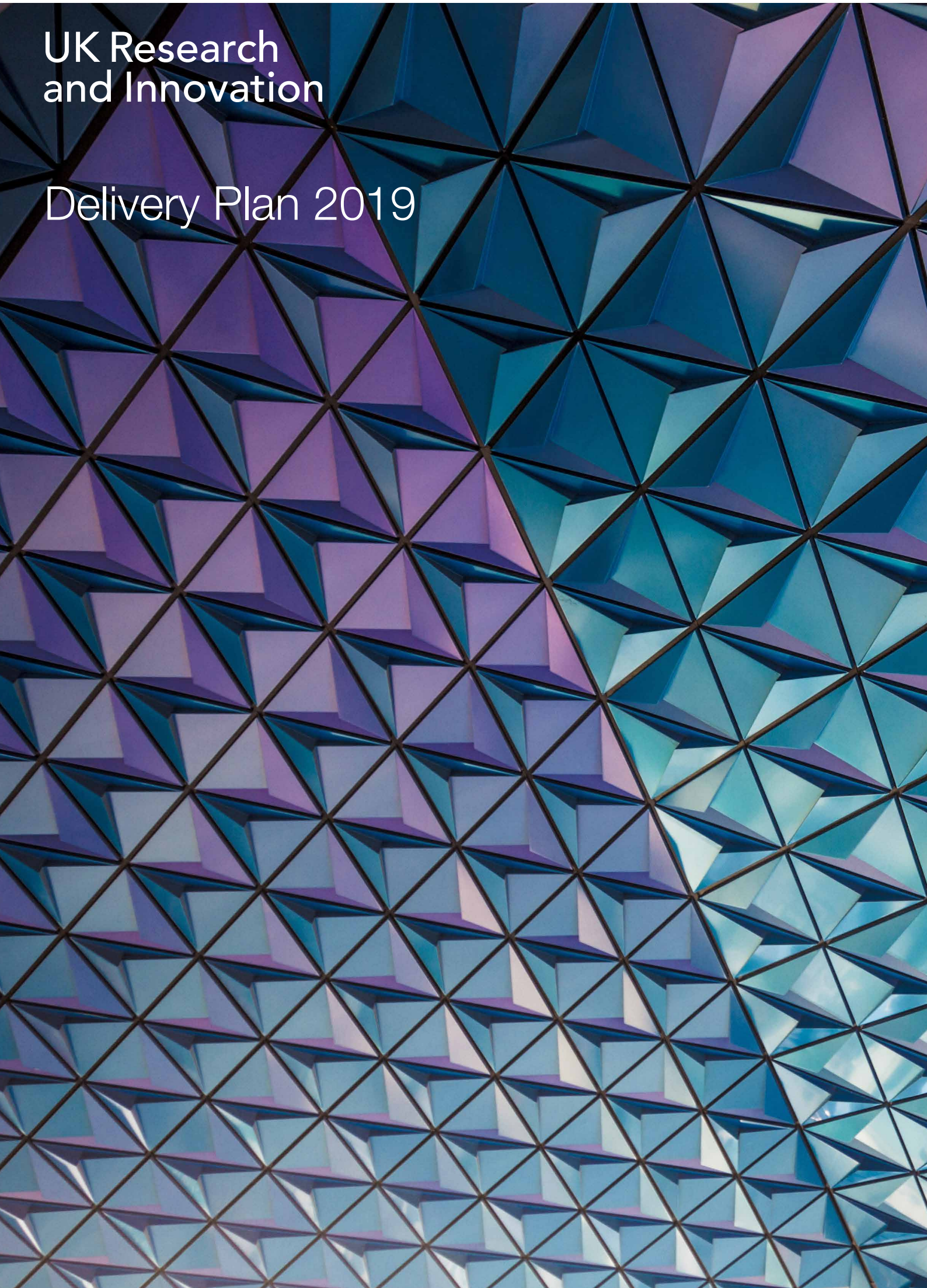
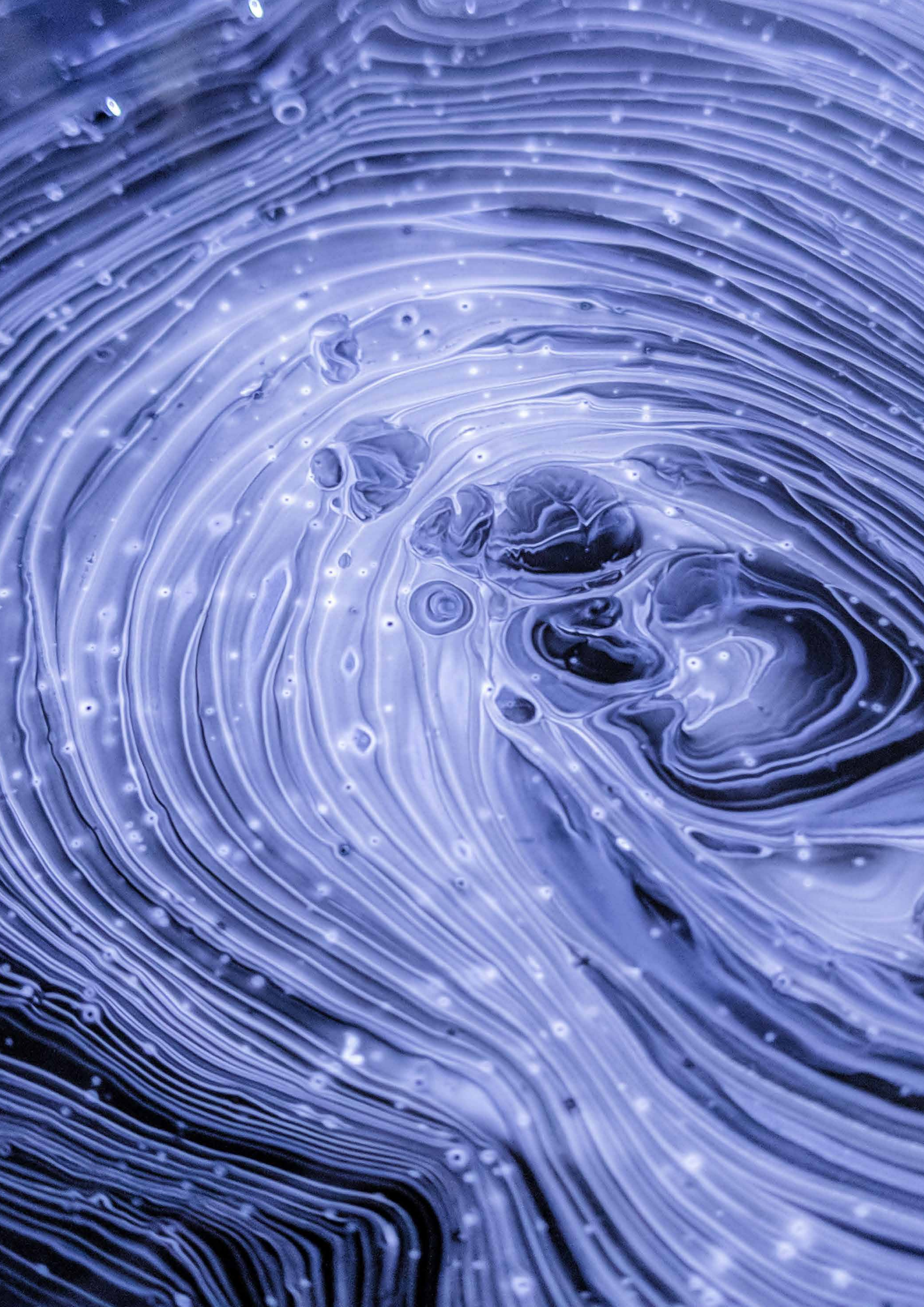
UK Research and Innovation

Delivery Plan 2019





Contents

Foreword

Professor Sir Mark Walport
UKRI Chief Executive Officer

We are at one of the most important, exciting and challenging times in the history of global enterprise. Powered by new technologies, the way we live our lives as workers, citizens and consumers is being transformed across the world. Britain is extraordinarily well-placed to benefit from this new industrial revolution. We are an open enterprising economy, built on invention, innovation and competition. Our universities and research institutions are among the best in the world.

Research and development has a central role to play in responding to the challenges we face and taking full advantage of the opportunities they offer. Advanced economies like the UK will only continue to grow and prosper if they leverage knowledge and new ideas to deliver a better, more productive economy. Research and development is core to the successful delivery of the four Grand Challenges identified in the Industrial Strategy, which aim to put the UK at the forefront of tackling global seismic transitions – in AI & Data, Clean Growth, Ageing Society and Future of Mobility – and grow the industries of the future.

Recognising this transformational potential, the government has positioned research and development at the heart of the Industrial Strategy, committing an additional £7 billion by 2021-22 and setting an ambitious target to increase total investment in research and development to 2.4% of GDP by 2027. It also created UK Research and Innovation, bringing together the world leading expertise and strengths of our nine councils, to ensure that world-leading research and innovation continues to grow and flourish in the UK. The creation of UKRI enables us to support new cross disciplinary approaches and to catalyse collaboration between the public and private sectors to develop new solutions.

The Government's additional investment rightly comes with high expectations. We have made a strong start, recognising that our support on research and development will help to deliver across the Industrial Strategy. With our stakeholders and partners, we have succeeded in:

- Setting up the Industrial Strategy Challenge Fund: a new model to address the most pressing opportunities and challenges facing the UK by bringing together business and research partners to address the Industrial Strategy Grand Challenges. This has already invested £1.7bn through waves 1 and 2, which is expected to leverage around £1bn from industry. Wave 3 will achieve even higher levels of leverage: £1.50 industry co-investment for every public £1
- Developing the Strength in Places Fund, which will enable us to drive R&D led economic growth across the country. This has already identified 23 promising proposals which are progressing as part of wave 1
- Setting up the Fund for International Collaboration, which is enabling us to strengthen and build powerful partnerships around the world

- Rolling out a new pan-UKRI Future Leaders Fellowship programme to help individuals with leadership potential in any discipline to accelerate their early careers
- Realising Paul Nurse's vision of a 'common fund' through the new Strategic Priorities Fund, which is already investing in new interdisciplinary programmes and to help solve pressing public policy challenges.

To support this, we have made excellent progress in setting up UKRI:

- We have established a strong Board
- We have welcomed 9 excellent Executive Chairs to lead the Councils
- We have recruited nearly 100 leaders from research, business and innovation to bring their expertise to our Councils
- We have set up shared corporate services, cross cutting strategy, analysis and communications functions.

Of course, there is much more to do. We are only one year old. UKRI is enabling all of the councils to work together to deliver an ambitious, globally significant agenda. In these delivery plans, we set out UKRI's overall approach to support the Industrial Strategy – boosting productivity through research and innovation investment, which will support meeting the government's 2.4% target. We also set out each of our council's ambitious plans, in support of UKRI overall approach.

I would like to thank all the employees of UKRI who have worked so hard to get to this point, as well as the stakeholders who have contributed to our progress. We look forward to working with you to ensure world-leading research and innovation continues to grow and flourish in the UK.

Introduction

The UK is recognised as a world-leading knowledge-driven economy, with strengths across its research base and innovation system. It is home to 16 of the world's top 150 universities, ranks second globally for the quality of its scientific institutions and is amongst the best at attracting international students. However, there is no room for complacency. As the OECD has pointed out, advanced economies like the UK can only continue to grow and prosper if we continue to use knowledge and new ideas to support innovation and growth in business.

Recognising this, and the role that it plays in improving UK productivity and earning power, the government has signaled its intent to capitalise on the UK's strengths and has positioned research and innovation at the heart of the Industrial Strategy. The government has invested an additional £7 billion of public funding and committed to increasing economy-wide investment on R&D to 2.4% of GDP by 2027, and 3% in the longer term. Research and innovation are core to the successful delivery of the four Grand Challenges identified in the Industrial Strategy, which aim to put the UK at the forefront of tackling global seismic transitions, in AI & Data, Clean Growth, Ageing Society and Future of Mobility and grow the industries of the future.

Economies around the world are being transformed by research and innovation. UKRI enables our councils to work together in new ways to deliver an ambitious agenda, building on the strength, breadth and diversity of our portfolio. Our councils each have great strengths in funding excellent research in the sciences, social sciences, arts and humanities, while supporting leading business innovation and enterprise:

- **Arts and Humanities Research Council (AHRC)**
  AHRC funds outstanding original research across the whole range of the arts and humanities. This research provides economic, social and cultural benefits to the UK, and contributes to the culture and welfare of societies around the globe.
- **Biotechnology and Biological Sciences Research Council (BBSRC)**
  BBSRC invests in world-class bioscience research and training. This research is helping society to meet major challenges, including food security, green energy and healthier, longer lives and underpinning important UK economic sectors, such as farming, food, industrial biotechnology and pharmaceuticals.
- **Engineering and Physical Sciences Research Council (EPSRC)**
  EPSRC invests in world-leading research and postgraduate training across the engineering and physical sciences. This research builds the knowledge and skills base needed to address scientific and technological challenges and provides a platform for future UK prosperity by contributing to a healthy, connected, resilient, productive nation.
- **Economic and Social Research Council (ESRC)**
  ESRC is the UK's largest funder of research on the social and economic questions facing us today. This research shapes public policy and contributes to making the economy more competitive, as well as giving people a better understanding of 21st century society.
- **Innovate UK**
  Innovate UK drives productivity and economic growth by supporting businesses to develop and realise the potential of new ideas, including those from the UK's world-class research base. They connect businesses to the partners, customers and investors that can help them turn these ideas into commercially successful products and services, and business growth.
- **Medical Research Council (MRC)**
  MRC is at the forefront of scientific discovery to improve human health. Its scientists tackle some of the greatest health problems facing humanity in the 21st century, from the rising tide of chronic diseases associated with ageing to the threats posed by rapidly mutating micro-organisms.

- **Natural Environment Research Council (NERC)**
  NERC is the driving force of investment in environmental science. Its leading research, skills and infrastructure help solve major issues and bring benefits to the UK, such as affordable clean energy, air pollution, and resilience of our infrastructure.
- **Research England**
  Research England is a new council within UKRI. Taking forward the England-only responsibilities of HEFCE in relation to research and knowledge exchange (KE), Research England will create and sustain the conditions for a healthy and dynamic research and KE system in English universities. It works closely with its counterparts in the Devolved Administrations.
- **Science and Technology Facilities Council (STFC)**
  STFC is a world-leading multi-disciplinary science organisation. Its research seeks to understand the Universe from the largest astronomical scales to the tiniest constituents of matter, and creates impact on a very tangible, human scale.

