Land to the north of Cambridge North Station, Milton Avenue, Cambridge
Brookgate Land Limited
Mr Michael John Derbyshire
APP/W0530/W/23/3315611

BIDWELLS

PROOF OF EVIDENCE - APPENDICES

MICHAEL JOHN DERBYSHIRE BA (HONS) MRTPI

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APPENDIX 1

SCHEDULE OF PRE-APPLICATION ENGAGEMENT WITH LPA

MEETING	DATE
Pre-Application 1	22 and 23 June 2017
Pre-Application 2	8 August 2018
Pre-Application 3	6 December 2018
Pre-Application 4	20 April 2020
Pre-Application 5	26 October 2020
Pre-Application 6	16 November 2020
Wholesale review of the site and appointment of new masterplanner	
Pre-Application 1	8 December 2020
Pre-Application 2	26 January 2021
Key Views Workshop	18 March 2021
Build to Rent Workshop	23 March 2021
Landscape, Open Space and Drainage Workshop	1 April 2021
Pre-Application 3	7 April 2021
Sustainability Workshop	13 April 2021
Ecology and Biodiversity Workshop	5 May 2021
Residential Workshop	12 May 2021
Commercial Workshop	17 May 2021
Pre-Application 4	1 June 2021
One Milton Avenue, Swale Street and Triangle Site workshop	7 June 2021
Triangle Site Workshop	2 July 2021
Pre-Application 5	4 August 2021
Ecology Workshop	10 November 2021

Commercial Workshop	12 November 2021
Design Workshop	24 November 2021
Ecology Workshop	29 November 2021
Drainage Workshop	6 December 2021
LVIA and Key Views Workshop	4 February 2022
Design and AAP workshop 1	28 April 2022
Design and AAP workshop 2	12 May 2022

APPENDIX 2

POLICY MATRIX – DRAFT POLICIES OF THE EMERGING NEC AAP (PROPOSED SUBMISSION VERSION)

DRAFT POLICY	APPELLANT RESPONSE
Policy 1: A Comprehensive Approach at North East Cambridge	The proposals are considered as the catalyst for the delivery of the wider objectives of the AAP,while the proposed development has been carefully considered to align with its wider context. The Council do not argue that the proposal is premature to the emerging AAP or Local Plan
Policy 2: Designing for the Climate Emergency	The principles of sustainable design and construction are clearly integrated into the development proposals. The method of achieving this is set out in Chapter 7 of the ES. In addition, a Sustainability Statement, Energy Statement and Energy Strategy have been submitted as part of the planningapplication. The council argue that the number of single aspect units may lead to overheating. Further modelling will be provided in the detailed stages of the application. Mr Ludewigs proof of evidence expand on the design approach to the apartments blocks
Policy 3: Energy and Associated Infrastructure	An energy strategy has been prepared to accompany the application. This includes considerations of more efficient heat pumps, optimising the design ofroof spaces and helping reduce peak demands on the electricity grid. Water use will be minimized in the operation of the buildings
Policy 4a: Water Efficiency **Policy 4b: Water Quality and Ensuring Supply** **Policy 4c: Flood Risk and Sustainable Drainage**	Policy 4a The Appellant is seeking maximum BREEAM credits for water and looking to minimize water consumption for residential use below current Local Plan standards. This approach has been welcomed by the Environment Agency. Policy 4b Water quality and water supply issues are dealt with in the proof of Ms Alison Caudwell Policy 4c No objections are raised on flood risk grounds or to the sustainable drainage solution proposed.
Policy 5: Biodiversity and Net Gain	The proposed development incorporates a biodiversity net gain in excess of 80%, far in excess of the 20% uplift targeted in Policy 5. The proposals are not considered to impact adversely upon any nearby ecological assets.
Policy 6a: Distinctive Design for North East CambridgePolicy 6b: Design of Mixed-Use Buildings	This is dealt with in length in the proofs of Mr Ludewig, Mr Willis and Mr Myers.

DRAFT POLICY	APPELLANT RESPONSE
Policy 7: Creating High Quality Streets, Spaces and Landscape	This is dealt with at length in the proofs of Mr Ludewig, Mr Willis, Mr Myers and Mr Smith.
Policy 8: Open Spaces for Recreation and Sport	The Councils agree that the open spaces proposed in the appeal meet the quantitative standards in the Local Plan and SPD. Mr Myers set out his approach to the quality and useability of these spaces in his proof of evidence.
Policy 9: Density, Heights, Scale and Massing	The appeal scheme is of an appropriate height, scale and massing and creates distinctive high-quality buildings which make a positive contribution to the existing and emerging context when considered from immediate, mid-range and long-range views. Detailed evidence on townscape and visual impact is provided within Mr Smith's evidence. Density is dealt with my Mr Ludewig.
Policy 10a: North East Cambridge Centres	The appeal site is identified as a Local Centre 'Station Approach' in the AAP. The mix of uses is in accordance with the policy. The appeal scheme has been designed to create a multi-functional, vibrant activity hub that supports community development and encourages a diversity of people to interact and dwell. The appeal scheme has been designed to create safe and active public spaces which meet the needs of all parts of the community.
Policy 10d: Station Approach	Station Approach Local Centre falls within the application site. The proposals have been crafted to broadly align with the design anddevelopment requirements for Station Approach Local Centre. In terms of quantum of uses, these have been fully considered and informedby Bidwells leisure and retail and commercial teams. Further commentary isprovided in the Retail and Leisure Market Update and the Occupational Needs Report submitted with the planning application.
Policy 11: Housing design standards	The proposals have been designed in accordance with the adopted local planstandards. The residential units will also meet the Government's Technical Housing Standards (or any future equivalent). Amenity, privacy and other development factors have been considered andmitigated to avoid significant harmful effects on residents.

DRAFT POLICY	APPELLANT RESPONSE
Policy 12a: Business	The need for offices, laboratories and R&D space is set out in Mr Bryan's proof of evidence. I deal with planning policy and the imperative of making best use of previously development land in sustainable locations in his proof of evidence. Mr Ludewig deals with density and the design approach to the appeal scheme in his evidence.
Policy 13a: Housing Provision	The proposal secures an appropriate mix of housing on site and contributesto the creation of inclusive, mixed and balanced communities.
Policy 13b: Affordable Housing	The proposals provide for 40% of the market homes to be delivered as affordable housing and 20% of the built to rent homes to be delivered asaffordable private rent.
Policy 13c: Build to Rent	270 of the 425 homes are proposed as Build to Rent. The homes meet the requirements as set out in the Greater Cambridge Housing Strategy Annexe:Build to Rent (2021)
Policy 14: Social, community and cultural infrastructure	The development proposals are supported by an appropriate provision ofcommunity uses to support the needs of the development. The location and quantum of retail and leisure units has been fully consideredand informed by Bidwells' leisure and retail team to ensure the buildings are designed in such a way as to be flexible across the Class E uses. A meanwhile strategy will be secured as part of the Section 106 Agreement.
Policy 15: Shops and Local Services	A mix of uses is proposed within the development that is appropriate for an emerging Local Centre.
Policy 16: Sustainable Connectivity **Policy 17: Connecting to the wider network**	The development facilitates travel by active and sustainable modes within and across the wider area. The site is in an optimal location for sustainable transport modes given its proximity to Cambridge North train station and established high-quality pedestrian and cycle links. Given the accessibility ofthe location, the residential development element is proposed as car-free. The Applicant is liaising with the LPA and County Council regarding the nature, scale and phasing of planning obligations relating to off site highway improvements.
Policy 18: Cycle and Micro-mobility Parking	The development will include for extremely low levels of car parking, within the identified trip and parking budget, and the Applicant will be working closely as part of the travel planning with the new tenants to make full use ofthe existing alternative modes. Clear justification is provided in the Transport Assessment for the level andtype of cycle parking infrastructure proposed to demonstrate it will meet thetrip budget.

DRAFT POLICY	APPELLANT RESPONSE
Policy 19: Safeguarding for Cambridge Autonomous Metro and PublicTransport	It is acknowledged that the proposed safeguarding land for CAM is indicativeat this stage, However, as it is currently shown in figure 40, the shaded area is wholly Network Rail owned land including Network Rail's station lease areaand operational railway land. Any proposed safeguarding of the land would need to be agreed with Network Rail and further engagement with Network Rail is required on this matter as and when it progresses.
Policy 21: Street Hierarchy	The proposal has been designed to manage vehicle movements in accordance with the street hierarchy shown in Figure 42 and the design principles of the AAP. The residential quarter is a proposed car-free zone.
Policy 22: Managing Motorised Vehicles	The trip budget and parking budget has been agreed with the Local Highways Authority.
Policy 23: Comprehensive and Coordinated Development a. The proposal demonstrates the development will make an appropriate and proportionate contribution to site wide infrastructure such as road and rail crossings, public transport, active travel, community facilities, open space and Green Infrastructure provision, to be secured through the use of planning contributions in accordance with Policy 27.	The s106 discussions are at an advanced stage and include detailed measures on highway mitigation and open space provision.
b. The proposal is supported by a comprehensive masterplan - accompanied as necessary by parameter plans in relation to layout, scale, appearance, access and landscaping - that accords with the overarching Area Action Plan Spatial Framework and other relevant Development Plan policies, including, where appropriate: i. The ability to connect and contribute to Area Action Plan-wide utilities and communications grids; and **ii.** The setting aside of land for strategic and site-specific infrastructure provision.	The proposals are supported by a comprehensive masterplan and suite ofparameter plans which show connectivity with the wider area. The Utilities Statement submitted with the planning application demonstrateshow the proposals will connect with existing site infrastructure.

DRAFT POLICY	APPELLANT RESPONSE
c. Through the masterplan, applications should demonstrate how the proposal: i. Contributes proportionally to the achievement of the vision and strategic objectives for North East Cambridge and the creation ofplace; ii. Integrates, connects and complements successfully with the existing and proposed surrounding context, including areas beyond the boundary of North East Cambridge, and supportingthe timely delivery and optimised approach to the phasing of development across North East Cambridge; iii. Supports the delivery of a new community, including demonstrating how early residents will be supported through community development; iv. Is landscape-led with respect to layout and access and design-led with respect to capacity, scale and form; v. Will achieve and secure the required modal shift in accordancewith the North East Cambridge Transport Study and Policy 22: Managing motorised vehicles , including the management of vehicle numbers, movements, servicing and parking, including throughout the construction phase of delivering the masterplan; vi. Responds to the impacts of climate change; vii. Contributes to biodiversity net gain and forms part of a coherent green infrastructure network; viii. Successfully mitigates environmental constraints; and ix. Where relevant, has regard to the existing site circumstances,including the existing character, neighbouring uses and constraints; implementing the Agent of Change principle to ensure the ongoing functioning and amenity of existing uses isnot materially affected.	All these matters have been dealt with above and more fully in the evidence of respective witnesses.
d. In instances where the infrastructure provision is to be phased, eitherstrategic or site-specific, an approved phasing strategy is in place;	The phasing of infrastructure will be secured under the Section 106 Agreement.

DRAFT POLICY	APPELLANT RESPONSE
e. The proposal demonstrates health and wellbeing impacts have been fully considered and accommodated for through design of the development and evidenced through the submission of a Health Impact Assessment; and	A Health Impact Assessment has been prepared in support of the application
f. The application is supported by a Statement of Community Involvement detailing the engagement with the Councils, surrounding landowners, occupiers and the local community on both the masterplan, phasing strategy, and development proposal.	A Statement of Community Involvement has been submitted with theplanning application.
Policy 25: Environmental Protection	The impact of the proposals upon the receiving environment have been carefully analysed and, where necessary, appropriate mitigation has been built into the proposed development.
Policy 27: Planning Contributions	The S106 discussions are at an advanced stage.
Policy 28: Meanwhile Uses	A meanwhile use strategy will be secured under the Section 106 Agreement. Details were provided within the original Landscape report.
Policy 29: Employment and Training	Employment, skills and training opportunities for local people will be provided in the construction phase of development and in the operational phase of the development, the details of which are set out in the Socio-Economics Chapter of the Environmental Statement and the Social Value Statement submitted with the planning application.
Policy 30: Digital infrastructure and Open Innovation	The scheme will secure appropriate provision of infrastructure suitable to enable the delivery of necessary media and broadband connectivity via appropriated worded conditions.

APPENDIX 3

EVIDENCE PAPERS MATRIX – THE EMERGING NORTH EAST CAMBRIDGE AREA ACTION PLAN (NEC AAP)

TOPIC	EVIDENCE PAPER	DATE OF PUBLICATIONAND CONSULTATION	RESPONSE
Transport and Connectivity	Transport Evidence Base (TEB)	June 2020 – published insupport of Reg 18 consultation in 2020	This is dealt with in the evidence of Mr Nettleton and within the s106 Agreement. Discussions are at an advanced stage on the S106 Agreement. The highway authority do not object to the appeal scheme.
	Greater Cambridge Local Plan Transport Evidence Report – Preferred Options Update	November 2021 – not subject to consultation	
	High Level Transport Strategy	November 2021 – not subject to consultation	
	Transport Position Statement setting out Interim Transport Approach	May 2020 and revised February 2022 – not subject to consultation	

TOPIC	EVIDENCE PAPER	DATE OF PUBLICATIONAND CONSULTATION	RESPONSE
Landscape Character and Visual Impact	Landscape Characterand Visual Impact Appraisal (2020)	July 2020 – published insupport of Reg 18 consultation in 2020	This document models the potential effects of three height scenarios on the wider NECAAP area. The three scenarios considered were described as High, Medium and Low. The blocks within the application site are shown at the same heights for each of the scenarios – ranging from up to 4 storeys (12m) to 7 stories(21m) in the south western part of the site. The recommendations of the LCVIA with regard to Massing and Height are set out in paragraph 5.10 and shown on Diagram 1: Graphic showing potential areas of development. The text describing the conclusions shown on Diagram 1 describes only four building heights (it does not include a low/medium category) although the Diagram itself shows five. In addition, the key to the Diagram also lists only four building height categories. The category missing from the legend is medium but from the Applicant's understanding of Diagram it is considered that the colour identified as low/medium on the diagram should in fact be medium. The Appellant consider that there are some discrepancies between the three scenarios considered and the final recommendation as shown on Diagram 1. In particular Block 4, which is within the application site, is assessed in each of the scenarios within stepped heights, from 4 storeys on the eastern edge and up to 6 or 7 storeys on the north western and south western edges respectively. On Diagram 1 the recommended height of Block 4 is medium/high. Although no exact heights are given in the LCVIA (either in storeys or m) for medium/high, the Townscape Strategy (November 2021) interprets it as 7-12 storeys or 21-36m (page10).
Design and Built Character	Heritage Impact Assessment (includes Archaeology)	November 2021 – not subject to consultation	In conclusion, the LCVIA considered three height scenarios in all of which buildings within the appeal site were shown at the same heights (from 4 to 7 storeys). However, the final recommendation within the LCVIA (Diagram 1) shows a substantial block of development within the application site as capable ofaccommodating buildings in excess of these heights and potentially up to 12 storeys.

TOPIC	EVIDENCE PAPER	DATE OF PUBLICATIONAND CONSULTATION	RESPONSE
			Matters of landscape character and impact are dealt with in Mr Smith's evidence. Section 5.3 of the Heritage Impact Assessment (HIA), Recommended Design Parameters, includes several recommendations with regard to building heights. Ofthese recommended design parameters two are of relevance to the appeal site. One of the recommended parameters is: '*Siting taller buildings away from the more sensitive eastern and south eastern edge of the NEC site to avoid an urbanising effect on the rural character of wider views in Fen Ditton and from Baits Bite Lock and in views from Riverside and Stourbridge Common Conservation Area*.' Although no height is given for taller buildings in this recommendation elsewhere taller buildings are defined as 10-13 storeys. The HIA also recommends that the heights of buildings should be stepped down '*where they interface with surrounding existing development, to avoid being an over-dominant presence, particularly to the south of the NEC near to The Golden Hind pub and to the east near to Fen Ditton and Baits Bite Lock Conservation Areas*.' Dr Burgess deals with heritage impact in his evidence.
	Townscape Strategyand Townscape Assessment	November 2021 – not subject to consultation	The Townscape Strategy was the final study that built on the conclusions of the LCVIA (2020) and the HIA (2021), and a Townscape Assessment prepared by Urban Initiatives Studio Ltd (2021). The Townscape Strategy included, as an appendix, a Review of the Regulation 18 Draft AAP. The Review raises several concerns with the proposed building heights from the Draft Area Action Plan and makes a series of recommendations: • *Set more definitive building heights for each character area/sub-area* • *Clearly define the rules for exceptional tall buildings*

TOPIC	EVIDENCE PAPER	DATE OF PUBLICATIONAND CONSULTATION	RESPONSE
			• *Tall buildings should mark places of functional or visual importance, or create clusters where this is part of the area's character* • *Heights to be proportionate to location and function* Figure 4.7 of the Townscape Strategy shows a different layout to that assessed by the LCVIA. It appears to be based on the Regulation 18 Draft AAP plan but has a more fractured character. It is assumed that this is in response to the Review of the Draft Area Action Plan and the conclusions of the Townscape Assessment. Figure 4.7 also includes a new set of building heights. The Townscape Strategy has significantly reduced the recommended building heights compared to the LCVIA although it is not explicit as to why there has been such a significant reduction from the recommendations. Although the recommended height of buildings on the northern and eastern edges of the development have remained the same at 12m (4 storeys) there is a marked reduction in the heights of buildings towards the centre of the AAP area (east of Milton Road). The LCIVA recommended that these buildings should be up to 36m in height, whilst the Townscape Strategy recommends that they are predominantly up to 18m (6 storeys) in height. The approach to height and massing within the application proposals gives detailed consideration to the context within which the site sits, the Landscape and Visual Impact Assessment (LVIA) undertaken, the heritage assessments undertaken, the existing and emerging policy context and the need to facilitate economic growth. As referred to above, the LVIA in support of the application concludes that, overall, the proposal is largely appropriate to the urban context and the testing of long distance views did not result in any significant effects on the Cambridge skyline. It responds sensibly to the residential edges and existing tall buildings,

TOPIC	EVIDENCE PAPER	DATE OF PUBLICATIONAND CONSULTATION	RESPONSE
Flood Risk and Drainage	Area Flood Risk Assessment Surface Water Attenuation Report Draft Surface Water Drainage Core Principles Integrated Water Management Study	2020 – published insupport of Reg 18 consultation in 2020 2020 – published insupport of Reg 18 consultation in 2020 2021 – not subject to consultation 2021 – not subject toconsultation	includes positive landscape spaces and proposes architectural technologies that align with the concept of high-quality design. As such, the proposed development is considered to represent a positive contribution to the evolving railway corridor, which is an important townscape character for Cambridge and the experience of the numerous visitors to the city. An appropriate FRA and SuDs scheme has been agreed with the LPA and LLFA.
Ecology	Ecology Study	2020 – published insupport of Reg 18 consultation in 2020	Ecology surveys have been completed and the LPA is satisfied the appeal scheme has no adverse impact on the site or surrounding area.
Infrastructure	Infrastructure Delivery Plan	December 2021 – not subject to consultation	An agreed set of contributions is set out in the S106 Agreement. Discussions on the s106 Agreement are at an advanced stage.
Viability	Viability Assessment	November 2021 – not subject to consultation April 2023. Draft note from BNP Paribas circulated to landowners group	The LPA appears to be reviewing its position on viability and its approach to an Infrastructure Levy across the site

APPENDIX 4

RESPONSE TO DEVELOPMENT MANAGEMENT GUIDANCE DOCUMENT : EVIDENCE REQUIRED TO SUPPORT PLANNING APPLICATIONS AHEAD OF THE NORTH EAST CAMBRIDGE (NEC) AREA ACTION PLAN (AAP)

EVIDENCE REQUIRED	APPELLANT RESPONSE
Comprehensive development which is designed in consultation with the councils,surrounding landowners, occupiers and the local community is likely to result in planning applications being supported and will avoid any undue delays in the planning process, to the benefit of everyone involved.	The proposals have been subject to detailed consultation with Council Officers, local stakeholders and the local community, as detailed within the Statement of Community Involvement and Planning Statement submitted withthe planning application.
In addition to the usual documentation required for validation of an application forplanning permission, to ensure comprehensive and coordinated development is achieved, a masterplan will be required to accompany a planning application for schemes within the NEC AAP area, supported as necessary by parameter plans in relation to layout, scale, appearance, access and landscaping.	A comprehensive masterplan package, compromising a set of parameter plans, has been submitted with the planning application to clearly articulatethe development proposals.
Through the masterplan, the applicant will be required to demonstrate, to theLPA's satisfaction, how their proposal: *a. Has regard to the existing site circumstances, including the existing character,neighbouring uses and constraints; implementing the Agent of Change principle so that new development does not materially affect the ongoing functioning of existing uses or cause unacceptable harm to the amenity of existing uses;*	The proposed development has been carefully crafted to support and enhance the functioning of existing neighbouring uses, such as the Phase 1element of the Cambridge North development, and to minimise any amenityimpacts upon other neighbouring properties.
b. Complies with the extant policies of the local plans, including recently publishedguidance for the NEC area on odour;	I set out in my evidence why I consider the appeal scheme complies with the development plan when read as a whole. It is common ground that the impact of odour from the Waste Water Treatment Plant has no impact on the appeal scheme.
c. Contributes to delivery of the vision and strategic objectives for NEC (as currently set out in the NEC AAP Issues & Options, Feb 2019) and the achievement of comprehensive regeneration of the wider NEC AAP area, including the timely and equitable provision of strategic social and physical infrastructure. Where appropriate, for example, this will include the provision of walking and cycling routes that integrate with existing and proposed networks within and outside of NEC, the delivery of a diverse network of connected and multifunctional open spaces and green links, the ability to connect and contributeto an NEC smart utilities grid, and the setting aside of land for future strategic infrastructure provision;	The proposed development has been designed to assimilate into the wider vision of the NECAAP area, with excellent linkages to transport networks, andact as a catalyst to bring forward the remainder of the site.

EVIDENCE REQUIRED	APPELLANT RESPONSE
d. Will integrate and complement successfully with existing and proposed neighbouring developments ensuring a continuity in the establishment of a neighbourhood character and supporting the timely delivery and optimised approach to the phasing of development across NEC. This should be demonstrated by submitting a geolocated 3D model in a readable format (i.e. FBX, OBJ, VU);	The proposed development has adopted 3D modelling to assess and minimise impacts upon neighbouring uses. The proposals have been designed to foster a sense of community within the new development and toenable the delivery of the wider AAP area.
e. Addresses the transport constraints identified in the A10 Study having regard tothe development potential of the NEC AAP area (see County Transport position statement) and the need to minimise car trips and maximise the take-up of non-car modes including walking, cycling, and sustainable public transport;	It is agreed that the appeal proposals accord with the vehicle and trip budgets for the AAP area and that optimal use is made of the sustainable location.
f. Takes account of the findings and recommendations of the relevant evidencebase studies being prepared in support of the NEC AAP	This is dealt with in detailed evidence of the witnesses.
g. Demonstrates sustainable development, in respect of design, communityhealth & wellbeing, social integration, and environmental outcomes, in accordance with the high-level vision and strategic objectives as set out in the Issues and Options 2019 Consultation;	The development will meet an identified need for new employment floorspacein a sustainable location. The principle of sustainability is enshrined within the project brief. The development has been designed to achieve BREEAM Excellent but aiming for BREEAM Outstanding for all new build elements.
h. Is supported by a Statement of Community Involvement detailing the engagement with the councils, surrounding landowners, occupiers and the localcommunity	A Statement of Community Involvement has been prepared andaccompanies the planning application.

APPENDIX 5
ARTICLES AND PRESS RELEASES ON LIFE SCIENCE SECTOR

DEVELOPMENT FOR SCIENCE, INNOVATION AND TECHNOLOGY – SCIENCE AND TECHNOLOGY FRAMEWORK MARCH 2023

Department for Science, Innovation & Technology

OUR PRIORITIES 2

GROW THE ECONOMY

SCIENCE & TECHNOLOGY FRAMEWORK

- taking a systems approach to UK science & technology

*Image generated using AI, inspired by science and technology

Contents

Secretary of State’s Foreword

The Rt Hon The Rt Hon Michelle Donelan MP, Secretary of State at the Department for Science, Innovation and Technology

In an increasingly competitive world, we find ourselves facing new challenges in keeping our nation secure, our people prosperous, and our planet healthy.

Britain has a long history of leadership and innovation, from the steam engine to the World Wide Web, that has brought growth and prosperity to both our nation and the world. As we look towards the future, investment in science and technology is more important than ever. It is at the heart of the Prime Minister's priorities: halving inflation to ease the cost of living and provide people with financial security, building a stronger economy with better jobs, and ensuring that NHS waiting lists will fall and people will get the care they need more quickly.

Despite our relative size, Britain outperforms our closest competitors and we are a main challenger nation to the US and China in many areas. We have four of the world's top ten universities and a technology sector worth over one trillion dollars. If you put together just eight of our university towns, they are home to more billion-dollar unicorn start-ups than the whole of France and Germany combined.

However, when others – France and Germany among them – are moving further and faster to invest in science and technology, we have got to do the same.

That is why we have created the Department for Science, Innovation, and Technology, focussing our best minds around a single mission: becoming the most innovative economy in the world.

We will do this by ensuring that Britain as a Science and Technology Superpower does not just challenge the rankings, but translates the benefits of that position into material benefits for British people.

Because a better future will be driven by Britain’s boldest businesses, whether that means using artificial intelligence to predict when equipment or machinery is likely to fail, allowing for proactive maintenance, reducing downtime, or the use of quantum computers to discover new life-saving drugs.

The Science and Technology Framework is a strategic vision which sets out ten key actions to achieve this goal by 2030. We must attract the best talent from around the world, build a skilled workforce for tomorrow's industries, provide infrastructure and investment to bring technologies to market, and encourage a regulatory environment that supports innovation.

This is an ambitious plan, and we will use every lever in government to deliver it, working closely with industry and academia leaders from both Britain and the world. Each lead department has been developing action plans so we can meet our strategic goals – a flavour of these plans is shared in the framework and any future policies in these areas will need to drive forward our strategy. My department will ensure we are working together to deliver and become a Science and Technology Superpower by 2030.

Our Department will be driven by a relentless focus on tangible improvements that matter to communities across the country, growing the economy and improving public services to help British people live longer, smarter, healthier, and happier lives.

UK Science and Technology Framework

Introduction

The motivation behind our Science and Technology Superpower agenda is simple: science and technology will be the major driver of prosperity, power and history-making events this century. The United Kingdom's future success as a rich, strong, influential country, whose citizens enjoy prosperity and security, and fulfilled, healthy and sustainable lives, will correspondingly depend on our ability to build on our existing strengths in science, technology, finance and innovation.

This agenda will only be delivered if the public sector, civil society, academia, industry and private sector, and international partners work together, and the general public is constantly engaged to ensure science and technology is not perceived to be at the fringes of citizens' lives.

Some of these outcomes will undoubtedly be very challenging to implement, but it is absolutely crucial to act quickly and act now.

This Science and Technology Framework sets out the government's goals and vision for science and technology in an enduring framework that will see us through to 2030. It has been developed in close collaboration with the UK science and technology sector, and represents a commitment to scaling our ambition and delivering the most critical actions needed to secure strategic advantage through science and technology.

