the need for supporting business services that, since the 1950s, have come to underpin 'new work'.

Office for National Statistics data cited by the Centre for Cities,[24] show the exceptionally high share of jobs in private knowledge-intensive services in Reading in 2017 (nearly a quarter (23.85 %) of its jobs compared with other top Greater South East performers outside London (Aldershot 19.94%, Milton Keynes 18.7%, and Swindon 17.64%).

This high percentage jobs in knowledge-intensive services, contrasts with Reading's low 2.83% of jobs in manufacturing by 2017.[25] A legal services firm interviewed in Reading explained that they wanted a presence in Reading because, "over the last ten years, banks and accountants are regionalizing and saying where shall we have our HQ, and Reading has been winning quite a lot of those discussions".[26]

Reading connectivity matters

The town's physical location just 70 km to the west of London with excellent transport services both to the capital and also to Europe's leading internationally connected airport hub,[27] has clearly been critically important for its popularity with international businesses requiring superb physical connectivity. However, within the Greater South East, Reading's concentration of knowledge-intensive services jobs was considerably higher than that of Slough in 2017 (Reading 23.85% vs Slough 13.82% of jobs)[28] despite Slough's greater proximity to London and to Heathrow airport.

As one legal services firm put it, Reading "got stronger because the Big Four accountants are in Reading, and the surveyors likewise, tend to be here. The banks tend to have their regional headquarters in Reading. So, Reading is very much a professional services centre, that's definitely strengthened over the last sixteen years".[29]

Reading's outstanding success as the Greater South East's knowledge economy centre is endorsed by 2017 employment data for other cities and towns outside London.[30] No other cities, including London itself (23.09%), matched Reading's (23.85%) concentration of private sector knowledge-intensive jobs;[31] this is an astonishing vote of private sector confidence in Reading as a centre for doing high-value specialized business. What is more, knowledge services support employment in a wider range of sectors and jobs in cities.

How to ensure a sustainable future for Reading to 2050 and beyond?

Despite Reading's success story, recent research led by this author into 'good density',[32] has identified sustainable development risks for economically vibrant cities and regions, including London and the Greater South East (**Figure** 13.3).

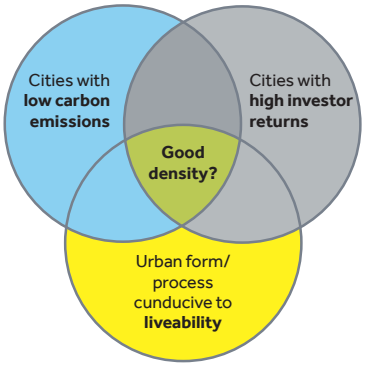


Figure 13.3 Vision – better density, better climate, better returns on investment. (Source: Pain et al., *Supporting Smart Urban Growth: Successful investing in density*, 2018)

The results from the study's multidisciplinary literature review and global quantitative analysis of 63 cities, highlighted a series of challenges faced by successful places needing to maintain excellent connectivity for knowledge-intensive businesses and employees while reducing traffic emissions that endanger human health and productivity and contribute to global warming. Importantly, the study shows for the first time, that compact

24 Based on data taken from https://www.centreforcities.org/city-by-city/

25 Ibid.

26 Pain (2008).

27 Pain and Van Hamme (2014).

28 Based on data taken from https://www.centreforcities.org/city-by-city/.

29 Pain (2008).

30 Based on analysis of data from https://www.centreforcities.org/city-by-city/

31 City rankings by author based on data taken from https://www.centreforcities.org/city-by-city/: Aldershot rank 2, Milton Keynes rank 3, Swindon, rank 4, Basildon rank 5, Bournemouth rank 6, Cambridge rank 7, Northampton rank 8, Brighton rank 9, Southampton rank 10, Southend rank 11, Crawley rank 12, Luton rank 13, Oxford rank 14 and Chatham rank 15.

32 Pain *et al.* (2018).

development when coupled with quality green and blue open space, not only mitigates CO_2 and creates a healthier urban environment, but is good for business, innovation, the economy, and returns on real estate investment.

High built-up density in compact cities, knowledge-intensive business and financial services, innovation and green environment are positively associated with returns on commercial real estate investment. Difficult to quantify built form characteristics such as heritage environment, city atmosphere and design quality could not be measured scientifically and accounted for in this quantitative study. However, a strong association between 'tourism' which may reflect such attributes, in cities having other 'good density' characteristics, suggests that qualitative urban elements are important determinants of city attractiveness and sustainability.

The report underlines the need for the private and public sectors to work together to promote smarter urban planning, investment and development, and to reduce emissions and benefit communities, the environment and the economy.

The specific arrangement of space (land uses, transportation infrastructure and open space) at individual city and city region levels is shown to be critical in underpinning 'good density' versus 'bad density' associated with sustainability risk factors (Figure 13.4). For example, the findings highlight the need for joined up inter-authority and cross-sector approaches to combat poor urban air quality caused by traffic emissions and their displacement across space in highly urbanised functionally interconnected city regions with intense travel flows, such as the Greater South East.

Senior Analyst at Grosvenor, Simon Chinn, said "the findings from the report highlight that investor attitudes to measuring density need to change." "Density encompasses more than just the number of people living or working within a defined area. It has to account for key characteristics of urban form such as clustering patterns, mixed use planning, amenity offer and transport infrastructure, which collectively play a role in creating the right kind of density for cities".[33] The incorporation of local good and bad density data in visual analysis trialled by the study, would allow the incorporation in smart planning of risk associated with density, for example, property location relative to public transport nodes and green space vs traffic flows, congestion, displaced CO_2 and air quality.

Figure 13.4 Good density components
(Source: Pain et al., *Supporting Smart Urban Growth: Successful investing in density*, 2018)

What does this mean for Reading?