Last year we published the Strategic Prospectus to start the process to develop a detailed UKRI Research and Innovation Strategy. Since then, we have continued to develop our strategy, drawing on extensive engagement with our stakeholders, both through council-specific activity, and through cross-cutting workshops. This has included a series of workshops held in partnership with stakeholder organisations, which explored the biggest questions around the 2.4% target. These workshops brought together expert stakeholders from across business, research, policy and academia and summaries of each workshop discussion can be found on our website . Each of our councils has also engaged extensively with their communities and advisory bodies to develop their plans.

In this document, we set out the next iteration in our strategy by publishing our delivery plan for each council. Each of these includes a 'forward look' which sets out longer-term ambitions and direction of travel. It also includes near-term actions which capture specific deliverables for financial year 2019-20 (the end of the current spending review period), and any further investments where budgets have been allocated beyond the current spending review period.

These delivery plans are a legal requirement under section 100 of the Higher Education and Research Act 2017, and UKRI will formally delegate functions to the councils to deliver the priorities in these delivery plans. Upon completion of the next Spending Review (SR), we will update our 'near-term actions' to reflect the financial years covered in the SR.

Each of our councils has ambitious plans, but UKRI will only succeed if we are collectively much more than the sum of our parts. During our first year of existence, councils have been working more closely together than ever was the case before. We are delivering a series of cross-cutting schemes through funds from the National Productivity Investment Fund that have been entrusted to us. To frame the council delivery plans, these schemes, as well as other cross-council activities, are described in this document.

[1] Wellcome Trust, Royal Society, Campaign for Science and Engineering, Royal Academy of Engineering, the Academy of Medical Sciences, What Works Centre for Local Economic Growth.

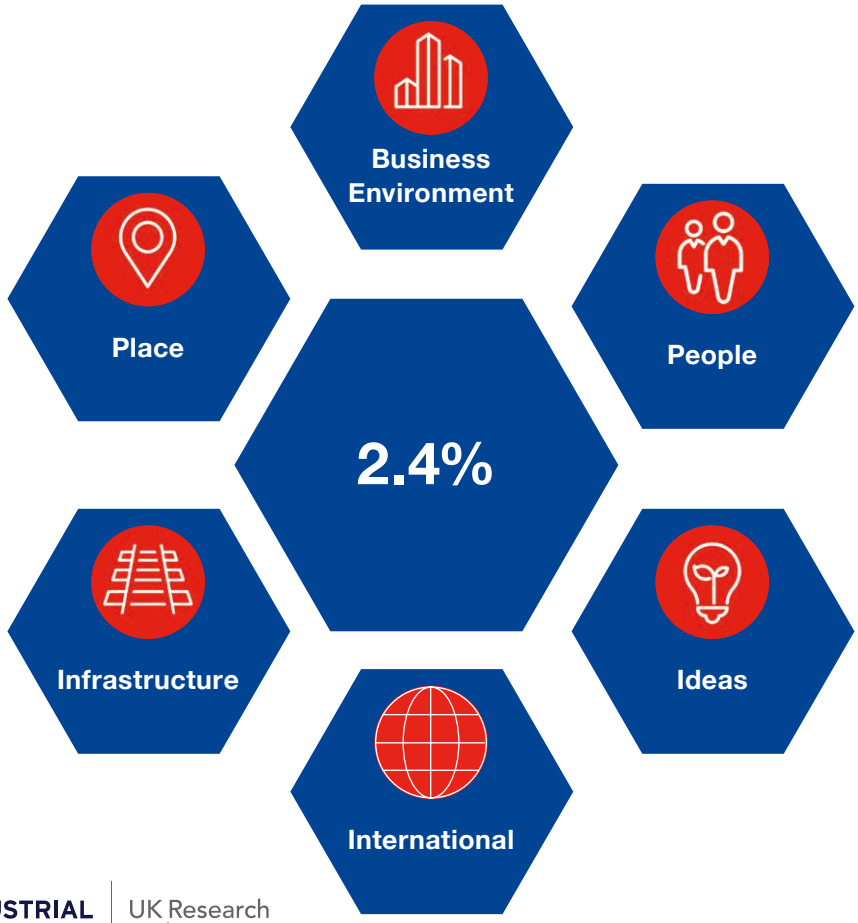
[2] https://www.ukri.org/about-us/increasing-investment-in-r-d-to-2-4-of-gdp/stakeholder-engagement/

UKRI's mission and objectives

Our mission is to work with our partners to ensure that world-leading research and innovation continues to grow and flourish in the UK. We will work with our many stakeholders to:

- push the frontiers of human knowledge and understanding; in order to
- deliver economic impact; and
- create social and cultural impact by supporting society to become enriched, healthier, more resilient and sustainable.

In the Industrial Strategy, the Government set out five foundations of productivity: ideas, people, infrastructure, business environment and places. In addition, the Government has established four Grand Challenges to put the UK at the forefront of future industries in AI & data, the ageing society, clean growth, and the future of mobility. UKRI has a central role to play in supporting each of these foundations as well as promoting the UK's research and innovation strengths globally. Together, these will help to deliver the commitment set in the Industrial Strategy to deliver long term benefits across the country by increasing research and development spend across the whole economy to 2.4% of GDP by 2027 (and 3% in the longer term). To achieve this target, it will be critical to stimulate a substantial increase in private sector spend and our delivery plans outline how we will work with business to achieve this.



INDUSTRIAL STRATEGY | UK Research and Innovation

UKRI's approach to delivering the government's target of 2.4% GDP spend on research and innovation

Business environment – we will deliver economic, social and cultural impact by:

- partnering with government, businesses, charities and other stakeholders to address the Industrial Strategy Grand Challenges
- supporting businesses across all sectors to develop their most innovative ideas
- translating ideas emerging from research and scaling up resulting businesses for economic and wider benefit.

Places – we will support growth across the UK by:

- supporting all parts of the UK to build on their research and innovation strengths so that they contribute to and benefit from the Government's 2.4% R&D target
- understanding how every region and nation of the UK can benefit from national investment in research and innovation, working closely with government departments.

Ideas – we will build global partnerships and address global challenges by:

- advancing the frontiers of discovery research
- seeking and supporting new, emerging and disruptive technologies and exploring their impact on the world and society
- helping to understand today's greatest challenges that span society and cross disciplinary boundaries.

People – we will build the skills and the environment required for research and innovation to thrive by:

- growing, developing and retaining the talented workforce the UK needs
- nurturing a supportive and responsible research and innovation culture
- inspiring the public and involving them in research and innovation.

Infrastructure – We will enable access to, and invest in, world-leading research and innovation infrastructure, by:

- developing an infrastructure roadmap to inform future investment decisions in research and innovation infrastructure and provide a framework for development of new projects from concept to design to implementation
- offering a coherent long-term vision to maximise the value of government investment in national and international infrastructure
- identifying common themes across the research and innovation landscape, which will benefit from a cross-sectoral approach.

International – we will build global partnerships and address global challenges by:

- continuing to support cutting-edge research and innovation addressing global issues
- deepening international collaborations and relationships.

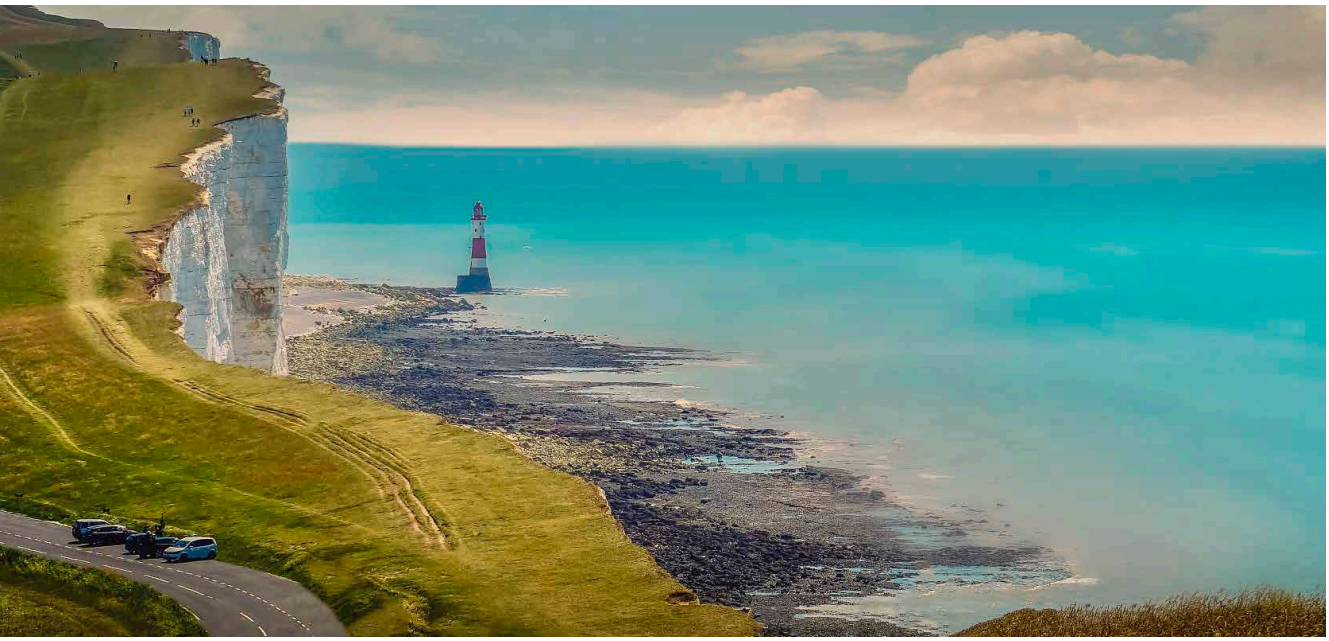
In this plan we set out our priorities as well as actions for 2019-20 in each of these areas. We also describe how we will evolve as an organisation, our approach to monitoring and evaluation to ensure we hold ourselves to account on the outcomes we deliver, and summarise financial allocations for the whole of UKRI.

1. Business environment: delivering social, cultural and economic impact

"Britain once again can lead the world as we exploit a new wave of scientific and technological discovery pouring out of our universities and research institutes, and we can solve the productivity challenge if we are willing to embrace the future" Autumn Budget statement, October 2018[3]

The application of new ideas and knowledge is a key driver of economic growth and social benefit and is at the heart of the UK's industrial strategy. Our ability to develop new ideas and deploy them is a great strength and we need to do more to ensure the UK's excellence in discovery research is translated into application and commercial practices.

We want the UK to lead the world in applying research outputs to deliver the widest range of impacts. UKRI aims to maintain the UK's competitive position and manage the pace of economic and societal change enabled by new knowledge and innovation. We will do this by investing in activities that will help accelerate the social, cultural and economic impact of our research and innovation investments. We recognise that economic and social challenges increasingly require a cross disciplinary and cross-sector approach. This motivates our new ways of working and new approaches to funding. Building on and enabled by the strong foundations within our councils, which already deliver world-class research and innovation, we will complement these investments with targeted cross-council interventions aiming to drive the application of ideas to deliver social, economic and cultural impact, including to address the four Grand Challenges (artificial intelligence and data, ageing society, clean growth, and future of mobility), and to support the 2.4% R&D investment commitment. To enable this, we have launched new funding streams and strategies, described in this section.



[3] https://www.gov.uk/government/speeches/budget-2018-philip-hammonds-speech

1.1 INDUSTRIAL STRATEGY CHALLENGE FUND (ISCF)

Announced by the Prime Minister in November 2016 as part of the National Productivity Investment Fund (NPIF), the ISCF is our flagship challenge-led innovation programme. It aims to bring together business with the UK's world-leading research base to meet the major industrial and societal challenges of our time. By driving technological progress and innovation, it is designed to create transformative opportunities for businesses and sectors across the UK, improving their productivity and competitiveness. By focusing on partnership with industry, it plays a key role in leveraging private investment and helping to reach the 2.4% target. It will:

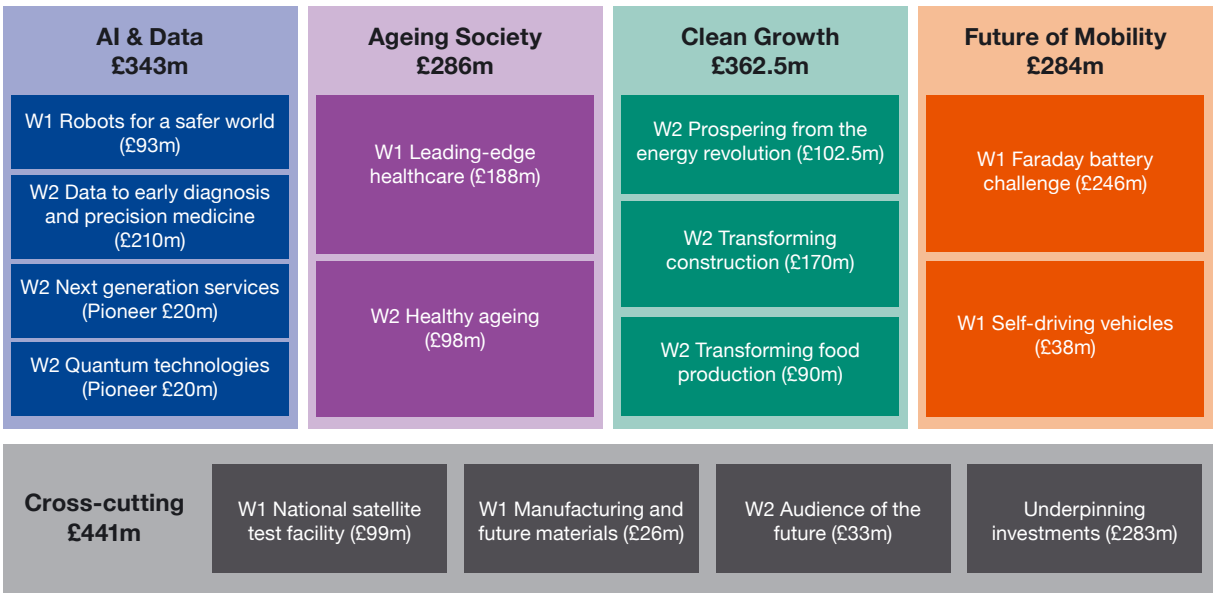
- **increase** UK businesses' investment in R&D, whilst also improving R&D capability, capacity and technology adoption
- **increase** multi- and interdisciplinary research
- **increase** engagement between academia and industry on targeted innovation activities
- **increase** collaboration between new, small companies and those that are established
- **increase** overseas investment in R&D in the UK.

The ISCF will drive innovation to deliver the four Industrial Strategy Grand Challenges: Ageing Society, Clean Growth, AI and Data and the Future of Mobility.