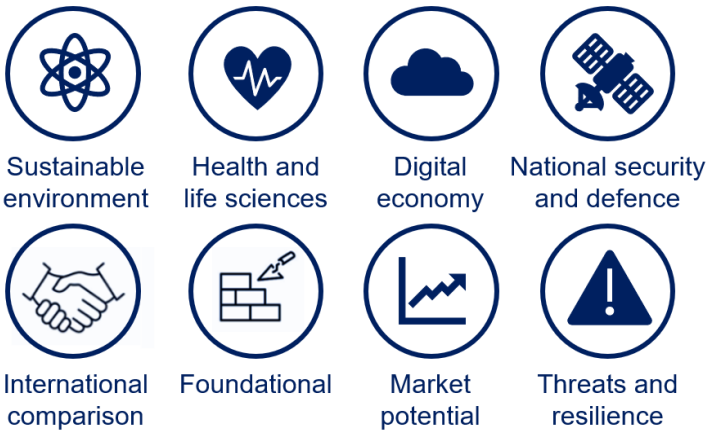
The Science and Technology Framework is the strategic anchor that government policy will deliver against, and which the government will hold itself accountable to. We will have a clear action plan for each strand of the framework in place by summer 2023 and delivery will be overseen by the National Science and Technology Council.

1. Identifying Critical Technologies

Vision: The UK has a track record of defining, pursuing and achieving strategic advantage in prioritised areas of science and technology application to deliver prosperity and security for the UK on our own terms and deliver benefits to global society. The UK's foundational science base is world-leading and broad, giving us the agility to rapidly advance discoveries and technologies as they emerge.

Actions and ongoing work - the government will:

- **Use a robust and repeatable approach to identify the technologies that are most critical to the UK**. We have assessed over fifty technologies against eight criteria:



Informed by this approach, we have identified a portfolio of **five critical technologies**:


Artificial intelligence (AI) – Machines that perform tasks normally performed by human intelligence, especially when the machines learn from data how to do those tasks.


Engineering biology – the application of rigorous engineering principles to the design of biological systems.


Future telecommunications - evolutions of the infrastructure for digitised data and communications.


Semiconductors – a class of electronic materials with unique properties that sit at the heart of the devices and technology we use every day.


Quantum technologies – devices and systems which rely on quantum mechanics, to provide capabilities that 'classical' machines cannot.

The National Science and Technology Council will review this list annually to ensure that the UK keeps pace and continues to develop global competitive advantage - although there will be a high bar to major change given the need for long-term planning.

- **Create the environment for these technologies to flourish in the UK, using the other nine levers set out in this Framework.** Where necessary, the government must

be prepared to intervene to shape markets. We will develop a cross-government plan to optimise the science and technology system for each critical technology. Plans will be informed by analysis of the UK's strategic interests and strengths, and other nations' postures, using an 'Own-Collaborate-Access' framework as a guide. We will consider where reliable and resilient supply chains are needed, with established methods for securing goods, to enable companies to grow and protect the UK from supply shocks.

The Department for Science, Innovation and Technology is working on a cross-government action plan for each of the critical technologies. **Initial work will include:**

- Developing a pro-innovation approach to regulating AI, which will be detailed in a White Paper to be published in early 2023.
- Publishing UK strategies for semiconductors and quantum technologies in early 2023.
- Publishing ambitious Wireless Infrastructure Strategy, which sets out our R&D priorities for future telecoms including 6G
- Establishing a strategic approach to Engineering Biology and its applications across the economy, by mid 2023, to maximise opportunities and mitigate the risks.
- For each critical technology, establishing a plan to protect the strategic advantage that we develop from state threats.
- Ensuring that emerging technologies such as Large Language Models can be used to support a more innovative public sector while managing the risks.

Note: "identifying critical technologies" is a unique strand of this Science and Technology Framework that is about choosing which critical technologies the UK should focus on to build strategic advantage.

The remaining strands describe other tools that the government can use to support these choices and create the environment for success. These tools may be system-wide, such as improving science, technology, engineering and mathematics (STEM) skills across the population, or directed at a specific critical technology, for example through investment in innovative companies.

2. Signalling UK Strengths and Ambitions

Vision: Domestic and international recognition of the UK's strengths and ambitions in science and technology ensures that all stakeholders have the confidence to invest their time, money and effort supporting our science and technology vision. There is a sense of shared common goals, and citizens trust that science and technology can improve their lives.

Outcomes – by 2030 we will have:

- **Clearly, credibly and consistently communicated the government's science and technology priorities and actions, increasing confidence among UK stakeholders to conduct activity that supports our objectives.** The narrative will be easy to understand, similar to China's Made in China 2025 or the US 1960s "we choose to go to the moon". Stakeholders will recognise that the government has clear ambitions on which it delivers.
- **Built a sense of shared science and technology goals that key stakeholders have co-created.** The government will champion UK success stories and more citizens will understand the positive impact that science and technology can have on their lives. Only 57% of people polled in Public Attitudes to Science felt that science could generate more work opportunities; this should be at least 80%.
- **Promoted internationally the strength of the UK science and technology system and our longer-term ambitions.** Polling by the government will demonstrate that the UK is seen as a top three nation in the world, and the leader in Europe, for the strength of its science and technology system.

The Department for Science, Innovation and Technology is working on a cross-government action plan in collaboration with the Cabinet Office and the Department for Business and Trade. **Initial work will include:**

- Increasing our reach to different audiences by delivering coordinated communications with key partners.
- Launching the GREAT Tech campaign in March to target the West Coast of the US. The campaign will improve investors' perceptions of the UK's technology ecosystem to attract more investment into the UK.
- Running the UK's second Global Investment Summit in October, with a particular focus on high technology sectors.
- Improving uptake of STEM subjects, technical education and advanced digital training through the Skills for Life campaign and the next phase of the Get the Jump campaign.

3. Investment in Research and Development

Vision: The UK's R&D investment matches the scale of the Science and Technology Superpower ambition, and the private sector takes a leading role in delivering this. Delivery under the Science and Technology Framework catalyses private sector R&D and boosts the innovation activity of firms leading to UK economic growth.

Outcomes – by 2030 we will have:

- **Increased private sector investment in R&D, building on record levels of public sector investment committed at SR21**. The UK will be delivering its plan for increasing private investment in the UK, anchored in our strengths in priority sectors. We will have delivered the biggest increase in public R&D investment, and have already committed to invest £20bn in R&D in 2024/25.
- **Ensured the UK has the right diversity in the science and technology landscape.** Alongside our excellent universities, we will optimise existing organisations such as Public Sector Research Establishments and Catapults, and consider new agile, innovative models such as focused research organisations and practical support for innovators. The Landscape Review led by Sir Paul Nurse will inform these choices.
- **Raised domestic public investment in R&D outside the Greater South East by at least 40%** as set out in the Levelling Up White Paper, to boost productivity, pay, jobs and living standards outside the greater south-east.
- **Accelerated translation, commercialisation and knowledge exchange** through targeted support for local innovation clusters.
- **Reduced bureaucracy of research and innovation funding**, with funders experimenting with new approaches. This will build on the Independent Review of UKRI and the Bureaucracy Review, and consider all government funded R&D programmes.

The Department for Science, Innovation and Technology is working on a cross-government action plan in collaboration with the Department for Business and Trade and the Department for Levelling Up, Housing and Communities. **Initial work will include:**

- Responding to the Tickell Review of Research Bureaucracy in early 2023, and Sir Paul Nurse's Review of the Research, Development and Innovation Landscape.
- Working with industry and philanthropic partners to increase inward investment by Summer Recess 2023.
- Piloting new Innovation Accelerators supporting UK city regions to become major, globally competitive centres for research and innovation.

4. Talent and Skills

Vision: The UK has a large, varied base of skilled, technical and entrepreneurial talent which is agile and quickly responds to the needs of industry, academia and government. This includes talent in STEM, digital and data, commercialisation and national security.

Outcomes – by 2030 we will have:

- **Created an agile and responsive skills system, which delivers the skills needed to support a world-class workforce in STEM sectors and drive economic growth**. We will articulate and, where possible, forecast skills gaps in critical technologies (within academia, industry, government and the third sector) and actions needed to fill them.
- **Recruited and retained high-quality FE and school teachers in STEM-related subjects**.
- **Expanded opportunities for participation in STEM and ensured that a more diverse range of people enter the science and technology workforce**. We will learn from examples like AI and data science conversion courses, where we have invested up to £30 million to help people from underrepresented groups join the UK's AI industry.
- **Established competitive advantage in attracting international talent to the UK.** The UK's offer will be attractive to the world's best talent across all career stages, with easy access through our 'high-skilled visa system' (Global Talent, Start Up/Innovator, High Potential Individual, Scale Up and Graduate). UK researchers will participate in exchanges which deliver international links and establish new collaborations.
- **Given people the opportunity to train, retrain and upskill throughout their lives to respond to changing needs.** We will create proactive career advice programmes which establish links between STEM training or education at 16 and well-paid jobs. This includes revolutionary initiatives like the Lifelong Loan Entitlement, especially important given 80% of the 2030 workforce is already in work.

The Department for Education is working on a cross-government action plan in collaboration with the Home Office, Department for Science, Innovation and Technology, Department for Business and Trade and the Cabinet Office. **Initial work will include:**

- Developing a DfE Skills Dashboard in 2023, to understand the supply and demand of science and technology skills for the technologies that we plan to prioritise.
- Taking forward the Prime Minister's ambition for all young people to study Maths to 18.
- Working across government, with educators and employers, to develop the pipeline of individuals entering priority computing and digital sectors.
- Finding and attracting the next generation of AI leaders from around the world, showcasing our fantastic offer and matching them to specific opportunities in the UK.
- Continuing to roll out a network of 21 employer-led Institutes of Technology (IoTs), which will offer higher level technical training. IoTs also have a remit to help widen participation at higher technical levels from disadvantaged and under-represented groups.

5. Financing Innovative Science and Technology Companies

Vision: There is sufficient supply of capital at all stages with increased participation from domestic investors, and an environment to grow and scale large globally competitive science and technology companies that drive growth in the economy and high-skilled employment opportunities for citizens.

Outcomes – by 2030 we will have:

- **Narrowed the financing gap for the UK's most innovative science and technology companies.** We will reduce the financing gap to the United States, particularly for scale ups at later funding rounds, capitalising upon our mature, open financial markets to support the UK's most innovative companies.
- **Increased the supply of UK institutional investment to deepen the pool of domestic capital available for scaling UK science and technology firms.** We will engage closely with institutional investors, particularly defined contribution pension schemes, to address any remaining barriers to investment in innovative UK companies. This will ensure that UK pension savers stand to benefit from higher potential returns and that our most promising companies can access domestic sources of capital to scale up and remain in the UK.
- **A scale up finance ecosystem capable of nurturing the next generation of globally competitive science and technology companies.** In addition to increasing the supply of capital, we will strengthen the pipeline of high-quality science and technology businesses and spin-outs, increase specialist knowledge of UK investors, tackle regional disparities, and smooth the pathway to taking companies public.

His Majesty's Treasury is working on a cross-government action plan in collaboration with the Department for Science, Innovation and Technology, the Department for Business and Trade and the Department for Work and Pensions. **Initial work will include:**

- Building upon the strong track record of the British Business Bank to strengthen support for the UK's scaling science and technology companies.
- Implementing in legislation the recommendations of the Hill Review to enhance the attractiveness of the UK as a place to list.
- Engaging with defined contribution pension schemes to unlock institutional investment into UK science and technology companies.
- Delivering the Digital Growth Grant to boost small and scaling technology businesses in all corners of the UK.

6. Procurement

Vision: Government departments create a demand for innovation that can catalyse their buying power into economic growth. Departments clearly articulate their technology needs through long-term strategies to give businesses confidence to invest and shape markets, with a proportion of departmental spend dedicated to procurement supporting innovation.

Outcomes – by 2030 we will have:

- **A track record of strategically pulling through current and future innovations** by clearly signalling the pipeline of technologies the government needs to procure to meet its own ambitions in critical technologies. Departments will articulate the requirements for innovation and effectively use their own spend and the procurement they influence (e.g regulated utilities), to stimulate innovation and pull through critical technologies.
- **The business development and venturing capability to back science and technology companies that support our objectives, forming a range of partnerships with innovative high-growth firms.** Departments will clearly articulate their technology needs and have the business scouting expertise to search for relevant technologies and work with businesses to support pull-through into procurements. Departments will build a portfolio of innovative projects, learning from the experiences of the Vaccine Taskforce, Ventilator Challenge, Defence and Security Accelerator and National Security Strategic Investment Fund.
- **Increased spend by departments on innovative products and services**, aided through a defined portion of procurement spend directly supporting innovation (to be defined by each department). This is achieved in part through making it easier for businesses of all sizes to apply for public funding.
- **A culture within policy and operational teams across departments to be an intelligent and coordinated customer** which supports innovation and critical technologies. This includes improved technical expertise within departments, consistently faster procurement by all departments, increased appetite for appropriate risk-taking and improved adoption of innovation to deliver government objectives.

The Cabinet Office is working on a cross-government action plan with departments that have a significant procurement spend. **Initial work will include:**

- Setting a minimum proportion of government procurement expenditure to directly support innovation in critical technologies.
- Scaling the Small Business Research Initiative to support our critical technologies.
- During 2023, progressing the Procurement Reform Bill through Parliament, to create a simpler and more flexible, commercial system making it easier for new entrants such as SMEs.
- Working with contracting authorities throughout 2023 to initiate culture change towards innovation across the public sector, through the training and guidance that will support the implementation of the Procurement Reform Bill.

7. International Opportunities

Vision: The UK is confident and upfront about its science and technology strengths and enjoys international partnerships which support critical technologies and the growth of our sectors. International relationships with governments, industry and academia make a meaningful contribution to the UK's science and technology capabilities. We are influential in shaping the global landscape, embedding our values into technology, and protecting our security interests.

Outcomes - by 2030 we will have:

- **Clearly and consistently communicated the UK's science and technology priorities, strengths and values** to a wide international audience of governments, academics, investors and industries. The UK's science and technology sector is consistently championed and strengthened through political engagement overseas and forms a core part of plans for engagement with our partners around the world.
- **A prioritised and varied set of science and technology-based international partnerships,** building on existing links (such as G7 and G20) and defined by mutually beneficial objectives. Partnerships will differ in scope and depth, but will each benefit the UK and strengthen the science and technology system and the UK's global influence.
- **A coordinated approach to international science and technology activity**, which will facilitate long-term research and infrastructure partnerships, explore new international collaboration funds, prioritise R&D in the Official Development Assistance budget, and effectively deploy the Science and Innovation Network.
- **Embedded a systematic approach to handling national security risks** around international R&D collaboration and inward investment, weighing the security risk of open collaboration and investment against the opportunity cost of limiting them.
- **A diplomatic network with strong science and technical knowledge and in-country networks**, and greater international technology leadership. Our diplomatic network will have a clear science and technology mandate, and develop relationships which meet UK science and technology needs across this Framework.

The Foreign, Commonwealth and Development Office is working on a cross-government action plan, in collaboration with the Department for Science Innovation and Technology, Department of Business and Trade and the Ministry of Defence. **Initial work will include:**

- Delivering the £119 million International Science Partnerships Fund to create bigger, better science than we can do alone.
- Expanding the UK's network of Tech Envoys to build our diplomatic network to have unrivalled technical knowledge and geographic reach.
- Establishing a UK Technology Centre of Expertise so that our tech experts can support developing countries to transform their economies, aligned with our common principles.
- Developing partnerships with emerging and leading technology nations, through targeted R&D investment and expertise, to build global resilience to shared challenges.

8. Access to Physical and Digital Infrastructure

Vision: Accessibility and coordination of infrastructure attracts talent and investment, establishes anchors for innovation clusters and enables companies to scale. The UK has diverse, agile and resilient facilities to support its technology choices and works with partners globally to deliver major science and technology projects.

Outcomes – by 2030 we will have:

- **Increased infrastructure capacity to deliver science and technology ambitions** by using a portfolio approach across all Technology Readiness Levels. We will have invested in infrastructure, upgrading and repurposing facilities which support research and commercialisation. This will be geared towards supporting innovative companies.
- **Access to a wide variety of research and innovation infrastructure across all regions of the UK** including Public Sector Research Establishments, Catapults, demonstrator facilities for process/product testing and "living labs" which establish public-private-user needs and partnerships to support applied R&D.
- **Ensured that the UK strategically invests in relevant and important international infrastructure** which sustains the UK's scientific edge (e.g. CERN, European Molecular Biology Laboratory), aligns with critical technologies, or facilitates knowledge exchange. We will host infrastructure funded by international partnerships. Our investments will support UK access to the best public and private collaborations and opportunities.
- **Promoted data as an enabler** as digital needs of academia, government and industry are met through well-established digital infrastructure including the Office for National Statistics Integrated Data Service, data sharing agreements and access protocols.

The Department for Science, Innovation and Technology is working on a cross-government action plan. **Initial work will include:**

- Setting out a long-term national plan for research and innovation infrastructure, which will set direction and enhance coordination, working with the public and private sector to ensure the long-term sustainability of the UK's infrastructure base.
- Publishing the Independent Future of Compute Review in March 2023, which will inform the approach to the UK's compute needs for the next decade.
- Investing in a research cloud pilot and giving researchers greater access to data from a range of sources through the Office for National Statistics Integrated Data Service.
- Ensuring the capabilities of Public Sector Research Establishments are understood, coordinated and available for use across the UK science and technology landscape.
- Convening government, academia and industry experts to identify science and technology infrastructure opportunities in critical technologies.
- Through our response to the Cyber-Physical Infrastructure consultation, setting out a plan to work with industry and academia to tackle systemic challenges and maximise the value to the UK and globally.

9. Regulation and Standards

Vision: The UK leverages post-Brexit freedoms and is at the frontier of setting technical standards and shaping international regulations. Regulation is pro-innovation, stimulates demand for science and technology and attracts investment while representing UK values and safeguarding citizens. The government leverages its science and technology strengths and international relationships to secure influence over regulations and technical standards.

Outcomes - by 2030 we will have:

- **A system of regulation and standards that is pro-innovation, easy to navigate and facilitates widespread commercial science and technology applications.** The role of regulators will be clear for each critical technology, including where they cut across sectors and regulatory remits. Regulators will have a mandate to support innovation testing costs for UK innovators to be internationally competitive.
- **Moved fast relative to others to establish rules for critical technologies** and, where appropriate, regulations to increase certainty for innovators in these areas. We will consider international contexts when setting domestic regulation to strengthen our first-mover advantage. Regulation covering critical technologies will be world-leading.
- **Led international efforts to shape standards and regulations for critical technologies.** We will play an active role in the WTO, G7, G20, OECD, NATO, Council of Europe, Commonwealth, and the UN. The UK will be a convener and a top tier author of international rules and conventions for critical technologies.
- **Become a champion of the global technical standards ecosystem that underpins international governance of critical technologies.** We will build capability in industry and government, forming multi-stakeholder coalitions to shape technical standards.
- **Used government horizon-scanning capability to support regulators to consider how emerging technologies** could become critical technologies. Dialogue between industry and regulators will inform reform and promote technology development in the UK.

The Department for Science, Innovation and Technology is working on a cross-government action plan in collaboration with the Department for Business and Trade and Foreign, Commonwealth and Development Office. **Initial work will include:**

- Implementing the findings of the Pro-Innovation Regulation of Technologies Review, to improve the regulatory landscape for digital technologies, green technologies and life sciences. Further work will follow on creative industries and advanced manufacturing.
- Working with global Standards Development Organisations (SDOs) including ITU, ISO/IEC, ETSI and IETF, to ensure that the standards underpinning our critical technologies reflect our UK values.
- Bringing together industry, government, regulators, consumer groups and civil society to inform and strengthen AI governance practices domestically and internationally through our AI Standards Hub Platform.

10. Innovative Public Sector

Vision: The public sector has a pro-innovation culture, with a system that adequately supports and rewards innovation while unblocking systemic barriers. This is supported by strong internal STEM capability. Civil Servants have the resources they need to test and develop ideas for delivering services more effectively. There is an appetite for appropriate risk-taking, minimal bureaucracy and the agility to work with business and support strategically important sectors.

Outcomes - by 2030 we will have:

- **The STEM skills and literacy needed to deliver science and technology policy for strategic advantage at all levels of government.** This includes interdisciplinary teams for more effective decision making. Government STEM capability will support the government's objectives, including government laboratories de-risking early stage mission-oriented research and forming the basis of innovation clusters.
- **Improved knowledge, talent and resource sharing within government, and between the public sector, academia and businesses.** We will increase collaboration between departments, professions and sectors. Partnerships will support Levelling Up by including Devolved Administrations, local administrations and innovation clusters.
- **A culture within the public sector where an innovative approach to delivering services is rewarded and supported**. The government will have an appropriate risk appetite when applying technologies to existing activities and growing new ones to scale. Value for money assessments will encourage a portfolio approach to innovation.

The Department for Science, Innovation and Technology is working on a cross-government action plan in collaboration with the Government Office for Science and the Cabinet Office. **Initial work will include:**

- Assessing progress against the 2019 Science Capability Review and determining what the government still needs to focus on beyond 2023.
- Coordinating advice and initiatives across government to ensure public services benefit from the opportunities of Large Language Models and other generative AI capabilities while managing the risks.
- Increasing the proportion of STEM graduates in the Fast Stream to 50%.
- Ensuring that Chief Scientific Advisers have clearly articulated their department's role in delivering this Science and Technology Framework based on each of their departmental science and evidence systems.
- Training government leaders to raise their awareness of the importance of science and technology, and the key role they play in science and technology systems leadership.
- Expanding the flow of diverse, world class technical talent and proven innovators into government.
- Providing physical space and support to public servants to test and develop novel ideas for delivering government business more effectively and efficiently.

Progress and next steps

Guided by this framework, the UK will grow and maintain the ecosystem we need to attract investment, grow companies, innovate, and deploy our world class science and technology research for good. This is a long term plan that will endure to 2030. But it will require concerted effort, agility and a delivery-oriented mindset involving all of government and partners outside government to deliver at pace. The prize is great and will bring immediate and long-term benefits to UK citizens and globally.

Enhancing government

We have been putting in place the structures needed to ensure strategic advantage through science and technology since this was set out as a core priority in the Integrated Review. These structures are already being used to make good progress across this Science and Technology Framework:

- The Department for Science, Innovation and Technology (DSIT), bringing together core science and technology functions across government. The Secretary of State for DSIT is now Deputy Chair of the National Science and Technology Council.
- The National Science and Technology Council (NSTC), a Prime Minister Chaired Cabinet Committee dedicated to matters relating to strategic advantage through science and technology. The NSTC is meeting monthly to consider matters across the Science and Technology Framework.
- The Office for Science and Technology Strategy (OSTS), now in the Department for Science, Innovation and Technology, a team dedicated to driving progress on this Science and Technology Framework across government.
- The National Technology Adviser, a role currently held by Sir Patrick Vallance, to advise the NSTC on matters relating to strategic advantage through science and technology.

Early wins

- We set up the Advanced Research and Invention Agency (ARIA) to fund high-risk, high-reward R&D with a core focus on identifying and funding transformational science and technology at speed, supporting ground-breaking discoveries that could transform people’s lives for the better.
- We have dedicated £250 million to ‘technology missions’ that exploit and sustain UK’s global leadership in three critical technologies artificial intelligence, quantum technologies and engineering biology.
- We are delivering the National AI strategy, to ensure AI technologies can be used in the UK to increase resilience, productivity, growth and innovation across the private and public sectors.

- To support underserved communities of innovators with specialist support, Barclays Eagle Labs has been awarded £12 million through the Digital Growth Grant to boost small and scaling technology businesses in all corners of the UK.
- The UK Digital Strategy committed us to rolling out world-class digital infrastructure across the UK and promoting data as an enabler within the science and technology landscape, improving access for researchers and analysts.
- We have strengthened bilateral international relationships in science and technology, for example establishing the UK-US Comprehensive Dialogue on Technology and Data, and launching the UK-Japan Digital Partnership.
- We have launched targeted campaigns, including the GREAT Britain and Northern Ireland Campaign, which are signalling the UK as a destination for science and technology investment and international talent.
- In 2022-23, the government will have provided over £11 billion of support across tax reliefs, loans, guarantees, targeted programmes and equity finance, and progressed key reforms such as the pensions regulatory charge cap and the recommendations from Lord Hill's UK Listings Review.
- The Chancellor reconfirmed the biggest increase in public R&D investment at Autumn Statement, rising to £20 billion by 24/25.
- We have published Sir Paul Nurse's blueprint of reform for the research landscape, and set out immediate actions that will have a positive impact.
- We have commissioned the Pro-Innovation Regulation of Technologies Review, led by Sir Patrick Vallance, Government Chief Scientific Adviser and National Technology Adviser, which will focus on identifying opportunities and enablers for digital technologies, life sciences and green industries.

Next steps

We will work across the whole of government to ensure progress against this Science and Technology Framework, driving delivery through the NSTC. DSIT is taking an overall leadership role across this Science and Technology Framework. By the end of 2023, we will publish an update setting out the progress that we have made, and the further action that must be taken on our path to being a Science and Technology Superpower by 2030.

SAVILLS - LIFE SCIENCE SECTOR SEES RECORD INVESTMENT VOLUMES ACROSS KNOWLEDGE ARC OF OXFORD AND CAMBRIDGE IN 2022

SAVILLS NEWS

Life science sector sees record investment volumes across knowledge Arc of Oxford and Cambridge in 2022

According to Savills, total investment volumes for life science related real estate across the Knowledge Arc of Oxford and Cambridge hit £1.65 billion in 2022. Up circa £50 million on 2021 figures, signifying a record year for the sector.

Savills notes that Oxford and Cambridge both broadly sustained their transactional activity in 2022, with other notable deals occurring across the broader Arc in locations including Potters Bar and Stevenage, accounting for an additional £200 million. This includes the acquisition of 33 acres of land by UBS and Reef from GlaxoSmithKline (GSK) and UBS's funding of the Ascend Cell and Gene Therapy GMP facility on the former Cancer Research UK site at Potters Bar. Savills advised UBS on both.

Key deals in Cambridge saw Savills advise Legal & General on the sale of 194-198 Cambridge Science Park to Cadillac Fairview and Stanhope for £85 million and the sale of joint venture Pace Development's 301,000 sq ft Botanic Place to Railpen. In Oxf acquired Oxford Technology Park for circa £180 million, whilst Nor Science Park was acquired by Brydell Partners for £20.4 million.

2022 saw a diverse range of buyers from UK institutions and overs private equity investors. Given the undersupply of stabilised assets within the life science sector, a number of acquisitions last year incorporated significant future development exposure. Consequently, Savills believes that much of this is expected to be built

Tom Mellows, head of UK science at Savills, comments: "Occupiers in the life science sector are desperately in need of good quality accommodation within the Oxford Cambridge Arc. The severe supply shortage is being addressed by significant investment into future development sites, and we expect to see a number of our clients speculatively develop high quality laboratory schemes within the next 12-24 months."

At the start of 2022, Savills estimated that there was in excess of £15 billion of live capital in the UK science sector. Looking ahead, 2023 has already got off to an encouraging start with £220 million of assets already under offer in Oxford and Cambridge.

James Emans, director in the investment team at Savills, comments: "Despite the headwinds in the second half of 2022, the buyer pool for the science sector remains extraordinarily healthy. Of the stock that was traded last year, there were over 20 different purchasers and we would anticipate there to be nearly three times this number who would consider themselves active across the Oxford and Cambridge investment market going into 2023. This is testament to the sector's ongoing resilience."

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LIFE SCIENCES

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Covid-19 has accelerated investor appetite for UK life sciences, with equity investment into high-growth UK life sciences companies reaching £967mn in 01 2021, more than any other quarter on record and 25% more than was raised across the whole of H1 2020. It was also a banner year for the number of deals, with 159 fund raisings.*

At the same time, Government - at both a national and regional level - has doubled down on its ambitions to raise the intensity of R&D based activities within the UK economy, with life sciences very much to the fore.

