UK Research and Innovation

Strategic Prospectus: Building the UKRI Strategy

Insight

Inspiration

Impact

May 2018

Shakardokht Jafari of True Invivo Ltd

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Dr Mirko Kovac (left), Director of Imperial College London's Aerial Robotics Lab, with his colleague, Dr Talib Alhinai

Ministerial introduction

This is a once-in-a-generation moment for innovation and research in the UK.

The UK's ability to thrive in a changing world, to solve the challenges we face as a society and to build a prosperous economy depends more than anything on ideas. To succeed, we must push the frontiers of knowledge, and find new ways to put our knowledge to practical use. That is why the power of ideas sits at the heart of the UK's Industrial Strategy.

The launch of UK Research and Innovation signals a step change in our ability to back new ideas and their application. By bringing together the seven research councils, Research England and Innovate UK, our ambition is to create the world's best funding organisation for research and innovation.

UKRI will continue the councils' strong tradition of funding excellent research in the sciences, social sciences, arts and humanities, supporting the UK's world-leading universities and research institutions. It will also be a powerful supporter of business innovation and enterprise, through the work of Innovate UK, the Catapult Centres, and the new Industrial Strategy Challenge Fund.

But this is not just business as usual. Creating a single voice and a strategic brain for research and innovation will bring new and significant benefits. It will help us take action on important issues, such as how to promote interdisciplinary research, how to guarantee research integrity, and how to ensure that scientific careers are open to everyone, regardless of gender, race or background. UKRI will have a nationwide remit to understand and maintain our research infrastructure and innovation landscape and use the research and innovation system to build on local strengths and deliver economic growth across the UK.

And it will also help us bring together our research and innovation talents to tackle global and societal issues, such as the Grand Challenges set out in the Industrial Strategy.

We are backing our aspirations with real investment. UKRI will benefit from the largest increase in research and development funding for forty years, announced in the 2016 Autumn Statement. And we have committed to further increase the UK's investment in research and development to 2.4% of GDP by 2027, and in the future to 3%. UKRI will be at the heart of our plans to make this investment a reality.

The Strategic Prospectus we are publishing today marks the beginning of a new era for innovation and research. It is an important step towards building the UKRI Strategy and we look forward to the work of UKRI over the coming months in tackling a series of important questions about how research and innovation can be supported in the most effective ways to maximise the benefits of its work across the UK. We wish UKRI and all its partners the greatest success in harnessing the power of ideas in the best interests of the UK.

Rt Hon Greg Clark MP

Secretary of State for Business, Energy and Industrial Strategy

Mr Sam Gyimah MP

Minister of State for Universities, Science, Research and Innovation

Foreword

UK Research and Innovation will play a fundamental role in ensuring the UK is able to meet the unprecedented societal and industrial challenges that we face both locally and internationally.

The UK is globally recognised as a world leading knowledge economy. It is vital that we maintain and capitalise on this status at this time of global demographic, technological, and geopolitical change. Recognising these challenges, the Government has positioned research and innovation at the heart of its Industrial Strategy. The Government has committed an additional £7 billion by 2021/22 and set an ambitious target to increase expenditure on research and development (R&D) to 2.4% of GDP by 2027. This investment reinforces the Government's support for UK Research and Innovation and rightly comes with high expectations.

UK Research and Innovation will work with all the research and innovation communities to:

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

To achieve this, we must invest public money wisely. We will partner with others to provide the best environment for research and innovation to flourish. We will work with public and policy stakeholders, involving them in the inspiring programmes we support.

To succeed as an organisation we need to be open to new and ambitious ways of working and ensure that we never cease to look for, and implement ways to "raise our game". We are building on the excellence of all of our individual councils, and innovation and collaboration must be at the heart of all of our work.

We will be much more than a confederation of nine councils. We will catalyse by working across UKRI with researchers, innovators and entrepreneurs in academia, business, charities and government to develop and bring to fruition the most exciting ideas. We will be ambitious in the ways that we support talented and diverse individuals and teams who are prepared to take on difficult and challenging opportunities.

This Strategic Prospectus represents the beginning of the process to develop a detailed Research and Innovation Strategy. Over the coming months, we will be conducting research and consultation to develop the approach of UKRI, working with others, to answer a series of big questions. These include how to grow the economy across different regions of the UK, whilst continuing to expand our existing world-leading excellence; how to reduce the gap in productivity that separates the most from the least productive businesses; and the best approaches to developing talent across the diverse population of the UK and providing the skills needs of the future. As part of this, each UKRI council will continue to engage researchers, innovators, businesses, charities and members of the public, and will come forward with detailed Strategic Delivery Plans.