Reading's knowledge-intensive business concentration and attractiveness to digital and creative firms engaged in 'new work', supports innovation and is important for economic renewal and resilience in changing global and regional economic landscapes. Reading's international firms are important in supporting local access to expertise that flows through knowledge-intensive cross-border business networks and to Reading's role in linking other cities in the UK to these wider business networks.

Reading compact urban development is likely to be positively associated with this knowledge-intensive international business concentration, innovation, a healthy green and blue environment, low per capita CO_2 emissions, and real estate investment returns that support a vibrant property market and the renewal of built infrastructure.

However, coordinated public and private sector decision-making is needed to ensure that urban density is not compromised by sustainable development risk factors. The advantages of compactness must be balanced with the retention of Reading's urban heritage and open space, green and blue environmental protection and improvement, and ensuring amenity and design quality.

Why does decision-making coordination matter?

Private sector commercial investment decision-making is critically important in determining the delivery and form of urban development and is subject to risk adjusted returns to investors which are influenced by conditions underpinning 'good' vs 'bad density'. Achieving Reading 'good density' therefore requires coordination between private sector investment and public sector land use planning and economic strategy actors.

Public sector inter-authority cooperation is also needed on cross-boundary strategic planning matters to secure 'good density'. This is because although the largest concentration of jobs is located in central Reading, Reading's functional area with regard to business

33 Ibid.

activity and travel to work patterns[34] extends well beyond the Reading Borough Council area.

Examples of cross-boundary matters requiring a joined up approach include: The mitigation of cross-cutting private and commercial traffic flows (commuting, leisure and business travel) and congestion that together contribute to total regional emissions and also to high air pollution levels in built up areas; provision of well-designed affordable homes in proximity to accessible sources of employment, schools, public transport, retail and leisure facilities, and green spaces, in the context of a widening prosperity gap in parts of the local community; management of sustainable green and blue environmental assets and corridors.

With robust local data, 'good' and 'bad' density risk factors can be mapped using a visualization tool developed at the University of Reading to assist joined up, smarter public and private sector decision-making.

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34 Research conducted in 2018 by SQW, found that Reading's travel to work area includes not only all or part of the unitary authority areas of Wokingham and Bracknell but also South Oxfordshire, part of Hart in Northamptonshire, and small areas of West Berkshire, and Windsor and Maidenhead (HM Government, 2019, pp. 8–9).

14 Delivering national growth, locally: the role of Thames Valley Berkshire LEP

Tim Smith Former CEO at Thames Valley Berkshire LEP

Introduction

In October 2010, against the backdrop of "the worst economic crisis of modern times", the Coalition government set out plans for local economic growth in a White Paper that shifted power to local communities and businesses. It proposed Local Enterprise Partnerships – LEPs – across England to bring together business and civic leaders, "*to set the strategy and take the decisions that will allow their area to prosper*."

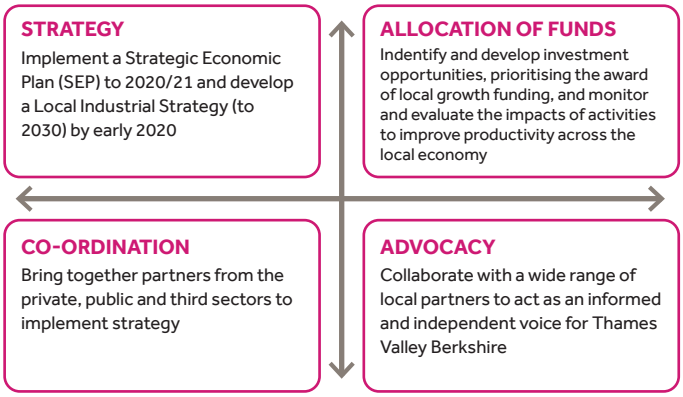
The first LEPs were established in April 2011, including Thames Valley Berkshire, and from April 2013 all areas of England had their own LEP – now 38 in total.

In November 2018, HMG stated that "*Local Enterprise Partnerships are business led public-private partnerships entrusted with investing public funds to drive growth England. Together they are responsible for a significant amount of public funding to drive inclusive growth, increase prosperity and improve productivity.*"

I would go further and say that we are here to make things happen in terms of economic growth – and that we compete with all other LEPs for public funds to invest in our area – Berkshire, or Thames Valley Berkshire as we refer to it.

Roles and responsibilities

The role of Thames Valley Berkshire LEP is to set the strategic direction on local economic priorities, develop and invest in projects that deliver maximum economic growth, increase productivity and help create local jobs. In its cross-ministerial LEP Review of summer 2018, the government set out four roles and responsibilities for LEPs:



And in its Industrial Strategy White Paper of November 2017, the government stated that every LEP area will have a Local Industrial Strategy in place by March 2020. The LEP Review of 2018 reinforced this, stating that, "*reformed and stronger LEPs will adopt a single mission: to promote productivity by delivering Local Industrial Strategies.*"

In the hiatus between our LEP being formed in 2011 and receiving this clarity from central government – some seven years – we agreed a set of fundamentals to make clear our form and our function. Our early and clear focus on productivity – the goal was to sustain the area's status as the most productive sub region in the UK – has positioned us well for the new, single focus on Local Industrial Strategies.

Strategy

In March 2014, all LEPs submitted multi-year Strategic Economic Plans – SEPs. These overarching plans for local growth set the context and priorities for other, more detailed plans and strategies to help achieve key economic ambitions in a LEP area.

Our mantra is "evidence-based interventions": we are business-led and therefore have a clear understanding of the barriers to economic growth. However, it is important that we test business priorities with evidence that will inform: if there is a market failure; the impact of an intervention; and if it will generate a return on investment. This ensures that our strategy is credible and that we are making the best use of public funds.