Announcements included the creation of the Advanced Research and Innovation Agency, backed with £800mn by 2024/25 and £37 million of funding for genomics and data projects to support the life sciences sector. As a result, UK Government R&D spending is now at its highest level in four decades.

This investment is fuelling the growth of the life sciences sector. 01 2021 saw an additional 300 life sciences companies incorporated in the UK, whilst a number of existing companies announced expansion plans off the back of funding. Oxford-based Al drug developer Exscientia, for example, raised up to $525mn in funding in April 2021. This additional funding will help them to double in size again this year. It is worth noting that this is a company that was only incorporated in 2012, illustrating the high-growth trajectory that many in the sector experience.

This poses some key questions for the real estate sector, notably is there a marked upturn in take-up from the life sciences sector off the back of this dynamic?

Closer inspection of the London market shows that investment is indeed translating into activity and growth from a real estate perspective. In London, it has been widely reported that there are extensive waiting lists for space at existing incubators, such as the London Bioscience Innovation Centre.

The past six months has also witnessed some substantial life sciences transactions such as the SYNLAB Group - a medical diagnostics provider - who have taken 103,000 sq ft at Friars Bridge Court. In particular, life sciences occupiers are gravitating towards those London sub-markets with concentrations of knowledge and research institutions and major teaching hospitals.

LIFE SCIENCES

GOLDEN TRIANGLE

LAB REPORT

Q4-2022

EXECUTIVE SUMMARY

The life sciences sector continued to experience rapid expansion in 2022, with underlying growth trends luring both new and seasoned investors into the market. At the beginning of 2022, Big Pharma reportedly had more than $1.7tn (£1.4tn) in dry powder set aside for the expansion of their IP pipeline. However, 2022 turned out to be a mild year for M&A activity, with $65bn (£54bn) in transactions among the top 10 pharmaceutical companies. The amount of venture capital raised was also lower than the record year of 2021, yet it was still 22% higher than 2020 levels.

Looking ahead, the demand from biotech occupiers for lab space remains strong and will continue to outstrip supply. We expect further delays in new starts, compounding the imbalance, despite a number of schemes reportedly forecast for delivery in 2025/26.

Take-up for the year in the Golden Triangle reached 635,866 sq ft, with the majority let on a Category A Lab (Cat A) specification. There is limited evidence of demand relenting, despite the reduced levels of venture capital raised. However, we have experienced the right-sizing of requirements, rather than built-in expansion, and an increasing number of tenants are requesting fitted lab over Cat A at handover.

London will continue to evolve as a location for life sciences, with occupiers finding a foothold where previously there was a lack of purpose-built supply and landlords only catered to office occupiers. Last year, London saw the first landmark Big Pharma company move into the heart of the science quarter, close to the Francis Crick Institute, universities, hospitals, and a developing AI cluster. London also saw the largest increase in Venture Capital raises across the Golden Triangle.

We believe the sector remains well placed to continue in its current vein, although we expect new stock to come online slower than previously forecast due to planning constraints and threatening economic headwinds. Land values have seen a correction in the short term to reflect the move in interest rates and cost inflation, however rents have seen a strong year of rental growth.

In this report, we take a closer look at investment volumes, leasing take up, lab supply and pipeline, and investment into life sciences real estate across Cambridge, London, and Oxford throughout 2022.

CUSHMAN & WAKEFIELD HIGHLIGHTS

TRANSACTION HIGHLIGHTS

GSK R&D CAMPUS STEVENAGE

Date: Oct-22

Advisor to GSK on the LLH sale of 33.16 acres to UBS / REEF Group

NORTH QUAY, LONDON

Date: May-22

Advised Canary Wharf Group in establishing a joint venture with Kadans Science Partners

OCCUPATIONAL HIGHLIGHTS

Within the UK's Golden Triangle, we advised on 61% of life sciences R&D occupational transactions signed during 2022 (on a sq ft basis) including the 1st ground breaking Big Pharma deal in London.

CAMBRIDGE 36%

OXFORD 42%

LONDON 81%

VALUATION ACTIVITY

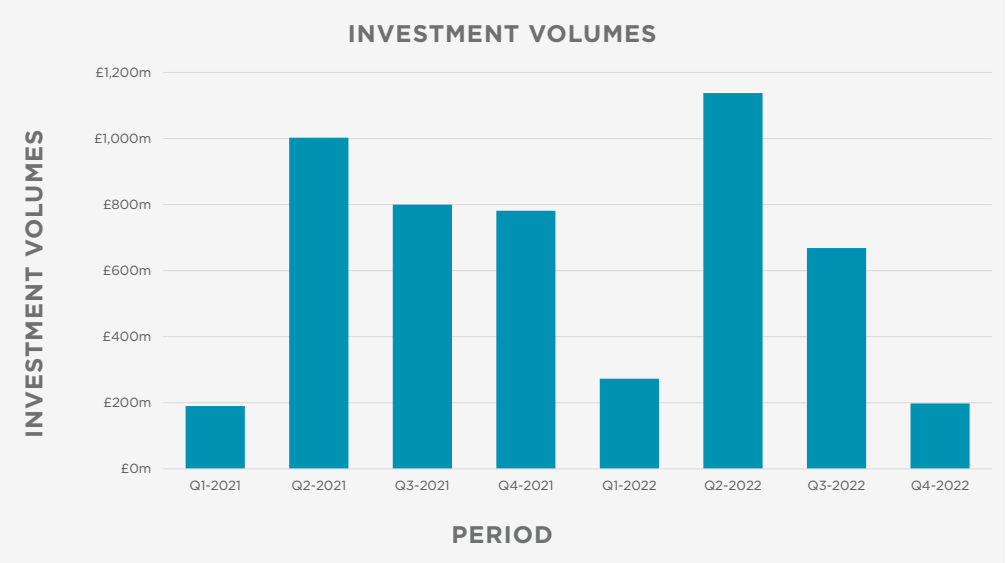
We valued in excess of £10bn across 18m sq ft of life sciences assets in 2022, compared to £7.5bn in 2021.

£10bn of life sciences assets across 18m sq ft.

INVESTMENT MARKET

2022 saw a strong first half, which accounted for 60% of the year's total investment volume (by value). H2 volumes dipped as a result of macro economic headwinds and total investment volumes for 2022 reached in excess of £2.45 billion. Although below 2021's investment volumes, the 2022 total remains above prior years. As a result of these macro economic factors, Golden Triangle prime yields have shifted outwards to 4.25% at the end of 2022.

In contrast to historic investment trends in the life sciences sector, 2022 saw more value add, development and repurposing activity, demonstrating the lack of available stock, with investors moving further up the risk curve to achieve exposure in the sector by delivering best in class life science assets.



Source: Cushman & Wakefield

PRICING

INITIAL YIELDS (%)			
Asset Location	**Q3-22**	**Q4-22**	**Outlook**
Prime	3.75 - 4.00%	4.25%	Outward
Secondary	4.75 - 5.00%	5.25 - 5.50%	Outward

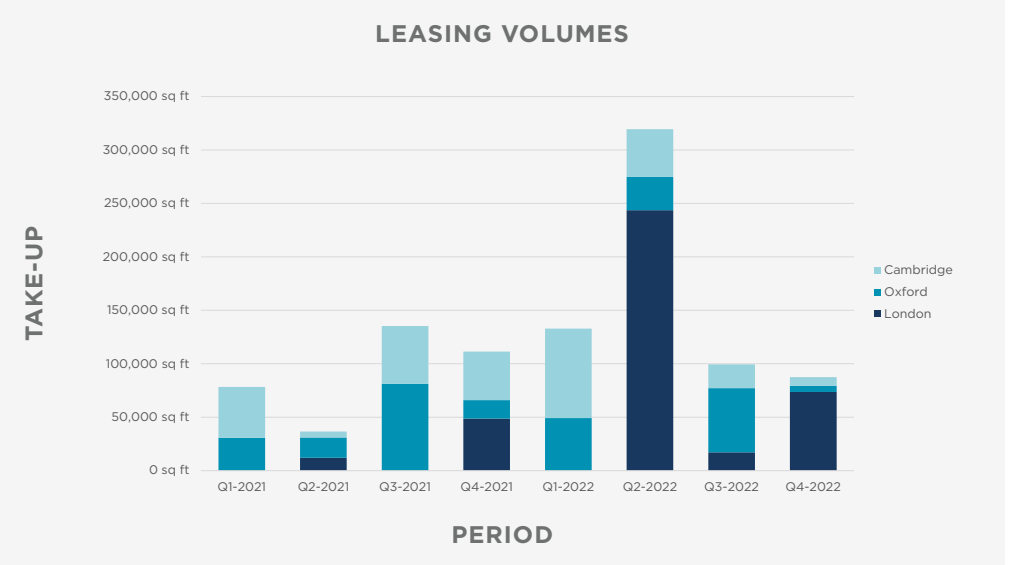
Q4 DEAL WATCH

COMPLETED							
	Type	**Date**	**Price**	**Size**	**Yield**	**Vendor**	**Purchaser**
GSK Park Road, Ware	Refurbishment	Nov-22	£13m	345,000 sq ft	N/A	GSK	Global Mutual
Windrush Court, Oxford	Income	Nov-22	c.£60m	75,000 sq ft	5.46%	Oxford Biomedica	Kadans Science Partners
GSK R&D Campus, Stevenage	Land Development	Nov-22	Confidential	33.16 acres	N/A	GSK	UBS / REEF Group
163 Cambridge Science Park	Land Development	Dec-22	£12.17m	0.89 acres	2.23%	Norwich CC	Stanhope / Cadillac Fairview
UNDER OFFER							
Hinshelwood Building, Oxford	Conversion	Dec-22	(Quote) £20m	75,000 sq ft	3.75%	Mayfair Capital	TOSP / GIC

OCCUPATIONAL MARKET

The occupational market has been affected by the lack of supply of quality labs in all markets, which has resulted in rising headline rents but a relatively modest level of take-up. Inventory remains low in all markets and those who have started to build have been rewarded, most noticeably at the Cambridge Biomedical Campus, where their 100,000 sq ft building at 1000 Discovery Drive is in detailed negotiations for almost the entirety, prior to practical completion at new rental highs.

London has recorded 39% of the Golden Triangle take up this year, dominated by the pre-let to MSD in Kings Cross but more recently supported by the letting at Rolling Stock Yard at £110psf for a fitted lab. All markets have seen rents rise to new highs with 10–20% year-on-year growth.



Source: Cushman & Wakefield

PRICING

PRIME HEADLINE 'CAT A' LAB RENTS (£ PSF)				
Asset Location	**2021**	**Q4-22**	**Movement**	**Outlook**
Cambridge	£55.00	£65.00	+18.20%	Increase
Oxford	£50.00	£55.00	+10.00%	Increase
London	£100.00	£110.00	+10.00%	Increase

Specifications varies between markets

Q4 DEAL WATCH

COMPLETED						
	Occupier	**Date**	**Rent (£ psf)**	**Size (sq ft)**	**Reflected Spec**	**Landlord**
Rolling Stock Yard, London	BlueGiant	Dec-22	£110.00	7,600	Fitted Lab	Life Science REIT
Apex Tribeca, London	LBIC	Nov-22	£65.00	28,000	Shell & Core	BAPT / Reef / BlackRock
20 Water Street, London	Kadans Science Partner	Nov-22	Confidential	38,200	Shell & Core	Canary Wharf Group
UNDER OFFER						
1000 Discovery Drive, Cambridge	BioNTech	Nov-22	£65.00	40,000	Cat A Lab	Prologis
245 Hammersmith Road, London	Resolution Therapeutics	Oct-22	£90.00	6,000	Fitted Lab	L&G
9400 Oxford Business Park, Oxford	MiroBio	Nov-22	£65.00	9,500	Fitted Lab	ARC

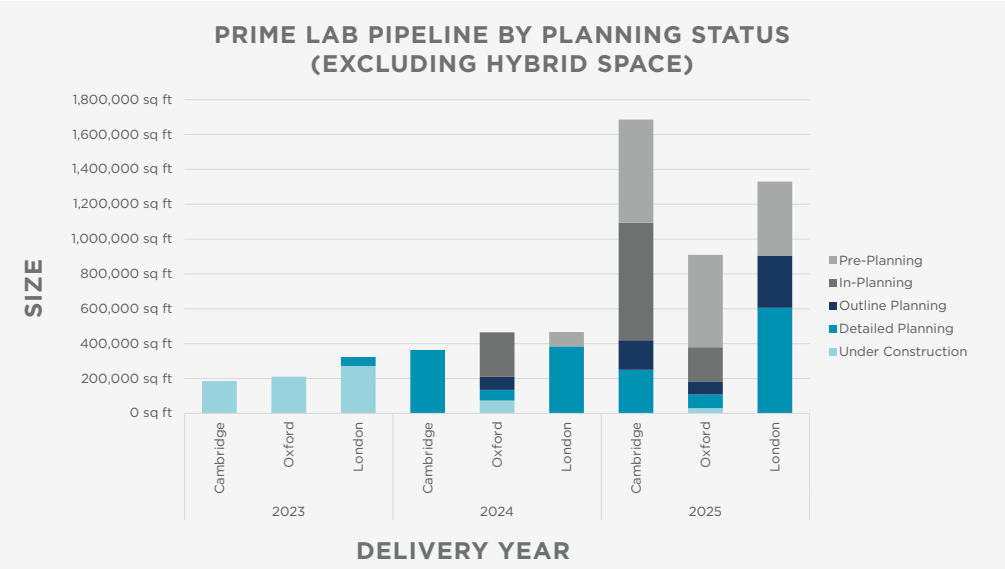
SUPPLY & PIPELINE

Supply in all of the core Golden Triangle markets remained constrained in 2022, restricting take-up levels in the sector. This is slowly being corrected as established life sciences landlords and new entrants to the market seek to capitalise on the unfulfilled occupational demand in the sector.

Within the core Golden Triangle locations, supply increased by 350,000 sq ft in 2022 and a further two million sq ft of new supply is expected to start on site in 2023/24. However, it won't be until 2025/26, when approximately four million sq ft of supply is set to be delivered and the greatest proportion of occupational demand will be met.

GOLDEN TRIANGLE LAB SUPPLY BY MARKET

Asset Location	Q1-22	Q2-22	Q3-22	Q4-22	Total Change	YOY
Cambridge	5,080,000	5,080,000	5,080,000	5,080,000	-	0%
Oxford	1,425,000	1,544,000	1,609,000	1,728,000	**303,000**	21%
London	387,000	421,000	438,000	438,000	**51,000**	13%



Source: Cushman & Wakefield

INVESTMENT INTO LIFE SCIENCES COMPANIES

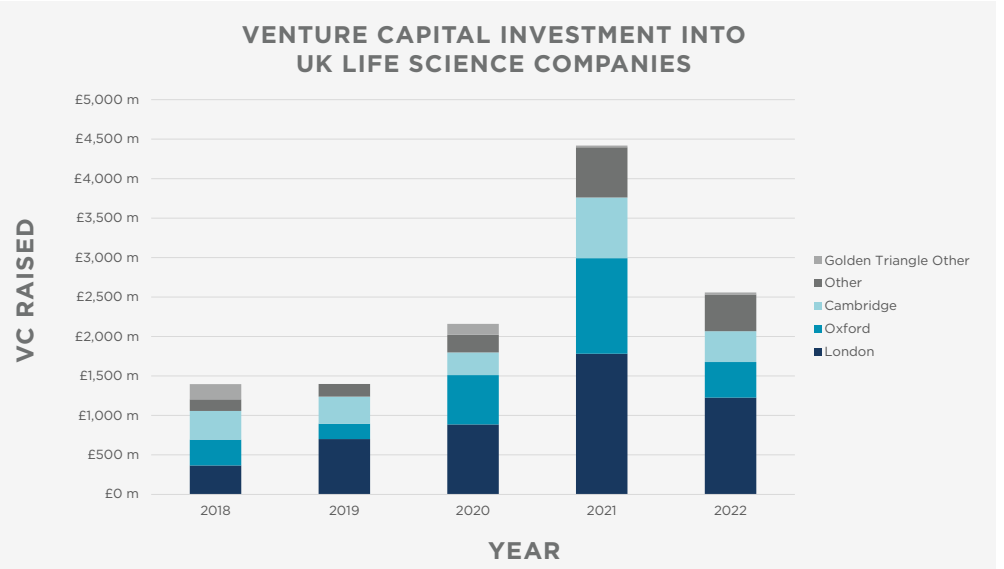
The first half of 2022 provided in excess of 65% of total activity for the year.

Venture Capital investments shrunk in 2022, due to a weaker public markets, with Biotech company valuations rebalancing to sustainable levels. Despite the fact that investment in life sciences companies decreased in 2022, by 42% compared to 2021, it's crucial to keep in mind that 2021 was an extraordinarily busy year and that 2022 investment is still 22% higher than in previous years.

There are strong underlying trends and fundamentals that make the market continue to be attractive to investors, such as increased healthcare spending, an aging population and government investment into innovation, science and research.

COMPANY INVESTMENT ACTIVITY

Investment Type	Q1-22	Q2-22	Q3-22	Q4-22	Total	YOY
VC	£654m	£778m	£550m	£575m	**£2.56bn**	-42%
IPO	£3m	£0m	£6m	£0m	**£9m**	-99%
M&A	£2.14bn	£702m	£1.16bn	£314m	**£4.32bn**	-45%



Source: Cushman & Wakefield

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THE TIMES – JANUARY AND FEBRUARY 2023

EMMA DUNCAN

Don’t blow Britain’s great life sciences chance

We are fast becoming an innovation hub but lack of investment risks sending best talent abroad

Emma Duncan

Thursday January 26 2023, 9.00pm, The Times

The announcement earlier this month that BioNTech is to trial its cancer therapies in Britain is great news. This brilliant German company developed the first licensed Covid-19 vaccine based on revolutionary mRNA technology. Its choice of Britain as a test site doesn’t just mean Britons will get early access to personalised cancer treatments, it is also a vote of confidence in the British life sciences sector.

With the British car industry collapsing, and tech and financial services firms shedding jobs as fast as Tory governments shed ministers, a lot of hope is being invested in life sciences. The optimism is well-founded, because Britain has a couple of huge advantages in the sector. Four of the eight top healthcare universities in The Times Higher Education league table are

British, and the "golden triangle" they inhabit — Oxford, Cambridge and London — is spawning firms. "This is the most vibrant innovation hub in Europe," says Andrew Williamson, managing partner of Cambridge Innovation Capital, who joined the firm from Silicon Valley six years ago.

The NHS is the world's best testing-ground for drugs. It gives 65 million Britons a unique identifier they carry with them from birth to death. From a standing start in March 2020, the Recovery (Randomised Evaluation of Covid-19 Therapy) trial recruited 10,000 patients within eight weeks and a month later found the first of the four effective drugs against Covid-19 that it has identified. It wasn't just the NHS, it was the whole ecosystem, according to Ugur Sahin, founder of BioNTech. "The NHS, academia, the regulator and the private sector worked together in an exemplary way."

This should be the moment at which the industry takes off, but it's struggling. In 2021, according to the BioIndustry Association, the UK biotech industry raised £4.5 billion; in 2022 it raised £1.8 billion. Most of the money comes from America and when times are tough in the capital markets, as they are now, American firms give up on difficult, far-away investments and focus on those that are easy and near-at-hand.

British start-ups are neither. Talent is one problem. The fall of sterling has made recruiting researchers harder. A young scientist with a PhD in biotech earns on average £40,000 ($50,000) in the UK and $70,000 in the US. Housing costs in the US are, on average, lower than in Britain's overheated golden triangle. Clever post-docs are in demand all over the world and a home secretary who makes it clear that foreigners are unwelcome in Britain will encourage them to take job offers elsewhere.

Getting lab space is tough too. According to Bidwells, an estate agent, in the Cambridge area there is demand for over 1 million square feet of lab space; only 10,000 is available. Alchemab Therapeutics, which is developing therapies based on individuals' immune systems, splits its research across two sites in Cambridge, which is not ideal. "Drug discovery is really hard," says Jane Osbourn, the firm's chief scientific officer. "You'd have thought getting hold of office space should be easy."

But the biggest problem is raising money. That seems odd, given that Europe's most successful life sciences innovation hub sits next door to its largest financial centre, which invests the vast pools of capital that pension funds look after. The problem is not so much seed money for tiny firms but the cash they need in order to grow. The City focuses on established companies that produce dividends, not start-ups that lose money, and the rules on where pension funds can put their money have tightened since the financial crisis. Only 20 per cent of defined-benefit schemes are invested in equities these days, down from 61 per cent in 2006. Most of the rest goes to bonds issued by governments or big corporations.

The government's decision last year to halve the tax credit for research and development for small and medium-sized companies doesn't help. The move is understandable, because low-growth companies were claiming it for run-of-the-mill expenses, but it has done real damage to the kind of companies the government wants to foster. According to Kate Bingham, vaccines tsar and partner in SV Health Investors, a venture capital firm, the start-ups in which her company invests "are moving jobs abroad and fewer clinical trials are being done in the UK" as a direct result.

The shortage of capital in Britain means start-ups tend to look to America when they want to raise cash. Dependency on American capital means that, when times are tight, British firms lose out; and when the capital flows, a firm's centre of gravity shifts towards America. In the end, it tends to get listed on the US stock market or bought by an American company, with the result that the jobs, profits and tax revenue from which Britain might benefit go to America instead.

The government is well aware of these issues and their solutions. A more liberal planning regime would ease the lab shortage and lower housing costs: the idea of an "Oxford to Cambridge arc", over which the government has been shilly-shallying for years, would allow that to happen. The City can be made more friendly to start-ups: Lord Hill's review two years ago pointed out how. Pension funds could be allowed safely to invest a small slice of their funds in high-growth companies: it happens in Canada, Australia and France, with no detriment. The R&D credit could be restored: it needs to be targeted on knowledge-intensive sectors, not sprayed around the economy as a whole.

All of these changes are in discussion or in the works. To get them implemented we need a government that's focused on the long term, not distracted by scandal and panicking about the next election.

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January 21 2023, 12.01am

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JOHN CAIRNS/UNIVERSITY OF OXFORD/AFP VIA GETTY IMAGES

Science superpower dreams thwarted by lack of laboratory space

Tom Howard

Tuesday February 14 2023, 12.01am, The Times

A lack of laboratory space in Oxford and Cambridge threatens to thwart Rishi Sunak's dream of making Britain a "science superpower".

In both cities, there are almost no labs left for growing life sciences businesses to move into. Bidwells, the commercial property agent, estimates that there is 10,000 sq ft of space available in Cambridge, compared with two million sq ft of demand. There is a similar picture in Oxford, where there is about 25,000 sq ft available compared with requirements from businesses of 845,000 sq ft.

Developers are rushing through new projects to try to catch up with demand.

Industry insiders have warned that if there is nowhere for start-ups to base themselves, the potential "unicorns of tomorrow" will be forced to move outside the UK.

The shortage of lab space poses another potential stumbling block for the prime minister and his quest to boost the country's science and technology sector. Sunak is still reeling from last week's decision by AstraZeneca, which said it had chosen the Republic of Ireland for a $360 million manufacturing facility rather than Britain because of a "discouraging" tax system.

Dame Emma Walmsley, chief executive of GSK, another big drugs group, also warned this month that Britain risked missing out on the "big opportunity" it has to grow its life sciences industry.

“We are at something of a tipping point if we don’t make the right decisions now,” she said. “We really do have to start to close the execution gap, and align the strategy and the opportunity to the delivery.”

Demand for lab space has surged in recent years. Pharmaceuticals companies, healthcare start-ups and drugs developers attracted significant investment during the pandemic, money that they have used to expand. To accommodate their growing employee numbers, many have been looking for more lab space for their scientists and researchers.

Because of their universities, Cambridge and Oxford have emerged as the nation’s two leading life sciences hubs.

Developers have blamed the planning system, as well as rising build costs, for not being able to put up new laboratories quickly enough. Last year, the Greater Cambridge Shared Planning Service admitted it was struggling to recruit enough officers.

Dame Emma Walmsley, chief executive of GSK, is among those to have sounded the alarm about the future of life sciences in Britain

KEVIN DIETSCH/UPI/BLOOMBERG VIA GETTY IMAGES

However, developers have been able to rush through a handful of lab schemes in Cambridge, with about 370,000 sq ft of space set to be ready this year. In Oxford, developers have been repurposing old shopping centres and office blocks to boost supply. That includes buildings in the old Oxford Business Park, which have been turned into labs.

“Much-needed laboratory and office space is finally on the way,” Sue Foxley, a director at Bidwells, said. “[This] will be a welcome boost for the regions’ knowledge-economies, especially for companies at the earliest stages of incubation.”

Still, there remains a mismatch between supply and demand, which Cushman & Wakefield, another commercial property agent, expects will persist until at least 2025 when 4 million sq ft of lab buildings are due to be completed.

The supply squeeze has pushed up lab rents to record highs. Before the pandemic, a decent laboratory in Cambridge would rent out for about £42 per sq ft, but this is set to exceed £60 per sq ft this year. Similarly, rents for purpose-built labs in Oxford rose 25 per cent in 2022 to £75 per sq ft, a new record.

"Much-needed laboratory and office space is finally on the way," Sue Foxley, a director at Bidwells, said. "[This] will be a welcome boost for the regions' knowledge-economies, especially for companies at the earliest stages of incubation."

Science

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FINANCIAL TIMES – JANUARY 2023

UK business & economy

Lab space shortage threatens life science boom in Oxford and Cambridge

Investors warn that lack of availability is driving some companies to US cities

A research facility in Cambridge. Business groups said the chronic shortage of space raised questions about the government's strategy for growing the life sciences sector © Lee Mawdsley

Peter Foster in London

The science clusters of Oxford and Cambridge have almost no available laboratory spaces for rent, according to new property data, raising concerns about the UK's ability to capitalise on a surge of interest in its life sciences sector.

Investor groups and chief executives have warned that the crisis in lab space in the so-called "Oxford-Cambridge arc" is driving companies to cities such as Boston in the US, which have millions of square feet immediately available.

Data collected by Bidwells, a property consultancy focused on the Oxbridge knowledge economy, showed availability was close to zero in June in both cities after demand surged by almost a quarter in the first half of this year.

Sue Foxley, research director at Bidwells, said the shortage is worse than she had seen before, and many companies are being forced to lease office and other commercial space, before refitting them as laboratories.