Informed by industry, these challenges are built around areas where:

- the UK already has world-leading research and businesses that are ready to innovate
- the global market is large or fast-growing and sustainable.

Through the first two waves we are investing over £1.7 billion to help solve ambitious industrial challenges, from transforming the UK construction industry to developing the next generation of batteries . Over the past two years, we have begun to deliver these first two waves closely aligning their progress to support the aims and objectives of the Grand Challenges in the Industrial Strategy:



Wave 3 of the ISCF

In his 2018 Budget, the Chancellor of the Exchequer announced an increase of funding for the ISCF, demonstrating continued government support for this programme. We asked industry directly to come forward with compelling challenge ideas to deliver the four Grand Challenges through a broad, open process. We received a huge response to this call for expressions of interest, which generated over 250 ideas. Based on our rigorous assessment of these proposals, ministers have agreed to invest in the following challenge areas through Wave 3, subject to business case:

AI and data

- accelerating detection of disease
- commercialising quantum technologies
- digital security by design
- manufacturing made smarter.

Future of mobility

- future flight
- driving the electric revolution.

Clean growth

- industrial decarbonisation challenge
- transforming foundation industries
- smart sustainable plastic packaging.

Early progress with the ISCF

Although we are at an early stage of delivering the ISCF (delivery began in 2017-18), we are starting to see the benefits of this challenge-led approach:

- It is securing a significant amount of industrial co-investment: we expect the £1.7bn from waves 1 and 2 to secure approximately £1bn from industry. This will in turn lead to further spillovers from both the public and private investment. Wave 3 will achieve even higher levels of leverage: £1.50 industry co-investment for every public £1
- It is bringing together diverse consortia of partners to address challenges: For example, the 'next generation services' challenge includes a consortium with Lloyds Insurance, AXA, PwC, IBM, Willis Towers Watson, Comparethemarket.com working together with the universities of Loughborough, Exeter and Queen Mary, London
- Programmes are already being recognised for the quality and potential of their work. The Offshore Robotics for Certification of Assets hub, led by Heriot-Watt University, won the Business Collaboration category at the prestigious Guardian University Awards 2018
- It is resulting in a spread of investment across the UK, with West Midlands and Wales representing the highest level of investment per capita.

Near-term actions

During 2019-20, we will:

- continue to drive forward delivery across the existing portfolio of wave 1 and 2 ISCF challenges
- actively monitor the delivery and outputs of the investment and undertake in-depth evaluations
- announce the final funding allocation for ISCF wave 3 and move into delivery for these programmes
- develop the approach for future waves of the ISCF, building on learnings to date.

AI underwater vision could slash inspection costs for off-shore energy

Innovative 3D vision technology will harness the power of Artificial Intelligence to slash inspection costs for off-shore power companies.

The work, led by Bristol-based Rovco and supported by the Industrial Strategy Challenge Fund, is developing survey technology that will revolutionise the way energy companies inspect undersea infrastructure.

The company is developing the equipment and software required to produce live-streamed, 3D data from challenging and extreme underwater environments.

Rovco predicts the integrated technology, which utilises advanced computer vision and AI systems with ROV platforms, could help energy companies save millions in inspection costs. It is also expected to directly generate 70 highly skilled jobs.

Powering the shift to zero emission vehicles

Advanced battery technology will unlock the potential of industrial electrification and put the UK at the forefront of zero-emission vehicles.

The Faraday Battery Challenge, part of the Industrial Strategy Challenge Fund, is supporting research and innovation projects and new facilities to advance the production, use and recycling of batteries.

One project, The Lithium Sulphur: Future Automotive Battery, is developing next generation battery technology specifically designed for larger vehicles such as lorries and buses – vehicles that account for substantial CO2 emissions.

This significant innovation has required the development of exciting new collaborations. For example, the involvement of the UK fine chemicals company William Blythe – who have not previously worked in the battery materials area – has led to significant investment in this new business area.

The Faraday Battery Challenge is a key component of the Future of Mobility Grand Challenge and the mission for all new cars and vans to be effectively zero emission by 2040.

1.2 GENERATING ECONOMIC BENEFIT FROM WORLD LEADING RESEARCH

Reaching the 2.4% R&D target must be led by the opportunities to drive a significant increase in private sector R&D. This must include maximising the potential economic benefit from our world leading research.

We are starting from a strong base. We know that the UK performs well on many measures by international standards. For example, a recent data review by Global University Venturing shows that, between 2013-2017, the UK was home to five of the top ten universities in the world by value of capital raised by their spinout companies.[5] But we also know from important reviews of landscape, such as the Dowling Review,[6] that there is a huge opportunity for the UK to become even better. As the largest public funder of research and innovation, UKRI is well placed to ensure that the UK leads the world in harnessing and exploiting research to deliver economic impact.

The Industrial Strategy set out several actions to further strengthen the UK's performance, such as the changes to the Research Excellence Framework to increase the weighting of impact, and the planned introduction of the Knowledge Exchange Framework led by Research England. To go further, we have established a programme of work to look across our full organisational remit to consider what more we can do to maximise the economic impact of our research in the UK. This work is being led by three UKRI Executive Chairs: Professor Lynn Gladden; Dr Ian Campbell and David Sweeney.

We will simplify our offer for research translation and impact including support for researcher-business collaborations – so that it is as straight forward as possible to navigate, and flexible enough to support the highest quality proposals. Our aim is to scale up our support to deliver economic impact from research, including the well-established catalyst programmes.

We are also considering how to ensure ambitious, innovative businesses can access the finance they need to grow and create more value and high-quality jobs in the UK. This will include working closely with the British Business Bank and investor community and delivering a range of loan and equity co-investment support.

We are continuing to enhance our institutional support to universities to help them engage with industry and maximise economic impact from their research outputs. The Industrial Strategy set out a commitment to increasing Research England's Higher Education Innovation Funding to £250m by 2020 – an increase of over 50% compared with 2016. We have also launched the £100m Connecting Capability Fund which is supporting collaborations of universities from across England to pool capacity and expertise.

We are also exploring how we can harness the economic potential across our range of infrastructural institutes, facilities and centres, including the growing network of UKRI Science and Innovation Campuses, such as Daresbury, Harwell and Norwich. This will include expanding their business incubation capacity and enhancing their entrepreneurial environment through stronger skills provision and networks.

These interventions are designed to complement the wider levers which are part of the Industrial Strategy and we will work closely with government to ensure that these are aligned. These include demand-side levers such as public procurement, and innovative regulation, for example, through the Regulator's Pioneer Fund.

Near-term actions

Throughout 2019-20 we will:

- Continue to deliver an increased 'Higher Education Innovation Funding', rising to £250m by 2020, supporting higher education institutions in England to help deliver the UK's Industrial Strategy
- Extend the pilot of 'Innovation to Commercialisation of University Research', supporting more early career researchers to find the right route to market for their commercially promising ideas.

[5] http://www.globaluniversityventuring.com/article.php/6810/2013-17-data-review

[6] https://www.raeng.org.uk/publications/reports/the-dowling-review-of-business-university-research

Rubbish green tiles win top design award

An award-winning company is turning manufacturing waste into tiles, tabletops and wallcoverings with design flair and the eco-credentials to match.

Preston-based Alusid Ltd sources unwanted manufacturing materials and puts them through an ingenious, low-impact process to give them a new lease of life.

The result is a new kind of material, combining glass and porcelain, to create solid surfaces and tiles with individual character and low environmental impact.

Launched in 2015, Alusid is the result of a research project funded by AHRC to explore ways in which waste and low-value materials destined for landfill could be repurposed into beautiful, versatile surface materials.

Additional AHRC impact funding allowed Alusid to partner with IP Frontier to secure £260,000 in venture capital funding. In December 2018 Alusid received further £1.34 million in private investment funding to support the design, planning and building of a new factory to transform production capacity.

The company won the 2018 Design Guild Mark Award, the 2018 Jonathan Hindle Design Award, Best Business Start-Up at the 2016 Institution of Chemical Engineers (IChemE) Awards and the 2015 Mixology North Design prize for Product of the Year. The company also won the 2015 Times Higher Education – Innovation in the Arts Award.

“Place your liquids in a bag please…” UK innovation is keeping air passengers safe

Major airports around the globe use innovative scanning technology pioneered at STFC’s Central Laser Facility to keep passengers safe and speed up security checks.

Cobalt Light Systems Ltd provides non-invasive, real-time chemical analysis of substances hidden beneath the surface of materials, such as liquids in bottles, aerosols, tablet capsules or raw materials in sealed containers.

Founded in 2008 and based on innovative Spatially Offset Raman Spectroscopy techniques pioneered at STFC’s Central Laser Facility, Cobalt’s products are used by more than 75 airports across Europe and Asia-Pacific, including eight of the 10 largest European airports.

Cobalt’s customers also include more than 20 of the largest 25 global pharmaceutical companies, using the technology to support quality assurance and safety.

The company, that also benefited from expertise and investment from the UK Innovation & Science Seed Fund (formerly The Rainbow Seed Fund), was recently acquired by Agilent Technologies Inc. for £40 million. Agilent’s global centre for Raman Spectroscopy is now based on the Harwell Campus close to the Central Laser Facility.

Cobalt won the Queen’s Award for Enterprise in International Trade in 2015 and was also the recipient of the prestigious MacRobert Award for Engineering Innovation in 2014, the UK’s longest running national prize for engineering.

Genetic tools boost salmon industry

New genetic tools being developed by spinout company Xelect Ltd are adding value to salmon production in Scotland and abroad by increasing yield and quality.

Xelect was established by Professor Ian Johnston and Dr Tom Ashton in 2013 at the University of St Andrews. In the early 2000s, whilst funded by BBSRC, the pair were approached by Young's Seafood to help them understand the genetic factors that affect the quality of salmon flesh. To do so, Johnston and Ashton developed methods to accurately measure the texture of salmon fillets – now used for quality control at Young's.

The collaboration also allowed the team to identify genetic factors that influence fillet yield, enabling them to pinpoint two genes which, when selected together, were associated with a 4% increase in fillet yield – a boost estimated to be worth about £600 per tonne to producers - this added value could equate to around £97.8M in increased annual revenue to the industry.

Subsequent BBSRC funding enabled the researchers to validate their markers with other producers in Scotland, Norway and Chile. The data enabled them to negotiate an exclusive European licensing deal for their technology with the major salmon producer Salmobreed A/S, as well as a trial licence to apply their technology to marker assisted breeding on salmon farms in Chile with the UK company Landcatch Natural Selection.

1.3 STRATEGIC PRIORITIES FUND (SPF)

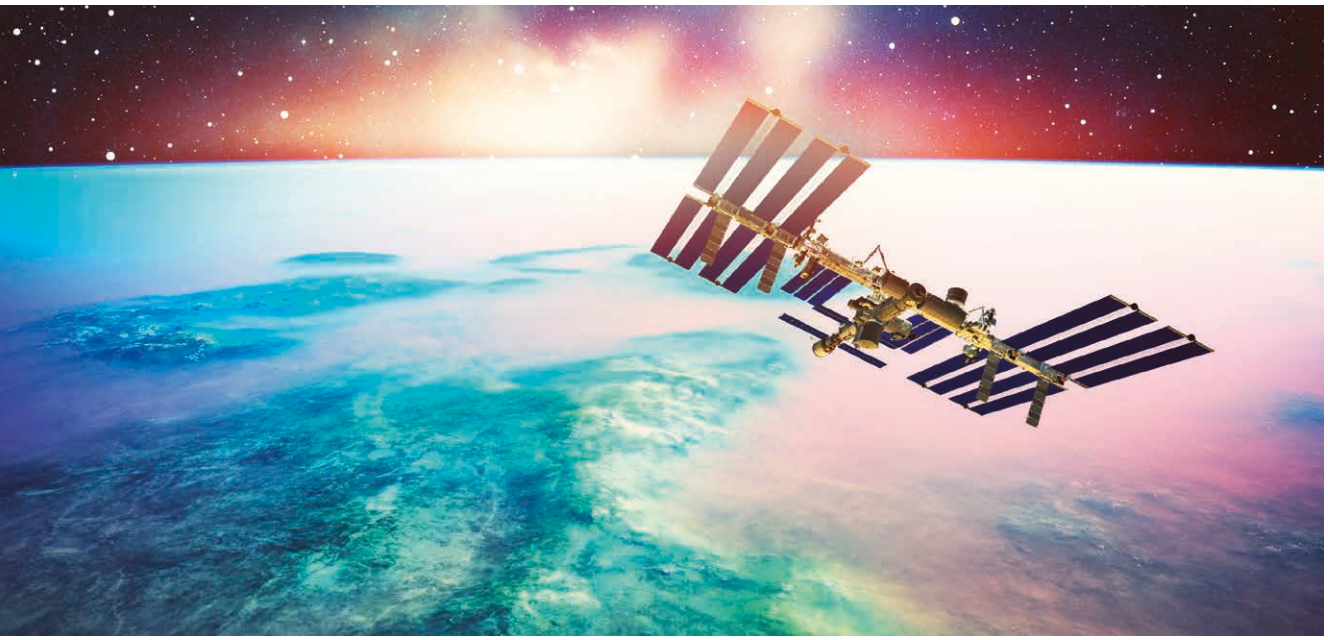
The SPF supports emerging priorities and opportunities and multi-disciplinary and inter-disciplinary research for activities that cross boundaries between the nine UKRI councils, or between councils and government departments. As part of the National Productivity Investment Fund, it builds on Sir Paul Nurse's vision of a "common fund", as recommended in his independent review of the research councils[7]. Nurse observed that the challenges, opportunities and priorities for UK R&D have shifted over time, but there was no mechanism to do any meaningful adjustment in response to this across the councils.

The SPF enables UKRI to invest in fundamental research and innovation priorities critical to the UK's future. It supports excellent programmes across the entire research and innovation landscape which meet the objectives of the fund, which are to:

- drive an increase in high-quality multi-disciplinary and inter-disciplinary research and innovation
- ensure UKRI investment links up effectively with government departments' research and innovation priorities and opportunities
- ensure the system is able to respond to strategic priorities and opportunities.

To identify which programmes should be funded through the SPF, we have engaged extensively with stakeholders through our councils, while working closely with BEIS and other government departments. This includes close collaboration with the Government Office for Science (GO-Science) and government departments' Chief Scientific Advisors (CSAs) to encourage alignment with published departmental Areas of Research Interest.