Within our current strategy, there are four programmes:

- Business environment
- Infrastructure
- People
- International.

Business environment

There are numerous elements to the Business Environment Programme but the two that currently involve significant public funds are the Business Growth Hub and our Funding Escalator. The latter is a dedicated fund for high-growth-potential SMEs, operated by the FSE Group. It will soon have £11.3m to invest in loans and equity and recently became an evergreen fund. The

fund is an award-winner and has supported nearly 60 SMEs, created or safeguarded over 750 jobs and levered-in over £30m of private finance.

Thirty eight Business Growth Hubs, one in each LEP area (directed by the LEP), integrate national and local business support to help businesses access the support and advice they need to thrive and grow. The Growth Hubs work with local and national, public and private sector partners – such as Chambers of Commerce, local authorities and banks – to co-ordinate local business support and connect businesses to the right solution for their needs.

Thames Valley Berkshire Growth Hub has been operating since 2014 and has engaged with over 2,000 businesses, provided intensive support to 700, helped over 180 individuals start a business and created over 200 jobs. Since early 2017, the LEP has contracted Oxford Innovation Services (OIS) to operate the Hub, using a mix of private, LEP, government and European funds. Separately, but in their role as Growth Hub operator, we have also commissioned OIS to lead on a programme to support scale-up businesses, known as ScaleUp Berkshire.

Infrastructure

The investment of Local Growth Funds (LGF) is a key focus for government in measuring the performance of all LEPs. Our six-year capital programme is worth £178m and we are investing in 51 projects such as the Thames flood scheme; digital infrastructure; new and upgraded rail stations; roads to unlock housing growth; cycle ways; skills labs; Internet of Things; mass transit routes; Park & Ride sites and town centre regeneration.

People

Similarly, over £16m will eventually be invested into projects that support employment and promote economic and social cohesion, using mainly European funds, those of the Careers & Enterprise Company or LGF to invest in capital projects such as STEM Solutions Labs at some of our Further Education Colleges.

International

Thames Valley Berkshire has the highest concentration of foreign-owned businesses in the whole of the UK. This number has grown to more than a thousand, in an area of just over 900,000 people. Foreign-owned companies are highly productive and do much to support a UK-based supply chain of SMEs.

Local growth with national impact

Our current strategy set out to grow the local economy by £700m GVA, by March 2021. This has been achieved several times over, though it's extremely difficult to extrapolate which of our interventions have contributed to the significant growth that our economy has enjoyed in the last five years. That's why, when we submitted our SEP to HMG in 2014, we gave it the title, *Delivering national growth, locally*.

I consider this to be the overarching challenge for a LEP such as ours: where best to invest the public pound in order to make a difference, in an economy of nearly £38bn GVA per annum; that reinforces the imperative for evidence-based interventions.

Berkshire Local Industrial Strategy

That challenge is particularly topical as we're leading on the development of the BLIS – the Berkshire Local Industrial Strategy. We understand that at a time of such uncertainty there is much expectation of economic policy. As an advocate for the area, we have a responsibility to respond to this and shape a strategy for the coming decade.

Much has already been done to build a robust evidence base: we recently published our BLIS Framework Document and are now asking for the support of the business, local authority, community and education sectors in taking this to government, to start the process of co-design, as all LISs must be co-owned by HMG.

In looking at the economic data underpinning the BLIS, we know that Thames Valley Berkshire is consistently the best performing LEP area in terms of headline productivity performance but, despite the significant growth in GVA alluded to earlier, our area is nevertheless dogged by very slow productivity growth (over recent years). Its comparative advantage is diminishing.

Our examination of this – through a Productivity Commission and professional advisers – when taken in the context of our assets, advantages and challenges, has helped define three key imperatives in our emerging BLIS:

The first is all about smart (and clean) growth.

The second is about the need to support routes to progression: TVB is a very expensive place to live and work. "Middle level" occupations are, literally, being priced out and there are high levels of in-work poverty.

The third is about the spill-over effects; are they being captured fully or is there so much transience that they are dissipated and lost. Do our places attract and retain talent and engender a sense of commitment, attachment and reinvestment? This drives the focus of the BLIS on towns and town centres.

Funding

The government pays core funding (currently £500,000 p.a.) to each LEP. This is contingent on a number of things including £250,000 of local value match; an Annual Performance Review; and certification that the LEP's Assurance Framework meets the revised standards set out in national guidance.

The largest source of LEP project funding is LGF. To date over £9bn has been allocated to LEPs across England; that Fund is now spent. LGF is secured through a series of Growth Deals with central government, i.e. we have to deliver on numerous commitments in return for the funds.

European Structural & Investment Funds or ESIF includes the European Social Fund (ESF), European Regional Development Fund (ERDF) and European Agricultural Fund for Rural Development (EAFRD). LEPs have an advisory role to the government's 'Managing Authorities' for ESIF, i.e. the money does not come to the LEP but is invested by government based partly on alignment with the LEP's ESIF (investment) strategy. The government has underwritten ESIF so Brexit will not have an impact on projects that are funded using ESF, ERDF or EAFRD. In most case the European funds have to be matched 100% by the applicant.

ESIF and LGF will be replaced in future by a 'UK Shared Prosperity Fund'.

Accountability

In most cases and certainly in the case of large amounts of capital such as LGF, the funds do not land with the LEP, they are released to an 'Accountable Body'. Since the LEP was established, this has been the Royal Borough of Windsor & Maidenhead. The relationship between the LEP and the Accountable Body is important: it's writ large in our Assurance Framework and is a requirement of government.

All of the major investments we make are summarised on our website in three eBooks[1]. These describe the latest status of projects that the LEP has or is investing in, using public funds, so it's important that we have an interesting and easily navigable website for all to use.