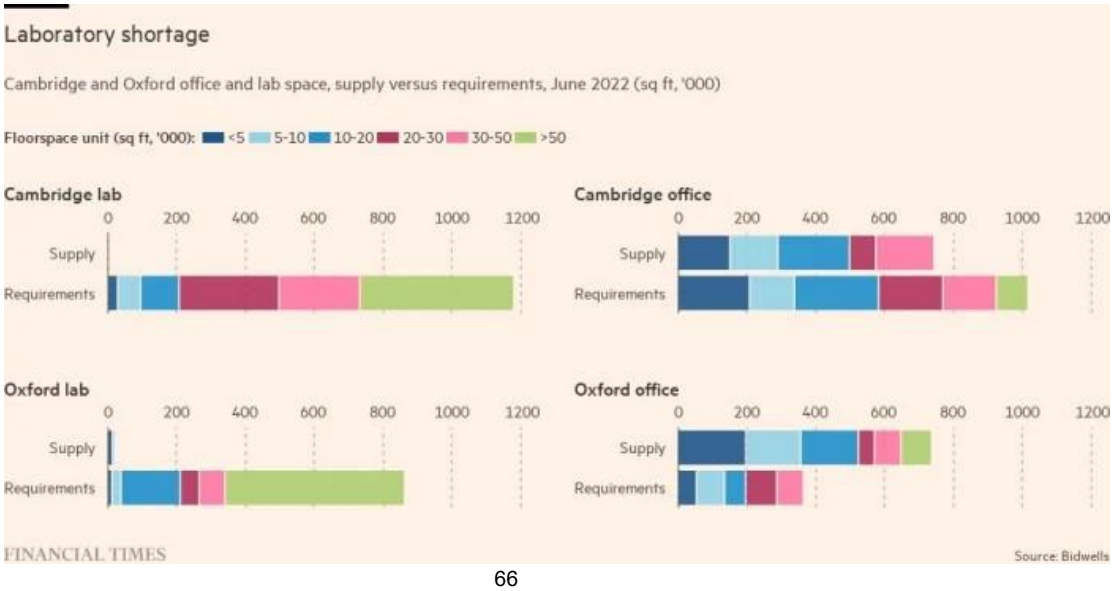
“The government has grand ambitions to transform Britain into a scientific superpower, but the Oxford-Cambridge arc is at threat of becoming a victim of its own meteoric rise, with the unicorns of tomorrow increasingly being locked out of mission-critical R&D space,” she said.

Alexis Dormandy, the chief executive of Oxford Science Enterprises, a £1bn investment company that partners with Oxford university to develop life science companies, said the OSE group had invested in creating 55,000 sq ft of its own lab space in order to guarantee capacity for its start-ups. But the scarcity of laboratories was hitting the ability of smaller entities to scale up.

“On the positive side, investment in life sciences is growing by 35 per cent a year — 50 per cent around Oxford — but we need to find innovative ways to invest in new lab capacity to keep up with that demand,” he said.

Business groups said the chronic shortage of space raised questions about the government’s strategy for growing the life sciences sector, where big names such as AstraZeneca, Apple and Microsoft have clustered around Oxford and Cambridge.

You are seeing a snapshot of an interactive graphic. This is most likely due to being offline or JavaScript being disabled in your browser.



In February it emerged that Boris Johnson's government had shelved a strategic plan to create a British rival to Silicon Valley around Oxford and Cambridge because it did not chime with the government's "Levelling Up" agenda.

The move has attracted criticism, including from former chancellor Philip Hammond, who warned that plans to level up the north should not be prioritised at the expense of high-growth areas such as Oxford and Cambridge.

"The Oxford-Cambridge arc can be a driver of prosperity across the whole of the UK but the government needs to facilitate this growth through the planning system, not stifle it because it doesn't fit with its levelling up dogma," he said.

More lab space is coming on stream, according to Bill Kane, president of UK and east coast markets at BioMed Realty, which pledged £850mn of investment last year to double the size of its UK portfolio.

"The Oxford-Cambridge arc is one of the most productive and innovative regions in the world . . . However, future innovation and growth will be limited without the physical infrastructure," he said.

In the interim, chief executives of life science businesses are warning that the UK will lose out to the US, where Boston alone had nearly 6mn sq ft of lab space under construction in 2021.

Mark Kotter, founder of Bit Bio, a Cambridge-based cell technology company, said that individual US states were far better at underwriting risk to developers in order to create a steady flow of lab space.

"The UK is extremely good at spinning out small start-ups, but not very good at building big companies. Most leave and are sold, and part of the reason for that is infrastructure that is not being provided for these companies," he added.

prioritised at the expense of high-growth areas such as Oxford and Cambridge.

The business department said it was investing in science research and development capacity through the infrastructure fund and had committed to increase total UK R&D investment to 2.4 per cent of GDP — or £22bn a year — by 2027.

“Only last month we announced nearly £500mn to provide world-class lab space to help unlock UK researchers’ full potential, as part of our £14.9bn investment in R&D in this financial year alone,” it said.

BLAIR AND HAGUE REPORT – FEBRUARY 2023

TONY BLAIR INSTITUTE FOR GLOBAL CHANGE

A New National Purpose: Innovation Can Power the Future of Britain

A joint report by Tony Blair and William Hague

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Published at https://institute.global/policy/new-national-purpose-innovation-can-power-future-britain on February 22 2023

Our Future of Britain project seeks to reinvigorate progressive politics to meet the challenges the country faces in the decades ahead. Our experts and thought leaders are setting out a bold, optimistic policy agenda.

Executive Summary

Science and technology have been the driving force of progress for much of our modern age. Our accomplishments have allowed us to live longer, healthier lives, to travel across the world and into space, and to generate food and energy at scale.

The United Kingdom has been at the forefront of many of these breakthroughs and was home to one of humanity's great leaps: the Industrial Revolution. Another revolution is now taking place as developments in artificial intelligence (AI), biotech, climate tech and other fields begin to change our economic and social systems.

Of course, as with the Industrial Revolution, this 21st-century technological revolution carries dangers as well as opportunities.

The challenge for policymakers is to mitigate the former and fully embrace the latter. But this requires a fundamental re-ordering of our priorities and the way the state itself functions.

The UK is starting with real strengths in many areas of emerging technology. It also has assets in its universities and in its private sector that offer significant advantages.

However, as we show in this report, without radical change, we risk decline. We cannot afford to fall behind.

The future of Britain will depend on a new age of invention and innovation. Technological superpowers such as the United States and China are investing heavily in their futures, raising the possibility that everyone else will be trapped behind these two forces – a risk the European Union is belatedly recognising and acting upon.

Britain must find its niche in this new world. To do so requires a radical new policy agenda, with science and technology at its core, that transcends the fray of 20th-century political ideology.

In turn, this requires a fundamental reshaping of the state, from how government itself works to how public services are delivered.

This new “strategic state” needs to embrace the technological revolution.

The private sector is already doing so. Individuals are already doing so. Across the board, the costs of electronic goods and software have been driven down, information has become abundant, and we can access entertainment, book travel or connect with friends and family almost instantly.

Government and public services, on the other hand, face costs increasing, service slowing and the public’s frustration building.

The starting point, then, is to ask how government can harness the benefits of this revolution for our country and use data and technology to drive down the cost of public services while improving outcomes.

The speed of the Covid response – particularly the development and deployment of new vaccines – shows what can happen when the government and the private sector mobilise effectively behind a clear purpose. We need to bring the same laser focus to the agenda we set out here.

Over the long run, a successful British state will likely be smaller in scope but more effective in its delivery. In practical terms, achieving this entails a series of reforms, including:

- **A reorganisation of the centre of government** to drive this science and technology agenda across government and public services, with the full weight of the prime minister’s authority behind it and, at the core, the skill set to ensure its effective implementation.
- **Building foundational AI-era infrastructure**. This should include:
    - Government-led development of sovereign general-purpose AI systems, enabled by the required supercomputing capabilities, to underpin broad swaths of public-service delivery.
    - A national health infrastructure that brings together interoperable data platforms into a world-leading system that is able to bring down ever-increasing costs through operational efficiencies.
    - A secure, privacy-preserving digital ID for citizens that allows them to quickly interact with government services, while also providing the state with the ability to better target support.
    - A shift in the government’s approach to data, so that it treats them as a competitive asset that can be used to drive down the cost of delivery and build high-value data sets, such as in the biomedical field.
- **Creating an Advanced Procurement Agency (APA)** with a specialised mandate to find opportunities for public-sector innovation, procure promising solutions and manage their deployment and testing.
- **Incentivising pensions consolidation** and **encouraging growth equity** by making the pension capital-gains tax exemption applicable only to funds with over £20 billion under management that allocate a minimum percentage of their funds to UK assets; and combining the UK Pension Protection Fund (PPF) and the National Employment Savings Trust (NEST) to create a single investment vehicle

that participates in market consolidation.

- **Reforming technology transfer offices (TTOs)** to encourage more university spinouts.
- **Increasing public research and development (R&D) investment** to make the UK a leader among comparable nations within five years, coupled with reforms to the way our institutions of science, research and innovation are funded and regulated to give more freedom and better incentives.
- **Investing in new models of organising science and technology research**, including greatly expanding the Advanced Research and Invention Agency (ARIA), and creating innovative **laboratories that seed new industries** by working at the intersection of cutting-edge science and engineering.
- **Pursuing broader planning reforms** to ensure infrastructure projects that are critical to the UK's economic transformation can get approval in six months or less, while also creating exemptions and fast-track processes for R&D infrastructure planning.
- **Mainstreaming new technologies in education** to build the skills of the future and develop a workforce capable of rolling out technological advances. This should include a new edtech-training fund to improve teachers' confidence and incentives to adopt innovation as part of learning.
- **Building stronger global partnerships** to avoid being trapped behind the tech superpowers of the US and China. This should include seeking to establish a new informal "T3" coalition between the UK, EU and US to find areas of common ground on global technology standards, enable associate membership of EU research programmes including Horizon, Copernicus and Euratom, and taking leadership of multilateral research initiatives on AI.

With science and technology as our new national purpose, we can innovate rather than stagnate in the face of increasing technological change. This purpose must rise above political differences to achieve a new cross-party consensus that can survive any change of government.

A New National Purpose

One of the biggest events in human history started in the UK: the Industrial Revolution. [1] In little more than 200 years, the majority of the world went from extreme poverty to a life of relative material abundance. Some consequences of this shift took generations to distil, but ultimately it transformed almost every part of life in our country. Electricity, aeroplanes, telephones, antibiotics and much more all became mainstream in a single lifetime.

Today, another revolution is underway: one whose consequences will dwarf those of the revolution that built the modern economy. We are now living through a shift to a new age of technological capabilities and their nexus with science. The exponential growth, dictated by Moore's law, that drove the computing revolution is now occurring in other technology domains.

In slightly more than 20 years, the cost of sequencing a full human genome has decreased from $100 million to $100 today, [2] with the potential to forge new frontiers for scientific research, disease diagnosis and preventative treatments at scale. The price of electricity from solar declined by 89 per cent in a single decade (from 2009 to 2019), with renewables accounting for 75 per cent of all new capacity additions worldwide in 2021. Lithium-ion batteries have also seen a similar cost reduction, having declined in price by 97 per cent since 1991.

AI is emerging as a transformative technology that has the potential to radically change economic models, the way businesses are organised and, in turn, how our society functions. It stands poised to transform every industry from education, health care and transport to space exploration and beyond. Progress continues to intensify – the computing power needed to train the most capable AI models has grown by a factor of 10 billion since 2010, and is doubling every five to six months. [3]

With all technologies it is hard to predict the future: the debate around automation a few years ago focused on the potential replacement of factory workers, but countries such as the UK and the US now face manufacturing-labour shortages. With generative AI, fears have now shifted towards its speculated impact on art, music and knowledge workers. This is understandable. At any given juncture any new scientific or technological advances will lead to concerns about society's ability to adapt and the possible friction that the process will cause.

This is rightly an area that requires political leadership, and the provision of support for those most affected by economic shifts. But this must not lead to stasis. The UK has a long track record of invention that extends beyond the Industrial Revolution well into the 20th century, from Bernard Lovell's radio telescope at Jodrell Bank and the RAF's Frank Whittle's development of the jet engine to Robert

Edwards's pioneering work on IVF, changing the outlook for families around the world. We now need to be home to the next generation of discovery.

The Technologies Changing the World

Technology companies have defined the past quarter century. Digital giants now surpass countries in terms of their R&D budgets; Amazon spent more than $40 billion on R&D in 2020 alone – approximately double the UK's public annual R&D budget. Companies such as Moderna and Tesla grew fast and redefined their industries, while others such as the Taiwan Semiconductor Manufacturing Company quietly became the engines of the 21st-century economy.

The nations that have made the greatest progress are those that have adopted and adapted to technology. In the US, where software has been most readily developed and adopted, wealth is now in a different order to that of the UK's while Ireland has surpassed us in terms of economic output. California, which has a population equivalent to 60 per cent of the UK's, boasts some of the biggest tech companies in the world and has an economy that is now larger than our own and close to surpassing Germany's. [4] This effectively makes it the world's fourth-largest economy.

Over the coming decades, there will be further acceleration as technological innovation increases. And if the atoms, bits and cells [5] are the foundations of the modern world, three innovations in particular will shape the future: AI, biotech and climate tech. These will be essential to grasp, but others such as space, materials science, quantum and robotics will also be critical – as will others we do not know of yet.

Artificial Intelligence

The promise of AI is to capture and recreate the essence of humanity's most powerful tools – language, creativity, reasoning and intelligence. Current approaches are based on deep learning, a subset of machine learning strongly inspired by the wiring of our own brains but one that, in practice, still produces alien forms of intelligence that we do not fully understand yet.

These advances are finally living up to decades of ambition to collectively become an epoch-defining development. As a general-purpose technology, AI has the potential to make an unprecedented impact that will exceed those of the steam engine and electricity combined during the industrial revolutions. These previous revolutions focused on the harnessing of energy to mechanise physical labour, but our current revolution is the first in history to automate cognition itself.

AI's Potential Impact

Progress is happening at breakneck speed, with the practical impact of AI almost entirely contained to the past ten years, especially since 2019. Breakthroughs over the past few months alone, such as OpenAI's ChatGPT and Stability AI's Stable Diffusion, provide the means for empowering human creativity and productivity in language and art as never before. ChatGPT became the fastest-growing consumer app in history, achieving 100 million users in two months. [6] Advances such as Alphabet-subsidiary DeepMind's AlphaFold are being leveraged to reduce drug-discovery time for cancer from years to just under 30 days. [7] In the words of Matt Clifford, co-founder of Entrepreneur First and Chair of the Advanced Research and Invention Agency (ARIA), we now have "infinite AI interns for everybody", while research from MIT suggests that widespread adoption of AI tools in R&D could triple productivity-growth rates. [8]

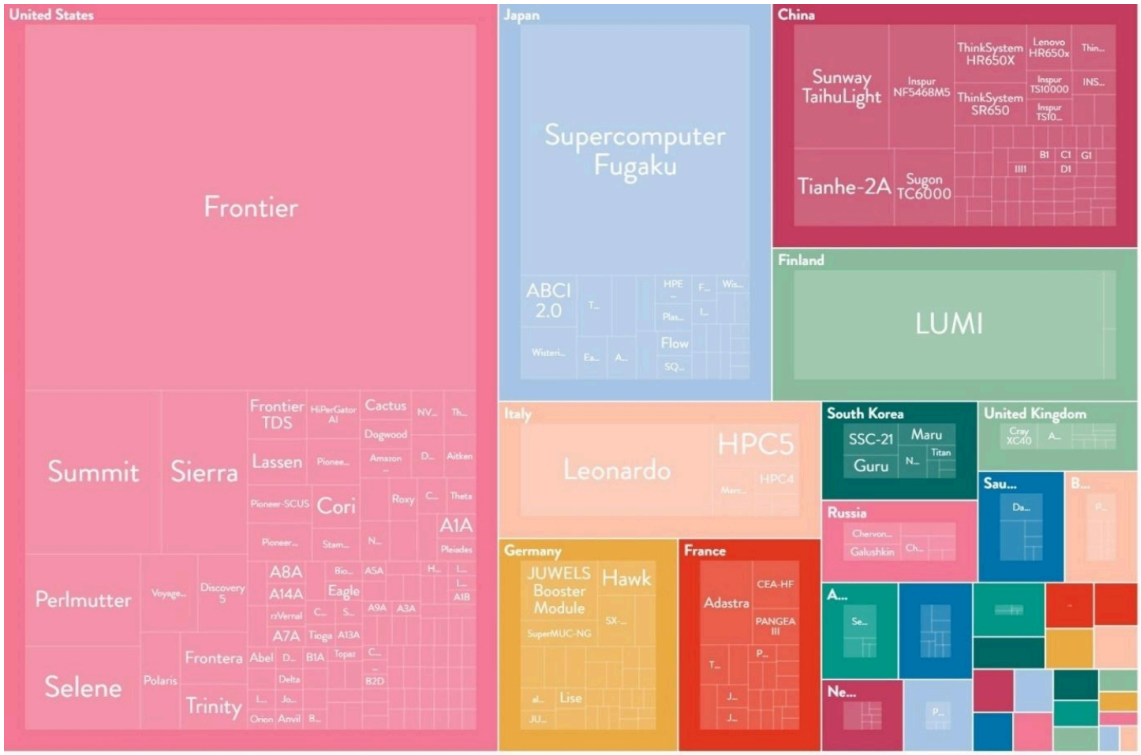
The early effects of this disruption are already being felt in education and the creative industries. ChatGPT is able to pass many graduate-level exams and write convincing essays, demolishing standard modes of assessment at a time when educators are already under significant strain. [9] Stable Diffusion has democratised creative expression and the ability to produce world-class art, albeit by training its tool using the work of talented artists who believe their intellectual-property (IP) rights have not been recognised sufficiently. [10] Sudden shocks such as these will continue to occur across fields.

International Standing

The UK has a strong reputation in AI. This is centred around our leading educational institutions in combination with the UK-founded DeepMind's ambition of "solving intelligence, to advance science and benefit humanity". We have a vibrant startup ecosystem that applies AI to strategic domains as well, including firms such as Oxford-based Exscientia, which is operating at the forefront of drug discovery, and Bristol-based Graphcore, which could provide the UK with sovereign capabilities in AI chip design. London-based Stability AI has recently emerged as a disruptive innovator in open-source generative AI, catalysing non-traditional online communities to work on large-scale scientific projects while releasing transformative AI tools for free for general public use.

However, we need to move fast to retain our competitiveness and strategic advantages in this rapidly progressing field.

Figure 1 – The aggregate computing power of the TOP500 supercomputers in the world, grouped by country



Source: TOP500, November 2022

The US and China are the other powerhouses of this revolution, with more than half the world's public supercomputing power and the highest number of papers published on AI between them. [11] By contrast, the UK contributes only 1.3 per cent to the aggregate computing power of the Top 500 supercomputers, less than Finland and Italy, and was the only leading nation to record a decline in AI publications last year. DeepMind has an outsized global influence in research at AI's frontier, but our universities are otherwise merely comparable to those in other medium-sized states in terms of research output and quality, rather than being genuinely world-leading.

As progress increasingly depends on a blend of engineering and scientific excellence, similar to the "big-science" approaches of other fields such as high-energy physics, disparate academic groups are unable to compete at the frontier of AI without centralisation and access to world-class engineering and computing resources, as well as the billions of pounds in funding needed. As a result, we face an "AI brain drain" of researchers leaving or entirely avoiding academia to instead enjoy significantly better compensation, resources and intellectual environments in the US or at US-owned companies. [12] The siloing of frontier-AI talent and development in these corporations means that the future is already here yet it remains largely inaccessible, and the state lacks the expertise needed to provide democratic

oversight of this technology. As Anthropic co-founder Jack Clark observes, for most of us, "the 21st century is being delayed". [13]

We are also unable to support startups when they show potential to grow into industry leaders. Enterprise AI-startup InstaDeep was originally attracted to London from Tunisia, but was recently acquired by Germany-based BioNTech in a £562 million deal. [14] This followed in the footsteps of other promising startups including DeepMind that pursue foreign-investment exits. In aggregate, foreign takeovers of UK companies have risen more than 400 per cent since 2015 as inward investment has fallen, [15] reinforcing the erosion of the UK's sovereign AI capabilities.

The UK government is attempting to grapple with many of these challenges. The Office for Artificial Intelligence is developing a white paper on AI regulation in follow up to the publication of the government's National AI Strategy in 2021. [16] The Centre for Data Ethics and Innovation recently released a well-considered AI assurance roadmap, an important step in building user and business trust in advanced AI tools, and one that ensures UK leadership in the emerging-services industry will deliver on this trust. [17] Prime Minister Rishi Sunak, in his former role as chancellor, launched an independent expert review of the nation's supercomputing needs. [18]

These strategies and reviews indicate a coherent vision that genuinely surpasses that of most of our peers, but they need to be backed up with substantial funding and action to demonstrate serious global leadership. We will not be assessed on the quality of our strategy documents but on our ability to deliver life-changing AI for billions of people. The opportunities and challenges of AI will be shared by all humanity, but UK leadership will ensure our collective response will be steered by and benefit from the values we hold.

Biotech

Biotechnology broadly refers to the combination of both scientific and engineering expertise to understand, heal, harness and improve living systems. From the sequencing of the human genome and rewriting of genetic code to the design of novel proteins using AI and the creation of artificial organs, the bio revolution has been one of the most profound developments of recent decades.

The discovery and development of CRISPR technology is allowing DNA, the code of life, to be edited with a precision that was impossible barely a decade ago, leading to new opportunities in the field of biological engineering that could transform health, agriculture and industrial processes. Meanwhile, mRNA technology and CAR-T cells are changing our approach to health, as seen over the duration of the pandemic, by harnessing the power of human cells to prevent and tackle disease. And while 3D printing is already revolutionising fields such as orthopaedics, innovators are working on pushing the boundaries to recreate complex organs and systems through tissue engineering.

Rapid progress is now also coming about through the confluence of biology and computing, including machine learning and AI. As a16z's Vijay Pande, a biotech expert, has argued, "this new era of industrialised bio — enabled by AI as well as an ongoing, foundational shift in biology from empirical science to more engineered approaches — will be the next industrial revolution in human history". [19]

Biotech's Potential Impact

The impacts of this are already being seen. Drug discovery is being remade by technologies such as AlphaFold, shortening candidate-identification pipelines from years to a few weeks. In combination with other advances, this could reverse the spiralling costs of producing new drugs and enable tailor-made medicines to be developed for rare diseases.

Synthetic organs grown in the lab could also be used for transplantation, abolishing the waiting lists and ensuring anyone who needs a transplant gets one in weeks.

Robotic and virtual-reality (VR) surgery platforms such as CMR Surgical and FundamentalVR look set to make robotic keyhole surgery affordable and accessible, also providing innovative ways to train surgeons via haptic feedback, which could expand both the number of operations available and their safety.

Meanwhile, technology is providing new ways to harvest, understand and use novel health data. Using this, we could detect disease much sooner when it is at its most treatable and even predict its emergence, offering new kinds of medicine prophylactically. Already in the UK, life-sciences firms such as Kheiron are using AI and machine learning to improve imaging and diagnosis, particularly for cancer. Its Mia platform for breast-cancer screening is world-leading and has been adopted in several National Health Service (NHS) trusts. As genome costs drop and wearable technologies continue to develop, ever more granular individual portraits will be used to predict, prevent and treat individuals. These new technologies will allow the NHS to focus on the promotion of national health rather than only the treatment of disease.

And the possibilities of biotech are not restricted to biomedicine. New materials, for example based on the incredibly strong and flexible spider silk protein, will make new products possible as the invention of plastics did in the 20th century. [20] This would allow the development of new types of medical implants that the body does not recognise as foreign, new forms of clothing and even self-healing materials for manufacturing. Biotech will also create new ways to produce biofuels efficiently without using large tracts of land, cultivate specialised bacteria to break down toxic chemicals in the environment and make artificial lab-grown meat in a climate-neutral way.

International Standing

This is now a large and rapidly growing field. In the US, Planetary Technologies estimates that the biotech economy generates more than $550 billion in revenue and is responsible for 2.4 per cent of GDP. [21] Globally the pie is bigger still, with the worldwide biotech market forecast to increase at a compound annual growth rate (CAGR) of 17.83 per cent over this decade, to reach a market size of $3.44 trillion by 2030. [22]

The UK is well placed to be at the forefront of this if it makes the right policy interventions. We are home to leading research institutions, which has translated at times into companies. Greg Winter, the Nobel Prize winner and founder of Cambridge Antibody Technology (a Cambridge spinout), invented Humira, which was for years the world's best-selling drug, generating $16 billion per year in sales. [23] Shankar Balasubramanian co-invented a technique for gene sequencing that was implemented by his startup, Solexa. This was subsequently bought by US company Illumina in 2007 for $600 million and has since multiplied its value almost hundred-fold. And Oxford University's Martin Landray, whose RECOVERY trial was essential to fighting Covid, is attempting to revolutionise clinical trials through Protas.

Beyond these examples, the UK's life sciences have a strong foundation to build upon, with £88 billion annual turnover in this industry, [24] raising £1.8 billion in finance in 2022, [25] with clusters spread across the country with over 50 per cent of jobs outside the South East.

In particular, we have major strengths in R&D, data and genomics that we must build upon – and which form the backbone of the UK's Life Sciences Vision and related documents. [26] These sector-wide strategies have led to some tangible progress and a handful of landmark deals. For example, the NHS is conducting large-scale trials for an innovative new early-cancer diagnostic tool while both BioNTech and Moderna have announced long-term investments in the UK. [27] The government has also announced £175 million of additional funding for genomics research alongside £113 million to tackle key drivers of populational ill health. [28] Oxford Nanopore is another example of a potentially world-leading company in the field of genomic sequencing.

However, despite strong foundations our overall performance across the sector continues to fall as international competition hots up. Unfortunately, the key markers of success are now pointing in the wrong direction. For example, we are seeing:

- A marked decline across all phases of UK clinical research.
- A significant decrease in our share of global investment in life-sciences R&D.
- Life-sciences innovators are still unable to access the capital they need to grow. In combination with our lack of sufficient commercial flexibility and novel commercial models, this means that

companies such as bluebird bio have been prompted to pull out of the UK and Europe entirely – taking jobs and investment with them.

- In breakthrough relevant science such as synthetic biology, only one of the 27 biggest advances of the last decade in a recent review came from the UK. [29]

Despite these worrying signs, the government and the NHS do not sufficiently recognise the risks, with the situation having deteriorated in recent months. For example, the 2022 Autumn Statement further squeezed smaller life-sciences innovators, with a cut to the small and medium-sized enterprises (SME) R&D tax-relief credits scheme that will reduce its value by 50 per cent. There are also other issues harming the ability of industry and the public sector to interact. [30]

This is creating a growing chorus of concern. Key figures including leading biotech investor Kate Bingham are publishing stark warnings on the sector's future, with commentators questioning whether the government's "science superpower" ambitions can be delivered. The ambition remains but action must be stepped up. [31]

Climate Tech

The transition to a low-carbon economy is like a mountain-climbing expedition: most want to get to the peak, but the argument is about the best way to summit. Some say it needs to be a straight shoot, even if there are strong blizzards. Others believe a slower but safer route is most feasible; such a practical path would not only seem to protect a way of life but also try to improve standards of living.

For decades, energy prices have been relatively constant but the ability to generate this resource at lower costs, and use it much more efficiently, would unlock many secondary benefits, including dropping the cost of transport and energy-intensive manufacturing dramatically while lifting millions out of energy poverty.

This will not depend on one single advance – the range of technology areas underlying our climate response will need to cut across traditional disciplines, ranging from novel materials and AI algorithms through to chemistry and atomic physics.

Climate Tech's Potential Impact

From the mobility and energy sectors to agriculture and heavy industry, the range of tech solutions available to address climate change is growing. While DeepMind was training AI to control superheated plasma inside a fusion reactor, IBM researchers were exploring how to use quantum computing and AI to accelerate the discovery of new materials for carbon capture. Meanwhile, Climeworks and Carbon180 are blazing a new trail in direct air capture, and Redwood Materials and Li-Cycle are considering recycling solutions for lithium-ion batteries. The $2 billion voluntary carbon market, now projected to

reach between $10 and $40 billion by 2030, is increasingly relying on digital technologies to source and verify offset projects while tools such as distributed ledger technology are enabling a greater inflow of capital into climate-friendly projects, irrespective of their location.

The annual investment in energy globally rose to $2.4 trillion in 2022, with approximately three-quarters of the growth attributed to low-carbon technologies. More than 450 financial institutions representing more than $130 trillion in assets have pledged to support the clean-energy transition. With the cost of solar and batteries declining by about 90 per cent, and offshore wind plunging in costs by 70 per cent over the past decade, renewables now account for the most annual additions to global electricity expansion worldwide.

