OXFORDSHIRE INNOVATION FRAMEWORK FOR PLANNING & DEVELOPMENT

OXFORDSHIRE COUNTY COUNCIL

CONTENTS

1. INTRODUCTION

This Innovation Framework (IF) is a guidance document setting out the need for developers and planners to consider innovation within planning and development, ideally including putting together Innovation Plans for new developments. It covers developments of all kinds, including residential, commercial, workplace, mixed use and infrastructure development. A roadmap of forthcoming innovations and a table on futureproofing measures and also included; in addition a template for developing an innovation plan is available. This document outlines the need for and benefit of considering innovation within the development process, explaining how considering innovation within development and infrastructure can support existing and developing strategies and addresses key challenges, therefore futureproofing development.

A single source of information for developers and planners to consider innovation in development and infrastructure ensures that common principles are applied from both sides of the process and a consistent approach is taken to futureproofing. This will help to assure investment in this area supports continuous development, as well as consolidate benefits across different domains by having more consistency. Developing an innovation-friendly county is positive for the regional economy, as it will also help attract innovators, support growth and accelerate the societal benefits to the area. Innovation is a term which could potentially mean a number of things depending on context. For the purposes of this framework, 'innovation' refers to anything which is new, or to traditional approaches being applied in new ways or contexts – this can range from new technologies (such as 3D printing) or data analysis and visualisation tools, through to new processes or approaches (such as co-creational public engagement, new ways of creating social infrastructure, or innovative procurement financing or recruitment techniques).

This framework does not propose that totally untested innovations be put in place within development or new infrastructure (though this may be appropriate in some situations), instead, it is suggested that emerging innovations which already have some level of evidence in place to show likely efficacy could be applied where site circumstances suggest good potential for a given application. Our aspiration is to strike a balance between enabling adoption and futureproofing developments (as to avoid costly retrofitting) while minimising the risk to

DEPLOYMENT	9	ACTUAL SYSTEM PROVEN IN OPERATIONAL ENVIRONMENT
	8	SYSTEM COMPLETE AND QUALIFIED
	7	SYSTEM PROTOTYPE DEMONSTRATION IN OPERATIONAL ENVIRONMENT
DEVELOPMENT	6	TECHNOLOGY DEMONSTRATED IN RELEVANT ENVIRONMENT
	5	TECHNOLOGY VALIDATED IN RELEVANT ENVIRONMENT
	4	TECHNOLOGY VALIDATED IN LAB
RESEARCH	3	EXPERIMENTAL PROOF OF CONCEPT
	2	TECHNOLOGY CONCEPT FORMULATED
	1	BASIC PRINCIPLES OBSERVED

Figure 1
Technology Readiness Level (TRL)

the public and the development. In terms of technology, it may be useful to consider the Technology Readiness Level (TRL), as an indicator of how advanced and ready to deploy a given innovation might be. This scale indicates 9 levels of technology readiness, ranging from level 1, where basic principles have been observed, through to level 9, where the actual system has been proven in an operational environment. This framework recommends focusing on innovations with a TRL of level 5 or above. See Figure 1.

The IF and supporting materials provide information on what should be considered within an Innovation Plan for the different stages of development, and how planners should consider innovation within the planning process, with examples and case studies of types of innovation within different areas. This covers innovations which could help to address key challenges facing developments and developers, ranging from catering for an ageing population and the need for resilience to climate change, to understanding the real needs of a given location. It also covers those which can help support key Oxfordshire and national aims, objectives, policies and strategies, such as achieving net zero carbon and enabling healthy and connected communities. Key aims and objectives are set out in the following section – these are the underlying principles which should lead the integration of innovative technologies and processes within development and new infrastructure. In addition, this IF covers how developments can be futureproofed for when current innovations become mainstream; this is based on thorough knowledge and research of existing innovations and their likely trajectory.

However, given the nature of innovation, new technologies and approaches or changes could disrupt the expected uptake. For this reason, forecasting future trends comes with risks. Near-term forecasting (within 5 years) is relatively reliable, but not an ideal timeframe for understanding and strategic planning for most development. On the other hand, whilst forecasting for 20 years and beyond would be a very helpful planning timeframe, due to the potential for maturation of new technology in this timescale and increased potential for unforeseeable events, forecasting for this long-term outlook is much more unreliable. The Institute for the Future (IFTF) therefore suggests around 10 years to be the best timeframe for forecasting. This medium-term forecast is sufficiently long to allow for the maturation of known emerging technologies and trends, while short enough to limit the impact of unknown factors, as well as being a sufficient window to encompass the timeline of much development. As such, this Framework focusses on future proofing for a 10 to 15 -year timeframe, although the longer term is touched on for context and completeness.

Oxfordshire County Council's Innovation Hub (iHUB) has led on the development of this framework. The iHUB was created in 2015, initially focussed on transport innovation, but has since broadened out into a wide range of other areas including energy, modelling, air quality, infrastructure, legal and procurement, new disruptive business models and health and care. The hub has been instrumental in developing links to business and academia, as well as securing external funding for projects for the county. Working with lead partners who are driving disruptive technologies, iHUB continue to challenge the status quo and drive new solutions for Oxfordshire and implementation beyond. The iHUB has been working collaboratively with world leading organisations to trial new ideas and models, enabling Oxfordshire to become a world leader in public space innovation. In 2018 and 2019 alone, the team secured more than £6m of income to the council, and more than £100m to the region. It has grown into one of the largest innovation teams in the country and helped the growth of companies such as Oxbotica, Latent Logic, Zipabout and Arrival.

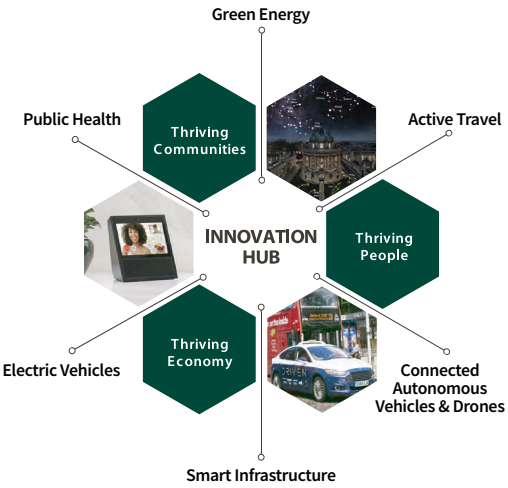


Figure 2
Oxfordshire Innovation Hub logo

1.1 Principles and aims

The Innovation Framework supports a number of key principles and policies. Innovation should not be introduced for the sake of innovation, but only where it can be shown to support these policies and aims, overcome challenges, mitigate risks, and bring benefit to the community, developer, planning authorities, other stakeholders and the environment.

There are a wide range of policies with synergies to this framework as well as other frameworks, guidance documents and strategies. This section therefore pulls together a number of principles and aims which support existing or developing policies, strategies, frameworks and guidance documents as well as introduce innovation-specific elements. The major documents with linkages to this one are covered in Appendix 1, outlining the main synergies where appropriate and providing links to the documents where available. The focus is on Oxfordshire-specific documents, rather than national or international.

Figure 3: The 9 IF principles

This IF supports 9 encompassing principles and goals, summarised in Figure 3.

In the following pages, these principles are provided in greater detail with a number of more specific aims which feed into them and identify some of the potential ways in which the overall principle could be achieved. Not all of the specific aims will be relevant to all types of development and infrastructure, but the overarching principles should be taken account of by all types of development.

- **Deliver accessibility and connectivity for all, minimising the need for travel, taking account of differing needs including all types of disability and age, with a focus on active and sustainable transport**
  - Making walking, cycling and micromobility[1] accessible, safe and desirable for all, following the standards set out in the walking and cycling design guides, with priority for active travel modes following the user hierarchy set out in the Local Transport and Connectivity Plan (LTCP)
  - Reduce the need to travel via high quality and high speed digital connectivity and physical connectivity and proximity to services
  - Support an environmental hierarchy, where sustainable modes of transport are favoured, meaning fewer journeys by fossil fuelled private car
  - Lessening traffic generation and its detrimental impacts, including on congestion, air quality and noise
  - Consider the needs of, support and facilitate first, last and only mile transport options, for both people and goods
  - Accessible electric vehicle charging infrastructure for residents and other occupiers, sufficient to meet anticipated future demand levels
  - Recognise the need for innovation that is appropriate for rural areas especially in transport and connectivity

- **Working towards Oxfordshire becoming a zero-carbon economy, with zero-carbon new development**
  - Maximising energy efficiency
  - The highest fabric standards and renewables maximised on-site to minimise embodied carbon
  - Renewably sourced heat as default in new developments
  - Community ownership of energy
  - Reduce the growth and overall volume of waste and proportionally increase recycling and reuse
  - Design to support reduced overall energy demands to avoid the need for grid upgrades

1 Micromobility technically covers a range of small, lightweight vehicles which operate a speeds usually below 25km/h, and in practical terms is used here to refer to scooters, e-scooters and e-bikes, including cargo bikes.

- **Supporting the Oxfordshire economy, with a focus on clean, sustainable growth**
  - Adopt a Living Lab approach, facilitating collaborations, data-based evaluation and decision making
  - Provision of affordable, professional and flexible working space
  - Supporting the development of an inclusive economy for Oxfordshire, embedding sustainable and circular economy[2] practices for long term economic gain
  - Support business growth, including training, incubators and accelerators for SMEs
  - Supporting the Local Industrial Strategy's aim for Oxfordshire to be one of the top three innovation ecosystems in the world
  - Provide the quality and choice of development needed to support growth and attract specialist and flexible skills at all levels, across different sectors

- **Using and gathering evidence and data transparently, ensuring ongoing monitoring systems are embedded in development**
  - Sharing data to support best practice and creating an evidence base
  - Supporting highway network management , asset owners and other operational teams (e.g. active travel and road safety)
  - Maximising the value of existing data to identify the needs of the development area, and cater to these needs
  - Integrating suitable smart monitoring approaches into development
  - Co-creating with the community
  - Using evidence to learn from experience, including the experiences of others, and integrating learnings into approaches and actions taken

- **Embedding of circular economy practices and principles into the whole development process from conception through to ongoing usage, maximising longevity of assets and minimising waste**
  - Minimising the need for maintenance, and making required maintenance as minimally invasive as possible, through design and materials use
  - Maximising use of appropriate recycled materials in construction
  - Using building practices which minimise waste production
  - Developing an environment that supports occupants to minimise waste, whilst ensuring compatibility with local authority collection methods
  - Ensuring sufficient provision of sustainable waste management on-site
  - Providing space for the sharing economy

- **Integrating flexibility and resilience into development, to cater for foreseen and unforeseen change, challenges and disruption**
  - Provision of re-purposable space
  - Provision of co-working space
  - Climate resilience, including ensuring developments are built to withstand weather extremes and flooding
  - Resilience to society's and individuals' changing needs over time
  - Building in effective emergency planning and access measures
  - Responding to changing trends in site usage identified by monitoring techniques
  - Building in resilience to public health crises
  - Futureproofing for anticipated, relevant innovations becoming mainstream

2 Circular economy – an economic system aimed at eliminating waste and continual use of resources, minimising inputs through reuse, sharing, repairing, refurbishment, remanufacture and recycling; it is in contrast to the linear economy, which works on the lines of 'take, make, dispose'.