Co-ordination

The essence of being a successful partnership is to be found in the way the LEP develops and fosters relationships and understanding between numerous stakeholder organisations; we cannot function without committing significant time and energy to this.

A good example is our Major Works Co-ordination Group. The essence of this is to scope out how we can work together to mitigate or at least manage the disruption generated by the huge investment into the road and rail network across Thames Valley Berkshire in the coming years. The Group is chaired by a non-executive director of the LEP, managed by our Head of Infrastructure and hosted by the Department for Transport (DfT).

All participants have now signed the Major Works Co-ordination Group Memorandum of Understanding.

We also work closely with the six unitary and planning authorities on a key priority for the LEP – housing:

- SHMA – we contributed to a Strategic Housing Market Assessment for Berkshire
- FEMA – we commissioned a study on Berkshire's Functional Economic Market Areas
- EDNA – and on the Economic Development Needs of those FEMA.

1 http://www.thamesvalleyberkshire.co.uk/investing-in-growth

All of this to help shape the six Local Plans for Berkshire's unitary areas. And we went a step further and commissioned our own SEN – a Spatial Economic Narrative that offers a business perspective on the spatial needs and growth of Berkshire.

Co-ordinating with six unitary councils, five FE Colleges and eight MP constituencies is a big part of the job of the LEP.

Advocacy

Strategic priorities such as a Western Rail Link to Heathrow and the expansion of Heathrow airport are good examples of us advocating for national or sub-national investment that will help improve our place.

The LEP has made public its support for the expansion of London Heathrow since 2012. We submitted evidence to the Airports Commission and spoke at its Hearing in Public. Our position has always been a majority one as the Royal Borough of Windsor & Maidenhead does not support expansion, so we make this distinction and agree to differ.

We also have three excellent sector propositions[2] covering our most important sectors: i.e. digital tech; life sciences & healthcare; and energy & environment. These tell a compelling story of our place and have been used for at least two investment decisions that we are aware of. They are also used by the Department for International Trade's overseas posts to provide a detailed summary of our area's assets, for anyone interested in investing in this part of the UK.

Governance and transparency

The governance & transparency of the LEP is significant and best described thus:

2 http://www.thamesvalleyberkshire.co.uk/international

The LEP Annual Delivery Plan 2019–2020

It's worth mentioning that guidance on LEP governance & transparency has grown since 2016 when it was first published – in 21 pages, to 2018 – in 37 pages – and most recently in January 2019 when the national assurance framework, as it's known, stretched to 95 pages and 85 mandatory actions for LEPs to comply with.

The LEP is a company limited by guarantee and as such, its Articles provide that it operates through a Forum and a Board. The Forum consists of 11 sector representatives, including those from the six unitary authorities in TVB. The Board consists of 10 non-executive directors and a paid, full-time Chief Executive. This model is cited by the Institute of Directors as the best-known two-tier Board structure, having:

- a supervisory body that oversees the management of the company (the Forum)
- a management body that manages the company (the Board).

Unless specifically reserved for the Forum, the Board exercises all the powers of the LEP and is its primary decision-making body.

In terms of transparency, all that we do is summarised each year in a digital Impact Report. From this year, we also produce an Annual Delivery Plan[3] so in time anyone can track what we did, against what we said we'd do!

Reach

The LEP is a very small organisation. We do a lot with very limited resources: 14 staff (c.11 FTE), combined with willing, professional and committed volunteers who contribute their time and expertise to making Berkshire an even better place to live and do business in.

We have published a framework document and started the co-design phase with central government. In the meantime, our two main funding streams are coming to an end – that's LGF and ESIF

3 http://www.thamesvalleyberkshire.co.uk/getfile/Public%20Documents/About%20us/Governance%20and%20Accountability/Thames%20Valley%20Berkshire%20LEP%20Delivery%20Plan%20for%202019-20.pdf?inline-view=true

– so without a new, single-pot fund that LEPs have some control over or at the very least involvement in, it's difficult to see a clear function from 2021 onwards that will provide us with any real levers to effect change. We therefore wait with some expectation, the government's consultation on the UK SPF, which is tied to Brexit.

Finally, a word on our wider role: The economies and labour markets in and adjacent to Berkshire determine the interventions the LEP should lead, according to their impact versus agility, i.e. what is the optimum intervention scale, LEP or cross-LEP, and will a strategic partnership achieve more leverage and thus impact.

It's also the case that several national issues dominate the local economy, yet their cause and effect are complex and often intangible in a local context. We co-operate outside of LEP boundaries to forge relationships (sectoral and geographic) that will have a chance of making an impact rather than trying to deal with (all) such issues locally.

Conclusion

We have secured £178m to invest in Thames Valley Berkshire and directed or influenced another £50m. We have helped to create jobs, train people, support businesses to grow, invested in SMEs and in infrastructure to unlock housing growth. As a start-up business, we've grown from one employee in 2012, to 14 in 2019 and have seen all of our non-executive directors complete their terms of office; our Board is unrecognisable from five years ago.

We're a private company, led by volunteers, paid from the public purse and heavily regulated. We champion an area with a truly amazing economy, but which doesn't hang together as one place; that makes the role of the LEP challenging, varied, fascinating, sometimes frustrating but always focussed on making Thames Valley Berkshire the place where people choose to live and work.

15 What impact will population change, and other factors have on housing in Reading by 2050?

Simon Macklen and Debbie Mayes Barton Willmore

Introduction

Population change is a key demand side driver in determining the need for future services and facilities including health, education, retail, leisure, employment, transport and housing. The focus of this paper is the impact of population change on housing in Reading by 2050.

In order to understand what the population of Reading might look like in 2050 it is necessary to consider factors which will impact population change. These factors can be grouped into 'internal' and 'external' factors. Internal factors include demographic factors such as natural change (the ageing of a population accounting for births and deaths) and migration; social factors such as an areas attractiveness, and the availability and affordability of homes; and economic factors such as the local employment opportunities. External factors include BREXIT; national infrastructure projects; and affordability issues across London and the wider South East.