We look forward to hearing your views and working with you to realise our vision for UKRI: benefiting everyone through knowledge, talent and ideas with insight, inspiration and impact.

Sir John Kingman and **Sir Mark Walport**

UK Research and Innovation

Vision, mission and values

Human civilisations have been shaped by their ability to generate and use knowledge. Knowledge is a cultural good and applying it wisely is vital to our health, wealth, wellbeing and resilience.

The world is changing fast, and the UK needs a research and innovation system that is fit for the future: able to respond to environmental, social and economic change on a global scale. In this changing world we face several challenges and opportunities:

- **New ideas and technologies are critical to addressing the complex challenges facing all societies around the world.** Climate change, ageing, security threats and the provision of better public services all call for policies and solutions that are informed by research and innovation.
- **Economic growth depends increasingly on knowledge**, and the UK must do more to make the most of its world-class research, and support its businesses to stay at the cutting edge.
- **The globalisation of research, innovation and business creates an intensely competitive international environment** and new tools are changing the way in which we explore the world.
- **Society is changing.** The rising use of social media is changing the nature of discussion. It has never been more important to engage the public in discussions about research and its application through innovation, to ensure we deliver maximum benefit for everyone.

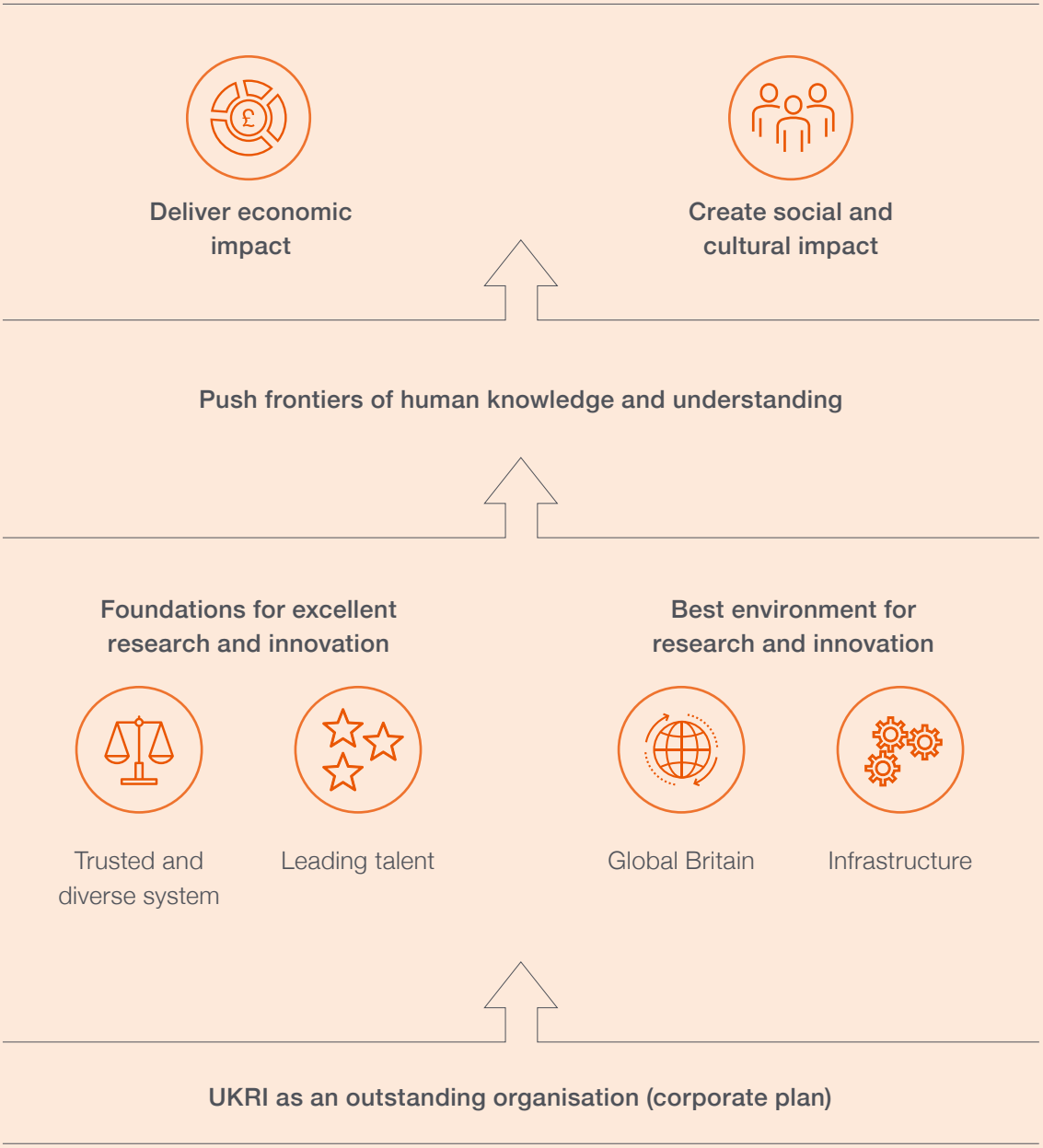
The UK benefits from world-class research and innovation. Our expertise spans all fields of knowledge, from the discovery of penicillin and the development of monoclonal antibodies, to the invention of the jet engine and the world-wide web. But we need to go further to address the challenges we face now and in the future.