- **Creating an environment to support healthy, thriving, safe, connected, diverse and inclusive communities, with a high quality of life**
  - Designing to reduce health inequalities
  - Reducing fuel poverty through building measures
  - Creating multi-generational neighbourhoods
  - Improving and designing for road safety
  - Providing green space, including space for communal food growing
  - Providing social space for the community, including promotion of the sharing economy such as community fridges
  - Engaging and co-creating with the community to address their health and wellbeing needs and promote community cohesion
  - Designing for autonomy and independence
  - Designing for social connectedness, both within new developments and between new developments and existing communities
  - Designing for security
  - Improving the ecological offer of the site, including consideration of wildlife corridors where beneficial
  - Designing for and promoting inclusivity and diversity

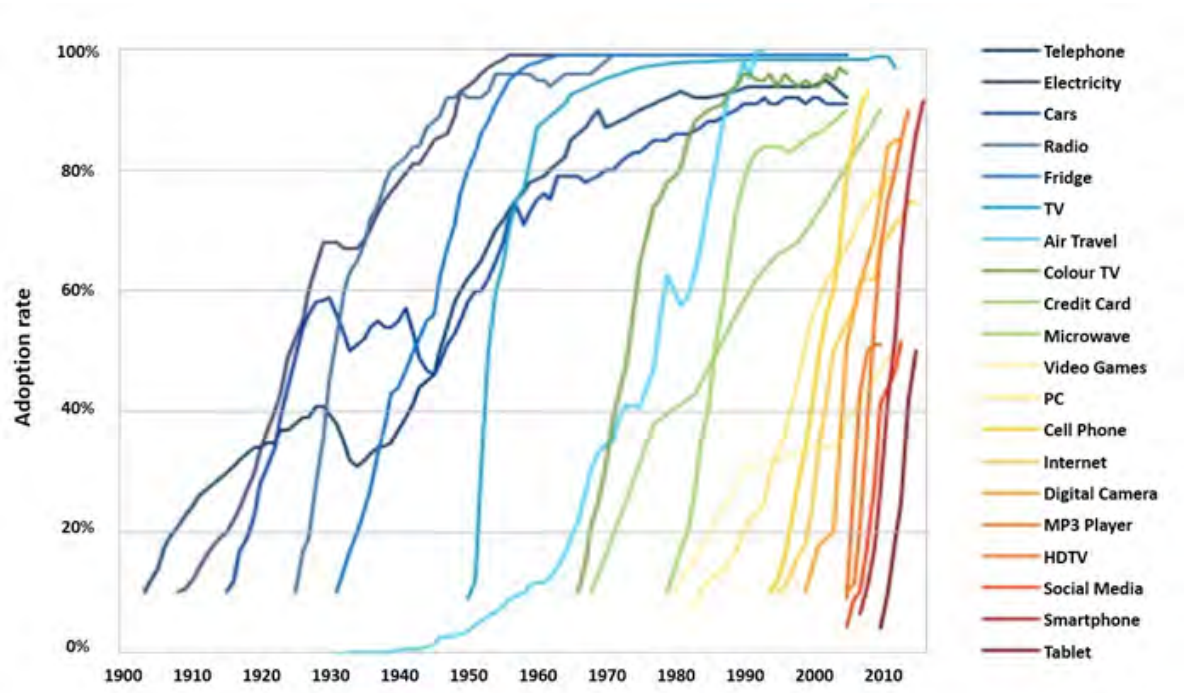
- **Ensuring appropriate solutions, software and technologies are put in place in support of the above principles, such that the solution (where relevant):**
  - Is replicable in multiple use cases or scenarios
  - Is scalable in a cost-efficient manner
  - Is platform- and vendor- agnostic
  - Facilitates data sharing
  - Has a robust cyber security design
  - Has a user-friendly interface
  - Has a simple system to system interfacing capability by design in order to avoid siloed and disjointed systems
  - Is appropriate for the specific use case and environment

- **Ensuring innovation is undertaken responsibly, maximising benefits whilst minimising foreseen and unforeseen or unintended negative consequences, following the guidance in the British Standards Institute's PAS 440:2020, Responsible Innovation Guide:**
  - Accountability for impacts on society, the environment and the economy
  - Transparency in decisions impacting on society and the environment
  - Ethical behaviour
  - Respect for stakeholder interests
  - Respect for the rule of law
  - Respect for international norms of behaviour
  - Respect for human rights
  - Balances the potential benefits against the potential risks of an innovation, considering impacts on all stakeholder groups

2. INNOVATION IN PLANNING

2.1 Setting out the need for innovation in development planning

The need for futureproofing development for new technology and for when current innovations become mainstream is well illustrated by the changing pace of technology adoption over the past century, with rates of adoption increasing (see figure 4 below).



Source: BlackRock, Asymco, Tony Seba

Figure 4: the increasing rate of uptake of new consumable items, US

Rates of innovation can also be seen to be increasing, and given the comparably long timescales involved in the development process, particularly for larger or more complex developments where gaining planning permission could take around 5 years, the need for innovation to be considered is particularly important. Whilst build-rates vary significantly depending on the market, local demand levels and the type and size of development, it will typically be around a year to 18 months between planning permission approval and the first units becoming available for use. Further, research in 2016 by Lichfields into the timelines involved in development has shown that a housing development of 1000+ units might sell at a rate of 160 units a year, meaning a full timeline of around 12 years from applying for planning permission to full completion. Once development of planning documents for larger and strategic developments, such as Area Action Plans, is also factored into this timeline, it can become even lengthier from conception to usage. Clearly, a significant amount of change in technology and innovation can be expected in this timeframe, not to mention beyond the period of occupation – by way of perspective, looking at the timeline for the internet, in under 15 years it went from inception to over 60% of US households adopting its use, whilst the smartphone a decade later went from around 10% to 90% adoption in just 5 years.

One example of the fast changes in today's world is the rate of expected adoption for connected and autonomous vehicles. There are several projects in Oxfordshire and worldwide, yet all are currently in search of the dominant

design - an operational model (both technical and financial) that can be scaled up. Once this is reached, the question is how long it would take for autonomous vehicles to become omnipresent. As a way to approximate this, the rate of adoption of the automobile is often used as a proxy. Indicatively, in the space of less than 15 years, 5th Avenue New York transitioned from a horse-and-buggy street to an automobile avenue:

Easter morning 1900: 5th Ave, New York City. Spot the automobile.

Source: US National Archives.

Easter morning 1913: 5th Ave, New York City. Spot the horse.

Source: George Grantham Bain collection.

Figure 5: 5th Avenue, New York in 1900 and 1913

Given the increased rate of uptake shown in the previous graph (figure 4), it is reasonable to expect a faster rate of adoption than this in the future, particularly given the availability of capital for SMEs to scale up more quickly than has been the case previously. Not addressing the likely future trends within development could therefore come with significant costs when it comes to the need to retrofit, either to local authorities, those occupying developments, or the developers. Consideration therefore needs to be given at all stages of the development planning system, to ensure sufficient thought for futureproofing.

There is also evidence to suggest that not futureproofing can have negative impacts on house prices. As far back as 2015, internet speeds were affecting housing values significantly, with some estimates suggesting up to 20% higher values for homes with the fastest broadband connectivity. Yet figures from early 2021 from ThinkBroadband looking at new builds up to October 2020, show there were still around 12% of new builds in the UK being built without full fibre connectivity, despite the clear government guidance towards this becoming the standard, with almost 1% of new homes with a speed of less than 10mbps for downloads. The move towards greater levels of home-working is increasing the demand yet further for good home broadband connectivity, likely exacerbating the impact on housing values.

Also in the area of connectivity, widespread use of concrete as a construction material in building walls in the 1970s is causing WIFI connectivity problems now, which were not futureproofed for. For example, the NHS have been experiencing this problem in many hospitals constructed during this period, with significant challenges in aspects such as transferring patient records, both externally and between parts of the hospital, such as from radiology to clinics.

When considering futureproofing, there are a number of questions to ask:

- What changes are anticipated during the life of the development/infrastructure?
- How likely are these changes to happen?
- What would the impact of these changes be on the development/infrastructure?
- What is the cost of futureproofing for these changes?

Answering these questions can help to identify when and how it is most useful to futureproof and avoid instances where futureproofing is undertaken for scenarios which do not ultimately occur.

There are also instances where futureproofing can be undertaken in such a way that it allows for the uncertainty of the future – for instance through flexibility by design to widen out the potential uses of a building. This might include aspects such as moveable partitions, multi-use spaces, open plan areas, or high ceilings, which can then facilitate a variety of changing functions and technologies. These kinds of flexibilities should be considered against the prevailing changes. For example, building in additional storage space may be sensible in some instances (e.g. to help facilitate the move towards greater e-commerce and the need for last-mile delivery storage solutions), but not in others (e.g. considering the move towards the down-sizing of technology, building in additional storage space for plant and machinery may not be efficient unless short-medium term business expansion is anticipated).

A roadmap of anticipated innovation is included below, but the reader is encouraged to look for the most updated version and information. This roadmap is based on research into existing roadmaps, strategies and targets set at national, European, or more local level. As such, it covers only innovations for which there is a generally high level of certainty, but it does not cover every innovation. Using this will help to answer some of the questions outlined above; in particular – what innovation might be expected within the life of a development, and how likely it is to occur. Confidence intervals have been provided for each innovation area. The reader may notice that innovations in the further future are more uncertain (shown as red), but should not be discouraged. This is to be expected in the field of innovation, and even if the precise prediction is uncertain (time, numbers), any prediction that has been included has been checked for consistency and agreement between different government, industry and academic roadmaps. Table 1, included later in this document, should be used in conjunction with the roadmap to provide advice on futureproofing measures for some of the innovations which are anticipated. Not all innovations in the roadmap need to be futureproofed for, either because they will not affect development design or infrastructure requirements, there is not sufficient confidence that they will occur, they are not relevant to a given development, or they do not support the principles guiding innovation's integration into development. Equally, the roadmap is not exhaustive and there are likely to be some innovations not included in the roadmap which should be futureproofed for in a given instance.

Case Study

DROMEDAS

The impact of COVID-19 has created citizen isolation across the county and is stretching the available human resources for patient care. This project seeks to alleviate this through the use of Unmanned Aerial Vehicles (UAVs) to deliver medications.

Figure 5: Innovation Roadmap

MOBILITY & TRANSPORT

	2021	2025	2030
Alternative fuel Vehicles - Electric & Hydrogen	Hydrogen being tested in different settings 2020 > 10.7% of new vehicles registered were electric or plug-in hybrid electric (3.2% in 2019)	By 2023 > retrofit of trains available to switch to hydrogen 2022 > Oxford Zero Emissions Zone full roll out	By 2025 > 1st UK hydrogen transport hub operational By 2025 > 90% of Oxfordshire new vehicles electric By 2025 > 15% of UK buses electrified	By 2030 > 2000km hydrogen backbone in place (National Grid) By 2030 > 100% of new car sales electric; approx. 80% of total private cars	Early 2030s > 50 hydrogen hubs for transport anticipated
Connected & Autonomous Vehicles (CAV)	Low-level automation (L1 and L2) built into some new vehicles 2019 > over 3M vehicles in UK with internet connectivity	New vehicles mostly equipped with low level automation and connectivity	By 2023 > connectivity units available to retrofit non-connected vehicles By 2025 > commercial HGV highway platooning By 2025 > up to 2% of vehicles with L4 or L5 autonomy: 1%-5% with L3 autonomy By 2026 > Short-range delivery robot/pods integrated to daily life By 2028 > automated logistics hubs rolled out	By 2030 > between 1% and 23% of vehicles with L4 or L5 autonomy By 2030 > all vehicles meet minimum connectivity standards	By 2035 > between 5% and 65% of vehicles with L4 or L5 autonomy
Unmanned Aerial Vehicles (UAV)	Civil Aviation Authority published roadmap for beyond-line-of-sight approvals, needed for autonomy 2021 > 1st beyond-line-of-sight approval given	Late 2021 > 1st UK based air-hub in operation, Coventry	Worldwide drone market expected to double between 2020 and 2025 Inspection and deliveries likely most significant drone applications	By 2030 > delivery drones are business as usual By 2030 > UK drone market share £42Bn	Longer term potential for passenger transfer beyond trials
Micromobility	50 e-scooter trials around the UK operating, inc. Oxford	2023 > potential for full legalisation of e-scooters (dependent on trial results)	2025 > global micromobility market forecast to grow by 15% from 2020	Global market size projected to almost quadruple 2020-2030	

High level of certainty (e.g. backed by laws / funding allocated for delivery)

Moderate/high certainty (e.g. backed by high profile research / government-led roadmap)

Moderate/low certainty (e.g. evidence generally in agreement on direction but inconsistencies on details or scope)

DIGITAL & COMMUNICATIONS

2021 > 2025 > 2030

Digital connectivity & communication

UK is a leading digital nation

2010-2020 > the data economy grew c. 2x faster than the rest of the economy

- Autumn 2021 > UK Government digital strategy to be published
- By 2025 > 1.12m to 1.97m data employees in Europe
- By 2027 > raised investment in R&D by 2.4% of UK GDP

5G & Next-gen mobile connectivity

2019 > 5G launched for consumer devices; coverage largely urban areas

2021 > Government review of permitted development rights for 5G equipment

- 5G bandwidth will become critical to Internet of Things data requirements
- 2025 > introduction of CAV contingent on high-bandwidth connectivity and good coverage
- By 2027 > Government ambition for most of population to have 5G access
- By 2030 > introduction of 6G networks
- By 2030 > pervasive artificial intelligence and augmented / virtual reality

Satellite communications

2019 > Global satellite communication market valued at c. $62bn

2020 > UK government acquired OneWeb (satcom company)

- By 2022 > 650 low earth orbit (LEO) satellites deployed by OneWeb
- By 2022 > superfast broadband equivalent speeds enabled worldwide through OneWeb
- By 2024 > machine learning needed to coordinate large numbers of satellites anticipated
- By 2024 > SpaceX to complete Starlink Project to provide high speed internet worldwide
- 2019-2027 > 9.2% forecast growth rate

High level of certainty (e.g. backed by laws / funding allocated for delivery)

Moderate/high certainty (e.g. backed by high profile research / government-led roadmap)

Moderate/low certainty (e.g. evidence generally in agreement on direction but inconsistencies on details or scope)

ENERGY

2021 > 2025 > 2030

Solar Energy

Price of solar photovoltaic (PV) has been falling

Currently used both on- and off-grid

- Global solar PV growth c. 115GW PA. Substantial price decreases anticipated to continue
- Increasing use of off-grid applications (e.g. for charging stations)
- By 2025 > Future Homes Standard – new homes won't be able to use fossil fuels
- By 2030 > performance to increase by c. 10% compared to 2020 level
- By 2032 > 85% of electricity from renewable sources