The SPF includes UKRI as well as five non-UKRI BEIS-funded R&D bodies: The Met Office, the National Nuclear Laboratory (NNL), the National Physical Laboratory (NPL), the UK Atomic Energy Authority (UKAEA), and the UK Space Agency (UKSA). An expert panel assesses potential SPF programmes and makes recommendations to the UKRI Board on funding approval. UKRI will deliver the following programmes, with our stated partners:



[6] https://www.gov.uk/government/publications/nurse-review-of-research-councils-recommendations

WAVE 1	**Environment** (£60 million)	• **UK Climate resilience** (The Met Office, DEFRA, The CCC Adaptation sub-committee - £18.7 million) • **Clean air: Analysis and solutions** (The Met Office, NPL, DEFRA, DHSC, DfT - £19.6 million) • **Constructing a digital environment** (Cabinet Office – £10.4 million) • **Landscape decisions** (DEFRA – £10.5 million)
	Bioscience (£55 million)	• **The Human Cell Atlas initiative** (British Heart Foundation – £6.7 million) • **Physics of life** (£31.2 million) • **UK Animal and Plant Health: understanding and countering bacterial plant diseases** (DEFRA, Scottish Government – £17.7 million)
	AI (£78 million)	• **Living with machines** (The Alan Turing Institute, the British Library – £9.2 million) • **AI and Data Science for Engineering, Health, Science and Government** (Home Office, Ministry of Justice, DfT, DEFRA, DHSC - £39.3 million) • **Ensuring the Security of Digital Technology at the Periphery** (DCMS, Home Office - £30.6 million)
	Large Capital Projects (£125.5 million)	• **The European Bioinformatics Institute** (EMBL-EBI) (£44.5 million) • **Extreme Photonics Application Centre** (MOD- £81 million)
	Productivity (£23 million)	• **Transforming productivity research** (BEIS, DHSC and DWP – £8.9 million)

Near-term actions

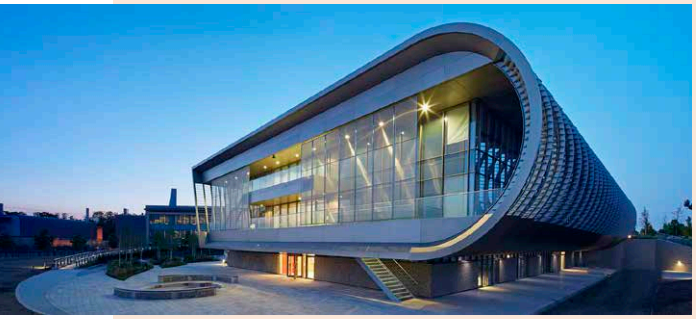
Throughout 2019-20 UKRI will:

- Work with our BEIS-funded R&D partners to deliver the SPF programmes announced to date, including running research calls and innovation competitions open to researchers and businesses across the UK
- Develop and make the case for further rounds of the SPF as part of the Comprehensive Spending Review, with a particular focus on cross-government collaboration.

£45 million boost for the big data that drives discovery

A £45 million boost to data and building infrastructure will support major advances in drug discovery, cancer genetics, regenerative medicine and plant health.

EMBL's European Bioinformatics Institute (EMBL-EBI), in Cambridgeshire, is a renowned global leader in bioinformatics, the science of analysing, storing and sharing large biological datasets that is essential to discovering how genes affect the health of humans, plants and animals.



Life scientists all over the world use EMBL-EBI's infrastructure to share and access data to drive cutting-edge research in genomics and molecular biology.

The new funding, delivered through the UKRI Strategic Priorities Fund working closely with the Wellcome Trust, will support the growing need for the biological data management and analysis provided by EMBL-EBI.

EMBL-EBI is currently supporting major scientific programmes including:

UK Biobank: genomic data from 500,000 volunteers is distributed via EMBL-EBI's European Genome-phenome Archive

Human Cell Atlas: contributing to the creation of the Data Coordination Platform which will enable scientists from all over the world to define every cell in the human body

Combatting serious threats to plant health, crops and forestry

Bacterial diseases can have a devastating effect on crop production, forestry and wider biodiversity, and the threat is increased by climate change and growing international trade.

A new £17.7m programme will produce the research and evidence needed to counter that threat and avoid the economic, environmental and social impacts it could cause.

The Bacterial Plant Diseases programme is supported by UKRI's Strategic Priorities Fund together with DEFRA and the Scottish Government.

In the first phase, a consortium of institutions coordinated by the John Innes Centre will inform the UK's response to the potentially devastating *Xylella fastidiosa*, a highly infectious bacterium that has proved impossible to eradicate in continental Europe.

If *Xylella* reached the UK, there would be risks to trees and plants, with potentially widespread damage to rural and urban landscapes, and restrictive control measures on the horticultural trade.

A second phase of the programme will support multidisciplinary research on a wider range of bacteria that threaten plant health.

2. Places: supporting growth across the UK

Research and innovation strengths exist across the UK, and this has been borne out by the Science and Innovation audits. UKRI is committed to supporting every part of the UK to build on its strengths, so that the whole country is contributing towards – and feeling the benefits of – the Government's 2.4% R&D target and Industrial Strategy.

UKRI is investing to maintain and build on these regional strengths through our cross-cutting programmes and council funding. From the Industrial Strategy Challenge Fund to research council grant funding; Centres for Doctoral Training to Knowledge Transfer Partnership – UKRI's programmes support regions across the country to benefit from public research and innovation investment.

A number of council programmes have a strong regional focus. For example, Research England's 'Expanding Excellence in England' pilot is supporting high-quality, but small, research units and departments in universities across England to build their research capacity. Additionally, the Connecting Capability Fund is supporting a number of university consortia to maximise the economic impact of their research. Many of these having a strong regional focus – such as the Midlands Innovation Commercialisation of Research Accelerator and the Northern Accelerator.

2.1 STRENGTH IN PLACES FUND

Most significantly, we have launched a new cross-cutting programme that has a specific focus on leveraging local research and innovation strengths to drive local economic growth and productivity improvements: The Strength in Places Fund.

The Strength in Places Fund is a new competitive funding scheme that takes a place-based approach to research and innovation funding, to support significant regional economic growth. Announced in the Industrial Strategy White Paper, it will invest £236 million between 2018-19 and 2021-22. The fund will support significant local clusters of research and innovation, based on local strengths, which will help to build research excellence across the United Kingdom, thereby supporting productivity and local growth increases in line with the Places foundation of the Industrial Strategy.

This is a competitive fund for collaborative bids from consortia including both businesses and research organisations, and with strong engagement from local leadership partners. Partners work together to leverage local research strengths and business capabilities to drive local economic impact. The programme is flexible and can support a wide range of interventions across our funding remit. It will make investments that align with priorities identified within local economic plans, including Local Industrial Strategies in England.

The Strength in Places Fund works in partnership with the higher education funding bodies of Wales, Scotland and Northern Ireland and the Office for Students. Research England and Innovate UK lead delivery, with input from across all UKRI councils. Its high-level aims are to:

- support innovation-led relative regional growth by identifying and supporting areas of R&D strengths that are driving clusters of businesses across a range of sizes with potential to innovate or to adopt new technologies, so those clusters will become nationally and internationally competitive
- enhance local collaborations involving research and innovation by building on the underpinning regional economic impact role played by universities, research institutes, Catapults and other research and development facilities such as Innovation and Knowledge Centres (IKCs)
- engage businesses at the forefront of delivering economic growth through innovation within the identified economic geography.

In the first wave, 23 ambitious projects, from environmental data to pharmaceuticals, from transport to the creative economy, have been awarded up to £50,000 to develop full-stage bids

The teams are now developing their full stage competition proposals – with four to eight set to receive between £10 million and £50 million each to deliver their projects.

Near-term actions

Throughout 2019-20 UKRI will:

- Support the shortlist of wave 1 consortia to develop full stage bids, with decisions made in 2020
- Launch Wave 2 of the strength in places fund to support the development of more high-impact clusters across the UK.

The Advanced Manufacturing Research Centre, Sheffield

World class clusters exist across the UK, with industry and research organisations working together to solve problems and create local and national impacts. A great example of this is the Advanced Manufacturing Research Centre (AMRC) in Sheffield.

The AMRC – which is now part of the Innovate UK-funded High Value Manufacturing Catapult – was originally founded in 2001 as a collaboration between the University of Sheffield and Boeing. Today, it has over 100 industrial partners and directly employs over 500 researchers and engineers across a number of sites in South Yorkshire and Lancashire.

The expertise and capabilities that have developed around the AMRC cluster has attracted investment into the area from a range of businesses. In October 2018, Boeing opened their first production site in Europe in Sheffield, with an investment worth over £40m.

3. Ideas: pushing the frontiers of human knowledge and understanding

"Creativity is core and requires freedom of thought and action to pursue an investigation wherever it leads. A researcher who is too strongly directed, or whose thoughts are restrained is unlikely to be fully effective in research. Similarly, in my view, societies which do not encourage freedom will find it harder to excel in research" Nurse Review[8]

Human curiosity about ourselves, the world and the Universe we inhabit has inspired the UK's long, proud tradition of enquiry. Our ever-expanding knowledge has been transforming and delivering lasting benefits for our economy and society.

A core part of UKRI's mission is to advance the frontiers of human knowledge and understanding. This is an important goal in its own right, but it is also crucial to secure our ability to deliver impact in the near and long term, as it helps:

- solve existing but currently intractable challenges
- respond with agility to unforeseen opportunities
- enable new applications with the potential to deliver economic growth, social prosperity and cultural impact in the longer term
- encourage internationally mobile individuals and businesses to choose the UK to conduct R&D and to invest and build their businesses.

Our ability to do this, and the strength of the research base, depend on creative and talented people, world-leading infrastructure and a healthy, sustainable research and innovation ecosystem.

Building on this, we invest in discovery research across the entire spectrum of disciplines, reflecting the broad range of domains of our Councils. The research questions across UKRI's portfolio cover a vast span: scales (from the smallest particle through to complex global systems); disciplines (from the biology of the brain to the philosophy of what it is to be human); and approaches (from individual investigators doing research in an archive or lab, through to global consortia coming together to invest in cutting edge infrastructure to address fundamental questions in particle physics).

Within this broad remit, our approach to investing focusses on:

- advancing the frontiers of discovery research
- seeking and supporting new, emerging and disruptive technologies and exploring their impact on the world and society
- helping to understand today's greatest challenges that span society and cross disciplinary boundaries.

The UK's approach to achieving this has at its heart the 'dual funding approach'. The two arms of the dual funding system are complementary:

- Research into priority themes and questions, including cross-cutting technologies and challenges, led through the research councils
- Performance-related investment to support investigator- and institution-led research, as well as to ensure the long-term sustainability of the research system, led through Research England.

Both elements of this system are based on rigorous competition: research council funding is allocated on the basis of international peer review; and Research England's performance-related investment is allocated on the basis of the Research Excellence Framework (REF).

This combination is the envy of the world. It ensures we can support the highest quality research in priority areas, while also ensuring curiosity driven research can flourish, pockets of research excellence throughout the country can grow, and ensures that the system is sustainable. The strengths and benefits of dual support are

[8] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/478125/BIS-15-625-ensuring-a-successful-UK-research-endeavour.pdf

widely acknowledged and reflected in the decision to enshrine this system in law for the first time in the Higher Education and Research Act 2017.

The priorities for our strategic mode funding are informed by our engagement with and understanding of our research and innovation communities, as well as policy and Governmental priorities. These include understanding priority cross-cutting technologies that have the potential to transform the way we do business, support our national security, and live our lives. For example, we continue to invest in the Eight Great Technologies such as quantum and synthetic biology. They also focus on the priority applications of our research, such as the Industrial Strategy's four Grand Challenge programmes and the missions beneath them.

Research England's performance-related funding plays a crucial role in ensuring that those at the forefront of research have the freedom to identify and pursue the questions and opportunities that they are best placed to identify. This freedom and flexibility helps to ensure the UK maintains its position at the global forefront of excellence in discovery research. It also prepares us to address those opportunities and challenges not yet seen or imagined. Even the most diligent horizon-scanning exercises a decade ago would not have identified some of the decade's hot topics and challenges, nor allowed the space for important serendipitous discovery. Revolutionary technologies with widespread applications across multiple sectors often depend on the culmination and convergence of many years of fundamental discovery research. Ground breaking new materials such as graphene, and areas such as quantum computing, synthetic biology, machine learning, mental health, the environmental impact of plastics and gravitational waves all emerged from the investigator-led discovery research part of the system.

The Research England part of the dual support system provides important support that nurtures the foundations underpinning the sustainability of the UK's research funding ecosystem. It supports the broad range of research activities necessary to provide the people, ideas, infrastructure and environments to inform and deliver research excellence and impact. This includes developing new strategic and interdisciplinary research activities and testing early stage, high risk ideas in advance of seeking external funding sources. It provides universities with the flexibility and resources necessary to forge new partnerships with key stakeholders in research, such as industry, policy makers and charities.

We are undertaking a programme of evidence-gathering and analysis on the dual support system, led by David Sweeney, Executive Chair of Research England, working closely with partners in the Devolved Administrations. We will use this work to better understand the pressures facing the higher education sector, the impact of different funding scenarios, and to provide advice to ministers on the most appropriate balance of funding. This will aim ensure we have a clear understanding of the potential impacts of changes to the balance of dual support funding, support a healthy and effective research sector and that the dual support system is leveraged effectively and sustainably as we deliver the 2.4% target.

Near-term actions

In 2019-20 we will:

- Continue to support world leading discovery research, as described in our councils DPs, while refining the list of priority emerging technologies
- Review our peer review mechanisms to best support multidisciplinary research
- Use our review of the dual support system, and use these findings to advise ministers on the appropriate balance of funding following the Comprehensive Spending Review.

Re-engineering cells could bring the hope of a new cancer treatment to many more patients

A novel gene-editing approach is helping extend the benefits of a new cancer therapy to many more patients and make it more cost effective.

CAR-T cell therapy is a new treatment that involves extracting a patient's specialised immune cells, called T cells, which are then "reprogrammed" in the lab so they recognise and fight the patient's cancer cells.

While this breakthrough technology has revolutionised the treatment of some cancers, some patients are unable to donate their own T cells and can't benefit from the therapy.

Researchers at UCL and Great Ormond Street Hospital are now using gene editing techniques to remove a key molecule called HLA, used by the body's immune system to identify whether a cell belongs to you or to someone else, from donor T cells.

This will produce T cells which could be used "off-the-shelf" to provide CAR-T cell therapy in any patient.

The work was supported by the Biomedical Catalyst Developmental Pathway Funding Scheme, a unique partnership between MRC and Innovate UK, supporting the translation of fundamental discoveries. The scheme funds the pre-clinical development and early clinical testing of novel therapeutics, devices and diagnostics, including "repurposing" of existing therapies. To date £400M external financing has been raised through 79 investors and 31 spin out companies have been created.