In considering the factors which will impact population change in the future, it is first helpful to look at historic population change in Reading. This paper begins by looking at what Reading's population was like 30 years ago before presenting the current (2019) population profile and housing trends in Reading. The paper then goes on to consider the internal and external factors that are likely to influence what Reading's population might look like in 2050 and then considers how this will influence future housing demand in Reading taking account of household formation assumptions.

Reading in this paper refers to the Reading Borough Council area.

Historic and current: population change and housing demand

In 1991, Reading had a population of 129,000 [1]. The child population (aged 0–15 years) accounted for 25% (32,000 people); the working age population (aged 16–64 years) accounted for 61% (79,000 people) and older people (aged 65+ years) accounted for 14% (18,000 people)[2].

Reading had a younger age profile than the South East region with a greater proportion of working age people (61% compared to 59%) and a smaller proportion of older people (14% compared to 17%).

Since 1991, Reading's population has increased by an additional 37,000 people totalling 166,000 people in 2019[3]. This represents a 30% increase which is higher than the rate of population growth in the South East region (23%) over the same period.

Population growth in the South East region over the last 30 years has largely been driven by an increase in the older age groups, whereas population growth in Reading has been within the younger working age population and associated child population – the polar opposite. For example, whilst the South East's population aged 70+ years grew by 52% between 1991 and 2019, Reading's 70+ year old population grew by just 17%. In contrast, Reading's population aged 40 to 54 years has grown by 47% in comparison to just 27% in the South East region.

As a university town, Reading's student population contributes to the younger age profile. Population pyramids (Figure 15.1, see over) demonstrate how Reading has a much younger age profile than the South East region (grey line) with the 'bulge' in people in their early 20s reflecting Reading's role as a university town.

Reading experiences net in-migration of 19-year olds reflective of those students moving to Reading to study. In recent years, Reading has seen an increase in net in-migration of 19-year olds from 647 in 2012 to 1,067 in 2018 with the rise largely reflecting the year-on-year increase in students at Reading University[4]. Historically, students have migrated out of Reading after graduating resulting in a net out-flow of migrants in their early 20s. However, it is apparent from comparing the population pyramids in Fig 1 that this trend appears to have diminished over recent years as the 'bulge' in the younger cohorts is becoming less pronounced.

Further analysis of migration trends (Figure 15.2) reveals that although the net out-flow of migrants in their early 20s in 2018 remains at a similar level to that seen in 2012, given that the

1 ONS, 1991 Census, Local Base Statistics Table 1

2 ONS, 1991 Census, Local Base Statistics Table 2

3 ONS, 2016-based Sub National Population Projections for England (projection for year 2019)

4 ONS, Analysis of Population Estimates Tool - 2018

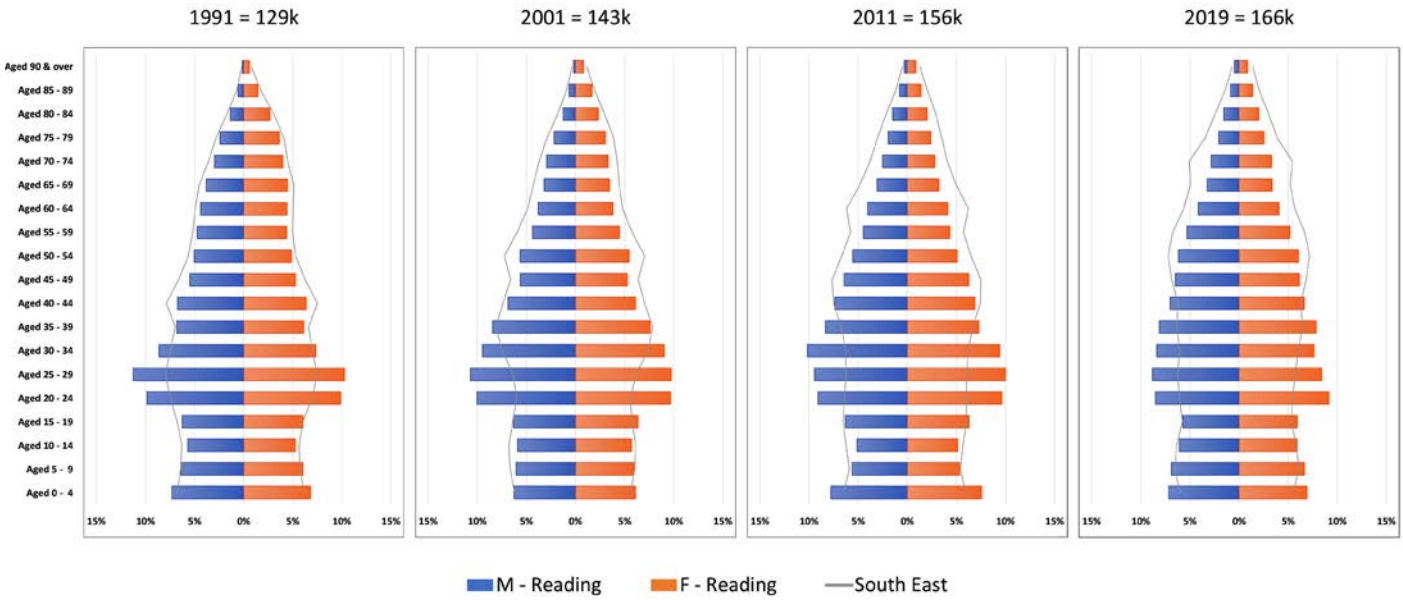


Figure 15.1 Reading's current and historic age profile

net in-flows of 19-year olds are higher, the overall volume of graduates remaining in Reading is increasing.