Hydrogen Energy

2021 > FutureGrid programme commenced, testing hydrogen as gas alternative in homes/businesses

- By 2023 > Hydrogen Neighbourhood heating trials begun
- By 2023 > up to 20% hydrogen blend in gas network
- By 2025 > Large Hydrogen Village trial commenced
- Mid-2020s > decisions about long-term strategy for hydrogen use in buildings
- By 2030 > 5GW low-carbon hydrogen production capacity
- By 2035 > fossil-fuel boilers completely phased out

Wind Energy

2019 > UK had largest capacity of off-shore wind in the world (10GW)

2010-2019 > renewables capacity grew by 5x

- 2024 > wind projects procured in 2019 start generating >5.5GW
- By 2030 > Offshore wind to produce 40GW – enough for every home
- Longer term – offshore pipeline projects alone sufficient to generate 50GW

Energy Storage

Increasing need for storage to maintain network stability as energy demand growing

- Increasing use of EVs necessitates extra flexibility. Likely to include local storage
- 2022 > CryoBattery facility to open – 1st commercial liquid air battery in UK
- Increased use of low carbon gas, hydrogen & electrochemical storage
- Increasing requirements for non-electrical storage, esp. for domestic heating systems

High level of certainty (e.g. backed by laws / funding allocated for delivery)

Moderate/high certainty (e.g. backed by high profile research / government-led roadmap)

Moderate/low certainty (e.g. evidence generally in agreement on direction but inconsistencies on details or scope)

Case Study

AIMCH

AIMCH (Advanced Industrialised Methods for Construction of Homes) is a 3-year collaborative project aiming to transform home building, using modern methods of construction (MMC). It is looking to tackle the need for additional housing set against skills and workforce shortages, poor productivity, low output and low affordability, by identifying, developing and trialling off-site construction solutions with a view to commercialisation and mass-market adoption.

The ambition is to create an approach to house building which can meet the target of 120,000 homes needed annually at the same or lower cost than traditional methods, 30% more quickly and with a 50% reduction in defects.

Further information:
https://www.aimch.co.uk/

As well as futureproofing for technological changes such as the uptake of CAVs and other technologies as described above, considering integrating innovation within planning and development can also serve to help address key challenges and support existing objectives, such as those around climate change, population health and adapting to sudden disruptions like COVID-19. Section 2.5 sets out some of the major challenges and risks developments need to address, and section 1.1 above outlined the principles which innovation should be used to support. Indeed the UK's planning system is ripe for innovation, from improved digitisation and mapping to public engagement approaches, whilst the construction industry is also lagging behind other sectors, such as manufacturing, in this area.

Potential benefits of adopting innovative solutions or technologies can be seen, with a number of significant players within property development and construction making use of approaches such as Building Information Modelling (BIM) overlaying a digital representation of a building with details about scheduling and cost to help ensure that sites are built correctly the first time. Balfour Beatty are adopting a number of innovative approaches in their work, for example using drones rather than surveyors to track the progress of infrastructure development, bringing increased accuracy and additional data collected more frequently than would otherwise be the case.[1]

According to Christian Faes at LendInvest, "technology is helping the property business to become more transparent and data-driven which in turn helps to unlock new development opportunities. From using Land Insights to assess the viability of various sites and planning permission through to Settled and ViewMyChain providing conveyancing and online agency services, new innovations are bringing greater efficiency."[2] The examples called upon here show how innovation can be effectively integrated through the whole lifecycle of a development, from the planning stage all the way through to occupation and beyond, bringing benefit to multiple players in the field.

There is also a financial case for ensuring that new technologies can be integrated into development, both from wider economic and more direct profitability perspectives. There seems, for example, to be a general consensus amongst tech experts that occupiers are willing to pay higher amounts for working spaces which are high-tech.[2] We can also see from examples such as Amazon locating in Seattle, that significant economic benefits can be brought from attracting high-profile tech companies into an area. Estimates suggest their location in the city brought around $38 billion to the city's economy, creating jobs and increasing real estate values. Companies of this kind are unlikely to seek to occupy developments which will not easily integrate the technologies they require to work effectively.

1 *Balfour Beatty (2021). Innovation 2050 - A digital future for the infrastructure industry. https://www.balfourbeatty.com/how-we-work/public-policy/innovation-2050-a-digital-future-for-the-infrastructure-industry/*
2 *Osborne Clarke (2018). Future proof real estate: is the property sector ready for the 2020s?*

Case Study

Cities-4-People

Seeking to transform mobility design, C4P aimed to provide new ways to create innovative, sustainable, and targeted mobility solutions by placing citizens at the centre of the development process. OCC partnered with C4P to solve real mobility issues in Oxford through a collaborative framework in which a community of citizens, local authorities, mobility providers and innovation experts created neighbourhood-level mobility solutions with a low environmental footprint and a sharing mentality. Partnering with University College London, Copenhagen Business School and local authorities in Hamburg, Budapest, Trikala, and Istanbul, C4P used the experiences in Oxfordshire and these municipalities to further develop People Oriented Transport and Mobility for use in urban and peri-urban environments throughout Europe.

Further information:
https://cities4people.eu/

Case Study

MaaS CAV

This project was a multi-disciplinary feasibility study that examined the integration between CAVs and Mobility as a Service (MaaS). Moreover, it studied combined business models in investing to develop and procure enabling infrastructure.

One challenge for CAV deployment in UK and in Europe in general is the need to fit new technology in historic locations. Streets in many UK towns have not been designed to meet the transport demand we have today. The study identified that new developments, where the road layouts have been designed to meet today's transport needs, could therefore present an opportunity for easier adoption of CAVs.

Infrastructure needs identified:

- good connectivity
- smart infrastructure to deliver V2N (vehicle to network) and V2I (vehicle to infrastructure) connectivity
- good road markings, with high durability and visibility
- high quality, unified signage, with consistent positioning

Beneficial Infrastructure:

- digitisation of assets and traffic information
- infrastructure to support geolocation
- simple road design
- shared-CAV lanes

Further information: http://maas-cav.info

At the same time, we need to be critical of the promises of any new technology, as there is an established psychological bias into being overly optimistic early in a technological development, followed by an overly pessimistic adjustment to expectations. This can be seen in the Hype Cycle for Technology, which illustrates these changing views towards a new technology over time (see figure 7 right). The IF can provide support into making gradual, data-based steps into sustainable long-term adoption that aligns with the IF principles, while not being overbearing in its requirements during early stages.

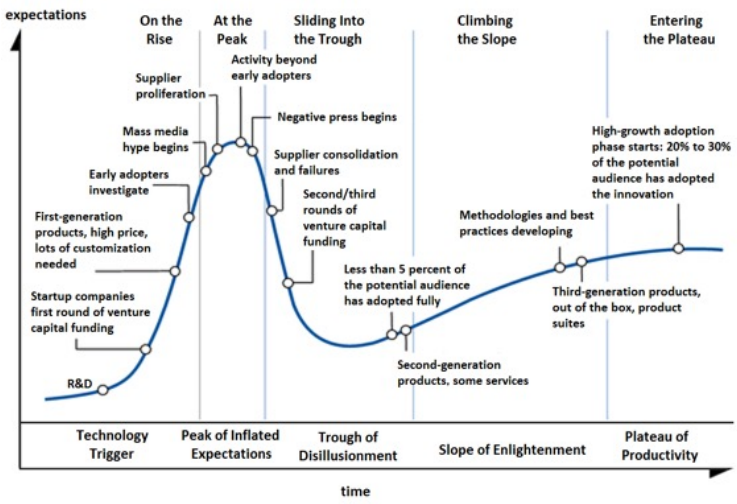


Figure 7: General Hype Cycle for technology

2.1.1 How innovation may affect the built environment

Innovations set to become mainstream over the coming years, such as those outlined in the roadmaps in figure 5 above, will have a significant impact on our physical and built environments. They will change people's behaviour and the way in which space is allocated and used. Further, they will facilitate mitigation and adaptation to wider changes and disruption.

Many of the innovations we anticipate to become mainstream are likely to support a move towards denser development, with fewer parking spaces. These innovations range from improvements in digital connectivity, augmented and virtual reality that will reduce the need to travel and commute for business; to the mainstreaming of autonomous vehicles, which facilitate access to vehicles without the need for local parking spaces. These changes could potentially significantly cut costs and increase profitability of development, widening design options. At the same time, with both the move towards automated vehicles and increased uptake of home delivery, curbside space is likely to become significantly more valuable, with a need for drop-off space and idling locations.

Autonomous vehicles, when used in shared-vehicle and freight scenarios (rather than private-ownership) also have the potential to free up road space, due to more efficient driving and convoying options. When paired with a move towards micromobility and UAVs and the impetus to create modal shift away from single occupancy vehicle usage taking some vehicles off the roads, infrastructure needs are likely to shift and allow for greater and more equitable space allocation towards active and sustainable modes of transport.

Changes in technology can also impact on land use designation needs. In one example, greater space will be needed for storage to accommodate continued trends towards e-commerce. In addition, the type and number of locations required by freight consolidation solutions that will be needed for the supportive technology that can facilitate last mile delivery such as automated bots (Personal Delivery Devices) and UAVs will increase. In another example, the move towards home working which technology facilitates will see a reduced need for office-space – a trend increased by the impacts of COVID-19. Finally, the innovation economy itself also brings with it a need for additional land to be designated for use in research and development activities within a mixed use setting - this is already being seen in the development of Innovation Districts.

Many of the design principles applied within Innovation Districts are likely to become more universally demanded over time as other industries see the benefits of aspects such as mixed-use development, co-working space and greater social infrastructure. Providing a balance which makes the location attractive for employees is becoming more of an important factor over time, as the population ages and leaves a skilled talent shortage within the workforce. Demand for these kinds of well-designed and integrated developments is therefore set to increase over time, as employers seek competitive advantage in the 'global war for talent'.

Reliable energy supply is a key driver both for businesses and individuals which, alongside new energy models, such as local production, storage and peer-to-peer trading, will affect our built environments. Oxfordshire already has a grid capacity challenge, which taken with the need to move to net zero carbon emissions and the increased demand created by the growth in electrification of vehicles and heat, will drive developments towards facilitating local renewable energy generation and storage solutions.

Digital disruptive innovations are also likely to as an impact on development as greater information becomes available to potential buyers and occupiers of real estate. The exponential growth in big data and increasing application of the Internet of Things bring with them greater levels of transparency and potential insight. As people become more used to having these levels of information more generally and see their potential benefit (especially when paired with developments in machine learning and AI), they will become expected of all sectors. This encompasses robust, reliable and fast digital connectivity, and the means to gather data and monitor effectively.

The built environment also needs to adapt to the uncertainty inherent in innovation and more widely (e.g. economically, socio-culturally and environmentally). Whilst it is possible to make projections about likely or potential future scenarios, no projection can be 100% accurate; as such, our built environment needs to be responsive, adaptive and flexible to change. Change therefore needs to be picked up on and analysed, and systems to gather data can be built into development and infrastructure using innovations such as the Internet of Things, smart infrastructure and big data. Various innovative approaches, such as more modular design, design for disassembly, a platform approach, and designing for multiple potential uses can then facilitate flexibility or alteration, to allow for changes as they occur.

2.2 Innovation from a planning perspective

Figure 8 below demonstrates key strategic interactions with the planning process for both Local Planning Authorities and Developers.

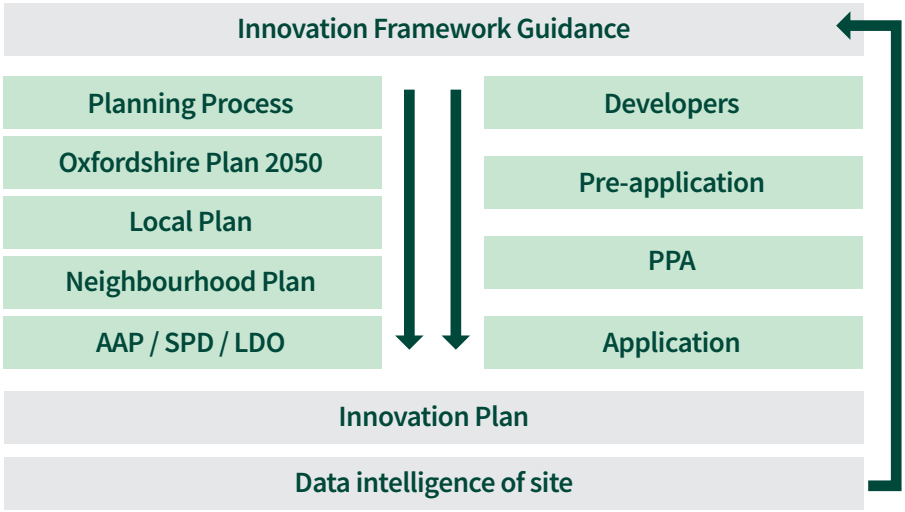


Figure 8
Strategic process flow for Innovation Framework

For planners, this means:

- ensuring developers consider innovation within their applications, ideally through the medium of an Innovation Plan (see section 2.3), by setting out the need for it within planning process documents such as Supplementary Planning Documents (SPDs) and Local Plans;
- considering innovation within infrastructure development, such as highways development, including when bidding for funding for infrastructure schemes (both in terms of futureproofing and integration);
- considering innovation within the developer funding process, and ensuring sufficient funding is secured to futureproof infrastructure impacted by development;
- on reviewing planning applications, ensuring that sufficient thought has been given by the developer to futureproofing the site, and that any innovation to be integrated into development serves a purpose to support the principles and aims, address challenges or mitigate risks;
- in assessing Health Impact Assessments submitted by developers, to ensure the impact of innovation will ideally improve health equality, but as a minimum not increase health inequalities

The iHUB is available to support integrating innovation into planning process documents such as Local Development Orders (LDOs) and into major infrastructure development design. The roadmap and Table 1 in section 2.3.2 can serve as a starting point for this, outlining key innovations to futureproof for. These are intended to act as a reference of innovations to consider within different areas, both from the perspective of futureproofing, and for the purposes of helping address any key challenges or objectives for development. It is not, however, exhaustive, and as such for more significant – strategic, or complex major – planning applications or infrastructure, it is recommended that a member of the iHUB is consulted to provide expertise.