Individual components of the UK research and innovation system have great strengths. Now we have built a new, unified system which will be able to respond with agility to new challenges and opportunities. The search for new knowledge and solutions increasingly crosses disciplines and sectors.

Three years on from Sir Paul Nurse's independent review of the Research Councils, UK Research and Innovation was created on 1 April 2018. We have brought together nine organisations, each of which are well connected with their communities and highly respected across the world. But the real work starts now. A programme of engagement and research will allow us to build on this prospectus and tackle the big questions facing our nation in partnership with the innovation and research communities.

UK Research and Innovation: benefiting everyone through knowledge, talent and ideas.

Delivering UKRI's vision and the Government target of 2.4% of GDP spend



Framework

In the Industrial Strategy White Paper, the Government set out five foundations of productivity: ideas, people, infrastructure, business environment and places. We will make a significant contribution to each of these foundations through policies, funding schemes and advocating and championing the value of ideas.

We will use this framework to describe how our plans will deliver new knowledge, and economic, social and cultural impacts; support the delivery of the Government's target to raise R&D spend to 2.4% of GDP; and help to deliver the Industrial Strategy.

The vision

The Government has set an ambition for the UK to become the most innovative country in the world, and has committed as part of the Industrial Strategy to raise investment in R&D to 2.4% of GDP by 2027. Increasing investment in R&D to 2.4% of GDP in a decade is ambitious and will require a concerted effort by the Government and business. We will work with Government to develop a plan for meeting this target, maximising the impact of public investment in research and innovation, and supporting businesses and other partners to invest more.

Our mission

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 support and help to connect the best researchers and businesses. We will invest every pound of taxpayers' money wisely in a way that generates excellent outcomes and ultimately impact for citizens, in the UK and across the world.

To achieve these goals, we must ensure that the UK continues to provide the best environment for research and innovation. The UK research and innovation system consists of a wide range of organisations – universities, businesses, charities, public sector bodies, and innovation and enterprise agencies.

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

We will work closely in partnership with these organisations and with the devolved funding bodies; learning from them and strengthening the networks which underpin our world-leading position in research and innovation. We will ensure that UK Research and Innovation continues to develop as an outstanding organisation.

Our values

The way we work, both with partners and internally, will be guided by our values:

Collaboration

We will work in partnership with the UK's diverse community. Our priorities are to:

- Increase the power of research and innovation to deliver for the UK, working hand in hand with business, universities, charities, independent research institutes, the national academies and other stakeholders.
- Work across the whole of the UK, respecting the responsibilities of the devolved governments and their funding agencies, and commit to working closely with the Office for Students in England.
- Maintain the UK's reputation for research and innovation excellence, nurture our many international collaborations and aim to catalyse new ones.

Excellence

We will ensure quality, value for money and sustainability are embedded in everything we do. Our priorities are to:

- Work in partnership with those at the front line of research and innovation to identify emerging opportunities.
- Balance these with key national strategic priorities identified through working in partnership with government.
- Continue the commitment to the Haldane principle and make funding decisions on the basis of excellence. We will make proper use of expert review in our research funding and assessment processes and continually strive to maximise our impact and efficiency.
- Work with stakeholders in the research system to review the key strategic drivers that ensure the competitiveness and sustainability of the UK system, and advise on the balance of funding across disciplines and for the dual support system.

Innovation

We will build on international best practice, learn from what works as well as what doesn't, innovate and take risks.

- We will build on existing strengths across our nine councils and ensure that they work together in synergy, in partnership with the devolved funding bodies.
- We will be flexible and agile, try new approaches, and seize new opportunities.
- Achieving the best research and innovation is an uncertain and risky business. We will support talented researchers and innovators to step into the unknown and to take risks.
- We will engage with the public to support and help to deliver the best outcomes.