Quantum “compass” could navigate without satellites

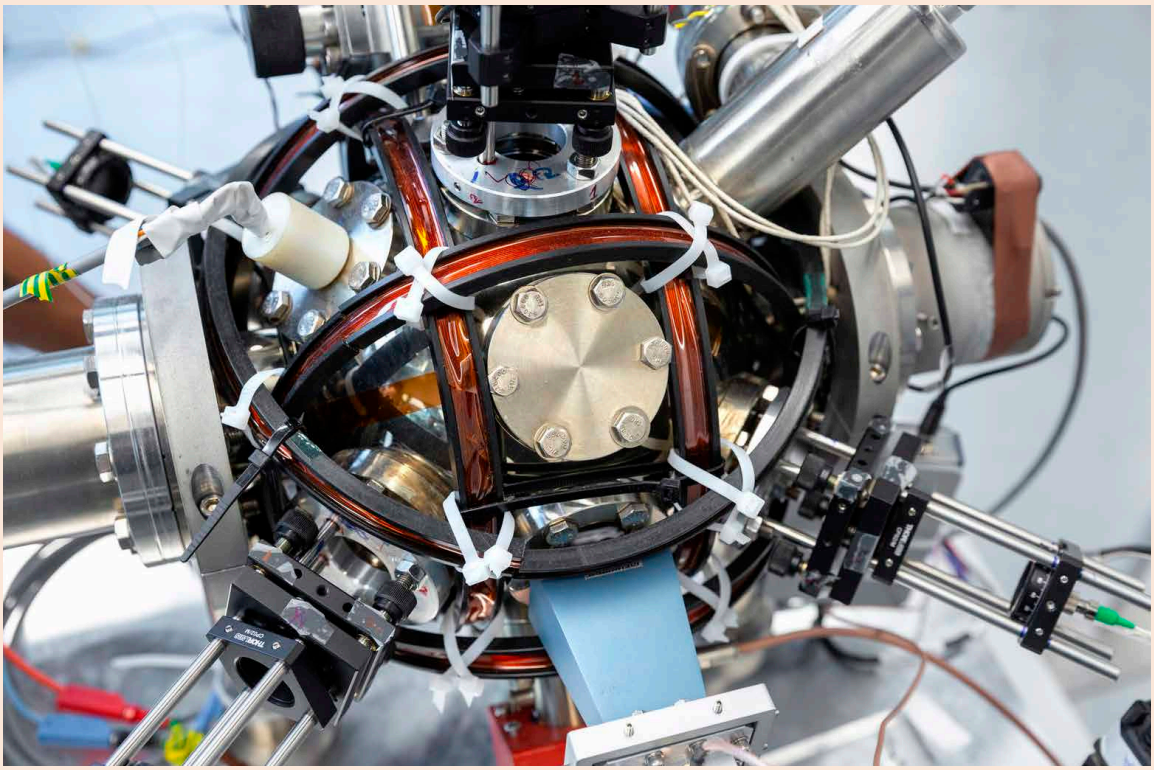
The UK’s first quantum “compass” has been demonstrated by a team supported by EPSRC, Innovate UK and dstl.

Most navigation today relies on a global navigation satellite system (GNSS), such as GPS, which sends and receives signals from satellites orbiting the Earth.

But the quantum accelerometer, demonstrated by a team from Imperial College London and M Squared, is a self-contained system that does not rely on any external signals. It relies on the precision and accuracy made possible by measuring properties of supercool atoms.

This is particularly important because satellite signals can become unavailable due to blockages such as tall buildings, or can be jammed, imitated or denied – preventing accurate navigation. A single day of outage of satellite service could cost the UK £1 billion.

The team demonstrated a transportable, standalone quantum accelerometer at the National Quantum Technologies Showcase, an event demonstrating the technological progress arising from the UK National Quantum Technologies Programme – a £270m UK Government investment over five years.



4. People: building the skills and environment for research and innovation to thrive

The UK is one of the world's most successful research nations. Building on our existing strengths, UKRI will ensure we can address the challenges of the future by providing the best environment for researchers and innovators, through:

- growing, developing and retaining the skills base
- nurturing a supportive and responsible research and innovation culture
- inspiring the public and involving them in research and innovation.

4.1 GROWING, DEVELOPING AND RETAINING THE SKILLS BASE

A highly-skilled and diverse workforce of researchers and innovators in academia, business and government is critical to ensuring world-leading research and innovation continues to grow and flourish in the UK. UKRI is developing a longer-term talent strategy that takes an overarching view on what the future research and innovation workforce will look like, and the systems-level interventions required, in the context of delivering the 2.4% target.

Achieving this will require growth in the research and innovation workforce, including the numbers studying PhDs, and a paradigm shift in supporting careers that seamlessly span sectors and increase mobility between business and academia to boost innovation. Opening up other career pathways into research and innovation, including vocational education, Masters level courses and apprenticeships, as well as supporting entrepreneurship, will become increasingly important. And it is essential that the UK must continue to attract talented researchers and innovators from across the world.

We have increased investment in early career researchers, including PhDs, through the National Productivity Investment Fund. This began in the 2017 Budget, when Government announced a £300 million investment in talent. These investments

will establish the next generation of research and innovation leaders through the new flagship Future Leaders Fellowship scheme (see below) and will support training by creating new PhD places over five years, increased investment in Knowledge Transfer Partnerships and innovation placements through our councils, and creation of a new programme to increase cross-sector mobility and to further knowledge exchange.

The Rutherford Fund (£100 million) has provided international fellowships for early-career and senior researchers from across the World (developed countries and emerging research powerhouses including Brazil, China, India and Mexico) to ensure the UK retains its world-leading position in science and research.

The following investments complement the skills and training activities described in each of the councils plans.

Future Leaders Fellowships

These will grow the strong supply of talent in the UK, by supporting early career researchers and innovators with outstanding potential in universities, in business and other organisations. The Future Leaders Fellowships programme will invest £900 million from the NPIF over the next 11 years to support at least 550 early-career researchers and aims to:

- develop, retain, attract and sustain research and innovation talent in the UK
- foster new research and innovation career paths including those at the academia/business interface and interdisciplinary boundaries, and facilitate movement of people between sectors
- provide sustained funding and resources for the best early career researchers and innovators
- provide long-term, flexible funding to tackle difficult and novel questions, and support adventurous, ambitious programmes.

Doctoral training

A total of £100 million has already been allocated for additional doctoral training focused on Artificial Intelligence (AI), pivotal to building a future skills base to support the delivery of the Grand Challenges in the Industrial Strategy. Using the successful Centres for Doctoral Training (CDT) mechanism for cohort-based training, the funding will provide around 1,000 additional PhD studentships in the field of AI over the next five years. A further 100 new doctoral places were funded in 2018-19 through existing research council schemes. This investment is in addition to the significant annual investment in doctoral training described in our councils plans, bringing UKRI's total doctoral funding to £422 million in 2019-20.

Near-term actions

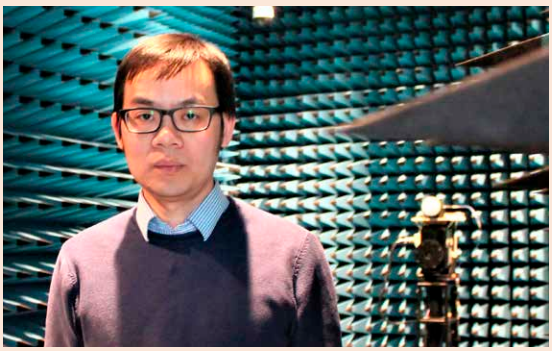
Throughout 2019-20, we will continue to deliver on our talent programmes as well as develop and launch new interventions to nurture future talent, including:

- Start new cohorts of AI CDT studentships. With 16 new centres supported, new cohorts will start in 2019-20, and 200 new students will start each year for the next five years
- Launch two further rounds of the Future Leaders Fellowship programme, managed by a cross-UKRI team. The first two rounds were opened in 2018 and the fellows will start their fellowships in 2019-20. In total, there will be six rounds across three years, with the third opening in April 2019
- Pilot a new Innovation Scholarship scheme, with the dual objectives of providing courses/training to meet industry demand and funding individual secondments between sectors, particularly academia and industry, to increase mobility and facilitate exchange of ideas and skills
- Work in partnership with the Office for AI and the Alan Turing Institute to launch a new fellowship scheme, investing £46 million to bring the best global researchers in AI to the UK
- Play a more active role in supporting technicians and skilled specialists, both in our own institutes and facilities and in the wider research and innovation workforce
- Engage with the Home Office to ensure the UK's future skills-based immigration system works for the research and innovation base.

Future Leaders Fellows

A new generation of rising stars across research and business will tackle pressing global challenges through UKRI's Future Leaders Fellowships initiative.

The prestigious Future Leaders Fellowships, supported by a £900 million investment fund, provide researchers and innovators from diverse backgrounds and career paths with the flexibility and time they need to make progress on truly challenging questions and open new markets.



Hien Ngo, Queen's University of Belfast

Hien Ngo aims to develop a totally new mobile network called cell-free massive multiple-input multiple-output, or MIMO.

Over the past 40 years, mobile networks have been based on cellular topologies where the land area is divided into cells, with each one served by a base station.

However, cellular networks are running out of capacity and are not suitable for future wireless systems which must be capable of managing billions of devices at the same time.

Different from cellular networks, in cell-free massive MIMO there are no cells. Instead, many thousands or more access points distributed over a large area jointly serve many users. This system can improve data speed, reliability and connectivity, and hence, meet demands of future wireless systems.

With the Future Leaders Fellowship award, Hein will build a strong research team, who will work directly with world-leading researchers in the field from both academia and industry to further improve this new mobile network.

Dr Natalie Shenker, Imperial College London

Natalie Shenker cofounded the UK's first independent non-profit human milk bank just under two years ago. The greater availability of safe, screened, donated milk means studies can begin into how donor milk can be used most effectively beyond extremely premature babies, including if it can act as a bridge to support new mothers in stressful circumstances to establish their milk supply.

Natalie will also study how the diverse composition of human milk – for example the types of fats – changes up to two years after birth, about which surprisingly little is known. Better understanding of these changes could help match donor milk to babies with different illnesses.

Natalie is also using the unique opportunity that human milk provides to study healthy breast cells from the mother. Changes in these cells' epigenetic profiles (how genes are switched on or off) could help predict a woman's future risk of breast cancer, allowing better screening tests to be developed.

Natalie said: "This Fellowship is a unique opportunity to start a much-needed programme of collaborative research with support for mothers at its core. I am passionate about enabling both women and men to understand more about one of our most fundamental abilities – nourishing the next generation."

4.2 RESEARCH AND INNOVATION CULTURE

We play a key role in nurturing a supportive and responsible research and innovation culture by developing and implementing policies to attract the best talent and to enable the best research and innovation. A healthy research and innovation environment is important to maintain public and international trust in the reliability of the research we fund. We have publicly committed to using our position as the largest public-sector funder of research and innovation in the UK to lead positive behavioural change nationally and internationally.

We are currently focusing on several key areas of policy interest which matter for this agenda including:

- Research integrity and ethics
- Equality, diversity and inclusion (EDI)
- Bullying and harassment
- Open Access to research.

In the following paragraphs we outline UKRI's activities in these areas. Our councils reference any specific applications of these policies in their plans.

Research integrity and ethics

Creating a supportive and responsible culture is crucial to enable the best research and innovation, and to gain and maintain public trust in the reliability of the research we fund. As outlined in the Strategic Prospectus we are committed to working with stakeholders in the UK and internationally to review the operating environment for research in the UK. We will act on the results to ensure that our funding and operations encourage the best practices and behaviours.

In July 2018 we welcomed the House of Commons Science and Technology Committee's report on research integrity in the UK. The report identified a number of causes for concern, including poor levels of compliance with the Concordat to Support Research Integrity ("the concordat"), the lack of transparency around research integrity issues, and the absence of independent oversight to examine whether research institutions have followed appropriate processes to investigate research misconduct.

Near term actions

Throughout 2019-20, we will:

- Continue working with BEIS, Universities UK (UUK), UK Research Integrity Office (UKRIO) and other signatories to strengthen the Concordat to Support Research Integrity and ensure the requirements and expectations are clearer
- Establish an entity which can independently examine whether research institutions have followed appropriate processes to investigate misconduct
- Develop a UKRI ethics statement and framework
- Collaborate with the Royal Statistical Society on a plan, led by ESRC, to boost the statistical competencies of researchers in the UK
- Undertake an assessment of the training on research integrity provided as part of our doctoral training partnerships to identify any challenges and to consider the case for adjustments
- Commission research, led by Research England, on the impact of incentives in the research system on researcher behaviour to identify options and approaches for adjustments and counterbalances needed to support research integrity
- Continue to work with stakeholders in the UK and internationally to review the operating environment for research in the UK and around the world to ensure the UK continues to promote the highest standards of research, collaboration and integrity.