In addition to considering innovation within the planning process, innovation can also be used to help support the planning process itself. There is significant potential to use innovative techniques within the planning process – for example, in standardisation, digitisation and digital communication and engagement approaches. Innovative

Case Study

HARMONY

"Holistic Approach for Providing Spatial & Transport Planning Tools and Evidence to Metropolitan and Regional Authorities to Lead a Sustainable Transition to a New Mobility Era (HARMONY)" is a H2020 42-month project lead by UCL, aiming to create multi-level (operational, tactical and strategic) transport models able to include the effects of emerging technologies and modes, like CAVs, drones and demand responsive transport, based on trial data.

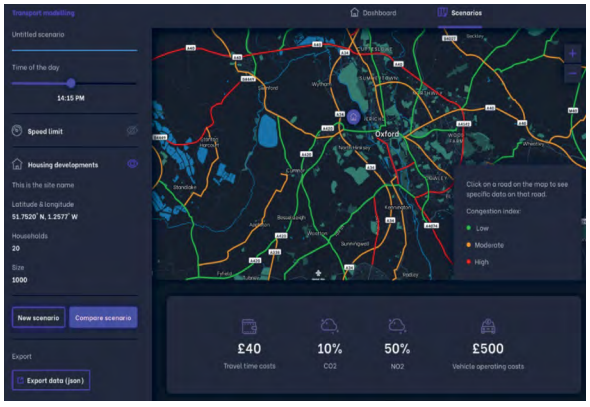
Further information:
https://harmony-h2020.eu/

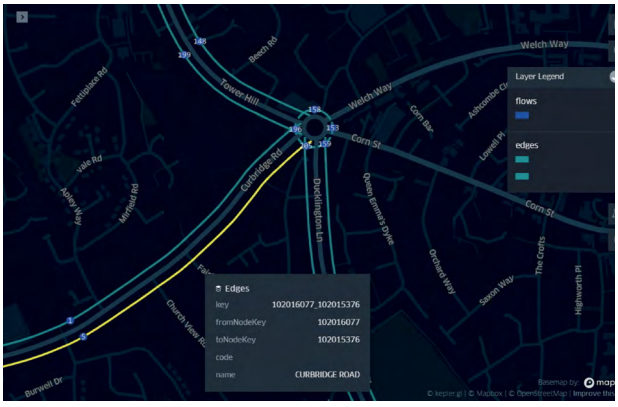
processes and tools could be extremely beneficial in securing a greater level of public participation in terms of generating more local input to the planning process, such as through developing local design guides.

In addition to digitisation, there is also potential around improved modelling approaches, to inform suitability of areas for development (e.g. in likely transport impact or expected impact of climate change on a given area such as increased flood risk).

The iHUB has led on the development of the Oxfordshire Mobility Model (OMM), MIMAS. This tool may be applied to assess the impact of development on the transport network, and its use is strongly encouraged. As well as using approaches aiming to overcome the drawbacks of more traditional modelling techniques, it has been designed to be user friendly, such that it can be applied directly by planners and transport professionals. By avoiding the need for individual requests to be run by experts in the model, each with an associated cost, this tool is considerably more accessible than predecessors. It has a number of potential applications within the planning process, as well as potential for developers to apply it, including:

- in informing Local Plans to help assess the suitability of a given area for development in terms of transport impact, particularly considering cumulative impacts;
- in supporting creating Transport Assessments for developments;
- in assessing the Transport Assessments submitted by developers, to ensure the impact has not been under-estimated by the developer;
- in assessing the level of need for developer funding to support additional transport infrastructure due to the impact of development;
- in assessing the likely impact of new infrastructure on the transport network as a whole, feeding into options appraisal and creating business cases.





2.3 For development and new infrastructure – Innovation Plans

2.3.1 Overview

An Innovation Plan is a site-specific plan produced by the developer or infrastructure planner setting out how a particular development or scheme will both integrate and plan for innovation, which helps planners and developers ensure developments that are fit for future generations. It should be considered alongside local and regional planning policy and the national planning policy framework, particularly when setting objectives for the development which innovation could help to support. For development, it should be produced as part of the planning application process and consider the different stages of development, covering the elements outlined below and guidance including the Innovation Plan template and other accompanying IF materials.

2.3.2 Contents

An Innovation Plan should cover the ways in which a site or infrastructure development will futureproof for when current innovations become mainstream, and how innovation will be integrated into the development process at each stage, in order to address challenges and risks, and achieve goals. Some of these goals and challenges will be generic, as outlined in other sections of this document; some will be specific to the site in question.

The Innovation Plan, should cover the following aspects:

- a brief outline of the development or infrastructure, with links to relevant documents containing more detailed information. This should include a site plan, design layout and/or description of the development or infrastructure;
- a section describing any specific challenges which have been identified for the development/scheme; for example, this might include aspects such as high flood risk, contaminated land, road capacity challenges, architectural or ecological impact etc;
- a section identifying any specific goals for the development/infrastructure; for example, this might include goals such as providing a higher proportion of affordable housing than usual, net biodiversity gain, increased network capacity, or reduced socio-economic deprivation etc;
- a section identifying how innovations will be applied to address the challenges and goals, including those which are more generally applicable to all development, such as climate change resilience, designing for an aging population and so on (see other sections 1.1 and 2.6 for more general goals and challenges respectively).
    - If traditional methods are (also) being used to address the above, these should be briefly noted for context.
- a section outlining how the site will address futureproofing for innovations becoming mainstream. When futureproofing, it's important to ensure that the principles outlined in 1.1 are not compromised – for example, dedicated autonomous vehicle lanes should not be installed at the expense of cycle infrastructure or walkability. The following table outlines some aspects that developments may need to futureproof for, with examples of their applications and measures which development could use to address them (for more detail, see the roadmap in Section 2.1):

Table 1: Future proofing for Innovations becoming Mainstream

Technology / Innovation	Examples of application	Futureproofing measures	Main principles and aims supported
Co-creation & civic participation 	• Local design guides	• Processes to involve citizens put in place – both digital and analogue to address all types of end user	• Taking account of differing needs • Connected and inclusive communities • Using and gathering evidence and data transparently
Connected and Autonomous vehicles (CAV) – passenger 	• Privately owned vs shared (SAV) • Automated buses, shuttles, cars or pods • Semi-automated vs fully automated • Connected vehicles without automation	• Consistent road marking • SAV idling, drop-off and pick-up points • Charging infrastructure • Connected and smart roadside infrastructure (most relevant in congested and more built-up areas) • Next Generation network management support • External Localisation & navigation technology • High definition digital mapping • Resiliency when failing or operating out of its Operational Design Domain (ODD) – where it is designed to operate	• Accessibility and connectivity for all • Catering for foreseen change • Designing to support autonomy and independence • Improving road safety
CAV – freight 	• Automated lorries, trucks, vans or robots • Connected vehicles without automation • Semi-automated vs fully automated • Platooning (convoy) • Health and care applications, e.g. delivery of health services	As above, plus: • Loading & unloading points • Docking points for bots	• Supporting first- and last-mile delivery options • Improving road safety
Digital twins 	• Digital replicas of physical entities • Better network and asset management • Building Information Management (BIM)	• Digital mapping and sensors on the network • High speed connectivity • Cloud computing resource for data storage and processing (if applying directly)	• Maximising energy efficiency • Minimising embodied carbon • Supporting reduced energy demand • Ensuring ongoing monitoring systems are embedded • Catering for unforeseen change • Maximising longevity of assets and minimising waste • Minimising the need for maintenance
Electric vehicles – passenger 	• Privately owned vs shared • Wireless charging vs wired charging • Electric buses, cars, boats or pods	• All residential properties with a drive: min 1 charge point • Unallocated residential parking: min 25% of spaces • Non-residential parking (e.g. commercial): min 25% of spaces • Smart chargers to be used, minimum 7kWh AC • Fast charging points recommended for most applications, with rapid only appropriate in some specific situations (e.g. some higher density housing, and workplaces using commercial vehicles) • Provision at mobility hubs, such as P&R sites • Consideration of additional energy needs over time, building in renewable, local energy generation to development	• Accessibility and connectivity for all • Reducing fossil-fuelled car use • Catering for foreseen change

Technology / Innovation	Examples of application	Futureproofing measures	Main principles and aims supported
Electric vehicles – freight 	• Electric vans, local delivery trucks or robots (larger freight less likely to be electrified)	As above (where relevant), plus: • Charging points at commercial locations in loading/unloading areas	• Catering for foreseen change • Supporting the Oxfordshire economy • Supporting first and last mile delivery options • Reducing the need to travel
Hydrogen vehicle – passenger 	• Privately owned vs shared • Buses or cars	• Fuelling land use designation	• Accessibility and connectivity for all • Reducing fossil-fuelled car use • Catering for foreseen change
Hydrogen vehicle – freight 	• Hydrogen lorries, trucks, vans or boats • Most relevant to longer distance/heavy load trips	• Fuelling land use designation	• Catering for foreseen change • Supporting the Oxfordshire economy • Reducing the need to travel
Internet of Things (IoT) / Everything (IoE) 	• Air quality, noise or other environmental sensors and monitoring devices connected to the internet • A tool for co-creation • A tool to support the aging population (e.g. new housing models using IoT) • Asset management • Health monitoring • Waste and resources management	• Accessible communication channels (e.g. LoRaWAN) • Electricity provision • Analytics • Cyber security and resilience measures	• Ensuring monitoring systems are embedded in development • Facilitates data sharing
Micromobility – passenger 	• Privately owned vs shared • E-bikes, pedelecs, e-scooters or e-skateboards (the latter 2 are subject to legal review)	• Secure, convenient, accessible, ideally covered storage at higher volumes • Consideration of locations for storage to avoid pavement clutter • Improved cycle infrastructure • Dedicated lanes	• Accessibility and connectivity for all • Supporting first, last and only mile transport options • Support an environmental hierarchy of transport use • Catering for foreseen change
Micromobility – freight 	• E-cargo bikes • First/last mile delivery	• Designated loading areas • Charging facilities • Microdistribution hubs • Dedicated cycle lanes	• Supporting first, last and only mile delivery • Support an environmental hierarchy of transport use • Catering for foreseen change • Reducing the need to travel
Mobility as a Service (MaaS) 	• All modes • Shared transport services (Car, e-car, bike, e-bike or e-scooter) • Integrated journey planning and payment	• Mobility hubs, e.g. bus & rail interchanges • Dedicated bike and car sharing spaces at transport hubs • Cycle parking at bus stops • Charging facilities • Real time, open source, multi-modal monitoring data • High definition, digital mapping	• Accessibility and connectivity for all • Supporting first, last and only mile transport options • Support an environmental hierarchy of transport use • Catering for foreseen change
Peer-to-peer energy trading 	• Local energy networks • Vehicle to Grid (V2G)	• Appropriate infrastructure	• Supporting the zero-carbon economy • Maximising energy efficiency • Community ownership of energy • Catering for foreseen change
Satellite communication 	• Internet provision • Personal communications • Media provision (radio, television) • Asset and conditions monitoring • Universal coverage	• Suitable locations for satellite infrastructure • Use of Ground Station as a Service providers	• Creating digital connectivity (especially relevant to rural and poorly connected areas)

Technology / Innovation	Examples of application	Futureproofing measures	Main principles and aims supported
Smart energy grids 	• Dynamic pricing, grid balancing and leveraging	• Appropriate infrastructure • Energy storage locations (battery, hydrogen, kinetic etc.)	• Supporting the zero-carbon economy • Maximising energy efficiency
Unmanned Aerial Vehicles (UAV) 	• Delivery, function performance such as maintenance or monitoring, health & care applications, e.g. delivery of medicines and medical equipment • (Longer term, passenger transfer) • Likely alternative-fuel powered	• Consider line of sight • Charging point provision • Privacy from above • High definition digital mapping • Take off/landing • Monitoring infrastructure/ corridors • Network management provisions (possible integration of air traffic management with Traffic Management Control centres) • Noise abatement considerations, especially for larger drones	• Supporting first, last and only mile delivery • Support an environmental hierarchy of transport use • Catering for foreseen change • Reducing the need to travel
Virtual & augmented reality 	• Immersive tourism • Health and care applications, e.g. for occupational therapy & addressing isolation • Creative industries	• High speed connectivity • Community spaces • Digital mapping	• Inclusive communities • Engaging with the community • Reducing the need to travel
3D printing 	• More localised production • Micro consolidation centres • Modular design	• Consolidation centres • Innovation hubs	• Reducing the need to travel • Supporting the zero-carbon economy • Reducing waste generation & growth
5G (5th generation wireless technology) 	• Telehealth • Immersive technologies • Autonomous vehicles teleoperation • Smart agriculture • Emergency response • UAV communications • Vehicle to Everything communications	• Fibre backbone • Accessible assets, e.g. streetlighting for mounting and electricity • Provision of space to avoid cabinets on pavements causing obstruction	• Creating digital connectivity • Catering for foreseen change • Reducing the need to travel

Case Study 

Project LEO

Local Energy Oxfordshire develops new local flexibility and energy markets, maximising the use of local generation and network assets and enabling innovative business models for investment in low-carbon and smart energy systems. OCC is developing an Energy Mapping Tool to identify opportunities to scale up local and low carbon energy generation to support integrated system planning across the county.