The population pyramid in 2019 reflects a young demographic, consisting of young families. However, further analysis of net migration trends suggests that young families are moving out of Reading illustrated (in Figure 15.2) by the net out-flow of people in their 30s and also children aged 0 to 18 years.

Historically, Reading has typically experienced net out-migration year-on-year, meaning that more people have been moving out of Reading than moving to Reading. Despite net outward migration from Reading, it is important to note how since 2002 there has been a net in-flow of international migrants to Reading. In the most recent year, there was a net increase of 1,802 people from overseas who moved to Reading. However, this net increase is counteracted by a net out-flow of 2,885 internal migrants (from within the UK) resulting in a net out-flow of 1,073 people. Despite this, Reading's population marginally increased by approximately 100 people. This indicates that population growth in Reading is driven by natural change (births minus deaths) rather than migration.

Nonetheless, given the large influence of international migration on Reading's population, the impact of Brexit raises uncertainty over the future population profile of the Town.

Turning to Reading's housing stock. Reading has a higher proportion of flatted development (31%) than the South East region (20%) and properties in Reading tend to be smaller. According to the 2011 Census[5], one-bedroom properties account for 16% of Reading's housing stock, compared to just 12% in the South East region. In contrast, only 17% of Reading's housing stock has 4+ bedrooms, whereas in the South East region the proportion is 23%.

Since 2011, Council Tax data[6] suggests that there has been a further increase in the proportion of smaller properties in Reading and a reduction in 4+ bedroom properties. This may help explain the apparent out migration of families from Reading. This may not be a concern if those families are moving into a neighbouring borough within the same housing market, but it does highlight a potential issue.

Is it the young demographic of Reading influencing the housing stock profile or the smaller housing stock profile attracting a younger demographic?

Since 2001, the proportion of one person households has gradually been increasing. This is typified by either an ageing population or a younger demographic, the latter more likely being the case in Reading given its university status. In contrast there has been a decline in the proportion of households with two or more adults which in a university town is usually reflective of groups of students living together/sharing accommodation. The decline in multi-adult households may be the result of an increase in purpose-built student accommodation, with compensatory increases in one person households. Nonetheless, multi-adult households remain the largest household type in Reading at the current time accounting for 38% of all households[7].

Since 2001, there has also been an increase in households with one dependent child. As the migration analysis presented earlier suggested, students are now remaining in Reading for longer after

5 ONS 2011 Census, Commissioned Table CT0798

6 VOA, Council Tax Stock of Properties 2018, Table CTSOP3

7 ONS, 2016-based Household Projections (projection for year 2019)

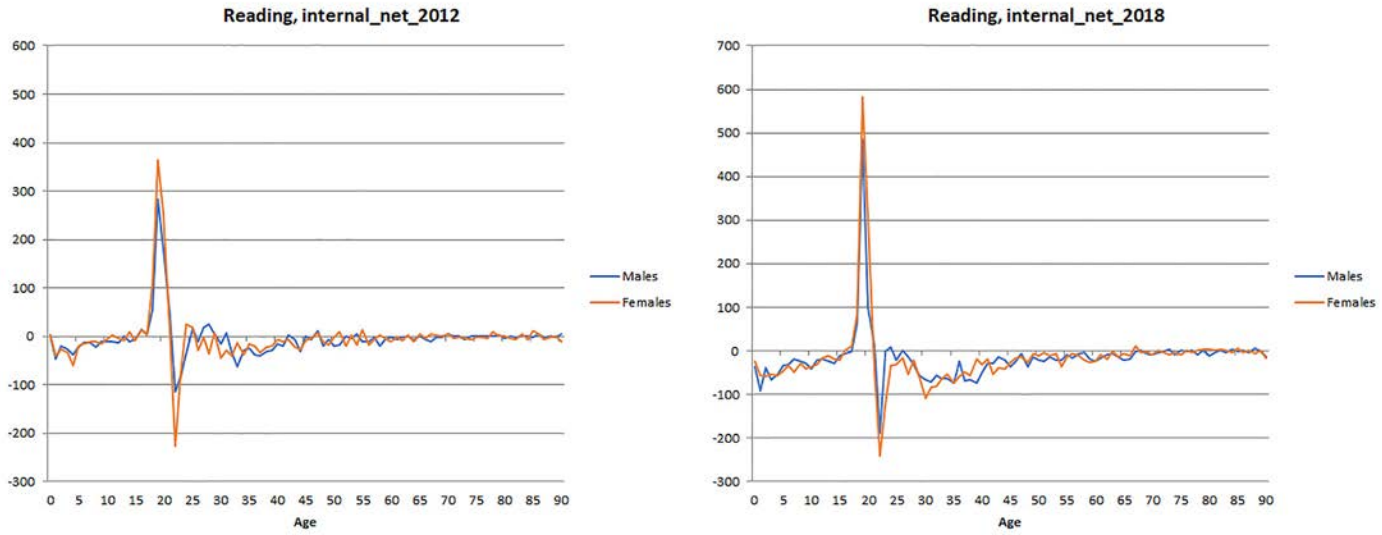


Figure 15.2 Net migration (internal migration only)

graduation and possibly starting a family before moving out of Reading once they are in their 30s. Households with larger families have declined between 2001 and 2019, again reflecting the net out-flow of families from Reading that was demonstrated earlier in this paper.

Reference to Experian's Mosaic consumer classification tool[8] provides further detail on the characteristics of Reading's population and their lifestyles. There are two prominent Mosaic Groups in Reading termed as 'Rental Hubs' and 'Domestic Success', with higher proportions found in Reading than compared to the average for the South East region. Rental Hubs generally reflects young people in their 20s, single and who are privately renting a flat either by themselves or with friends. Rental Hubs are typically found in urban locations and young neighbourhoods and within Reading can be found in the centre of town. Domestic Success generally reflects people in their late 30s/early 40s with children living in semi-detached/detached properties and with high levels of household income. Domestic Success are typically found in the suburb of Reading.