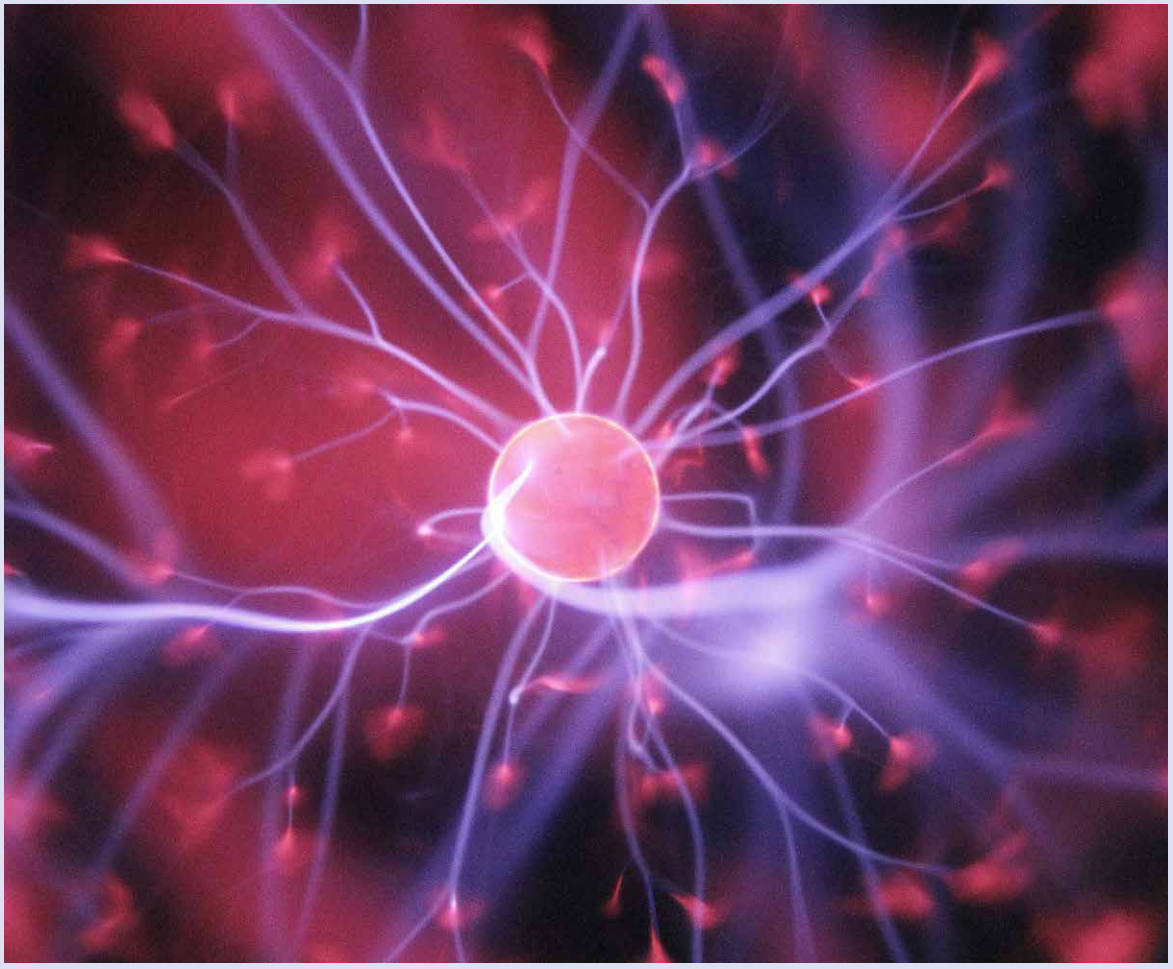
FACT BOX

The Concordat to Support Research Integrity

Developed in 2012 by the UK Government, Universities UK, Research Councils UK, the National Institute for Health Research, the Wellcome Trust and other stakeholders, the concordat recognised a need for greater openness and transparency, and to ensure adherence to consistently high standards across the research community. In 2019, these needs are greater still and the concordat has been revised, representing a renewed ambition.

It sets out five commitments that those engaged in research should make to help ensure that the highest standards of rigour and integrity are maintained. In order to meet these key commitments researchers, their employers and funding bodies play specific roles to:

1. uphold the highest standards of rigour and integrity in all aspects of research.
2. ensure that research is conducted according to appropriate ethical, legal and professional frameworks, obligations and standards.
3. support a research environment that is underpinned by a culture of integrity and based on good governance, best practice and support for the development of researchers.
4. use transparent, timely, robust and fair processes to handle allegations of research misconduct when they arise.
5. work together to strengthen the integrity of research.



Equality, Diversity and Inclusion (EDI)

Equality, diversity and inclusion – of people and ideas – is integral to excellence in research and innovation, letting us access the best talent and benefit from the broadest range of ideas. Everyone should feel that a career in research and innovation is a compelling choice. They should feel welcomed, supported and nourished in their development as professionals irrespective of their background. In doing so, we can include all potential researchers and innovators with ground-breaking ideas, and who have the potential to shape our futures for the better.

As a major funder and employer of circa. 7,000 people, UK Research and Innovation (UKRI) is in a unique position to drive real change to improve EDI across the sectors. In our Strategic Prospectus, we set out two overarching objectives in support of EDI:

- Champion equality, diversity and inclusion across the research and innovation sector, and support a healthy and high integrity culture
- Be a great place to work, which inspires, engages and learns from its people.

We are already making progress to realise our ambitions. Following the appointment of Professor Jennifer Rubin, Executive Chair of the Economic and Social Research Council, as the UKRI Champion for Equality, Diversity and Inclusion, we have established a UKRI EDI External Advisory Group, comprising of an outstanding group of individuals with EDI expertise from diverse backgrounds.

Near term actions

Throughout 2019-20 we will:

- Consolidate the existing evidence base and report on the findings from evidence reviews to help establish a current picture of what is known about the key challenges for EDI in the UK research and innovation landscape, and to develop an understanding of what interventions work and what has proven less effective, to identify and learn from effective practice
- Seek advice from our external advisory group and wider stakeholders to develop a strategic framework, which will help to ensure that EDI is considered and supported in all that we do, including in flagship programmes such as ICSF and SPF, by Summer 2019.

FACT BOX

Our External Advisory Group bringing together national and international experts from across the public, private and charitable sectors is working with UKRI to improve outcomes in equality, diversity and inclusion.

The group will provide us with independent advice and robust challenge, as we develop our policies and practices. Their work will build on the activities described within Council's plans.

The group's members include representatives from academia, business, government and the NHS. It is chaired by UKRI Executive Champion for Equality, Diversity and Inclusion, Professor Jennifer Rubin, with Dr Karen Salt of the University of Nottingham acting as deputy chair. Their collective experience and expertise will help to shape UKRI's development of an ambitious, long-term strategy for equality, diversity and inclusion.

Bullying and harassment

Everyone has a right to be treated with dignity and respect, and to be provided with opportunities to contribute and flourish in a supportive environment. Bullying and harassment is a significant issue for society at large, and the research and innovation sector is not an exception. We are very clear that these behaviours are completely unacceptable.

While employers have a primary duty to prevent these incidents wherever possible, and to take appropriate action as required, UKRI, as the largest funder in the UK research and innovation landscape, can and will play an important role in setting the tone, providing research evidence, and influencing the wider environment.

Near term actions

Throughout 2019-20:

- Work with national and international partners to develop the evidence base around the prevalence, challenges and evidenced effective interventions to prevent and tackle these problems
- Build on our stakeholder engagement to continue to listen to the sector and to discuss effective approaches and assurance mechanisms and seek a coordinated approach
- Work internally with UKRI HR and with our institutes, centres and units, to ensure our internal processes meet with guidance on best practice
- Adjust our terms and conditions of funding to reflect our new requirements
- Develop a robust assurance mechanism.

EXAMPLE

The Global Institute for Women's Leadership, King's College London, has carried out an evidence review into bullying and harassment that will inform how UKRI can take action to address issues in the research and innovation landscape.

The review has focused on current challenges both UK and internationally, an overview of approaches to prevent bullying and harassment in both the research and innovation sector and other sector, and an assessment of existing evidence for the effectiveness of those approaches and where gaps in knowledge are.

Open access to research

The public has the right to expect that the research and innovation supported by the public purse has the maximum possible impact. Open research is an important part of achieving this. It ensures research is accessible, transparent and cooperative. It produces better quality outputs, more efficiently and in ways that can be readily shared. Open research has a number of components across the whole research process. The UKRI Strategic Prospectus identified the following two as the highest priorities:

- **Open access (OA)**: that publicly funded research should be widely and freely accessible to all as soon as possible, under conditions that allow maximum re-use
- **Open data**: that research data should be made openly available in a way that is legal, ethical, and maximises economic impact.

In September 2018 UKRI became part of an international coalition called "Plan S". This aims to accelerate sustainable open access and seeks to collaborate with other research funders and stakeholders to achieve better value and impact of publicly funded research. Working internationally is important to help achieve open access since scholarly communications operate globally. Moving to openness requires alignment.

We have initiated an open access review that will take Plan S into account. The review seeks to develop a policy across UKRI that:

- enhances the research, societal and economic benefits that can be derived from our funded research through improving access to research outputs
- delivers sustainable support for open access and the best value for money
- ensures policy is joined up across our constituent bodies and that it is clear, unambiguous and as easy as possible to comply with
- encourages the development of new models of open access publishing
- supports the adoption of open access through collaboration and alignment with national and international partners.

As part of the OA Review we are gathering and commissioning evidence for the most effective way to achieve open access to meet our goals, and we are engaging a wide range of stakeholders, including researchers, businesses, universities, learned societies, and publishers. Any decisions on the implementation of Plan S will be subject to the outcomes of the OA Review.

The review is assessing progress in the UK since the last policy for open access that was put in place in 2013, and will develop a policy for formal scholarly publications, peer reviewed conference proceedings and monographs. We are working across Government.

Near term actions

Throughout 2019-20:

- We will continue to engage in Plan S in collaboration with other national research funders
- We are working with the Wellcome Trust and the Association of Learned and Professional Society Publishers to develop business models to aid the transition to open access for Learned Societies
- We will develop open access policy options and actions and assess their feasibility, including undertaking a consultation exercise to inform the final policy and implementation plan.

4.3 PUBLIC ENGAGEMENT

UKRI will only achieve its goals if we support research and innovation that is built on the knowledge, priorities and values of society and is open to participation by people from all backgrounds. This is because involving society leads to better outcomes: research and innovation that is more relevant, has more value and benefits more people.

Our new public engagement strategy will outline how we will support researchers, innovators and policymakers to engage people with their work, as audiences and as collaborators. The strategy will reflect our new responsibilities, for STEM inspiration, public engagement with research, public dialogue on policy issues and public engagement in the innovation process.

Based on our new areas of responsibility, we have developed four goals:

1 **Everyone in the UK has the opportunity to participate in research and innovation.** There is a gap between research, innovation and society in terms of who is able to participate and who decides what the priorities are. We want to give everyone in the UK opportunities to participate in research and innovation, as audiences and collaborators, no matter where they live or what their background is.

2 **Researchers and innovators know why, when and how to actively involve people in their work and are supported and incentivised to do so.** Active public participation in research and innovation can involve everything from volunteers collecting data to working with researchers to frame questions and with businesses to test their innovations. Alongside improving the quality and relevance of research, it can have important benefits such as providing an effective method of informal learning.[9]

3 **Young people feel empowered to participate in research and innovation across the arts, humanities, STEM and social sciences.** Research and innovation have the potential to inspire a new generation to develop the skills they will need to tackle global challenges, ensure a culturally vibrant society and secure the UK's place in the global economy of the 21st century. We will work in partnership to ensure that all young people have access to informal learning experiences, from museums to after-school clubs.

4 **Society plays an active role in shaping the direction of research and innovation.** Public bodies in the UK have a strong reputation for seeking to involve people who aren't experts in the policy making process.[10] We will build on this by developing new ways to engage society as we develop our plans and priorities, focusing on topics such as climate change and AI in the first two years of our public engagement strategy.

Near-term actions

In financial year 2019-20 we will:

- Continue to deliver a £9 million portfolio of STEM inspiration and public engagement initiatives:
  - Our flagship STEM Ambassadors programme, CREST awards and Youth Grand Challenges Programme, which enable young people to participate throughout the research and innovation cycle
  - The Sciencewise programme, which is an important tool that UKRI has to help the Government and research councils understand public concerns.[11]

[9] See Innovation in open science, society and policymaking http://discovery.ucl.ac.uk/10058422/1/Citizen-Science.pdf

[10] See for example the Sciencewise public dialogue on mitochondria replacement https://www.hfea.gov.uk/media/2618/mitochondria_replacement_consultation_-_advice_for_government.pdf

[11] Responsibility for Sciencewise transferred from BEIS to UKRI as of 1st April 2019.

- Develop and deliver over £2m of new activities:
  - A citizen science programme to encourage and support more diverse types of projects to use citizen science methods, in areas connected to the industrial strategy and global grand challenges
  - A funding call to support universities to develop new approaches to engage under-represented communities with research and innovation and embed this way of working
  - Commission research to inform our longer-term plans: opportunities for public engagement with innovative businesses; evidence and metrics for public engagement; barriers and incentives for public engagement; creative and innovative approaches to public dialogue.

Innovative citizen science project advances climate science and policy

Researchers harnessed the power of volunteer computers to improve confidence in complex climate prediction models.[9] Over 260,000 members of the public worldwide have participated since the website was set up in 2003. Running variations of the complex models on the volunteer computers enabled the team, supported by NERC discovery funding, to pioneer a new approach to climate science. The work informed the latest Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). IPCC reports are critical to the formulation of government policy on climate change, including in the UK.

[9] REF Impact case study: Climateprediction.net: Engaging the public in climate science

5. Infrastructure: enabling access to, and investment in, world-leading research and innovation infrastructure

The UK's global stature in research and innovation is founded on access to world-leading infrastructure that supports research and innovation activities at all scales, from individual investigators to large multinational collaborations.

Infrastructure includes institutions, facilities, resources and services that are used by research and innovation communities to conduct research and foster innovation in their fields. It can include:

- major research equipment or sets of instruments
- knowledge-based resources such as collections, archives and data
- e-infrastructures such as data and computing systems and communication networks.

These can be found in universities, institutes, businesses and other organisations that conduct research and innovation and depend on, and bring together, talent from the public, private and third sectors and across disciplines to enable them to develop and operate.

Funding for infrastructure includes large strategic projects, World Class Laboratories funding, the Research Partnership Investment Fund (RPIF) and formula-based capital research allocations. These are described in our councils plans.

5.1 INFRASTRUCTURE ROADMAP

Later in 2019 we will publish the first edition of a long-term (until around 2030) research and innovation infrastructure roadmap. Led by Professor Mark Thomson, Executive Chair of STFC, the Infrastructure Roadmap will:

- inform future investment decisions in research and innovation infrastructure and provide a framework for development of new projects from concept to design to implementation
- offer a coherent long-term vision to maximise the value of government investment in national and international infrastructure and contribute to the ambition to deliver an economy where R&D investment contributes 2.4% of GDP by 2027
- recognise common themes, which could benefit from a cross-sectoral approach
- promote the UK as a global leader in research and innovation.

Work has focused on international and national level infrastructure that receives significant funding from public sector research and innovation funders and is open to a wide range of users.

Published in December 2018 the Initial Landscape Analysis[10] captures our emerging understanding of the existing infrastructure landscape. It draws heavily on responses from existing infrastructure management teams to two questionnaires and is supplemented with insight gained from consultation workshops, interviews with stakeholders and previous analysis. Further work is being undertaken to understand critical gaps in our coverage of infrastructures. Drawing on the data submitted, an online portal for infrastructure discovery is under development.

[10] https://www.ukri.org/files/infrastructure/landscape-analysis-2-pdf/

Published in March 2019, the Roadmap Progress Report[11] synthesises input from our consultation with stakeholders during the first phase of the roadmap programme. This included a mix of interviews, bespoke workshops attended by over 350 participants and discussions with established advisory groups and networks. Previous roadmaps in individual disciplinary areas also informed this report.

The programme has received input from academia, representative bodies, learned societies, business networks, key charitable organisations, public sector research establishments (PSREs), the Catapult network, government departments, agencies and devolved administrations. It has also drawn on: the programme's advisory board, which includes council representatives from across UKRI, BEIS-funded PSREs, Universities UK (UUK), the Association for Innovation Research and Technology Organisations (AIRTO), devolved funders and the Royal Society. We have consulted internationally with the European Strategy Forum on Research Infrastructure (ESFRI) and colleagues responsible for the development of roadmaps in other countries.