The development and implementation of novel technologies is critical, as decarbonisation targets are extremely ambitious and will be unattainable without them. As the International Energy Agency (IEA) has said: "Roughly half of the reductions that the world needs to swiftly achieve net zero emissions in the coming decades must come from technologies that have not yet reached the market today." [32] These will need to tackle incredibly difficult challenges such as steel, ammonia, cement and plastics, as well as reforms to food and agriculture.

International Standing

The US has accelerated efforts to be the leader of the field, passing more than $500 billion in clean-energy industrial-strategy legislation over the past year, namely the Inflation Reduction Act (IRA), Creating Helpful Incentives to Produce Semiconductors and Science Act (CHIPS) and Infrastructure Law. Together, these aim to cut emissions by a gigatonne in a decade.

This is drawing clean-tech investors to the US. For example, Northvolt (a Swedish battery startup), Iberdrola (a Spanish energy firm) and BASF (a German chemicals company) have all claimed they will relocate a substantial portion of their investment or production to the US to take advantage of its subsidies. [33] Car companies such as Audi and BMW plan to create assembly plants in the US while Hyundai and Panasonic intend to build battery plants there. [34]

The IRA's emphasis on domestic production and manufacturing will fundamentally change the global clean-tech market through lower prices and the diversification of supply chains for critical minerals and clean-tech components. Responsive subsidies and other measures by leaders worldwide, especially in the EU, to incentivise clean-tech innovation and production risk leaving the UK behind. China is also making great strides in renewables and electric vehicles and dominates global lithium supplies.

More broadly, global investment in climate tech picked up pace in 2022: the IEA estimated annual growth of 12 per cent in clean-energy investment, rising from about 2 per cent where it had remained five years after the Paris Agreement. [35] Climate tech attracted more than a quarter of total venture-

capital (VC) funding in 2022 after growing five times faster than overall VC investment in the years leading up to the pandemic. [36]

This investment is happening all along the clean-energy value chain. Globally, EVs are projected to make up to 90 per cent of new car sales by 2050, nuclear fusion is reaching new milestones and next-generation nuclear technologies, including small modular reactors (SMRs), are changing the outlook on what is possible. [37] In the US, the SMR pioneer NuScale just became the first of its kind to gain regulators' approval for its design. [38] Grid and storage technologies are also attracting consistent investment, from large lithium-ion batteries to thermal storage and power-to-X solutions.

In the UK, climate-tech investment reached approximately £7.5 billion in 2022, up from £4 billion the year before. Exemplified by unicorns such as Octopus Energy and Vertical Aerospace, there is a growing startup scene, with approximately 5,000 companies here compared to more than 14,000 in the US. [39] The challenge and opportunity for the country is to meet demand at home while also winning a share of this globally expanding market. This requires the country to identify and leverage areas of comparative advantage while building strategic alliances to ensure our climate-tech products can compete in a post-IRA market.

A heavily emphasised state-based approach is not going to be the way forward here. Instead, we must focus on creating and facilitating strong tech-enabled markets, infrastructure and incentives that will allow industry, local actors and consumers to drive the change.

The challenge is significant. To decarbonise our economy, the action needed will include:

- The second-largest reduction in gas demand across Europe and the third-largest drop in oil demand.
- An extensive buildout of nuclear power and an increase in the pace of renewables deployment by three and a half times.
- An unprecedented expansion of the electricity grid, building seven times more capacity by 2030 than has been added over the past 32 years.
- An expansion of EV-charging points by tenfold in the next decade and an increase in the number of EVs sold from 15 per cent of total car sales to 100 per cent by 2030.
- A significant ramp-up in zero-carbon heat solutions in homes and businesses, with heat pumps increasing from 280,000 to 13 million by 2035 to meet our domestic carbon budgets.
- Industry to decarbonise through significant electrification of core industrial processes and the increased use of carbon capture, usage and storage (CCUS), taking it from a nascent to commonplace technology in the 2030s.

Getting to this point will not only require developing technology at speed and scale but also focusing heavily on deployment. It will also require bold action, with a level of ambition that often feels missing

from the state today. Fusion is one of the areas in which we still project a sense of ambition. It is also one that allows us to strengthen transatlantic ties. For example, in 2022, the UK Atomic Energy Authority signed an agreement with US company Commonwealth Fusion Systems to advance commercial fusion energy. [40] Innovative policies such as pivot-support programmes can ensure spillover effects from research are maximised, but the government should be investing more in our national laboratory, the Culham Centre, to strengthen it as a global centre for fusion. [41]

Fusion has the potential to become a century-defining sector, particularly as the nexus between software and industry develops. We need to ensure that we are laying down the conditions for some of the firms involved to be British.

Today's Powers Are Racing Ahead

Our competitors recognise that these technologies, as well as others such as quantum and materials science, are remaking the global economic order. Accordingly, the tech superpowers are fighting for supremacy by investing heavily in the industries of the future.

President Joe Biden is taking this challenge seriously: last year the US passed the CHIPS Act and the IRA. Together, these and other policies will result in more than $1 trillion invested in clean energy, R&D and the commercialisation of frontier technologies such as quantum computing, AI and nanotechnology.

Europe is trying to meet the moment with its Green Deal Industrial Plan for the Net-Zero Age, which, through a simplified regulatory environment, upskilling, accessible funding and efforts to build resilient supply chains, attempts to drive clean-tech innovation on the continent. The approach of the bloc is often to act as a regulator first, for example by leading on AI regulation, [42] but it is also investing in large-scale data infrastructure such as Gaia-X and frontier tech including cutting-edge satellites. [43]

Beijing is also preparing for a more competitive future. President Xi Jinping placed science and technology at the centre of China's 20th Communist Party congress, greatly increasing its representation on the Politburo and stating that China must "regard science and technology as our primary productive force, talent as our primary resource and innovation as our primary driver of growth". [44] Meanwhile Beijing's military-civil fusion strategy aims to foster greater tech innovation by linking China's civilian and defence economies. [45]

Recent US export restrictions on semiconductors have only reaffirmed Beijing's view that technological self-sufficiency is a matter of political survival. [46] As President Biden has highlighted, President Xi believes that changes in technology strongly favour autocracy. [47] It is the collective task of the world's democracies to disprove him.

In terms of sheer scale, the UK will not be able to compete with the US and China, but it is nonetheless possible to compete on quality. Nations such as Taiwan, South Korea and Israel are smaller than the UK but have nonetheless thrived, with R&D-intensive economies fusing public and private investment. These countries demonstrate a dynamic middle way between purely free markets and top-down state control, predicated on intelligent investment and action on the part of the state and a conducive environment for industry.

The UK will need to do more to remain competitive.

Reinventing the State

It is not too late to define a new path, but we have to be honest about the situation the country finds itself in.

The British people have experienced almost 15 years of stagnant productivity growth, resulting in flat or falling real incomes. Simultaneously, public services are struggling under a trilemma of needing to provide services at scale, at a sustainable cost and at an acceptable quality. As a result, the tax burden continues to rise.

The human cost of this situation is real. Across the country, 16-year-olds from disadvantaged families are 18 months behind their peers by the time they finish their GCSEs, and the picture has failed to improve over the past decade. The long-held assumption that children will be better off than their parents is crumbling. [48] Meanwhile, economic inactivity because of sickness is at its highest level since records began, with 2.5 million working-age adults inactive due to their health.

Any "Brexit dividend" is yet to be fulfilled. Ministers have made a start on considering where UK regulation can be made more nimble and efficient in areas such as gene editing and clinical trials, [49] but regulatory restrictions on innovation remain relatively high. For example, three years on, legislation for autonomous vehicles remains stuck, we kept EU rules on robotics that Germany has subsequently abolished so that they can build fully autonomous warehouses, while novel food companies are moving overseas due to regulation. [50]

The state also faces a new generation of challenges. Climate is at the forefront of these, but as Covid-19 showed, a deep and broad science and tech base is a vital strategic asset for health and economic prosperity. These problems call into question the ability of the British state not only to meet these challenges, but to leverage innovation to build a better future.

As it stands, the technology sector accounts for less than 5 per cent of the UK's total market capitalisation. [51] In Germany, it is 11 per cent. In the US, it is almost a third. The challenge isn't solely in

having good ideas or entrepreneurial spirit: since 2016, the UK has created more "tech unicorns" than France and Germany, though we arguably lack deep-tech unicorns. The problems come at a later stage. Looking at IPOs and acquisitions combined, 44 per cent of all exits from UK tech companies between 2011 and 2021 were by overseas investors, rising to 61 per cent if the company had received overseas investment at the equity-funding stage. We are losing valuable assets from the technology sector to overseas investors.

Seven of the top ten companies in the world by market capitalisation are tech companies (Apple, Microsoft, Alphabet, Amazon, Tesla, NVIDIA, Taiwan Semiconductor Manufacturing Company) and none are British. Our biggest company is Shell – the world's 44th largest by market capitalisation. Only two of the top 100 R&D-spending companies are based in the UK (GSK and AstraZeneca), while Germany has 12 in the top 100 – 500 per cent more than the UK.[5]

The starting point to getting a seat at the top table will be a reinvention of the state. Embedding technology and AI across all operations will be essential – including the NHS, schools, law and order, and reforming the way government functions.

We have shown that this is possible before. Our own life sciences industry did not happen by chance, but by a concerted national strategy of anchoring investment in research organisations such as the Laboratory for Molecular Biology backed by the capabilities of an integrated health-care system. Our Covid-19 success stories relied on investment in these institutions.

Digital technology now provides a new platform and possibilities, and Britain's centralised political system offers a greater chance for executing a coherent reform agenda and national strategy than similar nations. By expanding the potential for collaboration and coordination as well as focusing on the speed and pace of discovery, Britain can build a new model for science and innovation in the modern world.

Practical Actions to Drive Our New National Purpose

A 21st-Century State

To seize the opportunities of this century, we need to radically change the way in which our public services are delivered. This isn't just about injecting more tech into our existing approach. Rather, it will require a sustained whole-of-government effort and a new operating model for the British state. This is not about size or outdated left and right debates; it is about building a "strategic state" that provides a platform of opportunity for the British people. In reality, technology is likely to result in a state that is smaller than today's – but with an entirely new operating model and requiring different skills.

A series of reforms are needed to get there, which include:

- Reshaping public institutions and processes to build momentum.
- Building AI-era infrastructure, data capabilities and digital IDs.

Reshaping Public Institutions and Processes to Build Momentum

The UK's response to the Covid-19 pandemic highlighted what can be achieved when science and technology expertise is at the heart of government, people are empowered to drive ambitious programmes and obstacles are overturned to enable focus on a mission.

The increased competition and unpredictable changes that the technology revolution is bringing mean that we must once again prioritise adaptability and speed of execution in government. The pandemic showed that day-to-day government processes are not configured to help us rise to the challenges ahead. It is a sad fact that the greatest success of the UK's pandemic response – the work of the Vaccine Taskforce – was made possible by exempting it from normal government processes, yet there have been no significant operational reforms in response.

To have a chance of remaining relevant and to improve our global and economic position, we will need to deeply reform, reinvent and, in some cases, resurrect core assumptions of how the state should act. Improved state capacity will be central to our nation's success.

The foundational processes and assumptions about how Western states are governed and operate have developed without science and technology innovation being prioritised. We have an incredible

opportunity to rebuild the British state with science and technology at its heart by addressing Whitehall's long-standing limitations.

To make the most of this opportunity, we must:

- Foster a long-term, risk-tolerant investment attitude that avoids micromanagement. The state must view R&D spending as an investment with strong returns, not a sunk cost to be traded against other priorities.
- Create a central strategic and delivery unit, optimised for science and technology, to act as a centre of political and state power. It should be independent from vested interests and status-quo forces, and able to devise, drive and unblock a reform agenda.
- Ensure that decision-makers and advisors are experts in the areas within which they are operating, as would be the case in a technology company. The current ministerial system and civil service do not have or produce the relevant expertise required for this, with repeated attempts to change this having failed.
- Enable decision-making and operating at increased speed, recognising that in a tech race going slow may be worse than failing fast. This requires flat, non-hierarchical structures that empower executive decision-makers to manage portfolios (as with the Vaccine Taskforce), the removal of veto points and the creation of new organisations to institutionalise and support key decisions without micromanagement by Whitehall.
- Introduce a system that prioritises the goals, advice and agency of science and technology experts, rather than an excessive audit and micromanagement culture.

Reorient Our Public Investment Towards Long-Term, Expert-Guided R&D Spending

The Treasury's current mindset exists in part as the result of a healthy desire to control overall levels of public spending. However, this must be balanced against the need for and the requirements of investment. This balance has been off for some time.

We seriously underinvest in direct public R&D investment relative to our competitors, and have done for almost 40 years. Rather than lagging behind on this, we should lead. Public spending on R&D helps attract matching private investment, driving growth and boosting tax returns. For example, every £1 spent on public R&D expenditure brings in £2.50 of private R&D funds. [52] Investing more in public R&D as our economy improves and spending increases become more fiscally feasible can help achieve long-term growth.

In addition, public R&D spending is subject to extensive bureaucracy by the British state, which also micromanages it into small, siloed pots and creates continual annual funding cliff edges rather than facilitating sustainable investment. Recent years of investment have been characterised by single-year spending-review cycles, preventing the creation of meaningful long-term plans or commitments.

Increasingly granular decisions on spending are made not by science and technology experts, but by generalists. All of this sharply curtails research organisations' abilities to act effectively.

As recent articles have argued, [53] much of this arises from the culture and mindset of the Treasury whose excessive power creates a system of "policymaking by accountant". This stands at odds with what is required for science and technology investment. Notably, Institute for Government data suggest that the Treasury does not have any dedicated science and technology staff, despite the civil service being a large employer of scientists and engineers. [54] Yet the Treasury strongly micromanages science and technology spending and is the de-facto controller of the UK's national R&D strategy.

We need to reform how investment is made in fields relevant to R&D, and in turn break the control of the "accountant" mindset over the UK government. And as British cosmologist and astrophysicist Lord Martin Rees has argued, many scientific advances require time and freedom to allow unknown ideas to be explored. This does not suit the type of regular audits and performance criteria common in government funding. [55] A bespoke approach specifically designed for the needs of R&D investment would be a major competitive advantage for the UK. A number of core objectives would need to be set as part of this special arrangement:

- Return the monitoring of delivery-body performance to relevant departments, removing opportunities for Treasury micromanagement.
- Review and sharply curtail the business case, "value for money" and similar green-book criteria, with investment decisions instead being guided by the judgement of expert science and technology figures through the new central unit we outline below. Such Treasury processes were investing in building hospitals and roads, not high-risk tech investment, and make little sense in the context of highly uncertain, exploratory work with unpredictable outcomes. Special and separate processes should therefore exist for R&D in recognition of its very unusual nature.
- Embrace expert review, including using international reviewers, as the primary mechanism of performance evaluation for programmes and institutions, rather than audit by generalist officials. Progress, not paperwork, is what should be assessed.
- Place core R&D investment for key delivery agencies such as UK Research and Innovation (UKRI) and ARIA on seven- to ten-year spending cycles. Where necessary, such as for institutions and long-term investments, allow longer spending cycles with light-touch checkpoints based on expert international review.
- Manage major delivery agencies such as UKRI and similar new entities in the same way as ARIA – on single business-case processes – without micromanagement by Whitehall, and enable strong flexibility to reprofile spending across years.

Reforming such deeply ingrained, long-standing functions of the state is challenging, and careful thought will be required on how best to do this. Recent suggestions to split the Treasury should be considered but may not be the only way.

A Science and Tech Policy and Delivery Unit Across Number Ten and Cabinet Office

Devising and delivering a complex, inter-departmental science and technology agenda requires bringing science and technology to the very heart of the British state.

The creation of the Department for Science, Innovation and Technology (DSIT) is a very welcome step – bringing the governance of crucial technologies under one roof, elevating the status of the scientific agenda inside government and providing a single point of contact for global tech to use when interacting with government. It will be crucial to support DSIT in hiring expert technical talent, which may require relaxation of normal recruitment rules due to the global competition for such talent.

Alongside the commissioning of Sir Patrick Vallance's review into regulating emerging technology by the government and Labour's plans to quadruple investment in green technology, [56] this new department shows that both parties are increasingly committed to elevating the status of and focus on science and technology inside government.

The next challenge will be to embed the science and innovation agenda across the whole of government. DSIT will be unable to achieve this alone, given that many of the levers for implementing this agenda lie outside the department and it does not reside in the heart of government.

There needs to be an upskilling at the centre of power to drive this agenda as a top priority, with the full and active engagement of the prime minister. To do this requires creating a central coordinating brain that spans Number Ten and the Cabinet Office, with a high density of expert talent closely connected to the key organs of power in both. This should be a central strategic and delivery unit, along the lines of the White House Office of Science and Technology Policy (OSTP). The OSTP has some of the top minds in the US working there, including former Advanced Research Projects Agency (ARPA) programme managers. A push to create such a unit in the UK in 2021 appears to have stalled, but it should be endorsed on a bipartisan basis.

The unit would have a number of core objectives:

- **Apply a whole-of-government strategy.** Provide a site of synthesis and integration for the government's whole R&D strategy.
- **Attract top advisory talent.** Create high-prestige, empowered positions to attract top science and technology thinkers into government to advise the prime minister and cabinet directly.
- **Devise disruptive policy proposals.** Policies for bold change rarely come from existing stakeholders and consultations, instead they require radical policy thinkers in proximity to power.

- **Run the NSTC process.** Prepare meeting agendas for the prime minister's National Science and Technology Council, the cabinet committee.
- **Empower delivery and unblock problems.** Use the influence of Number Ten to unblock problems within the system, in particular empowering departmental leads and bringing together policy and delivery in the same way that Number Ten empowered Kate Bingham.

Such a unit would be expected to have close working relationships with related departments – especially DSIT – in a similar manner to joint special advisors, making them synergistic rather than in conflict with relevant departments. Over time, functions of the Treasury could also be moved into this structure, or into DSIT, to further this agenda.

Exemptions From Whitehall Controls for Tech

Whitehall's core systems are also not built for competing over top technical talent, or for evaluating science and technology processes. The following actions should be taken to allow science and technology decision-making to take place as efficiently and effectively as possible.

Decision-making in many areas of science and technology requires deep technical knowledge. Very few members of Parliament have the necessary knowledge in this field, putting great strain on the ministerial system. The government should create a new kind of ministerial position to attract expert leaders to run programmes in an executive fashion, similar to how the Vaccine Taskforce was run. These executive ministers would be accountable to Parliament in the normal fashion, but would bypass the usual House of Lords appointment process.

> **Technical recommendation:** Move beyond the standard ministerial system to appoint experts as specialist Whitehall executive ministers.

The government should also act to make it far easier to attract technical talent into the civil service and retain it, bringing world experts into government for meaningful periods of time, not merely to sit on external advisory boards. This should entail minimal friction and require rapid, enabling leadership to build internationally outstanding teams. World-class technical talent is used to being hand-picked and hired, rather than forced through six-month recruitment processes. For example, UKRI should be able to hire people rapidly into key directorial positions without completing the usual public processes. In addition, our top public R&D facilities should be exempt from the 2010 Pay Controls, allowing them to again compete for and retain global talent. Our best institutions are currently losing top talent they have nurtured as a result of these rules.

> **Technical recommendation:** Accelerate existing recruitment processes and exempt R&D facilities from pay controls to attract global tech talent and expertise.

Expert review, including international perspectives, should be used to assess whether a programme has been well conducted and responsibly budgeted, rather than non-specialists carrying out the assessment based on the National Audit Office's "Value for Money" criteria.

> **Technical recommendation:** Assess the success of programmes through expert review, not generalist audit.

Use Procurement to Directly Drive Innovation

From the semiconductor industry in the 1960s through to the reusable-space-launch industry in the 2010s, the US government's willingness to act as a "buyer of first resort" that creates markets for early-stage innovation has consistently accelerated progress for technologies that benefit the whole world. [57] The UK should draw inspiration from this, as well as from its own efforts with the Vaccine Taskforce, and leverage its significant procurement budget towards directly supporting R&D efforts that drive efficiency and greatly improve the quality of public services.

The Vaccine Taskforce used a procurement tool known as an "advanced market commitment" to help secure hundreds of millions of vaccines in an incredibly short window. The taskforce was also willing to take risks, act with urgency, empower expert judgement and adopt a portfolio mindset that tolerated failure. The US equivalent, Operation Warp Speed, saw government agencies guarantee sales for approved vaccines while paying firms to run trials and build vaccine-manufacturing plants at speed.

Similar procurement models could be applied to many domains where there are huge societal benefits, the scaling of relatively known science is required, traditionally significant regulation can be rolled back and pre-existing motivations need to be delivered at scale. As Chris Haley of the Global Entrepreneurship Network has observed, this will require a significant cultural change towards risk tolerance, as well as greater diversity in "alternative" procurement processes. [58]

> **Technical recommendation:** Update the government's procurement processes to account for the innovative potential of the relevant item. The government should strongly reduce friction to encourage risk-taking and reduce administrative requirements that favour incumbent players rather than SMEs.

An Advanced Procurement Agency

While we must reform broader procurement, we should also recognise the value of a smaller, nimble organisation to provide small-scale procurement of particularly high-risk innovative products and trial them in public services. Such an agency could play the same role as the US Special Forces play for the Defense Advanced Research Projects Agency (DARPA), providing a "buyer of first resort" for proof-of-concept work that is too risky for broader deployment, but which can be a stepping stone to nationwide use.

> **Technical recommendation:** Create an Advanced Procurement Agency (APA) with a specialised mandate to find opportunities for public-sector innovation, procure promising solutions, and manage their deployment, testing and subsequent marketing to the broader ecosystem, with a high tolerance for failure. This should create crucial market opportunities for higher-risk early-stage innovative products.

The APA should be run like an ARPA, with empowered programme managers who can exercise judgement and be autonomous within a flat hierarchy. Each programme manager would have a mandate to innovate in a particular area of public services, driven by a vision for how technology could catalyse progress in that area. This would resemble the role the special forces often play in military-technology deployments and similarly should have a small (less than 2 per cent) share of the overall procurement budget, but act as a "force multiplier" for the broader budget.

For example, a programme manager could aim to trial and apply advanced solutions for diagnostic screening and triage to a single NHS trust, then work with Whitehall to implement this system more widely if it succeeds. Another programme manager could work within a single school or even classroom over the course of a term to trial the use of AI assistants for educators and personalised tutors for learners. Yet another could work on deploying AI writing assistants for use by policy advisors within a single government department.

Beyond introducing visions for programmes that can drive innovation in narrow domains, we also need new mechanisms to present opportunities for innovation to the broader community and also to recognise success so that others can copy it. For example, the government could establish a range of prizes for the best examples of public-service adoption of innovative technology solutions across a range of different fields. Approaches drawn from highly innovative startup ecosystems should also be replicated.

> **Technical recommendation:** The new Office of Science and Technology Policy should conduct frequent foresight exercises that investigate how future technological advances could drive efficiency and improve experiences for services under departmental remits. These findings should enable departments to publish and maintain a "Request for Startups" list, like that used by American tech startup-accelerator Y Combinator, to signal to and incentivise innovators to work on relevant product ideas. [59]

Building AI-Era Infrastructure

The UK government has at times been a frontrunner in digital, with innovations such as the Government Digital Service and Cloud First Policy. But as the world enters this new era, the pace of reform needs to pick up.

Embed AI Across Public Services

While the use cases of generative AI and decision intelligence are still in the early stages of being explored, this technology represents a once-in-a-generation shift in our capabilities. As a cognitive assistant, it will be able to arm every civil servant and frontline deliverer of public services with syntheses of complex data, enabling them to make more informed choices without the need for technical expertise or access to privileged data sets. AI can convert text to designs, which can then be 3D printed, enabling almost-instantaneous experimentation and iteration of physical products in health care, for example.

A more focused use of AI systems in government could be as simple but effective as search tools that help people navigate gov.uk to access public services such as driving licences and tax accounts and make interactions with government a seamless process for citizens. The Estonian government, for instance, has launched Bürokratt, an AI virtual assistant that works on behalf of its citizens, proactively identifying and communicating public entitlements or services they would benefit from while providing them with controls and transparency on the use of their personal data.

AI is also on the cusp of revolutionising the education system. Machine-learning tools are now used to continuously assess students' progress, map strengths and weaknesses, and dynamically adjust the presentation of content. This helps students engage with homework and provides teachers with actionable insights. Emerging large language models, similar to ChatGPT, are being trialled as co-pilots for educators, helping to draft content or stand in as individual sparring partners for students. This, too, will help improve the average quality of instruction and encourage engagement with, rather than rejection of, new tech in the education system.

Sovereign General-Purpose AI Capability

Special focus should be placed on the transformative potential of next-generation, general-purpose AI systems such as ChatGPT, which could underpin considerable public-service delivery.

Given these AI systems will soon be foundational to all aspects of our society and economy, it would be a risk to our national security and economic competitiveness to become entirely dependent on external providers. Since the technology is sufficiently mature, the government should take on a greater role in its direct development to ensure the UK has sovereign capabilities in this field. Leading actors in the private sector are spending billions of dollars developing such systems so there may only be a few months for policy that will enable domestic firms and our public sector to catch up.

> **Technical recommendation:** Develop and procure sovereign general-purpose AI systems that can disseminate innovation throughout our public services. This should at first be done through procurement in partnership with a consortium of domestic AI firms that may be best placed with technical expertise. Simultaneously, an elite public-sector research effort modelled on

visionary labs such as OpenAI and DeepMind should be initiated to ensure public-sector expertise and ownership of this technology.

Considering the pace of AI progress, the state will need to adapt to opportunities as they arise and focus on getting research advances into the hands of users as fast as possible. Direct access to and control over general-purpose AI systems can ensure this is possible while also supporting other initiatives, such as levelling up UK academia's access to the frontier of AI and creating a world-leading AI-assurance ecosystem.

Supercomputing Infrastructure

Raw computing power is essential to unlocking advances in AI, so we will need to become global leaders in the area of supercomputing. While the UK has significant technical talent and expertise, it has not been supported with the requisite capital investment, which has left us trailing our peers. Leading AI companies are spending billions of dollars on cloud-computing resources, with the US also poised to invest billions in the creation of a public-sector computing resource dedicated to AI research. [60] An expert panel has been exploring this area for the UK government's Future of Compute review. Their recommendations should be implemented in full and with haste when published. Looking further ahead, we should also move towards managing compute, and even general-purpose AI, as enabling utilities much like our water or energy systems.

> **Technical recommendation**: Ensure we have sufficient supercomputing to support specialist AI researchers in the public sector and universities. Some of this should be specifically reserved for developing sovereign large language models to be deployed in public-service delivery. Government departments could submit bids to access the resource, judged by an expert board convened by Number 10 and the Cabinet Office.

Create Foundational Health Systems

If AI should be embedded across public services, technology should be the centrepiece of a new health-care model. Harnessing both the power of data and advances in biotech can create a more predictive, preventative, personalised and participatory model, with the power to radically improve outcomes, dramatically reduce costs and bring about broader economic benefits. [61] It is no longer sufficient to simply manage rising demands; we must ask how we reduce that demand too.

The technologies of today and tomorrow will be critical in revolutionising health alongside wider reforms. They will include:

- Systems of records that can bring together comprehensive personalised health data in a secure way to reveal unprecedented insights about our own health and the population as a whole.
- Systems of engagement that reimagine how we interact with health-care systems to make them

more efficient and accessible.