Further information:
https://project-leo.co.uk

The plan should also:

- outline how it has been developed and how particular innovations have been identified for the site. A participatory approach to developing the Innovation Plan is encouraged use of innovative participatory techniques in developing the site or infrastructure design, or documents such as the Travel Plan could form part of the Innovation Plan itself;
- include targets and/or Key Performance Indicators (KPIs), which may be taken from other plans and/or set specifically for the Innovation Plan;
- include a description of how the Innovation Plan will be monitored against the targets and KPIs, covering both process monitoring and outcomes;
- include a timeline for when it will be reviewed and updated and an explanation of the process for doing this, including how monitoring information will be used to inform it; and
- outline how the plan will be transferred to others, e.g. upon transfer of ownership or where sub-contractors are expected to carry out aspects of the plan.

A full template is provided which can be used as guidance for creating an Innovation Plan. The structure suggested can be adjusted to suit the needs of the site in question – it is not intended as a rigid structure that must be adhered to. However, unless not relevant, all elements outlined within the template should be covered in the Innovation Plan as best practice.

The Innovation Plan should encompass the timeline and different aspects of the development. In addition to the technologies outlined in the table above, the roadmap in Section 2.1 includes examples of technologies, approaches and innovations that could be considered for different aspects and stages of the development process to support a number of key principles and aims and address challenges. It should therefore be used in conjunction with the template to provide guidance on what could be included with the plan. The guidance is not exhaustive and discussion with the iHUB is recommended if there are specific challenges or needs for the development in question which examples provided cannot address; this should feed into the pre-application discussions held.

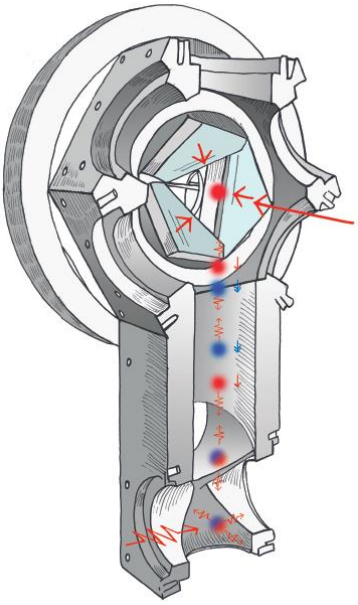
2.3.3 Benefits

An Innovation Plan should support the achievement of a variety of aims and principles common to a number of policy and framework documents as outlined in the previous section of this document (1.1) and with the documents outlined in Appendix 1. As such, it should help the developer to meet planning regulations and other obligations, for example, ensuring key legislative requirements such as the Equalities Act are efficiently met, and support planners with policy and strategy compliance. In addition, the Innovation Plan should help to futureproof developments and infrastructure to accommodate the mainstreaming of current innovations and overcome existing and forthcoming challenges, such as the requirement for housing allocations to be met whilst the construction industry faces workforce and skills shortages. This IF and supporting materials aim to provide an evidence base to show the benefits of integrating innovation into site and infrastructure development, helping developers and planners assess the suitability of different innovations for their and a site's particular needs.

Case Study

ABGRAV

The Innovate UK funded project ABGRAV aims to explore subsurface surveying using quantum gravimetry. The leading partner, M2 Lasers, will work to bring the gravimetric system to field ready state, while OCC will examine the commercial opportunity for the technology for applications related to the council's functions. These include highway maintenance, archaeology, mineral exploration and water table management. Utility mapping, sink holes detection and monitoring water table levels are some of the use cases which will be explored. Demonstration of the technology is planned for a suitable use case, determined by OCC.



Source: M Squared Gravimeter Handout

The COVID-19 pandemic is an apt example of significant disruption and societal changes with wide ranging impacts – construction output for example, fell by 35% in quarter 2 of 2020 according to the Office of National Statistics, impacting on the development sector as a whole. Use of innovative technology and approaches could serve to aid recovery following the pandemic – for example, using automated processes to a greater degree could aid social distancing, and in the process also address the workforce shortages facing the construction industry; but also help to develop sites in a more flexible way that allows a faster and more efficient response to disruptions of this nature occurring in the future. In the wake of the pandemic, now is the time to review approaches to integrate more efficient and resilient ways of undertaking development and construction, thereby supporting the re-building of the economy.

The Construction Leadership Council's Roadmap to Recovery for the Construction Industry sets out the need for transformation in order to 'sustain economic growth through the adoption of digital and manufacturing technologies to consistently deliver low carbon, sustainable and better quality outputs and outcomes'. Without this transformation the sector risks longer-term recession and further skills and capability loss, especially since Brexit has already reduced overseas workers within the industry. Particularly given the importance of the development sector to the UK economy as a whole (construction was 8.6% of GDP in 2019, and real estate was 7% of GDP), it is therefore important to ensure that recovery is sustainable; integrating innovation and futureproofing for it will help to achieve this.

2.3.4 How it fits into the planning process

Figure 8 demonstrates key strategic interactions with the planning process for both Local Planning Authorities and Developers.

Innovation should be considered at all stages of the development process, from aiding in the selection of a suitable site, to supporting its occupation and ongoing monitoring. The Innovation Plan itself should be:

- proportionate to the size and scope of the proposed development to which it relates and build on existing information wherever possible – this does not necessarily mean that larger developments should always have more wide-ranging plans than smaller ones, but that potential for innovation for a given site should be considered;
- established at the earliest practicable stage of a development proposal, ideally at the pre-application stage, in the case of development, with planners also giving consideration to innovation planning for both infrastructure and development within planning policy documents (Local Plan, SPD/AAP etc), using a co-creative approach in partnership with the community, stakeholders and developers, but otherwise within the application determination process itself;

- be tailored to particular local circumstances to ensure any innovation is appropriate to the place, with evidence to show how the local circumstances (i.e. risks, challenges and objectives) have been considered, such that any innovation being integrated is contributing to achieving the principles outlined previously (1.1);
- be brought forward through collaborative working with interested parties such as councils, communities and businesses. Engaging communities and local businesses can be beneficial in positively supporting innovation across developments, and in ensuring the plan is effectively tailored to the place and this is strongly encouraged.

2.3.5 When to create and update one

All developments and new infrastructure should integrate innovation and futureproof for when current innovations are mainstream. This holds true regardless of size, particularly the latter in order to avoid need for later retrofit. All developments and new infrastructure should integrate methods to monitor traffic that are able to distinguish different modes of transport. We recommend that for sites showing good potential for innovative techniques to be integrated and/or a particular need for futureproofing measures, an Innovation Plan is used as the medium through which innovation is planned for within new developments and infrastructure.

The innovative approaches could be integrated into the pre-application stage of the development process, in helping to assess the suitability of a site for a particular development, for example. A plan, if being produced, should be in place by the application stage of the process, to be submitted alongside the full or outline planning application, depending on the route taken. The document itself should be a dynamic and flexible document which can be updated and adapted as needed. It should therefore as best practice, be reviewed and updated at each stage of the development and occupation process (pre-application, application, reserved matters when applicable and occupation, with periodic review post-occupation), and in the case of any major disruption or change taking place, for which the plan could serve to help mitigate/support.

Consideration should be given at the pre-application stage to:

- the form and scope of the Innovation Plan;
- the outcomes sought by the Innovation Plan;
- the processes, timetables and costs potentially involved in delivering the required outcomes (including any relevant conditions and obligations);
- the scope of the information needed; and
- the proposals for the on-going management, implementation and review processes.

The above can be discussed with the iHUB, who are available to support at the pre-application and application stages of the process for larger or more complex developments. It will be possible for developers to gain some advice within the scope of an existing PPA, but for more bespoke advice, the iHUB charges for our time. The iHUB has a range of experience and expertise in innovation, including alternative fuel vehicles, connected and autonomous vehicles, health and care, community engagement, energy, data and monitoring. Some of the experience and projects the team has worked on are featured in the case studies within this document. In addition, the team has built up a wide network of partnerships, allowing potential to facilitate introductions and identify synergies. The team also has expertise in modelling and simulation, which could be provided to support site development plans. The Oxfordshire Mobility Model (OMM), MIMAS, is one modelling approach available to assess the likely transport impact of development.

At the application stage, the Innovation Plan should be submitted with the planning application for review, when the iHUB will provide feedback on the contents. A template is provided to support the creation of an Innovation Plan, but can be added to and adapted to suit the needs of the development in question. The iHUB will be able to advise on adaptations or additions to the template for specific large developments, and for types of development for which the template proves inappropriate at the pre-application stage.

Following submission with the planning application, it will be necessary to review the plan again prior to occupation of the site; in the case of large phased developments, this may require more than one review, in association with the phasing within the planning process and build-out, to ensure the plan is still relevant and encompasses the needs of the site. This will likely be a light-touch process in most instances simply to ensure continued relevancy and completeness. A process should be outlined to show how the plan will be transferred to builders (if different from the developer) and the occupier(s) of the site, to ensure that innovation continues and benefit is maximised during the build and beyond the occupation period. If the builders and occupiers have already been identified at an earlier stage, they should be included in the process of developing/updating the Innovation Plan. Synergies should be built upon with the Travel Plan and other planning-related documents, such that they support each other.

Monitoring should be an ongoing (ideally automated) process, which should also serve other monitoring requirements, such as Travel Plan monitoring, and can support network management and monitoring of travel patterns within the county, including uptake of active travel and other non-car modes.

Figure 9 below shows the process of creating and maintaining an Innovation Plan in relation to the timeline of a single-phase development.