Our councils have described their specific existing infrastructure investments within their plans.

Near term actions

In 2019-20 we will:

- Finalise and publish the first edition of the infrastructure roadmap, which will set out detail on future capability needs, options for how these might be achieved, and outline next steps
- Develop an online portal for research and innovation infrastructure discovery that identifies and signposts infrastructures available to researchers and innovators for release in summer 2019.

Accelerating materials innovation

The £81 million Materials Innovation Factory combines materials chemistry with cutting edge robots and high-performance computing to meet industry challenges and accelerate discovery.

Research England has invested £11 million into the factory at the University of Liverpool through its flagship scheme – the UK Research Partnership Investment Fund (UKRPIF).

The 11,600 square metre building boasts one of the highest concentrations of materials science automation technology in the world and can accommodate a range of academic and industrial researchers on a flexible, open-access basis, enabling cross-disciplinary collaborations, networking and knowledge exchange.

A key aim of UKRPIF is to encourage strategic partnerships between higher education institutes and other organisations active in research and strengthening the contribution of research to economic growth.

The Materials Innovation Factory is based on a strategic partnership between Liverpool University and global consumer goods company Unilever.

Unilever provided up to £25 million in co-investment, with an additional input of £4.5m for equipment and software and will base a key part of its research and development function at the facility.

The centre is also the Liverpool hub for chemical materials discovery within the Henry Royce Institute, strengthening the university's ties with other members of the institute including the Universities of Manchester, Sheffield, Oxford and Cambridge.

[11] https://www.ukri.org/files/infrastructure/progress-report-final-march-2019-low-res-pdf/

Supporting discovery for three decades

The ISIS Neutron and Muon source is expected to deliver £1.4 billion of net economic benefit based on its work to 2014, a return on investment of at least 214% and a further £1.4 billion of economic benefit is predicted up to 2030.

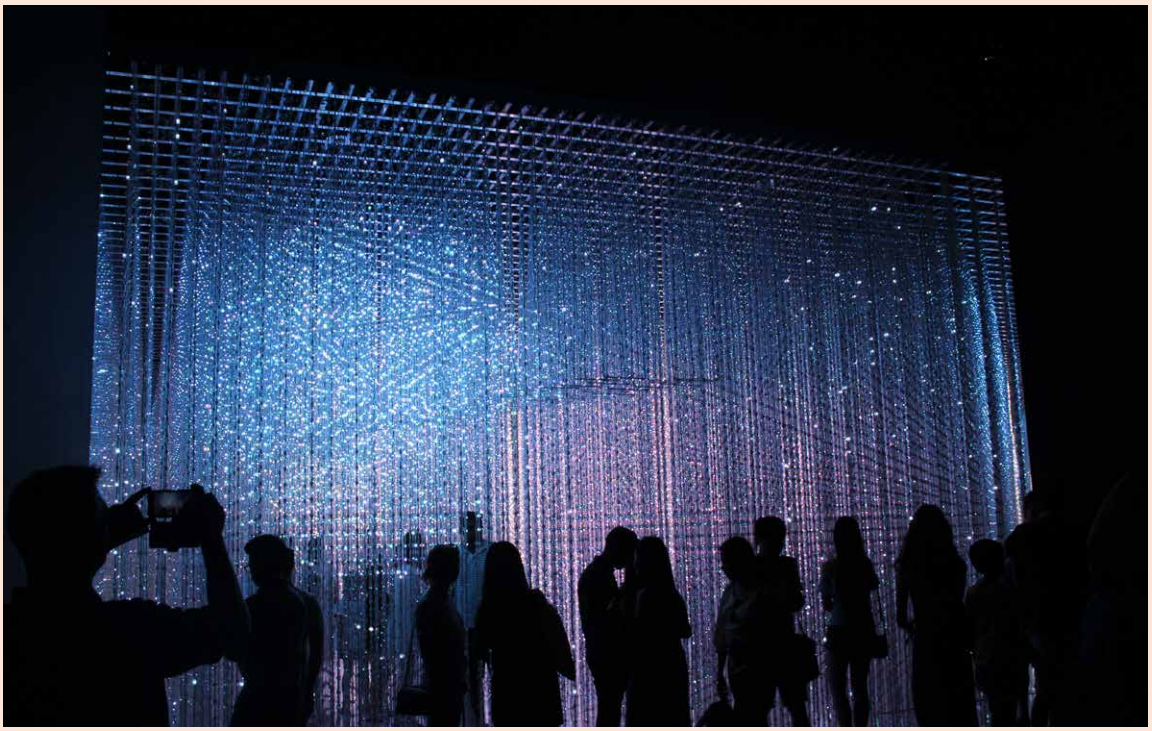
For over 30 years, ISIS has been the world's leading pulsed neutron and muon source, allowing scientists from across the globe to study materials at the atomic level. Applications have been wide ranging, from cleft palate treatment development to solutions for waste water management. The infrastructure has long established industrial links with more than 100 companies, including Rolls-Royce, Unilever, Airbus and BP and plays an important role in nurturing scientific and technical talent for the wider economy.

Using large-scale datasets to increase automatic enrolment in workplace pensions ESRC

ESRC supported Understanding Society data was essential to the automatic enrolment in Workplace Pensions, leading to increased total annual savings of £7.1 billion since 2012.

Over the last 15 years, the Department for Work and Pensions (DWP) has developed and introduced the New State Pension and in doing so, has implemented Automatic Enrolment into workplace pensions. This has been achieved through the use of a dynamic micro-simulation model which depends heavily on data from the British Household Panel Survey (now part of Understanding Society) for specific modules on partnership, fertility, labour market status, earnings and savings.

By using large-scale datasets containing representative samples of individuals and households (either from administrative or household survey data) samples are 'grown' through time by simulating the relevant life events for each individual and each family. Since being initiated in 2012, more than 6.87 million workers have been automatically enrolled by 293,868 employers and data collected up.



6. International: building global partnerships and addressing global challenges

Our Strategic Prospectus set out an ambition for UKRI to be a globally-facing organisation, cooperating and collaborating globally to realise benefits to the UK and partners around the world. The Industrial Strategy also set the ambition for the UK to remain a world leader in global science and innovation collaboration, as research and innovation are global endeavours. The newly published UK International Research and Innovation Strategy (IRIS) sets out how the UK will develop its international research and innovation partnerships to achieve the targets in the Industrial Strategy, and identifies seven key components of the UK's international offer. UKRI will support the development and delivery of these new international partnerships, enhancing the quality of UK research and innovation and attracting outstanding international talent to our universities, research organisations and businesses. We will build on our successful collaborations with our European and global partners, generate a source of UK soft power and open up new opportunities for export and inward investment to the UK.

International collaboration allows our excellent researchers and innovators to combine their expertise with the best in the world, enabling creation and exploitation of transformative new knowledge and ideas. Our innovative companies increase their economic impact when they work with other innovators to develop complementary technologies and open new markets. As one of the world's leading research and innovation nations, the UK wants to address the most complex and intractable challenges. Working with others means we can address these at much greater scale, increasing the returns on our investments.

Some cross-UKRI international priorities, which complement the significant activities described in our councils' plans, are set out below.

6.1 FUND FOR INTERNATIONAL COLLABORATION

As set out in the Industrial Strategy, we need to build excellence across the UK and maintain its world-leading position in global science and innovation. At the same time as working to support the Government's objective of an ambitious science and innovation agreement with the EU, we must deepen global partnerships. The recently signed Science and Technology Agreement with the USA, the Memorandum of Understanding with Canada and the first joint China-UK Science and Innovation Strategy demonstrate there is significant demand to work with the UK.

The £110 million Fund for International Collaboration helps us forge those partnerships. Announced in the government's Industrial Strategy, this fund enables our councils to establish new research and innovation programmes in partnership with international funders. With all supported activities involving co-investment from the UK and partner countries, the Fund for International Collaboration's objectives are to:

- enable UK researchers and innovators to collaborate with the best international partners, to carry out world-leading research and innovation that delivers new knowledge and societal and economic impact to the mutual benefit of the UK and partner countries
- support BEIS and wider government objectives, including science diplomacy, that enable the UK to strengthen its collective voice in research and innovation policy.

A first wave of 17 FIC-funded programmes is now under way. They reflect the breadth of UK research and innovation, ranging from new activities in social innovation and creative industries to agricultural technologies. Helping to expand the UK's engagement and influence in multilateral structures, such as the European Research Coordination Agency (EUREKA), the programmes involve a wide range of global partners including research and innovation funders in Australia, Brazil, Canada, India, Israel and the USA.

Near-term actions

Throughout 2019-20 UKRI will:

- Launch a further wave of Fund for International Collaboration-funded programmes
- Align with Industrial Strategy priorities, including international collaborations and partnerships to advance the Grand Challenges.

Thwaites Glacier

The UK and the US are teaming up on one of the largest joint Antarctic missions for more than 70 years to study a rapidly changing glacier roughly the same size as Britain. Over the past 30 years, the amount of ice flowing out of this 120-kilometer-wide region has nearly doubled. Scientists are concerned that a collapse of the Thwaites Glacier in West Antarctica could significantly raise global sea levels.

The five-year quest will see support teams cover about 7000 km in extremely cold and hostile conditions as they get field camps and supply depots set up and ready for the arrival of science teams.

The £20 million research collaboration, funded by NERC and the US National Science Foundation (NSF), involves over 100 scientists and support staff.

6.2 GLOBAL CHALLENGES RESEARCH FUND (GCRF)

The GCRF is a £1.5 billion Official Development Assistance (ODA) fund that the government announced in November 2015 to support cutting-edge research tackling the challenges faced by developing countries. The fund will continue to contribute to realising the ambitions of the UK aid strategy in terms of making progress on the global effort to address the UN Sustainable Development Goals.

The GCRF was created to generate innovative solutions to intractable development issues and identify practicable pathways to healthier and safer lives, sustainable development and prosperity for all, equal and effective education, social justice and human rights, and stable institutions. Its high-level aim is to create programmes that:

- promote challenge-led disciplinary and interdisciplinary research, including the participation of researchers who may not previously have considered the applicability of their work to development issues
- strengthen capacity for research, innovation and Knowledge Exchange (KE) in the UK and developing countries through partnerships involving excellent UK research and researchers
- provide an agile response to emergencies where there is an urgent research need.

We are one of the fund's nine delivery partners. The others are the Scottish Funding Council, the Higher Education Funding Council for Wales, the Department for the Economy Northern Ireland, the Academy of Medical Sciences, the Royal Society, the British Academy, the Royal Academy of Engineering and the UK Space Agency.

So far, we have invested in more than 800 projects set up to deliver social and economic benefits to over 100 developing countries. Key strategic investments include the Foundation Awards for health and food security research, centres for foundations of inclusive growth and the Growing Research Capability Programme. This investment has further enhanced the UK's already strong research base and, through equitable partnerships with and investment in developing countries, has started to lead to positive impact.

Delivered through our councils and the International Shared Capability, the programme is steered by GCRF Challenge Leaders.[12] These bring together projects in six strategic GCRF Challenge portfolios, building coherence, maximising impact and identifying areas for further investment.

We will continue to champion interdisciplinary approaches, equitable partnership building, and an approach focused on addressing the most pressing and intractable problems facing developing countries.

Near-term actions

During financial year 2019-20:

- the GCRF Interdisciplinary Research Hubs[13] will start their first year of operation. These are the flagship UKRI GCRF investments totalling £200 million, each set up to deliver a world-leading, well-integrated programme of research stimulating transformative approaches and radical new thinking to address multidimensional and complex development challenges
- Launch and deliver calls under the UKRI GCRF Collective Programme, a series of 16 calls across five councils and the International Shared Capability totalling £150 million. This will enhance coherence, strategic focus and overall impact across the six strategic GCRF Challenge portfolios:
  - Cities and Sustainable Infrastructure;
  - Education;
  - Food Systems;
  - Global Health;
  - Resilience to Environmental Shocks and Change;
  - Security Protracted Conflict, Refugee Crises and Forced Displacement.

[12] https://www.ukri.org/research/global-challenges-research-fund/gcrf-challenge-leaders/
[13] https://www.ukri.org/news/global-research-hubs/

- Begin a partnership with the African Research Universities Alliance (ARUA) aiming to address the UN Sustainable Development Goals, strengthen Africa-UK research collaborations and enhance research capacity across African and UK research communities.

Smartphone diagnostics for HIV care

Currently, more than seven million people are living with HIV in South Africa. Funded by UKRI through the Global Challenges Research Fund, m-Africa is transforming access to HIV testing and treatment by building a new generation of mobile phone-connected diagnostic tests and online care pathways. The project is an interdisciplinary partnership between University College London, Imperial College London, and the Africa Health Research Institute. m-Africa has also built on technologies developed by the i-sense EPSRC Interdisciplinary Research Collaboration.

HIV testing and treatment can prolong lives and reduce HIV transmission, however there are still some barriers to testing and accessing care. In response, m-Africa has conducted a study including surveys, in-depth interviews, app development, machine learning, diagnostic test developing using nanoenzymes, and simulated care pathways. The study has found high levels of enthusiasm for mobile phone-connected diagnostics for reasons such as privacy and saving time.

3D-printed microscope provides life-saving diagnosis

A research project led by the Universities of Bath and Cambridge, supported by UKRI through the Global Challenges Research Fund, led to the development of a game-changing high-quality microscope, using consumer electronics and ultra-low-cost 3D-printed components. Costing between £10 and £60 in parts, the basic version of the device uses mass-produced lenses, a Raspberry Pi mini-computer and a 3D-printed plastic frame to reliably magnify up to 1.5 millionths of a metre. Not only is it a fraction of the cost of alternatives, its open-source design is available to anyone with a 3D printer and locally produced microscopes are under clinical evaluation for diagnosis of diseases such as malaria.

This technology has been applied by WaterScope, a not-for-profit start-up, co-founded by the lead researcher Dr Richard Bowman, to bring safe drinking water to rural and urban settings, and bring about better diagnostics for public health and sanitation in the developing world. Supported by UKRI and the Royal Academy of Engineering, WaterScope is developing a simple-to-use bacterial imaging device to automatically identify and count bacterial colonies.

6.3 NEWTON FUND

This fund builds research and innovation partnerships with 17 active partner countries to support economic development and social welfare, and research and innovation capacity, for long-term sustainable growth. It tackles global challenges, such as sustainable food and water resources, natural hazards, atmospheric pollution and resistance to antibiotics, that have a major impact on the lives of people across the globe. With wider global benefits arising from many of the programmes it supports, it achieves its goals by strengthening research and innovation capacity in partner countries and unlocking further funding to support this work.