- Systems of intelligence that can utilise our individual health data to inform personalised treatments.
- Systems of collaboration that can drive clinical research to develop novel treatments and help protect us from global health threats.

Covid-19 underlined the value of data in delivering novel vaccines at record speed, with those people identified as most vulnerable prioritised. We must look to build on this legacy. The NHS already collects a vast amount of data at a local level but since it is often siloed or cannot be easily exchanged across the rest of the health service, the full value is not being harnessed.

In the UK, NHS England is attempting to address a long-standing challenge of data fragmentation across the health service, with legacy systems, data silos and a lack of interoperability impeding improvements in efficiency, delivery and research. For example, while approximately 90 per cent of NHS Trusts will have electronic-health-record (EHR) systems by the end of 2023 (10 per cent will still be paper based), these will be hosted by more than 60 different vendors across platforms that are not interoperable, making it difficult for different trusts to exchange data or for the centre to fully see the big picture. The federated data platform that the NHS is currently seeking to procure solves this requirement by building a platform that can abstract and connect data from different localised databases. This creates a single interface that aims to enable users to seamlessly store and retrieve data from different source databases within the federated system (even if these databases are heterogeneous).

However, a single centralised system would likely be a better option. It would mandate common data collection, data standards and interoperability, enabling the benefits of a connected data system to be fully realised. It would ensure a common standard of EHRs across the NHS, in terms of functionality, resilience and universal coverage. A single database would also be able to connect more easily with external systems to share data such as clinical-trials-management systems, trusted research environments or platforms providing data from devices such as wearables.

> **Technical recommendation:** The NHS is currently tendering for its own federated data platform. Instead, a single national health infrastructure that brings together data into a world-leading system should be developed as a once-in-a-generation attempt to revolutionise health in the UK.

The size of the prize of improving clinical decisions, public-health policy and health-care delivery is significant. In 2019, Ernst & Young estimated that unlocking NHS health data could be worth up to £10 billion a year through operational efficiencies, improved patient outcomes and wider economic benefits. [62]

Treat Data as a Competitive Asset

Data is critical to unlocking the benefits of artificial intelligence. As it stands, huge amounts of public data are distributed, owned by different departments and bodies but only partially connected, often in an ad-hoc manner. While the government has made admirable efforts to address this in core areas of public-service delivery, there is an opportunity to go further. Creating a shared data architecture is a huge lift but it is just as important as the physical infrastructure that has housed our public services over the past century.

It is easy to take much of our existing data infrastructure for granted. The Google Maps Platform is embedded in millions of companies' profiles, improving user search by many orders of magnitude. GitHub democratised coding in a manner previously unimaginable. Both enabled enormous downstream innovation, for their organisations and the wider economy. Yet this is not an area in which the government should sit idly by and let the private sector do all the building. A mindset change is required.

Government must use data as a competitive asset. Historically, publicly available data has been responsible for advances in AI. For example, ImageNet drove rapid progress in computer-vision algorithms while Common Crawl and The Pile have enabled modern language models. These data sets were relatively cheap to produce – in the region of hundreds of thousands of pounds – but have generated spillover value into the billions of pounds. Outside AI, the Human Genome Project birthed modern sequencing and personalised genomics, leading to Iceland's deCODE genome-sequencing project (with a value of $200 million) and the biomedical database and research resource UK Biobank, a benchmark study and a significant value-add to the UK's medical understanding.

Health provides an obvious example. While new secure data environments – which enable approved researchers to access (but not hold) anonymised data in a controlled environment – are a promising start, we must go further and faster. Biobanks have played a crucial role in increasing scientific knowledge in areas where it had previously been costly to collect data. Since 2015, the number of scientific publications using biobank data has increased more than fourfold. UK Biobank is helping to produce the world's largest organ-imaging data set, based on 60,000 participants, to assess disease progression. This is a fundamental 21st-century public good generating enormous public value.

The downstream effects of a more concerted data-collection and curation effort in health could be transformative. In limited trials, we have already seen new AI-driven techniques used in routine scans to help identify and predict more than 50 diseases of the eye, and to improve breast-cancer diagnoses. Careful curation of open-source protein and metagenomics data sets by entire subfields of biology was critical to enabling the training of AlphaFold, which in turn enabled new data sets of predicted protein structures for almost all known proteins. [63] Drug design and discovery could be similarly catalysed when built on massive data sets that the NHS would be among the best-placed in the world to collect.

By building the sort of national health-data infrastructure described above, and expanding access in an appropriate and safe way, we would make more effective use of the NHS's competitive edge over other health systems, providing invaluable data sets that could drive unparalleled progress in UK life sciences to deliver novel treatments and diagnostics. Furthermore, charging for life sciences firms to access national health data, where appropriate, could also generate funding for greater investment in public R&D. [64]

The government should extend these efforts in health and identify similar opportunities in other sectors to enable both sector-specific and more general AI advances.

> **Technical recommendation:** The government should run a "Future of Data Challenge". This should start by announcing a public call for the desired data. Proposals would then be considered during the submission of bids or they would be funded immediately, depending on feasibility. This would be carried out by a small team of mostly technical experts, with a focus on data sets that either directly incentivise AI research in valuable ways or drive down the cost of future ones.

This should involve the crowding in of private co-investment to fund each data set, just as 75 per cent of the UK Biobank was privately funded. Designed well, the benefits could be either solely or primarily extracted for the UK – for example, by generating data sets with immediate UK applicability, such as for self-driving cars.

Digital Identity

Today, many of us can set up a bank account in minutes and pay for shopping at the tap of a watch or phone. For the generation now entering middle age, this level of digital simplicity and streamlining is expected as a default while those in their 20s have grown up in an entirely digital age. Despite this, government records are still based in a different era.

The debate over digital IDs has raged in the UK for decades. In a world in which everything from vaccine status to aeroplane tickets and banking details are available on our personal devices, it is illogical that the same is not true of our individual public records.

Governments are the original issuers and source of truth for most identity documents, from birth certificates to passports. Rather than creating a marketplace of private-sector providers to manage the government-issued identity credentials of citizens, the government should provide a secure, private, decentralised digital-ID system for the benefit of both citizens and businesses. A well-designed, decentralised digital-ID system would allow citizens to prove not only who they are, but also their right to live and work in the UK, their age and ownership of a driving licence. It could also accommodate credentials issued by other authorities, such as educational or vocational qualifications.

This would make it cheaper, easier and more secure to access a range of goods and services, online and in person. A digital ID could help the government to understand users' needs and preferences better, improving the design of public services. It would make it simpler and easier to access benefits, reducing the number of people who are missing out on support they are entitled to. It could even help the government move to a more proactive model, meeting people's needs before they apply for a service, tailoring the services and support they are offered to their individual circumstances and reducing administrative burdens on both individuals and the public sector.

Technologies such as advanced encryption techniques using zero-knowledge proofs allow attributes to be securely shared and verified without exposing the underlying data or sharing unnecessary information, without the need for paper documents or counter-signatures. To date, the UK has made only tentative steps towards sharing data among public-sector organisations, either for policy-making purposes or delivering services. By contrast, in Estonia, a data-exchange layer called X-Road connects these systems and allows citizens to permit certain bodies to access information held on them by other parts of government. This is underpinned by the "Once-Only" principle – a legally binding requirement on the government not to request information from citizens if it is already held by another government entity.

A digital-ID system rooted in a public-sector data architecture like this could pave the way for individuals to make better use of their own data, for instance by using proof-of-mobile bill payments to support their credit rating, or by being able to prove school-attendance records as part of a job application. Far from being a nice-to-have or a question of marginal improvements in online public services, a properly functioning digital-ID system is the cornerstone of a digital-era public sector.

> **Technical recommendation:** Accelerate the implementation of a single digital-ID system for all residents, providing a digital wallet to access it, while ensuring that digital and physical copies of ID have the same legal status (as is the case in Ukraine). [65]
>
> **Technical recommendation:** Legislate for a wide-ranging "Once-Only" principle as a forcing mechanism to spur secure, proportionate data-sharing between government agencies.

Invest in Education to Build the Skills of the Future

If becoming a leader in science and innovation is central to the UK's new national purpose, every child, whatever their background or circumstances, must be able to get a first-class scientific education. Those children who choose to pursue an academic future must be able to become the UK's next scientists, mathematicians and entrepreneurs. Those who opt for a technical vocation need the skills to contribute to the industries of tomorrow from green manufacturing to retrofitting homes.

Higher education (HE) is already critically important to the UK's economy, which has become progressively more reliant on human capital over the past two decades. The sector's expansion has tracked the economy's shift from vertically integrated manufacturing industries (which required a relatively small number of HE graduates) to knowledge-intensive services (in which demand for graduate skills is high).

The fruits of this expansion are clear. For instance, approximately 20 per cent of the UK's economic growth between 1982 and 2005 flowed directly from accumulated graduate skills, while at least one-third of the increase in labour productivity in recent decades can be attributed to the rising number of graduates. [66]

All the signs are that HE's salience will continue to rise in the years ahead: as the government's own commissioned forecasts show, technological disruption is redefining the jobs market, placing even greater premium on higher-skilled individuals. Future HE expansion could also play a critical role in spreading the seeds of growth and skills development across less economically developed parts of our country.

Accelerate the Rollout of Edtech

Our school systems, which were under significant pressure even before the pandemic, are struggling to provide first-class education. The latest figures show 31 per cent of teachers who qualified in 2016 have left teaching five years on. [67] Workload is a factor in low retention rates, with 37 per cent of secondary-school teachers reporting this is a "very serious problem" for them. Moreover, less than half of a teacher's working hours are actually spent teaching. The latest figures show the average secondary-school teacher spends 49.1 hours a week working, but only 19.9 of these teaching. Most of the rest of their time is spent on lesson planning (7.3 hours), marking (6.3 hours) and general admin (4.8 hours). [68]

Social mobility is also in decline, with the longstanding attainment gap between disadvantaged children and their peers continuing to widen. For example, research by the Education Endowment Foundation suggests the gap in mathematical attainment between disadvantaged primary-school pupils and their peers increased by up to 17 per cent during the pandemic. [69]

Rolling out edtech could help make schools more effective and reduce the attainment gap. Embedding edtech platforms in schools would automate marking and other admin, allowing teachers to focus more of their time on teaching and inspiring their students. Adoption of even basic systems for student records and staff communication would save money and time for administrators and educators by reducing the burden of coordination.

In the classroom and lecture hall, technology can help scale up effective pedagogical practices (such as peer feedback) and new forms of assessment that better reflect the changing expectations of students.

Additionally, remote learning can improve access to high-quality teachers. A permanent, portable digital learner ID would enable our education system to keep track of students' progress across different stages, offering tailored support, and giving students more ownership of their personal data.

One AI-powered teaching and learning platform, from UK startup CENTURY, has already been found to cut workloads by an average of six hours a week, freeing up time for teachers and social workers to focus their attention on supporting children while spending less on paperwork. [70] Meanwhile, by expanding access to intelligent tutoring systems, disadvantaged children can be supported to better compete with their privately tutored peers and "disrupt the shadow education system". [71]

> **Technical recommendation:** Accelerate the rollout of edtech in schools across the country. With a recent evidence review commissioned by the government finding that staff confidence is a key challenge to implementation, ministers should introduce a new edtech-training fund that schools can access to pay for one of their teachers to become proficient in specific platforms. These teachers could then help upskill their colleagues to ensure the whole school benefits.

Remove Barriers to Attract the Best Talent in Priority Fields

We cannot shape the future without making Britain a go-to place for leading talent. In a population where 14 per cent of UK residents are born in another country, 49 per cent of the fastest-growing businesses in the country have at least one foreign-born cofounder. [72] However, our visa application process is complicated and Brexit has increased friction for would-be migrants.

The High Potential Individual (HPI) visa is a step in the right direction, but it is not accessible to a big chunk of global talent. For example, its academic criteria mean that Silicon Valley feeder schools such as the Indian Institutes of Technology (IITs) and Canada's University of Waterloo are missed out. This could be remedied by including the earning potential of graduates in the selection criteria for the HPI. Furthermore, when applied to narrower domains such as AI, some of the best graduate schools including the Universities of Montreal, Tübingen and Amsterdam are not covered under this route.

> **Technical recommendation:** Introduce talent visas for strategic science and technology priority areas, which accommodate the specialisms of different universities and their graduate-earnings potentials.

Our current system does not incentivise top-performing international students to stay or return to the UK. Our universities are not included in the criteria for the HPI visa while a student visa does not count as time towards an individual's indefinite leave to remain, even for priority talent such as PhD students in UKRI AI Centres for Doctoral Training. We are training world-class talent only to lose it to Europe and the US.

Furthermore, internship visas are still very difficult to arrange. In many key scientific industries, internships and fellowships act as a prerequisite for getting a full-time role.

> **Technical recommendation:** Create a High Potential Student visa for those studying in strategic science and technology priority areas. This should count as time towards an individual's indefinite leave to remain while also being more lenient in terms of working restrictions to enable these students to more easily work for innovative companies or build their own startups. Additionally, a more comprehensive High Potential Internship visa should be created.

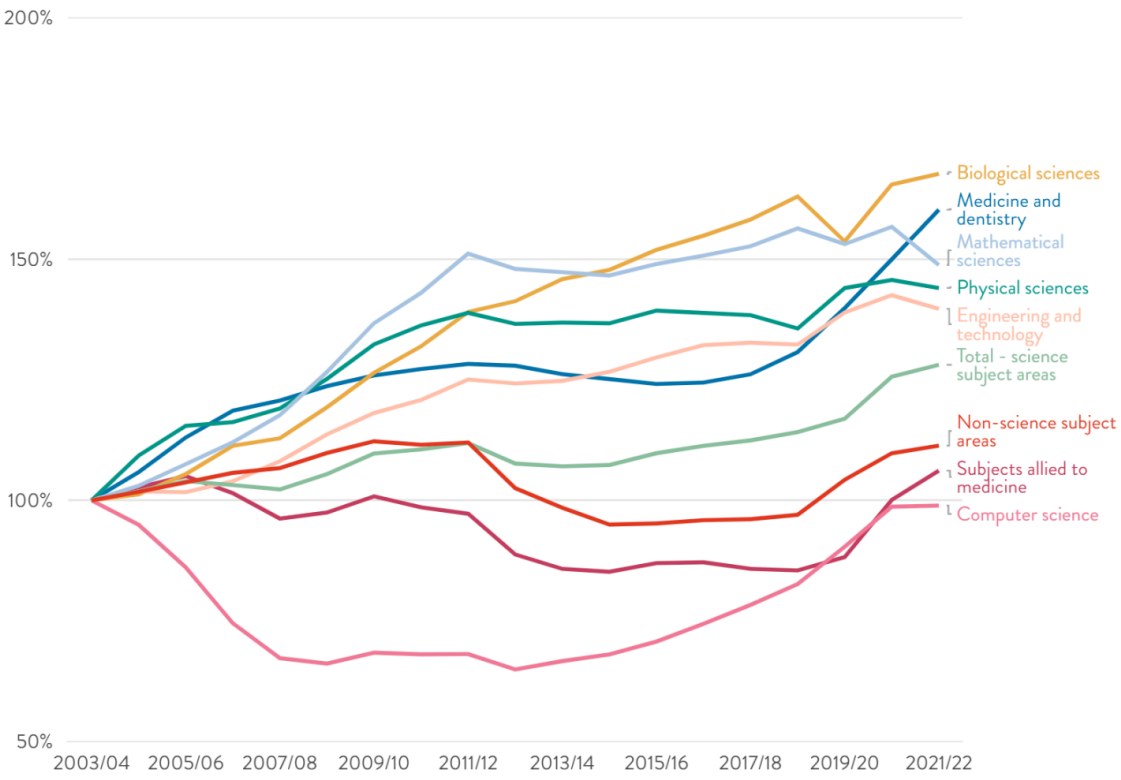
Educate, Train and Retrain Talent to Power the Science Revolution

Realising the UK's science and technology ambitions will be impossible without a large and skilled workforce to discover and roll out technological advances. This will require action on three fronts.

First, more needs to be done to encourage those studying STEM subjects at university to go into professions linked to research and innovation. The latest figures from the Association of Graduate Careers Advisory show that only 8 per cent of physics graduates are working as science professionals 15 months after qualifying compared with 22 per cent in business, human resources and finance. While the figures are better for biology and chemistry students, with more than 30 per cent of each graduate stream becoming science professionals, significant numbers are not using their degree to advance a national innovation agenda. [73]

Second, more must be done to encourage children to study STEM subjects at university. Some progress has been made in recent years, with the number of undergraduates studying STEM subjects having increased 28 per cent over the past 20 years, a growth rate more than double that of non-science-related subjects (11 per cent). Biological sciences and medicine have grown fastest at 68 per cent and 60 per cent respectively, while growth in engineering and technology has been more sluggish, standing at 40 per cent, and the number of computer-science undergraduates has fallen slightly (-1 per cent).

Figure 2 – The number of UK undergraduates by STEM subject between 2003 and 2022



Source: HESA

> **Technical recommendation:** Boost the number of graduates in engineering and computing by encouraging more women and girls to consider these fields, each of which are currently dominated by men (81 per cent of undergraduates in both are male). [74] Commonly cited barriers for women include stereotyping at school age, a lack of perceived female role models and not enough advice in schools on related careers. [75] Doing more to celebrate female visionaries such as Dr Özlem Türeci (who helped to pioneer mRNA-vaccine innovation for BioNTech) and Kate Bingham could help to elevate the status of female leaders, for example through new public honours for innovators. [76]

Likewise, providing more resources to support women in technology at different stages will help to close the gender gap. Programmes such as Code First Girls, which can be partnered with schools, will help children understand their potential from a young age while expanding doctoral-training support in areas that are experiencing the gender gap the most, such as AI and data science, will also have a similar function.

Although STEM is important for supporting the broader labour market, the elite-level courses already on offer also need reform. There is a supply-side problem at the apex of the technical courses being offered by top UK universities. For example, while Stanford University's computer-science major offers 36 core

classes in AI and a further 28 electives, Oxford offers only four and Imperial only one. Oxford continues to offer 32 places for computer science – the same as in 2002. Without scaling up the numbers who can study the best classes in subjects such as computer science, we are limiting our own talent pool and potential.

Additionally, the time taken for UK universities to update their courses holds back students from learning state-of-the-art subject matter. It can take up to three years for a new course to be approved at a UK university. In industries where the pace of progress is measured in months, this means that material could be out of date even before the opening lectures have begun.

> **Technical recommendation:** Reduce the time taken for new courses at UK universities to be approved and scaled to ensure that students have access to cutting-edge research and industrial insights.

Finally, skills training – both for young people and older workers who are seeking to retrain – needs to be mainstreamed. AI and other emerging tech will transform the jobs people do, reducing employment in some sectors and increasing it in others. With the latest government analysis suggesting that approximately 30 per cent of existing UK jobs face a high probability of automation over the next 20 years, ministers will need to provide much more support for workers to retrain. [77]

> **Technical recommendation:** Draw inspiration from cooperative education models such as those pioneered by the University of Waterloo, which incorporates multiple industrial placements into science and engineering undergraduate degrees. This ensures that students have diverse real-world work experience even before graduating. The university has been highly praised by Silicon Valley companies for the quality of its graduates. [78] This approach could be particularly useful in levelling up universities outside the UK's golden triangle of Cambridge, London and Oxford, while increasing the amount of graduates leaving university with applied skills.

Reinvent the Processes of Science and Innovation

To thrive in the 21st century, the UK needs a public R&D ecosystem that can compete with the very best in the world, anchoring global tech networks and attracting international talent. Our location, language, universities and history make us well placed to achieve this goal. But doing so also requires substantially increased investment, reform of our existing funding structures and diversification of our approach.

Increase Public R&D Investment

Public investment is essential to a vibrant R&D system, but the UK public R&D budgets have been among the lowest of any comparable nation for almost 40 years. Public R&D financing is the most reliable predictor of private R&D investment globally, with £1 of public R&D expenditure reliably crowding in £2.5 of private R&D funds at the overall national level. [79]

While the current government's increased R&D investment is very welcome, much of the uplift is the result of taking on the cost of Horizon programmes from the EU, [80] accounting for £6 billion this Parliament, and of an increase to defence R&D, accounting for another £6 billion. Substantially increasing government R&D budgets in other research areas will therefore be critical.

The UK needs to shift its macroeconomic attitude to view public R&D investment as a driver of growth and private R&D financing that pays dividends over time, not as a sunk cost to be traded against other priorities.

> **Technical recommendation:** Increase direct public R&D investment, aiming to become the leader among comparable nations in the metric of public R&D investment as a share of GDP within five years. This should be a key national benchmark, as is our NATO defence-spending target of 2 per cent of GDP and our 2050 net-zero target.

Given the small size of the UK's R&D budget relative to broader government expenditure, this tranche of spending can be markedly expanded without substantial alterations to the national debt. Furthermore, increased spending is likely to pay for itself through economic growth, improved public services and higher productivity, which will increase tax returns. However, such benefits are not immediate and will require patience. Further, it is important to realise that the resulting increase in private R&D investment occurs at the national level, not on an investment-by-investment basis. Expecting direct industry partnership on each individual investment can risk favouring large incumbents or subsiding existing work. Rather, government investment creates a conducive environment in which private industry can grow.

While some may worry about increased investment in difficult economic times, the hidden costs and lost opportunities of inaction and losing the technology competition are much higher – costs that do not factor into current calculations.

In addition to investments outlined in other sections of this paper, increased R&D spending should be directed towards an agenda of reform and diversification rather than a broad expansion of existing options.

Empower Our Universities and Institutions

Government needs to view our nation's key research assets not as employees to be micromanaged but assets to be empowered and nurtured. Every demand for data and metric-based targets reduces the agency, time and freedom of people on the front line, and risks constraining our institutions.

Reform starts with placing greater trust in delivery partners. There is currently far too much bureaucratic control of our top institutions. The Medical Research Council (MRC) Laboratory of Molecular Biology in Cambridge was originally reviewed by one five-page progress report every five years. That report has now grown to 2,000 pages. The Russell Group has even called for a public investigation of this issue. [81] The recent Independent Review of Research Bureaucracy was a step in the right direction, but a wide range of processes from the Department for Education and the Treasury were out of scope and must be addressed.

> **Technical recommendation:** Government should take steps to radically slim down the ever-growing audit culture and reduce the bureaucratic burden it places on our leading research institutions. This should involve removing the Teaching Excellence Framework (TEF), Knowledge Excellence Framework (KEF) and other processes predicated on central management and audit of our top institutions.

The increased number of universities has meant much greater competition for a similar-sized pot of research funding. Furthermore, universities with very different focuses are examined identically through the Research Excellence Framework (REF).

> **Technical recommendation:** Explicitly divide universities into different categories and create special support structures for institutions with an unusual focus, recognising different universities have different missions. This could include specialised arrangements for world-class academic research universities and leading institutions with more specialised technological expertise, such as the University of Strathclyde and Cranfield University.

The cultural challenges outlined above extend beyond universities and institutions to affect UKRI itself. The National Audit Office has identified major challenges in delivery that harm performance caused by excessive control and rules. [82] These should be addressed with ambition and vigour.

> **Technical recommendation:** Commission current and former UKRI CEOs and chairs to report on changes needed to the governance and oversight of UKRI to enable the organisation to perform better. Issues like public-hiring rules and pay scales, Treasury spending controls, and micromanagement by Whitehall should be considered.

Reform Our Funding Approach Through UK Research and Innovation

The UK has a great opportunity to tap into the global appetite for reform and lead on changes to how we organise and fund science.

The notion that there are major challenges with standard research-funding strategies is now mainstream. [83] Commonly cited problems include over-dependence on risk-averse approaches to resource allocation that reinforce the status quo, a short-term funding mindset and a system geared towards funding senior incumbent scientists rather than junior researchers with new ideas. [84] These issues have worsened over time.

As noted above, the system is also highly bureaucratic, with a strong audit culture emphasising paperwork over progress. These challenges are at odds with the need for freedom of exploration, curiosity and scientific creativity that are essential to promoting world-changing innovation, as highlighted by Lord Martin Rees and others. [85] Our research funders are also constrained by legacy academic disciplines and dependent on large institutional bureaucracies renowned for slowness and caution.

The elevated R&D investment that we argue for should therefore be matched by a substantial reform agenda driven by UKRI. This should aim to increase the agency of people and teams on the front line, place greater trust in researchers, and adapt science for the interdisciplinary, technology-intensive research of the 21st century. Some of this will come from the changes to the government's approach to investment outlined above, but there are several other reform directions to promote innovation:

> **Technical recommendation:** Restructure UKRI for 21st-century challenges. UKRI is currently organised as nine separate funding organisations, mostly defined by decades-old academic disciplines. These silos are not appropriate for the challenges ahead. UKRI should use the authority granted in the 2017 Higher Education and Research Act to create new bespoke research councils as needs arise. These councils could focus on strategic challenges and opportunities such as AI while remaining independent from the larger institutional bureaucracy and acting with agility through programme-manager-led approaches. [86] UKRI should also take steps to have a richer diversity of researcher backgrounds, diversifying beyond the academic hierarchy.
>
> **Technical recommendation:** Reorient the UK funding portfolio to attract and give independence to the large pool of junior talent. Globally, more and more power has moved to senior researchers, resulting in major concerns about the culture of research, an exodus of junior talent and an entrenchment of old paradigms, for example in academic AI. [87] While

initiatives like the Francis Crick Institute and the Janelia Research Campus have focused on recruiting and empowering junior talent, this has not been adopted at a national level in the UK.

Technical recommendation: Fund long-term teams, not projects. Our best researchers spend their time applying for many short, incremental grants. Learning from the world's leading non-profit research endowments like the Wellcome Trust and Howard Hughes Medical Institute, as well as Horizon, and the "research centre" approach pioneered at UC Berkeley, [88] we should give sustained, long-term support to world-class research groups, freeing the best research teams from the hyper-competition and pressures of the overall system, with particular focus on early- and mid-career. We should also experiment in Y Combinator and Entrepreneur First-style support programmes for teams of junior talent.

Technical recommendation: Embrace metascience experimentation in funding mechanisms. UK mechanisms of research funding have remained largely unchanged for decades. UKRI should be given a specific objective of experimenting with new approaches to funding, in line with the work of the UK Research on Research Institute. [89] For example, it could introduce funding lotteries to alleviate grant-proposal-optimisation pressure, as well as approaches such as funding-by-variance and "golden tickets" to reward non-consensus ideas. [90] UKRI's Economic and Social Research Council should also embark on a metascience research programme.

Create New Research-Institution Networks and Approaches Adapted to the 21st Century

We need new institutions specifically adapted to 21st-century science. The practice of science and technology has changed dramatically in recent decades, becoming more interdisciplinary, technology dependent, teams focused and globally competitive. Meanwhile, our institutions remain largely unchanged.

The UK once led the world in pioneering new institutional models of organising and convening researchers, such as the Royal Society and the MRC Laboratory of Molecular Biology. However, recently it has not kept pace with institutional innovation in other countries, especially the US. [91] The UK must be at the forefront of reinventing how science and technology is funded and organised to recapture its lost lead.

Countries like Germany and the US have highly diverse institutional landscapes for R&D, with specialised networks of research organisations that have specific missions. Germany has the Max Planck Society, Fraunhofer, Helmholtz Association and Leibniz Association, each with multi-billion-euro government funding annually. This approach recognises that different organisational models are suited to different kinds of challenges and have different incentives, and the approach promotes a diversity of research cultures.