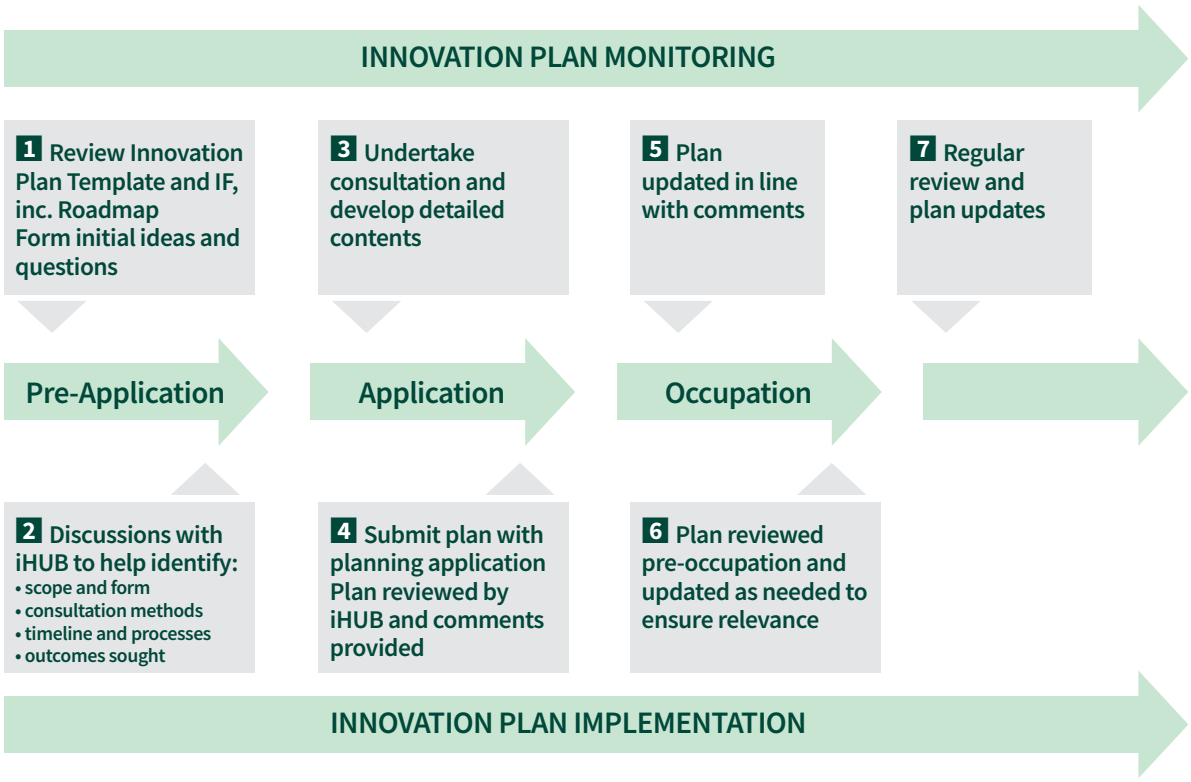


Figure 9: Innovation Plan process

2.3.6 iHUB support for developers

As outlined previously, the iHUB is available to provide support for some developments – strategic sites and more complex major developments – in considering the innovation needs of the site. Some initial support is available for sites within the scope of a Planning Performance Agreement (PPA), where agreed. Additional, more detailed and bespoke advice is also available, subject to an additional fee at the iHUB's cabinet-approved charging rates. The following packages of support are available:

Support Package	Type of Support	Level of Detail and Inclusions	Notes
1a	Site-specific Innovation SWOT (Strengths, Weaknesses, Opportunities & Threats) analysis	High level overview of site innovation needs. Includes 2 discussion meetings (pre- and post- SWOT development)	Included within PPA where agreed
1b	More detailed analysis of elements identified in SWOT	iHUB undertakes a more detailed analysis of specific parts of the SWOT carried out in 1a, as requested by the developer. Covers research and recommendations on possible approaches	1a must be concluded prior to 1b.
1c	Innovation proposal, based on outputs from SWOT	Based on the outputs of the SWOT, the iHUB reviews the potential innovation solutions and approaches for the site and creates a proposal for inclusion within the development	1a must be concluded prior to 1c.
2a	Innovation Plan Review and Suggestions	Following draft of an Innovation Plan, iHUB reviews and makes detailed comments and suggestions. Includes 2 discussion meetings	
2b	Innovation Plan Addendum or Section creation	iHUB creates a section of the Innovation Plan, and reviews other sections as per package 2a. Includes 2 to 3 discussion meetings	
3	Modelling future challenges and impacts	Using the Oxfordshire Mobility Model, combined with Innovation Roadmaps, the iHUB will assess likely future impacts and challenges for the site, and identify key issues	Can be combined with other packages for greater scope and depth

To discuss site-specific options and fees, please contact the iHUB at: cav@oxfordshire.gov.uk.

2.4 Updating this framework

By its nature innovation is a dynamic, often fast-paced process, and as such the framework document and supporting materials will also need to be updated to reflect the changing evidence base and new innovations and disruptions. As outlined above, what innovations are likely to become mainstream may be disrupted by societal changes, new technologies and approaches; each update will review changes of this kind and impact on the trajectories of innovation uptake. This IF document will therefore be reviewed and updated as necessary every 2 years. The roadmap will be reviewed dynamically, and as a minimum every 12 months, to ensure the most relevant innovations are included, and disruptions changing trajectories of uptake are integrated.

To support the process of updating Innovation Plans, dates and contents of changes made to the IF and supporting materials will be clearly identified to allow for easy review.

2.5 Change, Challenge and Risk

As well as supporting the principles highlighted in 1.1, innovation, in addition to being a potential source of change and challenge in itself, can serve to overcome some challenges and mitigate risks. This section sets out some of the key over-arching expected changes, challenges and risks likely to impact on development.

The following infographics set out key risks as identified by the World Economic Forum (WEF) in their annual Global Risk Report in 2020. It is split into the top risks by impact and likelihood, based on input from a variety of stakeholders to an annual survey undertaken by WEF.

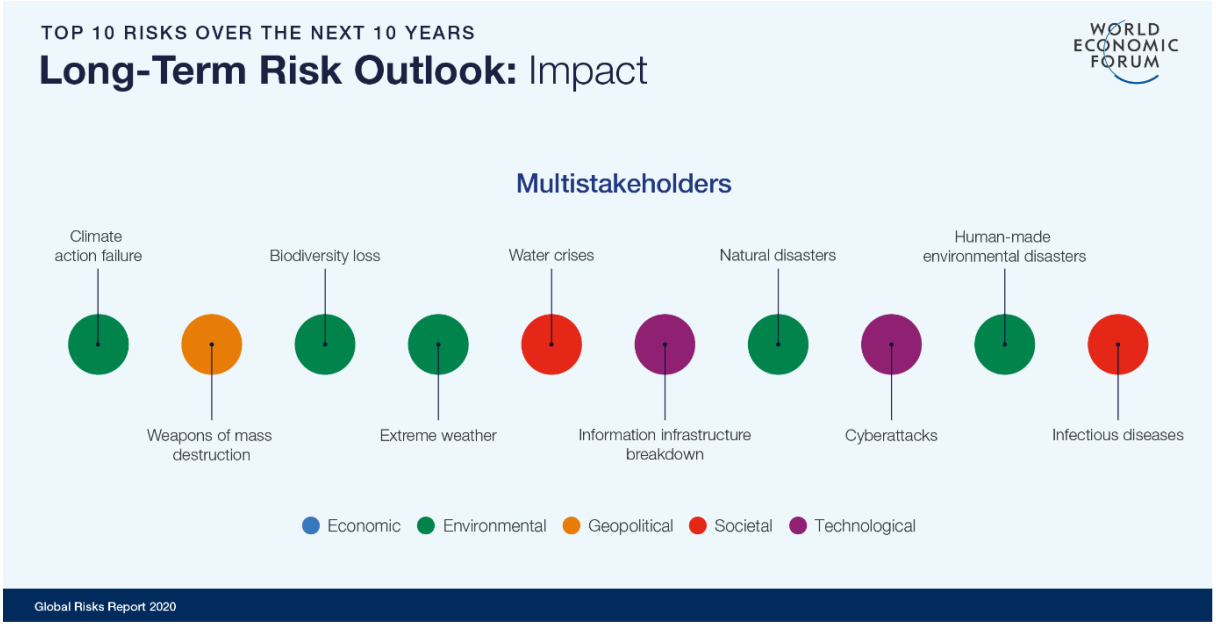


Figure 10: Top 10 risks for the next 10 years following 2020, based on Impact, as rated by multistakeholders

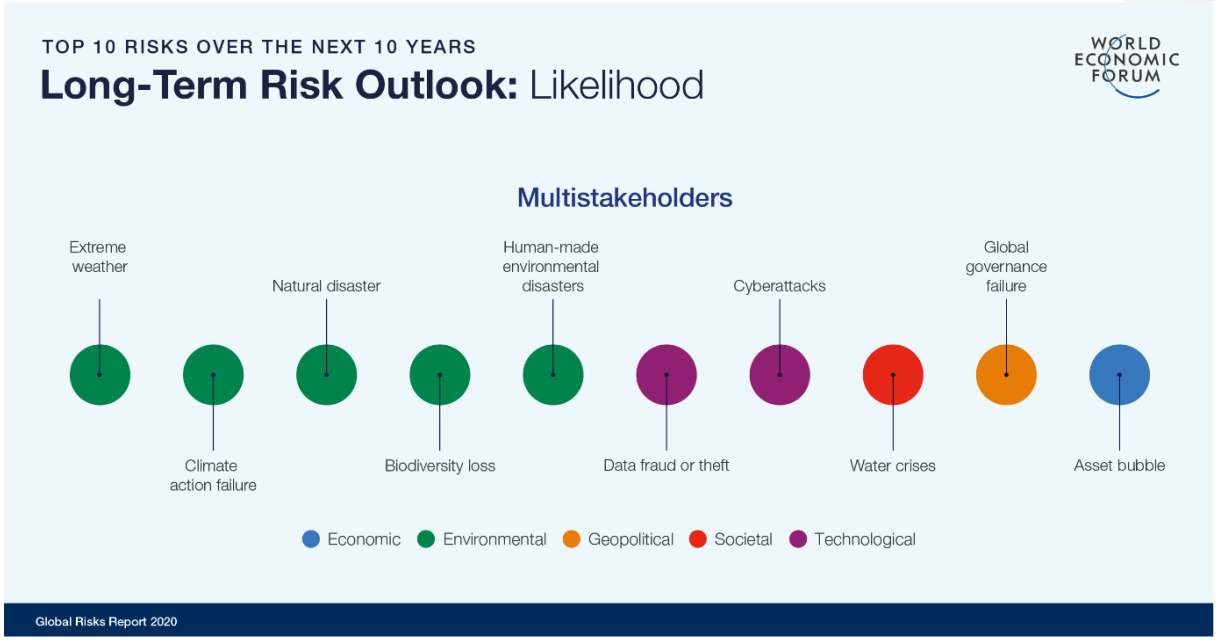
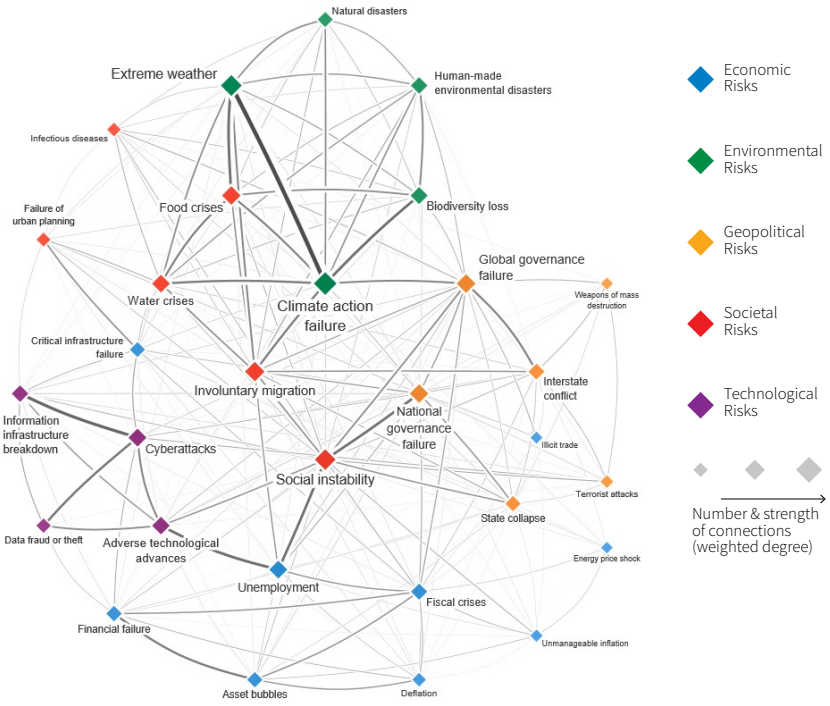


Figure 11: Top 10 risks for the next 10 years following 2020, based on Likelihood, as rated by multistakeholders



Source: WEF, Global Risks Report 2020

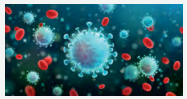
Figure 12: Connections between global risks

The graph, taken from the same report, shows the interconnected nature of these global risks. Positively influencing one risk can therefore potentially also help to mitigate connected risks and challenges.

In addition to the risks outlined above, there are also a number of encompassing challenges facing development shown in current trends, which also interplay with the above risks. These challenges and others like them need to be planned for within development to ensure it is robust and fit to meet the challenges and potential risks. If this is not done, there is potential for costly retrofit requirements at a later stage. Some of the key challenges are outlined in the following table.