The Newton Fund was launched in 2014 with total UK ODA investment of £735 million up until 2021. Partner countries provide matched resources, leveraging the UK's investment and enabling equitable funder-to-funder partnerships. We are one of seven UK delivery partners for the fund, developing and running calls and managing the successful programmes and projects it supports. The other delivery partners are the Academy of Medical Sciences, the Royal Society, the British Academy, the Royal Academy of Engineering, the Met Office and the British Council.

Newton Fund activities are developed with at least one of the partner countries, which are all on the OECD Development Assistance Committee (DAC) list of ODA-eligible recipients. Activities offered in each country are chosen and developed in collaboration with local government and funders, ensuring the programmes meet local priorities.

The Newton Fund covers three broad pillars of activity:

- **People:** increasing capacity in research and innovation, individually and institutionally, in partner countries.
- **Research:** involving research collaborations on development topics.
- **Translation:** creating collaborative solutions to development challenges and strengthening innovation systems.

Near term actions

In financial year 2019-20, we will:

- Deliver new portfolio-level, programme-specific activities aiming to provide additional impacts or broaden impacts into other areas and add value to the work of previous/existing programmes
- Deliver new activities aiming to develop the skills of participants from partner countries, enabling them to build up their experience and access opportunities not otherwise available to them
- Continue to work collaboratively to deliver activities and develop bids for new activities based on our overall objective of equitable partnerships, by which we mean funder-to-funder and researcher-to-researcher delivery, while matching our strengths with those of our partner(s) and addressing the development needs of the partner country
- Secondary benefits include:
  - increased co-funding and partnership working across UKRI and with other UK funders
  - growing the capacity of the UK research community to work on international development programmes and supporting the increase of international researcher networks
  - using our partnerships to increase our influence on major international facilities and projects.

[13] http://www.oecd.org/dac/stats/49483614.pdf

Creating green industries from citrus waste:

Millions of tonnes of citrus fruit are processed globally each year to make fruit juice, but as much as half of this may go to waste. However, an international collaboration between UK and Brazilian partners, funded by UKRI through the Newton Fund, could support the world's largest citrus farms to develop new products and markets from this waste, an example of innovation driving delivery of the Clean Growth Grand Challenge.

A York University team has developed new, patented technology, based on additive-free, low temperature microwave processing, to release the chemicals and materials from citrus residues. Working with research and industry partners across Brazil this research is moving towards the development of new facilities in Brazil to create new green value chains.

This technology is also being discussed with large-scale orange processors in Turkey and South Africa.

Reducing the carbon footprint of rice farming

Rice is the staple food for around one-third of the world's population, but this consumption generates more than 700,000 million tons of rice straw waste annually, much of which ends up being burned releasing black carbon into the atmosphere.

Rice straw has the potential to produce biofuels, however the current structure of rice straw makes it difficult to extract the energy and the high levels of silica cause it to produce large amounts of slag in biomass furnaces.

An international team of researchers funded by UKRI through the Newton Fund will explore ways to change the nature of rice straw to transform it from a waste by-product to a valuable resource. Ultimately their research will improve the income of rice farmers and local air quality as well as leading to greater understanding of the best ways to process rice straw and husks for use as biofuel and bioenergy, reducing reliance on petroleum.

7. Delivering and being accountable: UKRI as an outstanding organisation

The way we deliver our programmes is critically important to ensure we get the highest possible value from all of our investments. We are a learning organisation, which actively manages its interactions with the research sector and business to ensure that it generates the highest quality proposals for funding and then delivers them effectively. This will require increased emphasis on convening our key collaborators to catalyse the best possible proposals, including in cases when these are inter-disciplinary or span the research and business sectors. We want to use the best possible data to actively monitor and evaluate our investments and to continually adjust our approach in the light of evidence, experience and what works.

We have made significant progress in adopting this approach, typified by our delivery of our flagship cross cutting funds such as the Industrial Strategy Challenge Fund. We will embed this way of working further throughout the organisation and ensure that all our systems and processes are as efficient and flexible as possible. We will continue to develop the organisation to be agile, whilst enabling our teams to develop new ways of working to support efficient delivery of our programmes.

Our success in these areas reflects our values, which guide all our work:

Collaboration: Working in partnership, nurturing our collaborations and catalysing new ones

Excellence: Ensuring quality, value for money and sustainability are embedded in everything we do

Innovation: Build on international best practice, learn from what works as well as what doesn't and be flexible and agile, trying new approaches.

Integrity: We will be independent and objective and ensure decisions are based on evidence and rigorous analysis

7.1 TRANSFORMING OUR ORGANISATION

We will continue to transform our professional services to be as effective and efficient as possible and to support our expert teams – those who work with colleagues in the business and research world – to deliver. We also want UKRI to be easy to interact with for those who want to use our services to apply for grants and those who want advice and support.

We will continue to transform our professional services to be as effective and efficient as possible and to support our expert teams

Over the last year we have streamlined our operating model to ensure consistency of approach, clearer lines of accountability and clarity on decision making. As part of this Executive Chairs have taken on responsibilities that span UKRI's areas of activity:

Executive Chair	Council	UKRI SRO role
Professor Andrew Thompson	AHRC	International
Professor Melanie Welham	BBSRC	ISCF (jointly with Ian Campbell)
Professor Lynn Gladden	EPSRC	Maximising impact from research (jointly with Ian Campbell and David Sweeney)
Professor Jennifer Rubin	ESRC	Research Culture (including equality, diversity and inclusion and research integrity)
Dr Ian Campbell	Innovate UK	ISCF (jointly with Melanie Welham) Place (jointly with David Sweeney) Maximising impact from research (jointly with Lynn Gladden and David Sweeney)
Professor Fiona Watt	MRC	Talent and people
Professor Duncan Wingham	NERC	Maximising impact from research (jointly with Lynn Gladden and Ian Campbell)
David Sweeney	Research England	Open Access (jointly with Duncan Wingham) Place (jointly with Ian Campbell) Maximising impact from research (jointly with Lynn Gladden and Ian Campbell)
Professor Mark Thomson	STFC	Infrastructure

Our priorities for our organisation are:

- Our **people** are our biggest asset. We want to empower them to thrive in their jobs, with exciting career opportunities and a supportive learning and development strategy at all levels, including leadership, apprenticeship and graduate programmes. We will also promote the exchange of talent between our communities, the research base and business, to improve people's careers and deliver better outcomes
- We want to modernise our **grant funding processes, systems and policies** and make it easier to apply for grant funding, with a consistent, easy-to-navigate UKRI digital funding service in place by April 2021. As part of this we will be looking at how we can simplify our offer, making it more accessible to those who apply for funding and minimise administrative burdens
- We want to **increase our efficiency** by embedding new organisational designs and streamlining the way we manage our financial and human resource systems and replace our legacy systems
- We want to improve the way we **communicate** with our collaborators and ensure we provide a clear joined up offer across our councils.

Near-term actions

Our near-term transformation priorities for 2019-20 are to:

- Complete and embed our new organisational design
- Deliver a new people offer including learning and development
- Deliver a new UKRI Brand and Website
- Design and test new Grant funding service
- Design and test new HR and finance system.

7.2 MEASURING SUCCESS

UK Research and Innovation has performed well in its first year, rising to a number of significant challenges. The Executive Chairs, supported by new Councils, are providing excellent leadership to their areas and leading a broad range of cross cutting work across UKRI. The Government has entrusted UKRI with a substantial increase in budget and we have worked to deliver in new, ground breaking ways such as the Industrial Strategy Challenge Fund. A team bringing together expertise from across UKRI has also responded quickly and flexibly to the need to contingency plan for the consequences of EU Exit. Going forward, we need to further develop the organisation to be agile and efficient and to support and enable our teams to develop new ways of working.

We are committed to rigorously monitoring and evaluating our investments to understand our impact and learn from 'what works'. We want to build on existing strengths in evaluation and use the creation of UKRI as an opportunity to raise our level of ambition. We want to significantly invest in our data assets so we can develop new ways to look across the research and innovation landscape to understand the impact of our investments and maximise the return that we get.

In the Strategic Prospectus, we set out a high-level framework for measuring UKRI's impact. To enable reporting against this framework, we are developing a set of indicators that support a rounded, robust assessment of UKRI's impact that we will publish annually, starting with some headline indicators in the forthcoming Annual Report and Accounts (covering financial year 2018-19). To report on these indicators, we will make full use of available evidence on the outputs, outcomes and impacts of our research and innovation investments, using quantitative and qualitative evidence drawn from a variety of sources, including:

- Data on outputs and outcomes identified through systematic monitoring of our research and innovation grants, as well as relevant secondary (and where possible linked) data sources
- Active oversight of our bigger and cross cutting investments including through regular reviews, visits and oversight by programme boards. We will draw on the best national and international experts to help with these reviews
- Consistent and coherent collection of case studies revealing key discoveries and innovations and resulting impacts.

In the last year we have made significant progress on our data reform programme, bringing together key datasets and enhancing our analysis tools and capabilities to identify wider outcomes and impacts not captured by our monitoring data. We can now look at inputs, outputs and outcomes across the whole UKRI portfolio.

We will also undertake systematic and consistent evaluations of our key programmes of work, national facilities and major investments to assess their impact. So, for example, we currently have in progress an evaluation of the Diamond Light Source and the Industrial Strategy Challenge Fund. There are a range of substantive evaluations underway that are identified in each of the individual Delivery Plans. We have developed a systematic evaluation framework which we will apply to all our investments, in particular those funded through the National Productivity Investment Fund, so that we can look at them in a consistent way. We will ensure that our evaluations are subject to independent peer review.

We are also going to fund research into "what works", including looking at new and different ways to fund research and to help understand how best to design research and innovation policy. We will work closely with other funders to share knowledge and experience and develop new programmes of research.

Near term actions

In 2019-20 we will:

- Undertake monitoring of all the key cross cutting programmes funded from the National Productivity Infrastructure Fund and ensure that they have a robust evaluation plan in place
- Continue to develop our data reform programme, bringing together key datasets and enhancing our analysis tools and capabilities to better capture UKRI's wider impact
- Invest in "what works" research.

8. Financial allocations

UKRI is principally funded through the Science Budget by the Department for Business, Energy and Industrial Strategy (BEIS). BEIS funding for research and innovation represents the majority of public expenditure on research and innovation in the UK and is growing year on year.

As a first step in reaching the 2.4% target, the government announced an additional £7 billion in funding for research and innovation up to 2022. This increase includes £4.7 billion of National Productivity Investment Fund (NPIF) support between 2017-18 and 2020-21. It represents the largest-ever increase in public funding of R&D over a five-year period. Together with increases in the Official Development Assistance (ODA) budget, this provides a welcome, substantive boost to R&D funding.

Our budgets are currently confirmed to different timescales:

- The majority of government departments resource budgets are currently confirmed up until the end of financial year 2019-20. This includes our councils research and innovation budgets
- For science infrastructure capital, funding has been allocated up to 2020-21
- For ODA, funding has been allocated up to 2020-21.

Table 1: Duration of UKRI ringfenced budgets

Confirmed UKRI Budgets	2019-20	2020-21	2021-22
Councils research and innovation budgets up to 19/20			
Science Infrastructure capital			
ODA			
NPIF			

Full details of the financial allocations to UKRI are set out in the research and innovation funding allocation 2017-2021[15] booklet and summarised in Table 2.

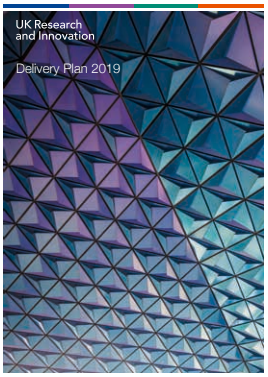
[15] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/731507/research-innovation-funding-allocation-2017-2021.pdf

Table 2: UKRI Budget Overview

UKRI, £m		2019-20
Research and Innovation Budgets		**4,989.5**
o/w	AHRC	91.5
	BBSRC	327.0
	EPSRC	763.7
	ESRC	142.5
	Innovate UK	742.6
	MRC	562.4
	NERC	282.1
	Research England	1,647.3
	STFC	413.0
Science Infrastructure Capital		**902.4**
o/w	AHRC	-
	BBSRC	64.1
	EPSRC	189.3
	ESRC	26.2
	Innovate UK	-
	MRC	65.7
	NERC	88.2
	Research England	304.9
	STFC	196.3
Official Development Assistance		**372.6**
o/w	GCRF	297.8
	Newton Fund	74.8
National Productivity Investment Fund		**1,112.3**
o/w	ISCF	486.8
	Skills	95.4
	Funds For International Collaboration	85.0
	Strategic Priorities Fund	55.9
	Other	373.9
HE Teaching Grant Contribution		**57.7**
Innovation Loans		**23.6**
Total Programme		**7,458.1**

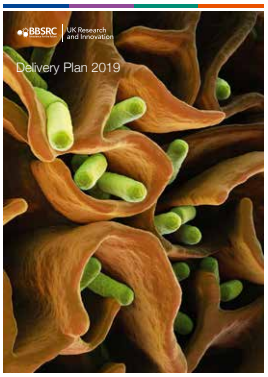
For Infrastructure Spend - planning allocations to individual bodies are higher than the UKRI budget limit to mitigate the risk of underspends and ensure best use of available funding.

UK Research and Innovation Delivery Plans

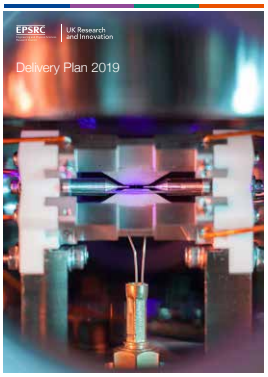


UKRI

AHRC



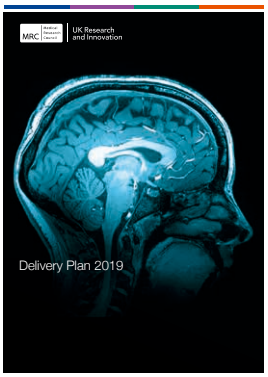
BBSRC



EPSRC

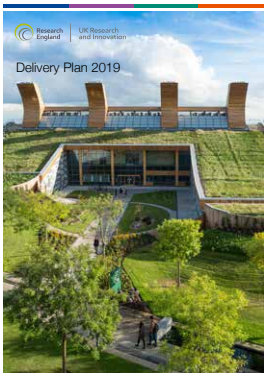
ESRC

Innovate UK



MRC

NERC



Research England

STFC

UK Research and Innovation