By contrast, R&D budget cuts in the UK since the 1980s have led to the most homogenous research system of any comparable nation with a strong dependence on university research, [92] leading to high-profile calls for a more diverse approach. [93] While universities have many strengths, they are not designed for all kinds of problems, [94] suggesting a need to move beyond a one-size-fits-all model. As noted by research-policy expert James Wilsdon, "if there is an iron law of research policy it is that plurality and diversity are really important". [95]

Technical recommendation: Expand funding for the Advanced Research and Invention Agency (ARIA) to embed nationwide programme-manager-led research. ARIA is the first ARPA-style agency outside the US and the legislation establishing it affords it key legal freedoms and independence to be a genuine ARPA agency, closely modelled on DARPA's independence from the US Department of Defense. ARIA also has the freedom to engage in broader metascience-related experimentation. However, as has been widely noted ARIA has an extremely modest budget averaging only £200 million per year, roughly one-fortieth the annual US ARPA investment and one-twentieth DARPA's alone, barely the size of a single major DARPA project. ARIA should be funded at a much higher level to operate with strategic significance.

Technical recommendation: Create a network of "Lovelace Disruptive Innovation Laboratories" to create industries of the future. [96] Currently, the UK lacks a mechanism to bring a diversity of skilled, world-class talent to bear on nascent fields of technology at the pre-commercial stage. This lack of "mission" or "vision" focused institutions is a major gap. The UK should invest in a network of research institutes tasked with securing our lead in established competitive areas like synthetic biology and AI as well as pioneering new ones with speculative, risky bets as we did in creating the Cambridge Laboratory for Molecular Biology in the 1950s. The proposed institutes should be benchmarked to leading international competitors in core funding and bring together a critical concentration of researchers across science and engineering. This would apply lessons from the historical examples of Bell Labs, Xerox PARC and more recently Google DeepMind and Gerry Rubin's Janelia Research Campus, which share many common features that differ markedly from conventional research environments. This network could be named in honour of a British technological visionary, such as Ada Lovelace, seeking to find and nurture today's equivalents of her vision.

Technical recommendation: Expand the Catapult Network in size and role to empower applied innovation. Modelled on the German Fraunhofer network, the nine leading technology and innovation centres that comprise the Catapult Network have a mission focused on applied research close to industry, but they are currently limited in scope and scale. The Catapults should be broadened in role, given greater independence, diversified in target and expanded in number so they can act as devolved hubs of regional development. New Catapults should be

created, for example learning from the "Living Labs" such as the Glasgow Living Lab, [97] which brings together local universities, NHS trusts and industry to experiment and deploy solutions in real-world scenarios.

The new institutional networks should be given a royal charter and placed on a separate legal footing, as they are in Germany, with mission, defining principles and independence codified in legislation. This will help ensure they have the durability and independence to have a lasting impact.

Beyond restoring research diversity by copying the successes of our peers, the UK state should also look forward to entirely new modes of disruptive science. One example is the emergence of distributed research collectives such as EleutherAI, the Large-scale Artificial Intelligence Open Network (LAION) and CarperAI that have pushed the frontier of AI research. These self-organising groups of independent researchers have flat hierarchies, are coordinated on unconventional online forums such as Discord servers and are open for anyone to join without consideration of credentials.

In addition to their work producing highly impactful AI models and data sets for release as public goods, distributed research collectives have served a secondary purpose in finding and empowering otherwise hidden talent that traditional academic systems ignore or fail to support in a timely manner. Researchers discovered through these collectives have gone on to build AI startups or have directly joined elite industrial labs such as OpenAI.

> **Technical recommendation:** Support distributed research collectives to democratise research, uncover talent and broaden opportunities for researchers throughout the UK. The government should empower young, online communities through access to scientific-computing infrastructure or direct funding and explore how to replicate the unconventional approach of these collectives in areas of science and engineering beyond AI.

Incentivise Century-Defining Companies and Industries

Venture capitalist Matt Clifford has written about the need to create greater talent density and a virtuous circle of entrepreneurship. One of the keys to the strength of Silicon Valley as a tech hub, for example, is that successful founders go on to invest in new founders. In his view, efforts need to include raising the "status of entrepreneurship" to become a destination of choice for top technical talent, as well as building more clusters. He argues that if incentives are set up correctly, "the results are self-perpetuating. More high-quality entrepreneurs mean greater network density for the next generation of founders. And entrepreneurs with denser networks have better ideas, get better advisers and generate more revenue." [98]

Improving the density of entrepreneurial talent in the UK requires reforms to education and skills, as mentioned above, as well as political leadership. In recent months the government has cut policies such as R&D tax credits and Business Asset Disposal Relief, decisions that have been met with concern from those building companies in the UK and prompted some to look at options to relocate overseas. [99] This comes as other countries are adopting policies to encourage scale-ups in frontier tech, including new funds such as Germany's Deep Tech & Climate Fund (DTCF) and France's ambition to create 500 deep-tech firms and 100 unicorns. [100]

Unlock Massive Growth Equity

The UK has produced more tech unicorns – young companies valued at more than $1 billion – and secured more venture-capital investment than any country in Europe. Yet we have struggled to turn this entrepreneurship to our advantage.

One of the challenges is encouraging the patient, long-term capital and first-of-a-kind financing that is critical in deep tech, including in climate and biology, as technologies of this kind often face "valleys of death": first, in proving that ideas that come out of the lab can scale; second, in trying to commercialise technologies that have larger capital requirements than software and are not suited to traditional venture capital.

Wider reforms are also needed to encourage entrepreneurship and VC funding, such as passing the London Stock Exchange listing reforms recommended in the UK Listings Review chaired by Lord Hill and the Kalifa Review of UK FinTech, including allowing dual-class share options. Some implementation has begun to happen but given that London accounted for only 5 per cent of IPOs globally between 2015 and 2020, action needs to be quicker.

The British people stand to benefit if we get the incentives right.

One critical issue in taking advantage of our technological strengths is the UK's ability to effectively deploy the capital it does have. Currently, the UK has the second largest pensions market in the world. Despite this advantage, overseas pensions invest 16 times more in venture capital and private equity in the UK than domestic public and private pensions do. [101]

For example, in 2021, the £330 billion Canadian Pension Plan (CPP) invested £300 million in one UK-based company, equivalent to the average size of a UK defined-benefit (DB) pension fund (£330 million) and more than the entire UK pensions system invested in private equity and growth capital (£190 million) that year.

The CPP was started in 1999 with around £9 million in taxpayer funding. At the end of 2022, the CPP Investment Board managed £330 billion in assets, making it 1,000 times the average size of a UK DB

private-sector pension fund and 8.5 times the size of the £39 billion UK Pension Protection Fund (PPF). [102]

Despite startup financing being the focus of several government reviews and new funds, the UK has continually struggled to deliver a sufficient scale and volume of patient and growth capital to the country's startup companies.

The UK's DB pensions industry is fragmented, with over 5,300 schemes with an average size of £330 million. Their investment strategies, driven by risk-averse corporate sponsors and finite investment horizons, have typically pursued a zero-risk approach.

According to Michael Tory, co-founder of the advisory firm Ondra Partners, the UK is one of the only major economies where domestic pension funds have in effect abandoned investment in UK companies. [103] The proportion of UK pension funds invested in bonds increased from less than 20 per cent in 2000 to 72 per cent in 2021, even as their investments in UK equities dropped from 50 per cent of their asset allocation in 2000 to just 4 per cent in 2021. [104]

Overall, larger pension funds have generated higher returns for pensioners. The £330 billion Canadian Pension Plan Investment Board's (CPPIB) annualised return for the past ten years (net of its investment costs) was 10.8 per cent and £39 billion PPF returned 9.2 per cent, compared to just 6.2 per cent for the UK's private-sector DB schemes.

These rates of return compound over time and, coupled with new pension contributions, have allowed the CPPIB to diversify its asset allocation and make individual investments that dwarf the capacity of UK pension funds. The PPF generates higher returns because it allocates 41.5 per cent of its portfolio to return-seeking assets, while the rest of the UK pension system invests almost 75 per cent of its portfolio in fixed-income assets and only 5 per cent in private equity and growth capital. [105]

Until recently, defined contribution (DC) pensions have largely avoided investing in private equity because of concerns that performance fees, typically levied by private-markets managers, would put them at risk of breaching the 75 basis-point cap on retirement savers' fees. To date, most of the reforms for pension funds have focused on adjusting the 75 basis-point charge cap for DC pensions to allow fund managers to better accommodate performance fees and allow investment in private markets. Yet fees in other countries are often lower, [106] raising questions about the extent to which the fee structure is the problem and suggesting the fragmented nature of the UK DC pensions industry is a bigger issue.

The UK could use pension consolidation, as recommended by Sir John Bell, Martin Wolf and Michael Tory, to generate a £100 billion UK Pension Plan Investment Fund that would provide funding across multi-decade horizons with independent oversight. [107] Done right, it could give future generations a stake in Britain's success as a science and tech superpower.

Technical recommendation: Incentivise consolidation in the UK pensions system. The DB system should be consolidated from over 5,000 schemes to 100 or less and the DC system should shrink from over 27,000 individual employer schemes to a smaller set of master trusts. To encourage consolidation, the pension capital-gains tax exemption should only remain for funds with over £25 billion under management and that allocate 25 per cent of their funds to UK assets (for example infrastructure, equities or growth companies).

Technical recommendation: By combining PPF and NEST to create a single investment vehicle that participates in market consolidation, the UK could create a £100 billion UK Pension Plan Investment Fund with a mandate to invest 25 per cent of its assets in UK infrastructure, equities and growth companies. The fund should be managed independent from government oversight.

Eliminate Barriers to Academic Spinouts

Taking cutting-edge research from university labs to commercial success remains a critical challenge in the UK. This has long been identified as a problem, and the government has commissioned multiple reviews in recent years (MacMillan, Rees, Dowling, independent research commissioned by BEIS, Lambert). [108] Air Street Capital's Nathan Benaich has argued [109] that technology transfer offices (TTOs) are more of a hindrance than a help and should be reformed, and has put forward suggestions to do this. [110]

Technical recommendation: The options for how TTOs manage intellectual property can be simplified and made more transparent. Introducing a "Simple Agreement to Spinout" (SAS) would give TTOs a one-off payment for any patents used by the spinout and the option to select from the following options: 1) a common equity stake, 2) a small per cent royalty on net sales (direct or sub-licensing based) in the case of clearly identified IP over a drug molecule or medical device, or 3) a small per cent on exit. If the spinout does not use licensed IP for 24 months, it must return it to the university for recycling. No other fees are levied.

Technical recommendation: The goal and assessment criteria of TTOs should be recast as maximising the number of spinouts formed under the SAS, with a commitment to complete the process in no more than three months.

Reform Planning – Including Tech Infrastructure Exemptions

The limitations of current planning regulations for economic growth and inequality are well known. [111] This is a particular issue in science and technology. New infrastructure is vital for R&D endeavours, but the current planning system is a major time and resource constraint. It curtails the ability of

entrepreneurs to build the infrastructure they need and attract talent due to high costs and delays. For example, there is currently demand for around a million square feet of laboratory space in Cambridge, but only 10,000 square feet available. [112] Long delays also curtail endeavours in areas like nuclear fusion and advanced manufacturing where international competition for attracting partners is intense.

> **Technical recommendation:** Pursue broader planning reforms to ensure infrastructure projects that are critical to the UK's economic transformation can get approval in six months or less. This will mean reviewing, modernising and streamlining every step of the process, including the 2008 Planning Act, the process for setting out and updating National Planning Statements, and the process for local consultation and environmental audits. There must also be greater flexibility for amending a development-consent order once it has been submitted. A minister could be given responsibility for bringing together state actors – from local authorities and community groups to grid operators and planners – to speed planning approval and project delivery.

The construction of tech-relevant infrastructure such as laboratories is a very small part of overall building but has a disproportionate impact on the economy. It is an area where speed is vital.

> **Technical recommendation:** Create exemptions and fast-track processes for R&D infrastructure planning. This would allow rapid clearance of planning proposals in technology areas, prioritisation in planning and potentially access to sites otherwise not deemed available for development.

Build International Partnerships to Scale Our Efforts

To be a world leader in science, the UK will need to work with other countries to boost international innovation, set global standards for the responsible use of technology and share the benefits of technological advances to help improve the lives of the world's most vulnerable people.

Boosting International Innovation

It is clearly not feasible for the UK to cultivate a strategic advantage in every aspect of future technology. Even in areas in which we are well placed to succeed, like AI and the life sciences, we will need to cooperate with other countries. The government is seeking new bilateral science partnerships to replace the kind of research links we enjoyed within the EU – in the past three months alone this has included deals with Saudi Arabia on space-based solar power and critical minerals, the launch of a new International Science Partnerships Fund with Japan and a set of projects with South Africa to tackle antimicrobial resistance. [113] But without a strategy to connect these kinds of deals and outline the broad

contours of our domestic and international priorities on innovation, we risk a scattergun approach to this agenda. Ministers should take action on two fronts to address this.

First, the government should secure structured cooperation on science and innovation with our most important partner in this space: the EU. From Horizon to Euratom, the bloc has some of the most successful science programmes in the world, and these have been enhanced by the UK's involvement as a member state. The UK and EU agreed to discuss structured cooperation in science and research, particularly on Copernicus, Horizon, Euratom and the European component of international nuclear-fusion megaproject ITER, [114] but this has not been possible due to the dispute over the Northern Ireland Protocol.

Associate membership of Horizon Europe, the world's largest collaborative research programme, would help the UK build stronger research links both inside and outside Europe. Under Horizon Europe's predecessor, Horizon 2020, the UK established more than 237,000 collaborative research links in 163 countries, with 12 per cent of the individual links outside the EU. [115] Although the government is right to try and replace Horizon funding while awaiting certainty over the UK's participation, [116] the true value of the programme lies in these cross-border research collaborations, which are harder to replace. Meanwhile, participation in Copernicus would help the UK stay at the forefront of Earth-observation technology, and involvement in Euratom will help ministers deliver on their UK fusion strategy. With the Conservatives, Labour and scientific institutes in both the UK and the EU all keen to see British involvement in these schemes, [117] ministers should seek to secure participation as a matter of urgency.

Furthermore, ministers should also consider seeking participation in the European Defence Fund (EDF). Industry figures have expressed their concerns about the impact of non-participation on the UK's defence sector, [118] and the European Commission's plans to launch a new European Defence Investment Programme are likely to damage our domestic sector further. [119] Given the benefits of closer defence alignment for European security and the commitment in the 2019 Political Declaration to explore the UK's participation, [120] the EU would likely be receptive to an application to take part in the EDF.

> **Technical recommendation:** If the government can resolve the Northern Ireland Protocol dispute, it should seek associate membership of EU research programmes, including Horizon, Copernicus and Euratom, as a matter of urgency. It should also consider seeking participation in the EDF.

The second action ministers should take is to publish a long-term strategy for their planned approach to international partnerships on science and innovation. Using the Integrated Review's "own–collaborate–access" structure, this strategy should identify the areas in which the UK will seek to establish ownership of technological advances, collaborate with other countries on joint research endeavours and access critical science and technology from others. [121] Setting this out in a clear strategy

will provide investors with greater confidence about which aspects of the UK's tech sector they should invest in, as well as making it easier to monitor government efforts to reduce tech reliance on strategic competitors like China.

As part of this strategy, the UK should in particular prioritise research links with Japan, given both countries' expertise in science and innovation and their desire to strengthen ties in response to growing uncertainty in the Indo-Pacific. Supercomputing in particular would be a strong area for greater cooperation: to lead in this sector, the UK needs Japan's expertise in advanced manufacturing, electronics hardware and robotics, while Japan needs the UK's experience in the commercialisation of both AI and quantum. A government-led national-innovation partnership covering these areas would help both countries leverage their complementary strengths in supercomputing. [122]

> **Technical recommendation:** The government should publish a long-term strategy for international partnerships on science and innovation, using the "own–collaborate-access" framework to identify approaches for different sectors.

Setting Global Standards for the Responsible Use of Technology

While scientific and technological innovation can transform the world for the better, used in the wrong ways by hostile states or terrorist groups it can also be a tool of repression and authoritarianism. Take, for example, the Chinese Communist Party's use of surveillance technology to facilitate their oppression of ethnic minorities in Xinjiang. The UN has highlighted reports that the monitoring of the Uyghurs is being driven by "an ever-present network of surveillance cameras, including facial-recognition capabilities" and "broad access to people's personal communication devices and financial histories, coupled with analytical use of big-data technologies". [123]

As innovation accelerates, the potential capabilities of digitally enabled authoritarianism will only increase. Countries like the UK that value human rights and democratic norms need to do more to embed safeguards for responsible use of these emerging technologies within global frameworks. True leadership on science and innovation is therefore as much about developing frameworks for moral governance of new technology as it is about developing technology itself.

But China is currently shaping these frameworks, not the UK. As the Foreign Affairs Committee noted, that Beijing made 90 per cent of the standards proposals for surveillance technologies at the International Telecommunication Union between 2016 and 2019 shows China's firm intention to set the rules of the road for future technology. [124] But with a new national purpose underpinning science and innovation, coupled with our existing soft power, the UK should also play an important role in setting these rules.

The best way to achieve this would be to develop some form of structural cooperation on tech standards with the US and the EU, who regularly liaise on this issue through their Trade and Technology Council. [125] The informal E3 diplomatic coalition of the UK, France and Germany, with semi-regular meetings to discuss shared foreign-policy objectives, offers a potential model for what this kind of structural cooperation could look like. Meeting regularly to coordinate positions on tech standards, a "T3" of the UK, US and EU would be in a powerful position to influence international-standards bodies.

> **Technical recommendation:** The UK government should seek to establish a new informal "T3" coalition between the UK, EU and US to find areas of common ground on global technology standards.

Leadership on the global regulation of AI is particularly crucial, given the technology's potential for use by authoritarian governments. The UK has a natural advantage in this space due to the co-location of both technical and governance expertise in London, which does not exist in either Brussels or Washington, DC. The UK should serve as a mediating ground for aligning the AI approaches of our allies and agreeing standards that help to solve immediate challenges in a low-risk way, for instance by allowing governments negotiated access to their citizens' private medical data. As progress in this space is currently driven by private-sector actors, there will also need to be much better information sharing between these leading innovators, as well as with government and academia. The government should enable interfaces between these innovators and other aspects of civil society – for instance through citizens' assemblies, external ethics oversight and ombudspersons.

While we currently have an absolute advantage over all other countries except the US and possibly China in the field of AI, it is in our best interests to prevent a "race to the bottom" in which the speed of progress in AI would outstrip our ability to oversee and control it in a safe manner. We may only have a limited window of opportunity in which to leverage our leadership towards this. We should pursue more ambitious and multilateral science diplomacy in AI, drawing inspiration from initiatives in other areas such as the International Space Station, CERN and ITER, in a way that embeds our leadership and values into the frontier of this field.

> **Technical recommendation:** The UK should initiate and lead a multilateral scientific effort at the forefront of AI to ensure that this technology is developed safely, in alignment with our values, and has liberal democratic oversight and control.

As the impacts of AI may emerge suddenly and unexpectedly, the UK should also lead on its proactive and anticipatory governance. In particular, we should look beyond sector-specific regulation and focus attention on general-purpose AI systems. These systems will underpin progress across many sectors at once, and will require significantly more technical expertise than downstream sectoral users will possess to deal with these impacts.

> **Technical recommendation:** The UK should develop proactive and anticipatory governance of general-purpose AI. This would require better benchmarking of AI progress, even against speculative concerns, as well as improved oversight of the development of advanced systems, such as through monitoring and reporting on compute infrastructure used for training AI.

The UK, in partnership with its allies, should also consider using export controls on AI to prevent authoritarian countries using our technological advances to commit human-rights abuses; many experts are now calling for such controls. [126] Here we can learn from the US, which recently introduced export controls to prevent AI computer-chip designers from selling to China. [127] The UK also has an opportunity to lead R&D developments such as compute monitoring and verification that will be necessary to uphold such controls, and future treaties on the training and deployment of advanced AI. The UK's National Security and Investment Act 2021 and its associated regulations already allow for government intervention in AI-related business transactions that could impact national security. [128] However, some experts have criticised ministers for being reluctant to use these powers. [129]

> **Technical recommendation:** The government should work with other liberal democracies to introduce export controls on AI to authoritarian countries, and show more willingness to intervene in takeovers of and investment into UK AI companies by groups linked to authoritarian states.

Sharing the Benefits of Technological Advances

Alongside the benefits that science and technology can bring for the country's people, UK leadership on innovation can also help improve the lives of the most vulnerable people across the globe. For example, UK leadership on gene editing could present opportunities for developing countries to grow crops without having to buy expensive seeds from multinational firms, or help to increase crop resistance to adverse weather conditions as climate change accelerates. [130]

Leaving aside the moral argument for a more innovation-centred approach to international aid, there are strong geopolitical benefits. During the Covid-19 pandemic, while Western countries hoarded their vaccines, Beijing saw the potential to enhance its reputation by donating vaccines to target countries such as Cambodia and Ethiopia. [131] Although the soft-power benefits of this vaccine diplomacy were blunted by the comparatively low efficacy of the vaccines, as China's technological prowess advances across multiple sectors the soft-power benefits of technological aid to other countries will only increase.

The UK needs to learn from China's approach and focus more of its international aid on sharing the benefits of technological advances. While the proportion of international aid earmarked for research and innovation increased year-on-year between 2016 and 2020, overall cuts to aid have disproportionately affected this area. Regardless of whether the government should reinstate the UN-recommended 0.7

per cent target for aid (having reduced the target to 0.5 per cent from 2021), ministers should consider prioritising more of the UK's international-aid budget for boosting science and innovation in developing countries.

Figure 3 – Official development assistance for research and innovation, 2016–2021 [132]

	2016	2017	2018	2019	2020	2021
BEIS – Research and innovation ODA (£m)	337	443	533	622.5	607	368
Total government ODA (£m)	13,377	14,051	14,542	15,176	14,477	11,423
Percentage spent on R&I	2.5%	3.2%	3.7%	4.1%	4.2%	3.2%

Source: FCDO, Statistics on International Development: final UK aid spend 2021, 23 Nov 2022; BEIS, Annual reports and accounts, 2016–2021

As we advance our global leadership in AI in particular, we should safeguard this technology against harmful use, while sharing access to our supercomputing resources and advanced AI technologies with developing countries for their benefit and ours, as US President Dwight D Eisenhower's "Atoms for Peace" campaign sought to safely share nuclear technology 70 years ago.

Technical recommendation: Significantly increase the proportion of international aid spent on research and innovation, including through in-kind access to supercomputing resources and advanced AI technologies with developing countries for geopolitical and social benefit.

Conclusion

The British people need a new national purpose – one that is bold and optimistic. It must recognise the principles of ambition, invention and compassion that characterise our collective spirit.

We have the opportunity to shape a radically different future for Britain. One that embraces technology to restore our natural environment, helps people live longer, healthier lives and creates well-paid, internationally competitive jobs across all four nations of our country. Achieving this will require a once-in-a-generation shift in our operating model and a whole-economy transformation in how we work and innovate.

While there are many challenges to confront, we must not be pessimistic about our future. Ahead of us is the opportunity to make the UK a force for the next century – it's an opportunity we must seize.

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Footnotes

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APPENDIX 6
RESPONSES TO REASONS FOR REFUSAL

Reason for refusal 1: Impact on the landscape character and visual amenity of the area

1.1 *"Policy HQ/1 of the South Cambridgeshire Local Plan provides that all new development must be of high-quality design, with a clear vision as to the positive contribution the development will make to its local and wider context. Sub-paragraph (a) provides that proposals must preserve or enhance the character of the local urban and rural area and respond to its context in the wider landscape. Sub-paragraph (b) provides that proposals must conserve or enhance important natural and historic assets and their setting. Sub-paragraph (d) provides that proposals must be compatible with their location and appropriate in terms of scale, density, mass, form, siting, design, proportion and other matters in relation to the surrounding area.*

Policy NH/2 provides that development will only be permitted where it respects and retains or enhances the local character and distinctiveness of the local landscape and of the individual National Character Area in which is it located.

Policy NH/6 provides that the Council will aim to conserve and enhance green infrastructure within the district. Proposals that cause loss or harm to this network will not be permitted unless the need for and benefits of the development demonstrably and substantially outweigh any adverse impacts on the district's green infrastructure network.

Policy NH/8 provides that development on edges of settlements which are surrounded by Green Belts must include careful landscaping and design measures of a high quality.

Policy SS/4 sub-paragraph 4a provides that all proposals should take into account existing site conditions and environmental and safety constraints.

Policy 60 of the Cambridge Local Plan (2018) provides a framework for assessing any proposal for a structure that breaks the existing skyline and/or is significantly taller than the surrounding built form and requires proposals to demonstrate how they fit within the existing landscape, townscape and historic environment.

The NPPF, at Paragraph 130(c), seeks to ensure developments are sympathetic to local character and history, including the surrounding built environment and landscape setting, while not preventing or discouraging appropriate innovation or change.

The eastern edge of the site is particularly sensitive due to its long views over the River Cam across the Green Belt towards the City. It is considered that the proposals, due to their height and massing, create an abrupt, hard edge that fails to enhance or preserve the character of the area and is not sympathetic to or in keeping with the site's context in the wider landscape including the setting of the City.

The height and massing of the proposed development is not sympathetic to the scale, density and massing of the surrounding areas which comprise primarily low level and low-density development. Accordingly, the development will not result in a well designed place that responds positively to the surrounding context and is considered to have an overbearing presence on the existing development to the east of the development on Fen Road and to the west of the development particularly on Discovery Way.

Overall, the proposed development is not considered to result in high quality development that delivers a well designed place contributing positively to its surroundings. Instead, the proposals result in harm to the surrounding landscape and Green Belt, particularly on the eastern edge of the site, and to the urban area and its relationship with the wider North East Cambridge Area, the City skyline and the landscape beyond. The proposal is therefore not in accordance with South Cambridgeshire Local Plan policies HQ/1, NH/2, NH/6, NH/8 and SS/4 and Policy 60 of the Cambridge Local Plan and the NPPF."

Appellant's response

1.2 I deal with the relevant development plan policies for Reason for Refusal One in my main proof of evidence and conclude, drawing on the evidence of others, that the scheme fully complies with the development plan when read as a whole.

1.3 In their Statement of Case, the Council also rely on the AAP evidence base in supporting reason for refusal one. This includes the NEC Townscape Strategy, the NEC Landscape Character and Visual Impact Appraisal (LCVIA) and NEC Heritage Impact Assessment. The Appellant considers these documents carry "very limited" weight. The LPA considers they carry "limited" weight.

1.4 Mr Smith in his proof notes that the proposed masterplan would provide a coherent and distinctive sense of place within an area that is currently dominated by car parking and waste ground.

1.5 He says the height and massing of the development has been carefully conceived, with heights reducing towards the eastern edge and roof heights also varying considerably along both the western and eastern edges. This variation in height helps to provide visual interest, and further visual interest and distinctiveness is provided by a range of high quality materials, as well as articulation in the elevations to provide patterns of light and shade. Landscaping has also been included along the eastern edge, both on the elevations of some of the buildings but also within a landscaped margin along the east of the site.

1.6 Within the development the landscaped spaces, which as Mr Myers explains exceed the quantum required in the Council's Open Space SPD standards, provide opportunities for informal and formal recreation, food growing, as well as an enhancement in biodiversity.

1.7 He concludes that the proposals would provide beneficial landscape effects upon the character of the site and its immediate context.

1.8 The proposals would also be visible from adjacent landscape and townscape character areas, and Mr Smith has acknowledged within his assessment, (and it is also acknowledged in Bidwells LVIA), that, in accordance with best practice, this would result in some less than significant adverse effects on landscape character as well as some localised significant adverse visual effects. The proposals would not, therefore, completely preserve local character.