Table 2: Challenges for development, planning and infrastructure by area

Area	Mobility & Transport	Health & Care	Ecology & Green Space	Waste	Digital & Communication	Energy	Buildings & Infrastructure
Climate change 	Car dominance significantly contributes to climate change, also leads to congestion, road safety, and use of space challenges. Traditionally, infrastructure and development has been primarily designed for vehicles, building in car dependency and exacerbating climate impact.	The need to design to mitigate the impacts of climate change are even greater for those in ill-health. The infirm or elderly are more significantly impacted by extreme weather events than healthy people.	Climate change is significantly impacting on ecology and biodiversity. Consideration of longer-term weather patterns and climate should be taken account of when deciding on suitable plant species for a site for example.	Climate change mitigation requires reduction of waste production and increased levels of repair, reuse and recycling. Local facilities reduce transport emissions and create local jobs.	Climate change adaptation and mitigation measures could increase demand for digital and communications services, potentially putting pressure on digital resources.	Little progress has been made in decarbonisation of heat, due to the cost of electrification.	More frequent and widespread extreme weather events (droughts, flooding, heatwaves etc) impact on design requirements and resiliency needs. Significant energy consumption from buildings Need to consider embodied carbon impact, which can be challenging to address.
Aging population 	Almost half of over-80s experience difficulty accessing amenities (supermarket, healthcare etc).	Oxfordshire's population is older than the UK average already. At the same time, the number of children and families in the county is also increasing, so the needs of the aging should not eclipse the needs of other population segments. Increased demand for (already stretched) social care services.	Over-65s are the most likely age group to be in poor health, but research also shows they may be the least likely group to benefit from green infrastructure in urban areas, due to access inequalities.	The elderly may find recycling and managing their waste challenging, especially if in poor mental or physical health and living alone. Waste storage and management approaches and locations should consider the needs of the elderly and infirm, e.g. in relation to reduced mobility.	Due to the lower levels of digital literacy amongst older generations, a higher proportion of elderly people are unable to access digital solutions. This challenge will reduce over time, however as generations which have learned how to use digital technologies become older.	The aging population could influence energy requirements, especially as it may lead to greater numbers of small households.	The construction industry is already showing an aging workforce and difficulty engaging younger entrants; this is likely to be exacerbated by the aging population.
Increasing inequalities 	Rural vs urban split –there is a high proportion of older people in rural areas with lower levels of transport amenities; combining with the aging population challenge above, this could be an increasing challenge over time. More income deprived areas often have lower transport and other amenities, further exacerbating inequalities.	There is significant segregation by multiple factors – values, education, ethnicity, power, prosperity, age etc. Housing cost drives much segregation, which in turn drives health inequalities. Those living in more deprived areas face significantly more ill health and lower life expectancy – a 15-year gap was seen between the most and least affluent wards in Oxfordshire in 2019-20.	Access to nature and green space is not equally distributed amongst social groups, with more affluent groups tending to have easier access to them. Given the mental and physical health benefits in having such access, development and transport infrastructure should aim to address this inequality.	Areas of deprivation are more likely to have lower rates of recycling amongst households. Those who are particularly well off may also be more wasteful, since they are able to keep up with changing trends more easily.	There is poor rural digital connectivity compared to urban connectivity – this exacerbates challenges faced for an aging population due to high rural concentrations of older people.	Fuel poverty is a major challenge for millions of less affluent households in the UK, due to high energy costs and poor insulation. Increasing energy demands from electrification of assets for example, could magnify this challenge.	There is a need for affordable housing – Oxfordshire's house prices are especially high compared to the national average. There is a need for integrated design to minimise social segregation (e.g. age, income, ethnicity, religion etc).
Regulatory framework and information governance changes 	E-scooter legislation. Ban on internal combustion engine new car sales from 2030. Carbon zero agenda. New forms of mobility (e.g. CAV) using new and expanding datasets. New and changing security, storage and usage governance impacts potential for deployment.	Changes in retirement age.	Potential for noise regulations.	Carbon zero agenda. Waste regulation changes following Brexit. National Resources and Waste Strategy (DRS, EPR, Plastic Tax, Consistency). Environment Bill	Data control risks – collection, storage and use requirements are changing in an increasingly digitised and sensed world. Threat of fraud or theft of data increases as more data becomes available.	Carbon zero agenda.	Planning reform. Carbon zero agenda.
Air pollution 	Traffic impact of development and new infrastructure can lead to increased air pollution.	Deaths from poor air quality were almost as high as tobacco-related deaths in 2019. There is also inequality in those most exposed to poor air quality usually being those least contributing towards it.	Poor air quality impacts on species, potentially causing decline.	Waste can contribute to poor air quality, for example through transportation requirements. Minimising waste is therefore important in reducing this impact. Provision of local facilities will also minimise the need for waste transport, helping to reduce emissions.	Greater knowledge about levels of air pollution, due to more prevalence of sensors may impact on demand in areas of poor air quality.	Domestic open fires and other fuel burning contribute to poor air quality.	Construction often has significant air quality impacts, both from particulates caused by construction dust and transport/delivery requirements.

Area	Mobility & Transport	Health & Care	Ecology & Green Space	Waste	Digital & Communication	Energy	Buildings & Infrastructure
Political changes (e.g. Brexit) 	Political change affects mobility & transport priorities and levels of support, as well as funding availability for transport infrastructure.	Brexit is exacerbating aging population challenge due to reduced migration.	Economic structures and power relations often drive environmental change, either positive or negative – political change can therefore impact on ecology.	Political changes can influence waste management options, e.g. where recycling is processed abroad.	Data storage in other countries may be impacted by political changes.	Costs of gas and other sources of energy can be affected by political changes.	Supply chain challenges already in existence could be exacerbated by political changes such as Brexit.
COVID-19 and other communicable disease 	Unpredictable mobility patterns are being caused by COVID-19 – there are some drivers towards reduced overall travel, some drivers towards increased SOV use. Long term impacts are difficult to predict.	In addition to its direct health impacts, COVID-19 has caused a significant impact on both mental and physical health due to isolation and lower levels of physical activity, exacerbating existing trends towards worsening mental health and poor activity levels.	Access to local green space has been highlighted as a key deficiency for some groups of people, particularly in more deprived urban areas, as a result of COVID-19.	Waste collection and management has been impacted by COVID-19, due to closures and social distancing. Increase in household waste levels of around 6%. Longer term impacts if we don't return to 'normal'. Changing waste composition – more card as more deliveries. Good waste disposal hygiene is important for reducing potential for communicable disease.	COVID-19 has increased need for digital connectivity to facilitate home working, and access to online services. There are particular challenges for those under-served (e.g. older, less affluent, rural etc) to access the services needed.	COVID-19 has created a higher demand for domestic energy use, against a lower demand for commercial energy use. Unpredictability of likely long-term impact on homeworking could influence levels of energy consumption.	There have been difficulties with construction slow-down during the pandemic. Consideration of land designation is needed, to respond to potential long-term shifts in demand for development and infrastructure types.
Space allocation conflicts 	Existing conflicts between different types of road user, which will be exacerbated by changing mobility trends and new modes of transport (e.g. shared mobility modes). There is a need to balance current requirements against likely future requirements as car use likely reduces long-term (e.g. in parking allocation levels).	Increasing requirements for extra care housing and retirement village provision, due to the aging population. Space allocation to non-active forms of transport supports physical inactivity, leading to massive costs to the NHS, society and business. Health is significantly affected by our environment – only 10% of well-being is determined by access to health care. Housing, green space and nature access, transport and a sense of community are large contributors.	Ecology needs to be taken account of in space allocation, to ensure than biodiversity is not reduced (and is ideally enhanced). Provision of green space can sometimes conflict with other requirements in constrained locations. Green and blue corridors for wildlife movement also need to be provided in instances where development crosses habitats (e.g. where some species might migrate for reproduction), to ensure movement of species is not impaired.	Road space allocation needs to cater for collection vehicles, and storage locations also need to be compatible with collection techniques used. These can differ between district areas and therefore need to be reviewed as part of site design. Circular/sharing economy space is needed. Consistency/ separate collection/ Extended Producer Responsibility requirements. Internal and external space needed.	There is a need for allocation of space for connectivity requirements (e.g. communications infrastructure such as 5G and satellite).	Some more sustainable modes of energy generation require specific types of location or land (e.g. solar and wind power), and can sometimes take greater quantities of space than traditional energy generation methods.	Land may be constrained, especially in urban development locations such as Oxford, making it hard to cater for all infrastructure needs and accounting for all needs outlined in the other themes.
Behavioural changes 	Changing mobility patterns – there was a decrease in shopping trips, but an overall increase in demand for transport pre-COVID-19. It may be harder to predict mobility behaviours in the future, given COVID-19 and advent of new modes of transport.	Changing mobility patterns influence levels of physical activity. People are becoming increasingly inactive, with 1/3 of the Oxfordshire population not achieving 30 minutes of activity per week.	Human behaviour can significantly impact on ecology, for example reduced use of motorised vehicles reduces risk to animals.	Behavioural change is needed to increase waste reduction, reuse and recycling of materials. Whilst recycling rates have increased significantly over past years, there is still room for improvement. Reuse and repair of items also requires support, which can potentially be facilitated by planning and development.	Uptake of new digital and communications services is increasing. New services being created will also lead to further behavioural change, impacting on the level of need for aspects such as transport infrastructure and types of development.	Increased energy demand due to uptake of electric modes of transport and heat pumps could result in grid constraints and supply constraints.	Infrastructure and development type requirements are influenced by changing behavioural patterns, which can be hard to predict and/or cater for.
Poor population health (mental and physical) 	Designing to support active travel modes is important in supporting improved mental and physical health. However, in doing so, it is important to ensure the accessibility needs of disabled users of different kinds are facilitated.	In Oxfordshire, over 1/2 of adults were classified as overweight or obese in the 2021 Joint Strategic Needs Assessment (JSNA). Growing trend in the UK towards poor mental health – loneliness is rising, general emotional state and anxiety and depression disorders are worsening. Estimated cost of physical inactivity in the UK is around £1bn a year to the NHS, and £7.4bn p/a when wider costs (e.g. loss of working days) are factored (Public Health England).	Green space and access to nature are important health determinants, both in facilitating physical activity, and supporting good mental health.	Those in poor physical and mental health, including those with disabilities, may find it hard to organise and recycle waste. Different health concerns should be taken into account in the provision of waste management infrastructure.	Increased access to digital technologies can lead to reduced physical activity and social contact, potentially exacerbating existing health concerns. However, there is also potential for improved digital connectivity, especially when paired with technologies like virtual and augmented reality to facilitate social contact for those unable to do so physically.	Energy has a number of impacts and links with health, both direct and indirect. For example, fuel poverty has been shown by several studies to impact significantly on mental health in adults and adolescents.	It is important to ensure that infrastructure and buildings are designed for a range of health concerns, which in some cases will have different requirements.

3. RECOMMENDATIONS & CONCLUSION

The case for integrating innovation within development planning is strong – it can support important objectives, help overcome major challenges and mitigate key risks; in addition, innovation brings with it the challenge of changing the status quo – it is therefore something which needs to be considered when designing for the future to ensure the need for costly retrofit is avoided as far as possible.

The recommended route for development, including infrastructure development, to ensure innovation is effectively addressed is via the medium of an Innovation Plan, which should identify both the key relevant innovation areas to futureproof for and how to do so, as well as identify any innovations which will be integrated into the development itself in order to bring about benefit.

Planners can also make use of innovative techniques and technologies in supporting a number of areas throughout the planning process, from developing Local Plans through to assessing development proposals. It is also recommended that innovation is an area of consideration when assessing planning applications, to ensure that development is being suitably futureproofed, and using appropriate innovations to support achieving specific aims and overcoming challenges and risks. The iHUB is available to support this process, alongside the use of this framework and associated supporting materials.

APPENDICES

Appendix 1 - Policy and Strategy background

Policy & Strategy (Oxfordshire, County):

- **Local Transport and Connectivity Plan (LTCP)**
  The LTCP is an over-arching plan which brings together the council's vision and goals within the transport and connectivity spheres, in order to ensure its systems are fit to support population and economic growth in the county. It is comprised of a series of sections and supporting documents with more specific focuses on locales including wider areas such as Oxford and corridors such as the A40, and themes and modes of transport, such as innovation, bus, and active and healthy travel.

  LTCP is currently being created, to replace LTP4, and due to be completed by early to mid- 2022.

- **Climate Action Framework**
  The Climate Action Framework sets out Oxfordshire's over-arching aim to become a zero carbon economy. New development will need to feed into this, and in particular, the framework stipulates the needs for:
  - Zero carbon new developments with:
    - The highest fabric standards and renewables maximised on-site;
    - Renewable heat as default in new developments;
    - Accessible electric vehicles charging infrastructure for residents; and
    - Community ownership of energy

  The framework also sets out the need for:
  - Climate resilience, which will be important for new developments to take on board and design in from the outset;
  - Promotion of the circular economy to minimise waste;
  - Continuous improvement as technology and national policy evolve, creating more areas for action; and
  - Designing out existing energy inequality

- Oxfordshire Plan 2050
  The Oxfordshire Plan is currently under development, and will set out the regional approach to ensure a joined up strategy for future housing and infrastructure development. It will identify key areas for sustainable growth, whilst considering how to help tackle climate change

- Oxfordshire's Strategic Vision for Long-Term Sustainable Development
  The Oxfordshire Growth Board has developed this strategic vision, aiming to realise sustainable growth and shape healthy, resilient communities. It looks towards an Oxfordshire in 2050 which:
  - Is carbon neutral, and moving towards removing more carbon than is emitted annually
  - Has improved biodiversity and supports social, economic and ecological resilience, building capacity to adapt to change
  - Has improved physical and mental health amongst the population
  - Is a globally competitive economy – sustainable, diverse and inclusive in narture
  - Has greater equality, so all have the opportunity to prosper

- Has a rich and diverse, high quality built and historic environment
- Has energy efficient, well-designed homes that meet the needs of the population
- Has greater digital and physical connectivity in ways which enhance environmental, social and economic wellbeing
- Has flourishing, diverse and vibrant communities

In particular, for development, it sets out an expectation that development is high-quality, with a positive impact on communities, using low-impact building and construction methods and materials, and is supported by necessary infrastructure. Everything built or designed should be fit for purpose in 2050, meaning it must respond to different circumstances.