Therefore, whilst Reading's demographic is generally younger, there is a large variation in the life stages of this population and therefore the demands placed on the housing market.

Affordability of housing influences people's ability to get on the property ladder. Affordability is measured by the ratio of house prices to earnings based on median values. The affordability ratio for Reading in 2018 was 8.54 meaning that a median price house would cost 8.54 times a person's annual earnings[9]. This makes Reading relatively affordable in comparison to other authorities nearby where the affordability ratio is much higher. For example, in Windsor and Maidenhead the affordability ratio is 13.16; Wokingham 11.17 and West Berkshire 9.61. The affordability of homes will be influenced by the housing stock profile and therefore the higher proportion of flats and smaller properties in Reading is likely to have contributed to the relative affordability of homes in Reading in comparison to other areas.

Whilst a median price home in Reading will still cost more than the current mortgage lending criteria of 4 x earnings, Reading's relative affordability will still make it an attractive place within the local housing market to live and will therefore influence migration behaviour within the surrounding area. For example, young people looking to get onto the property ladder may not be able to afford a property in neighbouring Wokingham and may therefore decide to move to Reading where property is more affordable. The increasing affordability pressures in London may also increase net migration to Reading either through direct migration to Reading where property is more affordable, or through a ripple effect of displacement – displacing those on lower incomes living on the outskirts of London.

The affordability of homes therefore influences migration, but also commuting patterns as people chose to live in more affordable areas and commute further distances to work, for example in the cities. Reading is currently a net importer of labour which means that there are more jobs than economically active residents and therefore there are more people commuting into Reading than there are commuting out. Therefore, whilst Reading has historically suffered from net out migration, it's relative level of affordability and employment opportunities suggest that this trend could be reversed in the future.

Despite Reading being a net importer of labour, job growth in Reading over recent years has been fairly volatile. However, forecasts provided by Oxford Economics[10] suggest a steady

8 Experian, Mosaic Consumer Classification, 2018

9 ONS, 28 March 2019, House price to workplace-based earnings ratio 2018

10 Oxford Economics, August 2019, Local Authority Forecasts

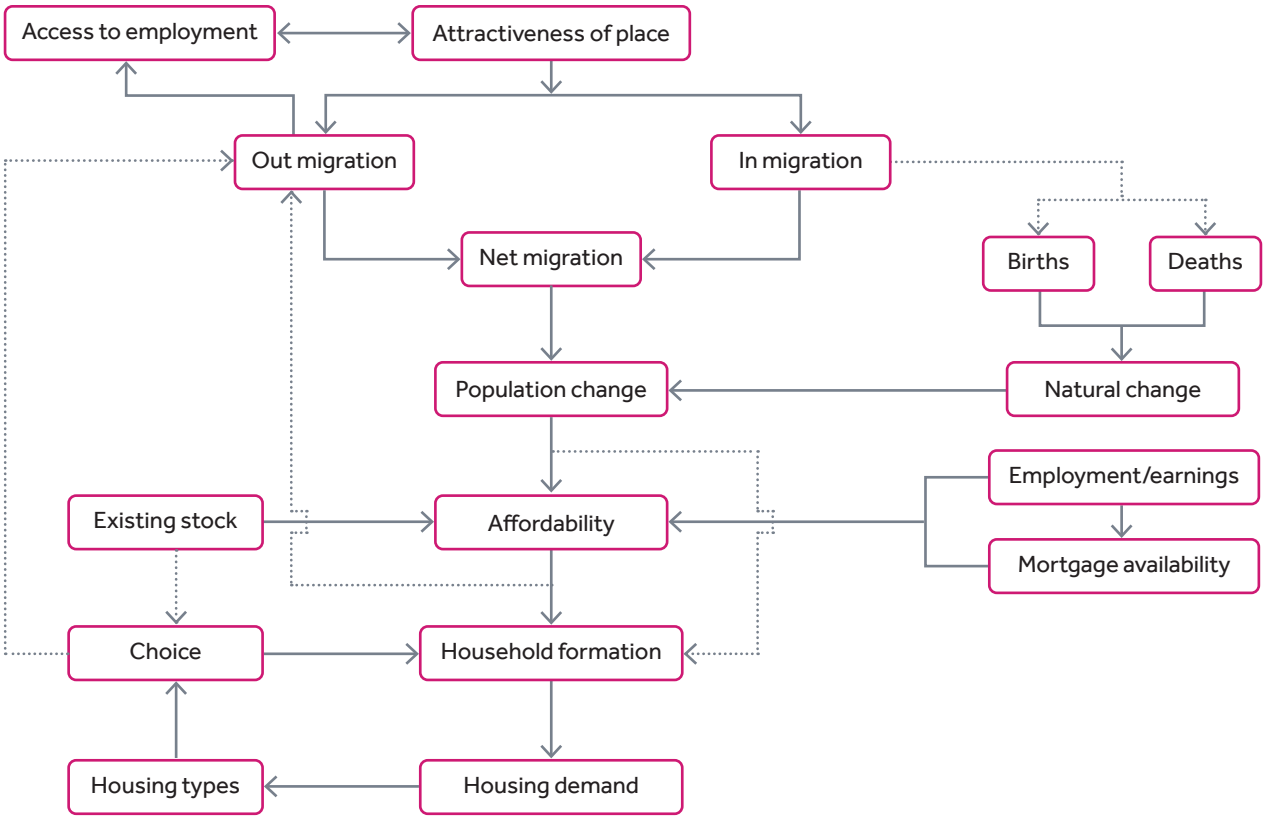


Figure 15.3 Drivers of housing demand

level of future job growth in Reading. The question is whether the level of job growth can materialise from the projected levels of population growth or whether that will be a constraint to employment growth. Employers can compensate by employing people from further afield, increasing inward commuting, but this is less sustainable and less attractive to employers and employees. Dependent on the balance between job growth and labour force growth, it may be necessary to actively plan for increases in the working age population through greater planned provision for housing.