1.9 But, In his view, it is probable that any form of mixed use development upon the appeal site as envisaged by policy SS/4 and the NECAAP evidence base – would also result in increased prominence in built form in surrounding landscapes, and consequently it is possible that no development could fully accord with policy HQ/1.

1.10 Furthermore, he has also noted that in design terms the appeal proposals would provide a positive marker in the landscape, defining the location of the railway station and a new, vibrant mixed-use area with high quality, distinctive buildings.

1.11 In terms of Policy HQ/1 (b), I respond to this under Reason for Refusal Two.

1.12 Mr Ludewig, Mr Willis and Mr Myers explain in detail within their proofs of evidence why the appeal scheme has had full regard to its location and context and is appropriate in terms of scale, density, mass, form, siting, design, proportion, materials, texture and colour.

1.13 Both the Bidwells LVIA and Mr Smith's own landscape and visual review have concluded that the appeal proposals would result in beneficial effects for the landscape of the appeal site and its immediate context, and that there would be no significant adverse effects upon any landscape receptors in and around the site.

1.14 Both the Bidwells assessment and Mr Smith's review acknowledge that the appeal proposal would result in some adverse landscape and visual effects, due to the increased prominence of built form. This includes moderate/minor adverse effects upon the Cam River valley, which Mr Smith has concluded to be a valued a landscape in the sense of paragraph 174(a) of the NPPF.

1.15 He also says it is essential to recognise that the proposals provide a high-quality design which, very appropriately, marks the position of the railway station and a new vibrant mixed-use area.

1.16 He therefore concludes that the proposals certainly respect local character and that they would result in localised enhancement of character; however they would not entirely retain the character of the locality.

1.17 My Myers deals with green infrastructure and explains the benefit of the scheme in detail.

1.18 Mr Smith concludes that whilst the proposed buildings would be visible from the Green Belt they would have no effect on the perception of openness of the designation itself, which would thus continue to provide the open setting to the city.

1.19 In terms of Policy SS/4 a, the planning application is supported by a suite of technical assessments which consider the existing site conditions and environmental and safety constraints. The Council do not allege that there are any adverse environmental or safety impacts arising from the appeal scheme.

1.20 Mr Smith notes that the appeal proposals would have no effect upon Cambridge's historic centre, nor would the proposals have any effect on the Strategic Views identified in Appendix F of the Cambridge City Local Plan.

1.21 He says that the scale and massing of the proposed development strikes an effective balance between marking an important new community and transport interchange, whilst avoiding being either overbearing or dominant. He concludes that the proposals are of high design quality and would provide a positive addition to the Cambridge skyline.

1.22 All of this design and assessment work confirms that the appeal is consistent with Paragraph 130 of the Framework.

1.23 Mr Ludewig explains that multiple view studies were conducted to test the adoption of the architectural design principles along these blocks. Depth, height and width of divisions across the blocks were identified parameters, tested to finetune and adopt a clear massing strategy along this edge. The 'fingers' concept stipulated the division of each block in quarters, stepped in minimum increments of 3m along the eastern edge in plan and further articulate in elevation with further setbacks at the roof level of minimum 5m along the eastern edge to further articulate and break down the massing.

1.24 To assist in the assessment of the impact of the appeal proposal on the eastern edge, the three buildings were submitted as full detailed planning applications.

- Mr Willis explains his design approach to the eastern edge and sets out in his evidence how a number of steps were undertaken to avoid an abrupt transition between development and countryside, these are;
- The articulation of the building edge,
- The articulation of the building height as set out in the masterplan parameters (CD2.26)
- The articulation of the materials and planning grid,
- The inclusion of amenity terraces,

- The inclusion of landscaping on the upper levels,
- The set-back of the buildings behind significantly scaled landscaping.

1.25 He explains that the LVIA (CD1.42) was a key design tool in developing this strategy. The exploration of this study and the potential impact on the design was used to inform the final building design. The input of both Bidwells and Turleys was considered in the final massing and tested in the VuCity model.

1.26 To that end, his design response was to treat this as an important piece of cityscape.

1.27 Mr Smith notes in his proof, the height and mass of the proposed buildings reduces towards the eastern edge of the appeal site. He also notes that the massing of the proposed development has been broken intro discrete development blocks of varying heights, and that the design of the eastern edge of the proposals has a varied roofline, articulation of elevations, with landscaping both on the building and at the east of the appeal site.

1.28 He opines that the appeal site is set within an urban context and does not directly interface with either residential uses or the more rural areas along the River Cam Valley. There is therefore a transitional zone of existing urban and suburban uses around the appeal site which also ensures that the proposals do not create an “abrupt, hard edge”.

1.29 In conclusion, he says that the proposals do not represent a hard, abrupt edge but instead represent a high quality, well-designed edge which accords with the recommendations of the LCVIA. But like any development of any scale on the appeal site will not entirely retain or preserve the character of the local area.

1.30 The LPA allege that the appeal scheme is harmful and has an overbearing presence on both Fen Road and Discovery Way. The nearest properties closest to Fen Road on the eastern boundary range between 80 metres and 112 metres to the eastern edge of the buildings on the appeal site. Properties in Discovery Way range from between 86 metres and 126 metres from the closest properties on the western boundary. These are very significant distances.

1.31 As Mr. Smith says in his evidence, just because a building is visible does not automatically equate to harm. There is a big difference between a building that is visible and one that is “overbearing”. I agree with this.

1.32 Figures 7, 8 and 9 in the Daylight and Sunlight Assessment (CD1.45) confirm the amenity spaces to the east of the railway line and the Nuffield Road Allotments will receive high levels of daylight and sunlight after the development is completed.

1.33 The height and mass of the proposed buildings is not excessive in any case: the residential quarter and proposed S4 building are broken into discrete blocks of varying

height from 15 metres to 30 metres, with setbacks in the elevations providing visual interest in the elevations. The mobility and hub and buildings S6 and S7 vary between maximum heights of approximately 15 metres and 22 metres, with lower parapets sections.

1.34 Mr Myers, Mr Willis and Mr Ludewig set out how the appeal complies with the National Design Guide.

1.35 Reason for Refusal 1 has a number of parts to it but when broken down and examined properly I consider the evidence shows very clearly the careful approach to design and striking the right balance in terms of optimising the opportunities this site offers and minimising harm.

Reason for refusal 2: Impact on heritage assets

1.36 *"Policy HQ/1 of the South Cambridgeshire Local Plan provides that all new development must conserve or enhance historic assets and their settings.*

Policy NH/14 provides that development proposals will be supported when they sustain and enhance the special character and distinctiveness of the district's historic environment including its countryside and create new high quality environments with a strong sense of place by responding to local heritage character. It continues that development proposals will be supported when they sustain and enhance the significance of heritage assets, including their settings, as appropriate to their significance and in accordance with the National Planning Policy Framework. The proposed development fails to accord with these objectives.

It is considered the proposed buildings, due to their height and massing, together with their siting in a row along the eastern edge with minimal gaps between the buildings, would constitute a permanent change to the visual quality of the Fen Ditton and Riverside & Stourbridge Common Conservation Areas and would have a negative effect on the way in which they are experienced and appreciated. The proposals would generate increased visibility and presence of urbanising elements of development within the conservation areas and would affect the experience of their rural character. The intensification of development would affect the riverside setting which is a fundamental characteristic of the conservation areas and is sensitive to change. The development proposals would result in a less than substantial harm to the significance of these heritage assets at a moderate level. The public benefits of the proposal do not outweigh this harm.

In addition, there is insufficient information to demonstrate that the proposals do not harm the setting of Anglesey Abbey registered park and garden. Accordingly, the

proposals are contrary to South Cambridgeshire Local Plan policies NH/14 and HQ/1 of the local plan and is not in accordance with the NPPF.

Appellant's response

1.37 The impact on the eastern edge in general is dealt with in my response to Reason for Refusal One. I point out, relying on the evidence of others, the great care that has been taken to the articulation of the buildings on the eastern edge and how the design has evolved.

1.38 The appeal scheme has included a thorough visual assessment which assesses the impact on townscape, landscape and heritage assets. In the latter this has clearly included assessment from Stourbridge Common and Ditton Meadows.

1.39 The impact has been fully assessed and through the course of the design development, various amendments have been made to respond to comments and to seek to mitigate the impact of the development and enhance its quality. These have included variation of building height, stepping back areas of the facades and changes in materiality together with landscape enhancements and tree planting.

1.40 Turning to the NPPF, Dr Burgess acknowledges that the feeling of an intensified, more urban development in occasional views out from the RASCCA and Fen Ditton Conservation Areas will cause a very low level of less than substantial harm to their heritage significance.

1.41 It has been agreed that the appeal proposal has no adverse impact on Anglesey Abbey.

1.42 Applying the balancing exercise as required by Paragraph 202 of the Framework, the benefits of the scheme, by a considerable margin, outweigh the less than substantial harm identified.

Reason for refusal 3: Design

1.43 *"Policy HQ/1 of the South Cambridgeshire Local Plan provides that all new development must be of high quality design, with a clear vision as to the positive contribution the development will make to its local and wider context. Sub-paragraph c provides that proposals must include variety and interest within a coherent, place-responsive design, which is legible and creates a positive sense of place and identity whilst also responding to the local context and respecting local distinctiveness. Sub-paragraph e provides that proposals must deliver a strong visual relationship between buildings that comfortably define and enclose streets, squares and public places, creating interesting vistas, skylines, focal points and appropriately scaled landmarks along routes and around spaces. Sub-paragraph i provides for safe, secure, convenient and accessible provision*

for cycle parking and storage within the development. Sub-paragraph l provides that proposals mitigate and adapt to the impacts of climate change on development through location, form, orientation, materials and design of buildings and spaces. Sub-paragraph m provides that proposals include high quality landscaping and public spaces that integrate the development with its surroundings, having a clear definition between public and private space which provide opportunities for recreation, social interaction as well as support healthy lifestyles, biodiversity, sustainable drainage and climate change mitigation.

Policy SC/7 provides that all housing developments will contribute towards Outdoor Playing Space and Informal Open Space to meet the need generated by the development in accordance with minimum standards including 0.4ha. per 1,000 people.

The NPPF, at Paragraph 130(d) seeks to ensure that developments establish or maintain a strong sense of place, using the arrangement of streets, spaces, building types and materials to create attractive, welcoming and distinctive places to live, work and visit.

The planning application fails to provide high quality public open space or a public realm which would result in a well-designed coherent sense of place that contributes to local distinctiveness. The proposals fail to provide sufficient formal children's play space which is convenient for residents to use, clearly distinguished from the public realm and not bisected by vehicular routes.

The shape and form of buildings within the outline application are not considered to appropriately respond to their locations, resulting in potential incompatible building designs fronting streets and open spaces. The lack of flexibility in the parameter plans potentially precludes, or at least limits, this incompatibility being resolved at Reserved Matters stage.

Building S4 (One Milton Avenue) is overly large and bulky for its location, which its architectural detailing and articulation fails to overcome.

The proposed development, through its over reliance on two tier cycle parking together with the poor relationship of some cycle access points in relation to cycle ways, fails to provide convenient and accessible provision for cycle parking and does not sufficiently promote active travel.

As such the proposal is considered to be contrary to South Cambridgeshire Local Plan policies HQ/1 and SC/7 and the NPPF.

Furthermore, without the applicant demonstrating that development can come forward with no single aspect north-facing apartments there is conflict with Policy HQ1 (l) and paragraph 153 of the NPPF."

Appellant's Response

1.44 Through the evidence of Mr Ludewig, Mr Willis and Mr Myers, it is concluded that the appeal scheme is a transformational piece of placemaking in Cambridge.

1.45 The scheme complies with the Council's open space standards and Mr Myers sets out the quality of the Wild Park.

1.46 Mr Ludewig explains how the buildings in the outline element of the appeal scheme do respond to their context and building frontages.

1.47 The parameter plans provide sufficient flexibility to deal with detailed design matters for the outline elements.

1.48 Mr Willis demonstrates how One Milton Avenue (S4) is an outstanding piece of architecture.

1.49 Cycle parking is in accordance with the standards and is convenient to use.

1.50 The residential element is in outline form and the proposed floorplans are only illustrative at this stage. As such, detailed work on the design and layout of the apartments will take place as part of any detailed application process, which will include design measures to reduce the level of overheating risk, informed by detailed thermal modelling. Whilst the LPA considers the parameter plans do not provide flexibility, I consider that they do.

1.51 There is no specific development plan policy requirement with regards to provision of dual aspect units. Indeed, the position from the LPA appears to be that of zero tolerance to single aspect north-facing apartments, so just one single aspect north-facing window would result in non-compliance.

1.52 Based on the illustrative floorplans, the proposal provides 109 (25%) single aspect units. Of the single aspect units, 21 are north-west facing. This represents 20% of the single aspect units or only 5% of the overall unit numbers. In a scheme that has been designed to create positive frontages on all sides there will be an instance of north facing units. Mr Ludewig points to other exemplary schemes where this occurs.

Reason for refusal 4: Comprehensive development

1.53 *"Policy SS/4 of the South Cambridgeshire Local Plan allocates an area, including the application site, for high-quality mixed-use development primarily for employment uses as well as a range of supporting uses, commercial, retail, leisure, and residential uses*

(subject to acceptable environmental conditions). The amount of development, site capacity, viability, time scales and phasing of development is to be established through the preparation of an Area Action Plan ('AAP'). The policy provides at criterion 4c that proposals should ensure that appropriate access and linkages, including for pedestrians and cyclists, are planned in a high quality and comprehensive manner. Criterion 4e of policy SS/4 requires that proposals should ensure that the development would not compromise opportunities for the redevelopment of the wider area. The supporting text to the policy at 3.31 provides that planning applications submitted before the adoption of the AAP will be considered on their own merits and subject to ensuring that they would not prejudice the outcome of the AAP process and the achievement of the comprehensive vision for the area as a whole that will be established by the AAP.

The application does not explain, in the absence of a comprehensive and appropriate S106 agreement, how the requirements of the development plan for comprehensive development of the areas would be achieved, and the proposal is accordingly considered to be contrary to the objectives of policies SS/4, TI/2 and TI/8 of the Local Plan."

Appellant's Response

1.54 The Appellant understands from the LPA that this reason for refusal will be withdrawn on the parties entering into a s106 Agreement. It is the Appellant's understanding that heads of terms for a s106 Agreement have been broadly agreed with the LPA and the County Council and work is continuing between the parties to work these heads of terms up into a detailed s.106 Agreement.

1.55 It is therefore expected that this reason for refusal will be withdrawn.

1.56 Notwithstanding the above, I have explained in my evidence how the proposal will not prejudice comprehensive development.

Reason for refusal 5: s106

1.57 *"Mitigation in the form of financial contributions and obligations are required to mitigate the impacts of the proposed development. Alongside the use of planning conditions, the development generates a requirement for a range of community infrastructure on the site or in the locality. This would be secured by way of a legal agreement. In the absence of an agreed S106 agreement the necessary mitigation to make the proposals acceptable cannot be secured in accordance with policies SC/4, SC/6 and TI/8 of the South Cambridgeshire Local Plan."*

Appellant's Response

1.58 I refer to my response to reason for refusal 4.

Reason for refusal 6: Flood Risk

1.59 *"Policy CC/7 provides that all development proposals must demonstrate that there are adequate land drainage systems to serve the whole development. Policy CC/8 provides that development proposals must incorporate appropriate sustainable surface water drainage systems appropriate to the nature of the site. Policy CC/9 sub-paragraph b provides for an allowance for climate change where appropriate.*

The application provides insufficient clarity on the climate change allowances utilised. In particular, the commercial, retail and laboratory buildings have been accounted for a shorter lifetime than the surrounding residential areas, utilising a 20% climate change allowance on the 100 year storm. However, it is likely that these structures will be contributing to the impermeable areas for the lifetime of the development. Whilst it is acknowledged that the proposals include a sunken area for informal flooding, the LLFA has advised that the proposed SuDS system on site should be designed to accommodate the lifetime that these areas will be impermeable and therefore contributing to the drained area.

As such the proposal is considered to be contrary to South Cambridgeshire Local Plan policies CC/7, CC/8 and CC/9 and the NPPF."

Appellant's Response

1.60 The impact on flood risk and drainage is now agreed and the LPA are no longer defending reason for refusal 6. This is agreed in the Statement of Common Ground.

Reason for refusal 7: Ecology

1.61 *"Policy NH/4 provides that new development must aim to maintain, enhance, restore or add to biodiversity. Where there are grounds to believe that a proposal may affect a Protected Species, Priority Species or Priority Habitat, applicants will be expected to provide an adequate level of survey information and site assessment to establish the extent of a potential impact. This survey information and site assessment shall be provided prior to the determination of an application.*

The application provides insufficient information to adequately assess the ecological impact of the proposals. In particular, the bat surveys must be completed as the

building/structure B1 is within the landscape drawings submitted for full consideration under the outline planning permission. In addition, the impact of the additional bird species identified has not been assessed. On the basis of the information submitted, the application is contrary to South Cambridgeshire Local Plan policy NH/4, the Biodiversity SPD 2022, the requirements of the Environment Act 2021 and 06/2005 Circular advice.

1.62 It is now agreed that sufficient information has been provided to adequately assess the ecological impact of the proposals.

1.63 The LPA are no longer defending reason for refusal 7.

Reason for refusal 8: Safeguarded Sites

1.64 *"Policy SS/4 of the South Cambridgeshire Local Plan criterion (a) provides that proposals should take into account existing site conditions and environmental and safety constraints. Policy 16 of the Cambridgeshire and Peterborough Minerals and Waste Local Plan 2021 requires applications to demonstrate they will be compatible with the safeguarded sites identified in the Plan.*

Insufficient information has been submitted in the noise report to demonstrate that the interaction between the proposed commercial use and the Aggregates Railhead (a Transport Infrastructure Area) will not prejudice the existing or future uses of the Transport Infrastructure Area as required in Policy 16: Consultation Areas of the Cambridgeshire and Peterborough Minerals and Waste Local Plan 2021 and the 'agent of change' as set out in para. 187 of the NPPF and contrary to criterion 4a of policy SS/4 of the South Cambridgeshire Local Plan."

Appellant's Response

1.65 It has now been agreed that sufficient information has been submitted to demonstrate that the interaction be between the proposed commercial use and the Aggregates Railhead (a Transport Infrastructure Area) will not prejudice the existing or future uses of the Transport Infrastructure Area.

1.66 The LPA are no longer defending reason for refusal 8. This is agreed in the Statement of Common Ground.

APPENDIX 7
RESPONSE TO RULE 6(6) PARTY

Cambridge Past Present and Future (CPPF) are the Rule 6 Party in this matter. They have produced a Statement of Case which helpfully summarises their objections to the appeal. My response to their case is set out in the table below.

CPPF CASE	APPELLANT RESPONSE
LANDSCAPE AND TOWNSCAPE	
Cambridge PPF's case accords with reason for refusal 1 and relates to our objection to the height, scale and design of the proposed buildings, especially those along the eastern site boundary. It is vital that this site is designed and developed to the highest standard. The development will create a new edge to the city which needs to contribute to the special character of Cambridge. Paragraph 2.31 of the adopted South Cambridgeshire Local Plan list some factors which define the special character of Cambridge and its setting. These include:- • Key views of Cambridge from the surrounding countryside; • A soft green edge to the city; • A distinctive urban edge. Cambridge PPF's case will refer to the design of blocks S6 and S7 and how the design does not make a positive contribution to the Cambridge skyline, city edge or landscape setting.	Detailed evidence is provided in relation to reason for refusal 1 of the LPA in the evidence of Mr Smith, Mr Ludewig, Mr Willis and Mr Myers.
Cambridge PPF will object to Wild Park not being retained in perpetuity. The park, if correctly planned, provided and managed, will be an important ecological and recreational benefit to the development and the wider area and needs to be retained in perpetuity. It is assumed that the park forms part of the biodiversity net gain and the Environment	Any future relocation of the Wild Park OMH habitat would be subject to a fresh application and be determined on its own merits. The advantage of OMH is that is has to be actively managed to mimic intermittent disturbance. It can, as a seedbank, therefore can be translocated to other suitable areas and quickly recover its intrinsic value.

Act states that habitats should be secured for a minimum of 30 years but the intention is for it to be in perpetuity.	As part of the discussions on the wider masterplanning to the north of Cowley Road, alternative locations have been reviewed and are feasible but do not form part of this application but an indicative OMH Phasing Plan has been updated as Appendix 3 of the Ecology Technical Note Appended to the Statement of Common Ground.
Cambridge PPF will argue that notwithstanding the range of habitat creation within the site, the layout of the residential area, the relatively narrow entrances into Chesterton Gardens and the wall of development of blocks S13-S16 are not conducive to wildlife connectivity across and beyond the development.	The proposals for green infrastructure work to supplement and enhance existing tree belts as well as create new networks and clusters across the development. Along the western edge, the existing tree belt is boosted by additional tree, native hedgerow and understorey planting. The northern boundary is lined with native hedgerow and intermittent tree planting. Large scale 'avenue' tree planting enhances Milton Avenue and both Cowley Road North and Cowley Road East; and extensive tree planting is proposed in Chesterton Gardens. Ground level habitat corridors are created through widely planted floriferous species in the swales of Station Row, and rain gardens of Chesterton Gardens and Milton Avenue. In the Wild Park, the reinforced Open Mosaic Habitat seeding and pond- side planting are key wildlife habitats. Biodiverse rooftops are also extensive across both sides of Milton Avenue. Whilst the existing Cowley Road/Milton Avenue junction may limit the crossover of some ground level habitats, the proposals offer a huge benefit to the existing green infrastructure, creating new networks and enhancing existing ones.
Reference will be made to the appellants visualisations and Cambridge PPF photographs in Appendix B. Cambridge PPF will refer to adopted Local Plan Policies SS/4 (Cambridge Northern Fringe East and Cambridge North railway station), HQ/1(Design Principles), Policy NH/2 (Protecting and Enhancing Landscape Character, Policy NH/4 (Biodiversity) and Policy NH/8 (mitigating the impact of development in and adjoining the Green Belt).	This is dealt with in full in the evidence of Mr Smith, Mr Willis, Mr Ludewig and Mr Myers.

HERITAGE	
Cambridge PPF's case accords with reason for refusal 2. It is considered the proposed buildings, due to their height and massing, together with their siting in a row along the eastern edge with minimal gaps between the buildings, would constitute a permanent change to the visual quality of the Fen Ditton and Riverside & Stourbridge Common Conservation Areas and would have a negative effect on the way in which they are experienced and appreciated. Cambridge PPF will refer to the Fen Ditton Conservation Area and the Riverside & Stourbridge Common Conservation Areas. Reference will be made to the contribution to the special characteristics of the Conservation Areas, of the views across the meadows and river to the appeal site. Reference will be made to policies HQ/1 (Design Principles) and Policy NH/14 (Heritage Assets).	This is dealt with in the evidence of Dr Burgess, Mr Smith, Mr Willis, Mr Ludewig and Mr Myers.

APPENDIX 8
RESPONSES TO THIRD PARTIES

THIRD PARTY COMMENT	APPELLANT RESPONSE
Cam Cycle	
Camcycle objects to application on the grounds that it does not comply with Policy TI/2	See Appellant's transport evidence. The County Council has not raised an objection to the appeal proposal.
Montagu Evans on behalf of The Crown Estate	
The Crown Estate supports the principle of sites within the AAP area coming forward in isolation, and in some cases, progressing in advance of adoption of the AAP. The Crown Estate are concerned that given the prematurity of the planning application ahead of the emerging NEC AAP, the extent to which the proposals exceed the development parameters could undermine the delivery of the AAP objectives as a whole. The Crown Estate therefore seeks further clarification that the determination of the application in advance of the AAP adoption will not compromise the wider transport capacity, infrastructure contributions or planned delivery of growth across the AAP as a whole.	The Local Planning Authority do not allege that the appeal scheme would prejudice the AAP and a decision to allow the appeal would be premature. It is the Appellant's understanding that heads of terms for a s106 Agreement have been broadly agreed with the LPA and the County Council and work is continuing between the parties to work these heads of terms up into a detailed s.106 Agreement. This includes a comprehensive package of measures under the Highways, transport and traffic mitigation Heads of Terms. Notwithstanding the above, I have explained in my evidence how the proposal will not prejudice comprehensive development.
Cambridge Curiosity and Imagination (CCI) in partnership with Shirley Community Primary School	
Looking for Brookgate and other possible partners to work with them to make Bramblefields Nature Reserve a safe space.	Brookgate are willing to work with CCI in partnership with Shirley Community Primary School as part of the future development of the Cambridge North masterplan
Carter Jonas on behalf of U+I PLC and TOWN	
Objection due to failure to demonstrate how the development will contribute to the comprehensive regeneration of North East Cambridge.	It is the Appellant's understanding that heads of terms for a s106 Agreement have been broadly agreed with the LPA and the County Council and work is continuing between the parties to work these heads of terms up into a detailed s.106 Agreement. This includes a comprehensive package of measures under the Highways, transport and traffic mitigation Heads of Terms. Notwithstanding the above, I have explained in my evidence how the proposal will not prejudice comprehensive development.

THIRD PARTY COMMENT	APPELLANT RESPONSE
Residents	
20 representations were received from public residents. A number of residents raise broadly similar issues which can be categorised as follows: • Height, scale and design of the proposal and its impact on the Stourbridge and Fen Ditton conservation areas • The layout, design and appearance of the proposed blocks • Premature of the outcome of the DCO for the Waste Water Treatment Plant • Concern regarding impact to local and strategic road network and lack of highways mitigation • Concern regarding lack of on-site amenity provision • Concern over whether there is sufficient demand for commercial space • Concern regarding environmental impact My response to each of the above issues is dealt with below.	
Height, scale and design of the proposal and its impact on the Stourbridge and Fen Ditton conservation areas	This is dealt with in full in the evidence of Dr Burgess, Mr Smith, Mr Willis, Mr Ludewig and Mr Myers.
The layout, design and appearance of the proposed blocks	This is dealt with in full in the evidence of Mr Smith, Mr Willis and Mr Ludewig.
Premature of the outcome of the DCO for the Waste Water Treatment Plant	The Local Planning Authority do not allege that the appeal scheme would prejudice the AAP and a decision to allow the appeal would be premature.
Concern regarding impact to local and strategic road network and lack of highways mitigation	See Appellant's transport evidence. The County Council has not raised an objection to the appeal proposal.
Concern regarding lack of on-site amenity provision	See Appellant's landscape and planning evidence.
Concern over whether there is sufficient demand for commercial space	This is dealt with in full in the evidence of Mr Bryan.
Concern regarding environmental impact	The appeal proposal is supported by a suite of technical assessments which consider the existing site conditions and environmental and safety constraints. The Council do not allege that there are any adverse environmental or safety impacts arising from the appeal scheme.

THIRD PARTY COMMENT	APPELLANT RESPONSE
The Bike Depot 140 Cowley Road Cambridge, Cambridgeshire, CB4 0DL	
The planning application poses a serious impact to my business. The major increase in construction traffic and residential traffic poses a serious risk to safety on Cowley Road. There is no adequate pedestrian footpath running along the perimeter of Tarmac Cambridge Concrete Plant, linking the nearby Business Park at CB4 ODL to Cambridge North Station and beyond. The planning application makes no provision for a permanent wide footpath at this location. Drawings suggest that the unofficial path will be replaced by landscaping, cutting off pedestrian commuters and customers to the Business Park from the nearby transport links.	See Appellant's transport evidence. The Highway Authority raise no objection to the appeal scheme.