- Oxfordshire Energy Strategy

  The Oxfordshire Energy Strategy sets out a framework for Oxfordshire to foster clean growth and lead in energy innovation. In line with the Climate Action Framework, it aims to first reduce countywide emissions by 50% by 2030 (on 2008 levels), and then achieve zero carbon growth by 2050. In particular for new builds, the strategy endorses:
  - The need for modern, clean and properly planned growth, aiming to achieve the planned increase in housing and employment, whilst meeting the county's commitment to reducing carbon emissions, meaning that:
    - New housing needs to meet the highest possible energy standard
  - Seeking the benefits of the low carbon transition by supporting:
    - Ambitious and innovative clean energy projects; and
    - Projects that reduce energy demand and increase energy efficiency for buildings and transport

- Local Industrial Strategy

  Oxfordshire's Local Industrial Strategy (LIS) is the Oxfordshire Local Enterprise Partnership's (OXLEP) strategy to position the county as one of the top-three global innovation ecosystems, responding to the UK Industrial Strategy, aiming to increase growth and productivity and create more prosperous communities. It responds to the grand challenges:
  - Artificial intelligence and data
  - Ageing society
  - Clean growth
  - Future mobility

- Older People's Strategy for Oxfordshire 2019-24

  This strategy focuses on prevention that helps people live well for longer, ensuring they can remain independent for as long as possible by making sure that they have access to the support that is needed at the time it is needed. Specifically, for developers, this highlights the need to:
  - Design for easy access to services
  - Consider the safety needs of older people in site-design, to support their ability to be physically active and socially engaged with the community
    - Good lighting
    - Easily maintained paths and roads
  - Oxfordshire's population is older than the UK average, which means designing for older users is particularly important in Oxfordshire

- Providing new housing and associated environment that can adapt to changing lifestyle and needs (including phasing of housing delivery against delivery of facilities to avoid lag)
  - Inbuilt technology
  - Energy efficiency
  - Communal open spaces
  - Walk and cycle links to local shops and facilities
  - Need for additional extra care housing

- Oxfordshire Market Position Statement (for care services in Oxfordshire) 2019-22

  This statement is aimed at potential providers of extra care housing, amongst others, in response to Oxfordshire's ageing population. Specifically for developers, the market position statement:
  - Encourages development of private retirement villages (outside of the definition of extra care housing)
  - Encourages increased provision of extra care housing, making Oxfordshire a "county where older people have access to high quality, affordable Extra Care Housing that is safe, inclusive, geographically spread, well-connected and integrated with local communities and where older people can access the care and support they need to thrive."
  - Ensure that the design of extra care homes is inclusive to meet the requirements of a range of different needs (including physical disabilities, dementia and learning disabilities)

- Oxfordshire Joint Health and Wellbeing Strategy (2018-2023)

  This strategy aims to:
  - prevent ill health before it starts;
  - give patients and services users a high quality experience as they use our services;
  - work with you on re-shaping your local services and tackle our chronic workforce shortages.

  The priorities can be summarised as:
  - Agreeing a coordinated approach to prevention and "healthy place shaping".
  - Improving the resident's journey through the health and social care system (as set out in the Care Quality Commission action plan).
  - Agreeing an approach to working with the public to re-shape and transform services locality by locality.
  - Agreeing plans to tackle critical workforce shortages.

  The strategy uses an approach which covers all ages and stages of life, ensuring A Good Start in Life, enabling adults to continue Living Well, paving the way for Ageing Well.

- Oxfordshire Electric Vehicle Infrastructure Strategy

  This strategy sets out the approach for ensuring that Oxfordshire's electric vehicle infrastructure is sufficiently comprehensive, accessible and efficient to enable rapid adoption of electric vehicles. It sets out a series of policies to achieve this. In particular, for new development:
  - Planning standards and guidance to include statements and policies supportive of EV charging infrastructure
  - Minimum standards to be set for quantities of EV charging to be provided in development in planning requirements, such that developments will only be given planning permission if they provide charging facilities to the levels identified in the Oxford City Council Local Plan (2016-2036) – these are summarised in Table 1 of this document

  A Technical advice note for developers and planning officers will be produced to support deployment of EV charging, sharing knowledge and best practice.

- Oxfordshire Infrastructure Strategy (OXIS)

  OXIS was produced to provide a view of infrastructure and development needs to support jobs and housing growth in the county from 2016 to 2031 and beyond. In particular, it seeks to:
  - Prioritise delivery of strategic infrastructure
  - Maximise use of available and planned infrastructure capacity
  - Make better informed choices about future growth locations
  - Align infrastructure delivery with growth and strategic planning work across the county
  - Better position Oxfordshire in funding and investment discussions with government
  - Improve context and quality of bids for external funding
  - Inform and enhance strategic developer funding negotiations
  - Facilitate dialogue with developers, stakeholders and the community on growth impact
  - Demonstrate Oxfordshire as an attractive business investment location

  OXIS is currently being updated, to be completed Spring/Summer 2021.

- Digital Infrastructure Strategy

  This strategy aims towards ubiquitous access to future-proof digital infrastructure within the county – full fibre and 5G connectivity, with 95% of premises having full-fibre and 100% with 5G connectivity by 2033. In particular, for new developments, the strategy aims to ensure that:
  - Local Plans are aligned with the February 2019 NPPF guidance in respect of full-fibre provision in all new housing developments

- Oxfordshire Joint Municipal Waste Management Strategy

  This strategy sets out the aims to:
  - Keep household waste growth to zero (per person per annum)
  - Increase the amount of recycled household waste to 70% by 2030
  - Send less than 3% of household waste to landfill by 2020 (not met)

  The strategy follows the waste hierarchy, whereby waste should be prevented first and foremost (reduce, reuse, repair); then waste that is generated should be recycled wherever possible (or composted), and where not possible burned to recover energy, with landfill being the last choice for disposal.

  Specifically for developers, the strategy looks to:
  - Provide a planning guide for property developers to ensure adequate provision for sustainable waste management in new developments
  - Work with local authorities, OxLEP and Growth Board to embed principles of circular economy into Oxfordshire's growth agenda

Policy & Strategy (District, Local)

- **Local plans:**
  Local plans are set out for all of Oxfordshire's districts. Some are currently in the process of being updated (as of mid-2021), and where this is the case links to both the adopted and information on the review are both linked below; in addition, other districts are anticipated to start work on Local Plans in the near future, including a joint local plan between South Oxfordshire and Vale of White Horse District Councils:
  - Cherwell Local Plan 2011-2031
  - Cherwell Local Plan Review 2040
  - Cherwell Local Plan 2011-2031 Partial Review
  - Oxford Local Plan 2016-2036
  - South Oxfordshire 2034
  - Vale of White Horse 2031
  - Vale of White Horse 2041
  - West Oxfordshire Local Plan 2031

  The district councils also have additional planning documents providing guidance on a number of issues such as air quality, neighbourhood-level planning, design guides and more. These can be reached from the planning sections of their websites:
  - Cherwell District Council
  - Oxford City Council
  - South Oxfordshire District Council
  - Vale of White Horse District Council
  - West Oxfordshire District Council

Guidance documents:

- **Streets design guide**
  This guide sets out the standards that developers should use when designing streets and place within development; it replaces the previous Residential Streets Design Guide.

- Oxfordshire Cycling design standards
  This guide sets out the standards that developers and others should use to ensure attractive and functional route design for cyclists, that will help to increase uptake of cycling including amongst demographics that usually do not cycle, making cycling the preferred mode of transport more often. It comprises a section specific to development, outlining ways to make the ideal conditions to make cycling first choice for many journeys, including outlining the need for:
  - Connected and permeable street layouts
  - General accommodation of cyclists on-street rather than via completely segregated routes, with short links just for cyclists and pedestrians to maximise permeability
  - Providing convenient and secure cycle parking
  - Ensuring good connectivity to the wider network

- Oxfordshire Walking design standards
  This guide sets out the standards that developers and others should use to ensure an attractive and functional environment for walking that is available to all users, supporting the 4 key aims for walking from the Active & Healthy Travel Strategy, to:
  - Enable and encourage walking
  - Make best value for capital investments for walking, adopting good practice standards
  - Support the county council in gaining additional funding for walking measures
  - Raise awareness of physical and mental health benefits of walking

- Travel Plan guidance
  Oxfordshire has Travel Plan (TP) guidance set out for new development in this document, outlining when and how Travel Plans of different types should be developed for new and extended sites. The Innovation Plan and TP should support each other in the relevant sections, in particular with regard to monitoring and with common aims.

- **Innovative Waste Collection guidance**
  This sets out the considerations that developers must take account of when proposing innovative waste collection and management solutions/technologies. Waste management teams at all authorities welcome early discussions with developers to ensure that any system proposed brings the environmental benefits intended.

Appendix 2 - Additional resources

Alongside the previously cited policies, strategies and guidance documents in Appendix 1, there are a number of pre-existing innovation-related resources which may be of benefit to planners and developers when considering new developments and infrastructure. These fall into a series of categories, outlined below, though some fall into multiple categories:

Information, knowledge sharing, and partnership forming resources:

- Knowledge Transfer Network (KTN): https:// ktn-uk.org
- Transforming Construction Network Plus (N+): https://www.ucl.ac.uk/bartlett/construction/about-us/transforming-construction-network-plus
- Catapults: https://catapult.org.uk
- Community Action Group (CAG) network: https://cagoxfordshire.org.uk/
- Digital Twin Hub: https://digitaltwinhub.co.uk/

Real world trials and evidence:

- Living Oxford: https://www.livingoxford.org/
- Mobox: https://mobilityoxford.com/
- Eco Bicester living lab: https://bicesterlivinglab.org/
- MK:Smart: https://www.mksmart.org
- Active Building Centre: https://www.activebuildingcentre.com
- ADEPT Living Labs: https://www.adeptnet.org.uk/livelabs
- Sharing cities: http://www.sharingcities.eu/

Tools:

- Oxfordshire Mobility Model (OMM): https://mimas.services/
- Co-creation tools: https://ccn.waag.org/
- LEO Energy mapping tool
- Building Energy Performance Improvement Toolkit (BEPIT): https://bepit.org

Innovation & Design Guides:

- Construction Innovation: https://www.ice.org.uk/knowledge-and-resources/best-practice/eight-steps-towards-innovation-in-construction
- Traffic free route design: https://theodi.org/article/introducing-the-odi-data-landscape-playbook/
- Data landscape Playbook: https://theodi.org/article/introducing-the-odi-data-landscape-playbook/
- Ten Features of a Resilient Transport Network: http://its-uk.org.uk/wp-content/uploads/2021/06/Network-Workshop-on-ITS-and-Resilience-output-document.pdf

Innovation support services and Funding:

- European Commission open innovation resources: https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-innovation-resources_en
- UK Research and Innovation (UKRI): https://www.ukri.org/
- European Commission funding opportunities: https://ec.europa.eu/info/overview-funding-programmes_en
- Construction Innovation hub: https://constructioninnovationhub.org.uk/
- Plantech – Connected Places Catapult: https://cp.catapult.org.uk/opportunity/connected-places-catapult-launches-digital-planning-system-challenge/

Roadmaps:

- UK Research & Development: https://www.gov.uk/government/publications/uk-research-and-development-roadmap
- Electric Vehicles: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/739460/road-to-zero.pdf
- Built environment: https://www.cdbb.cam.ac.uk/fourfutures
- Built environment: https://indd.adobe.com/view/f2092c85-cd16-4186-9035-e2a63adc2bf9
- Artificial intelligence: https://www.gov.uk/government/publications/ai-roadmap
- Artificial intelligence: https://www.ukri.org/wp-content/uploads/2021/02/UKRI-120221-TransformingOurWorldWithAI.pdf
- Urban mobility: https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0144:FIN:en:PDF
- Connected and Autonomous Vehicles (CAV): https://smarttransportpub.blob.core.windows.net/web/1/root/connected-places-catapult-market-forecast-for-connected-and-autonomous-vehicles.pdf
- CAV: https://zenzic.io/roadmap
- Path to net-zero: https://smarttransportpub.blob.core.windows.net/web/1/root/the-sixth-carbon-budget-the-uks-path-to-net-zero.pdf
- Energy: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945899/201216_BEIS_EWP_Command_Paper_Accessible.pdf
- Real Estate: http://www3.weforum.org/docs/WEF_A_Framework_for_the_Future_of_Real_Estate_2021.pdf
- Transport Decarbonisation: https://www.gov.uk/government/publications/transport-decarbonisation-plan
- Future of flight: https://www.ukri.org/publications/future-flight-vision-and-roadmap/