In addition to forecast job growth in Reading itself, there are a number of other national infrastructure projects that may impact on the demand for homes in Reading. For example, the Heathrow Extension will create additional employment opportunities and the development of Crossrail will increase the ability of people to commute more easily into/out of London. Given affordability issues within London and elsewhere within the South East region, these national infrastructure projects may increase the demand for homes in Reading given its relative affordability currently.

So, it is apparent that there a number of internal and external factors that impact on population change and the demand for homes in Reading. Internal factors include demographic factors such as natural change and migration; economic factors such as the employment opportunities; and social factors such as the availability and affordability of homes and the attractiveness of a place. External factors largely fall outside of Reading's control but impact on the attractiveness of Reading and influence migration patterns (both positive and negative) including national infrastructure projects, affordability in London and across the wider South East, commuting patterns, international migration and Brexit.

The key drivers of housing demand and the inter relationship between them are illustrated in Figure 15.3.

Future: population change and housing demand

Having considered the factors which impact on population change we now turn to how these factors might influence population growth in Reading to 2050.

The Office for National Statistics (ONS) 2016-based principal projection[11] for Reading projects that the population of Reading will reach 186,000 by 2050 which is equivalent to a 12% increase since the year 2019. Population growth in Reading is therefore projected to slow over the next 30 years in comparison to the level of growth experienced historically over the last 30 years (+30%).

11 ONS, 2016-based Sub National Population Projections

However, these projections are based on demographic trends (migration, fertility and mortality) over the last five years and as such reflect net out migration from Reading. The projections do not account for employment growth and/or any additional population required to meet the future labour force requirement. To sensitivity test the implication of alternative assumptions in relation to international migration, the ONS produce variant projections[12] which consider the effect on the future population if net international migration was to increase by c.40% and conversely reduce by c.40%. As discussed earlier in this paper, international migration is an important component of Reading's population change and therefore the high migration variant projects Reading's population to reach 198,000 in 2050 (6% higher than the principal projection) and the low migration variant projects Reading's population to reach 174,000 (6% lower than the principal projection).

There is a common trend noticeable in all future population scenarios for Reading. By 2050 there will be a noticeable ageing in Reading's population. Whilst historically Reading's population growth has been concentrated in the working age and child populations, over the next 30 years there will be significant growth in the population aged 65+ years. The ONS principal projection estimates that Reading's population aged 65+ will increase by 75% over the next 30 years – this compares to growth of just 11% over the past 30 years.

Applying household formation rates[13] (the likelihood of a person of a given age and gender to form a household) to the projected population provides an indication of the household types that will exist in Reading in 2050. Multi-adult households will remain the largest household type in Reading by 2050 totalling 31,000 households (an increase of 24% or +5,900 households). However, the largest growth over the next 30 years will be in one person households which are projected to increase by 34% (+7,200 households), with the growth being largely driven by the ageing of the population. Family households (with 1 or more dependent children) are projected to increase by just 3%. However, it is important to remember that the projections are trend-based and as such reflect a continued level of net out-migration from Reading, which as reported earlier in this paper, is predominantly out-migration of young families.

When considering future housing demand, it is important to look beyond the absolute levels of household change, because an increase in one person households does not necessarily translate into an increased demand for one-bedroom properties. An older person, whose household type will have changed through various life stages, and who may now be represented as a one-person household, is likely to already own a home. As such, when planning for future homes it is important not to take the relative levels of households by household type at face value and therefore plan for a large volume of one-bedroom homes, as the increase by household type might suggest. Older people will have a choice of whether to remain in their own family home or move into smaller accommodation. Alternatively, it may be necessary to plan for greater levels of family accommodation in order to reverse the trend of out-migration of families. However, this may be offset by the provision of specialist accommodation for older people which would increase the choice of housing for older people, allowing them to move into accommodation more suited to their needs, in turn also freeing up the existing family housing stock. Similarly, greater provision of student accommodation may free up smaller properties for those seeking to get on the housing ladder (rent or ownership). Therefore, planning for homes to meet the needs of specific population groups may assist in creating better efficiencies in the housing market.

Conclusion

This paper has identified that Reading's population is projected to reach 186,000 people by 2050 based on current population projections underpinned by demographic trends experienced in Reading over the last 5 years. As such, this projection may be considered conservative given it reflects net out migration of families and doesn't take account of policies i.e. economic growth objectives that may have the effect of reversing past trends.

Reading Borough Council adopted its Local Plan on 4 November[14], with the Local Plan making provision for the delivery of 15,847 net additional homes between 2013 and 2036 (equivalent to 689 new homes per annum). The Plan seeks to ensure that 50% of dwellings on sites of 10+ dwellings have 3+ bedrooms. The focus on providing family homes is likely to reduce out-migration of families, therefore retaining a working age population that will also provide a local labour force to support economic growth aspirations also set out in the Local Plan.

In conclusion therefore, it is clear that population change will impact on future housing demand in Reading. However, future population change will be influenced by a number of internal and external factors. Whilst it is necessary to ensure the overall quantum of housing is adequately planned for to support population change, it is also necessary to ensure the right type of housing is delivered in the future to meet the needs of Reading's population in 2050.

12 ONS, 2016-based Variant Sub-National Population Projections for England: 2016-based

13 ONS, 2016-based Household Projections, detailed data for modelling and analytical purposes

14 Reading Borough Council, Reading Local Plan (adopted 4 November 2019)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