Integrity

We will be independent and objective, supporting our work with rigorous analysis. We are committed to robust monitoring and evaluation of the outputs and outcomes of our work.

- We will promote and safeguard the public value of research and innovation.
- We will ensure decisions are based on evidence and rigorous analysis. We will champion evidence-based policymaking across government.
- We will be robust in our monitoring and evaluation and share guidance on what works – and what does not.

Foundations for excellent research and innovation

To achieve our vision, we need to get the foundations right.

We will focus on four key areas:

Leading talent

Nurturing the pipeline of current and future talent

Openness and transparency

Supporting the development of a research and innovation system that is accessible, transparent and cooperative

A trusted and diverse system

Driving a culture of equality, diversity and inclusivity providing the best opportunities for individuals and teams of people from all backgrounds to thrive

Research culture

Promoting the highest standards of research, collaboration and integrity.

Building on the right foundations we can nurture and grow the widest pool of talent, which will help to ensure that the UK remains a top destination for global researchers and innovators. The UK will continue to promote the highest standards of research, collaboration and integrity.

As part of this, we will continue to lead the world in our approach to Open Science; championing the aim to make the findings of research, and its underpinning data, available to every interested citizen. We believe this will increase the impact of research, facilitate collaboration and increase trust in the system for both researchers and the wider public.

01

Leading talent

The UK is a top global destination, with a world-leading research and innovation base for attracting and retaining researchers and innovators in both academia and business. A highly-skilled and diverse workforce is crucial to delivering the Government target of a total of 2.4% of GDP to be invested by public and private sectors in research and development by 2027.

We have created a new Future Leaders Fellowship to develop the next generation of innovation and research leaders from the UK and across the world, providing up to seven years of funding for early-career researchers and innovators. We will develop a longer-term Research and Innovation Talent Strategy in 2018, working closely with our partners.

We will:

- Seek to **increase skills** at all levels, to maintain a broad disciplinary skills base, and work with partners to identify key skills gaps and build capacity. We will support vocational education and apprenticeships alongside more traditional pathways through higher education.
- **Support individuals** to move between business and research careers, creating opportunities to develop careers in ways that stimulate creativity and innovation.
- **Back universities** to develop vibrant research environments which act as magnets to attract and nurture talent.
- **Support multidisciplinary teams** when these are needed to conduct research and innovation. This will require the creation of more highly-valued roles for technologists, data scientists and others for the teams that are needed to tackle tough challenges.
- **Promote continuing professional development**, accompanied by lifelong learning and training throughout the careers of researchers and innovators.

02

A trusted and diverse system

Equality, diversity and inclusion

Everyone has a right to be treated with dignity and respect, and to be provided with opportunities to flourish and succeed in a supportive environment. Diversity of ideas, experience and cultures produces and sustains the best results and performance.

In its first year, UK Research and Innovation will engage with its stakeholders to develop a strategy and action plan for equality, diversity and inclusion. We will consolidate the existing evidence base to guide our work and commission new analysis and research where we identify gaps in our knowledge.

We will establish an External Advisory Group to help us articulate the challenges and identify opportunities for UK Research and Innovation to lead and strengthen equality, diversity and inclusion across the sector.

We will:

- **Drive change**, both as an employer and through our research and innovation funding.
- **Embed equality**, diversity and inclusion at all levels and in all that we do.
- Seek to **create a culture** that facilitates and safeguards the opportunities for all to be respected and treated fairly.
- Take an **evidence-based approach**, commissioning and funding research and evaluations to understand the issues, what interventions work – and what do not.
- **Collaborate and engage** with partners nationally and internationally, in order to gather evidence and ideas, and help catalyse and facilitate change.

03

Research and innovation culture

Creating a strong and responsible culture is crucial to enabling the best research and innovation and gaining and maintaining public trust. We will use our position as the largest public sector funder of research and innovation in the UK to lead positive behavioural change both nationally and internationally.

We will work with stakeholders in the UK and internationally to review the operating environment for research in the UK and around the world. We will act on the results to ensure that our funding and operations encourage the best practices and behaviours.

Building on work initiated by the Research Councils to develop a common approach to research culture, we have become a signatory of the Concordat to Support Research Integrity and will scope a new UK Research and Innovation Ethics Policy and Framework.

We will prioritise four related areas:

- **Research and innovation ethics** – norms that define acceptable behaviour and practice
- **Conduct** – the use of honest and verifiable methods in proposing, performing, and evaluating research
- **Reproducibility** – the ability to achieve commensurate results when an experiment is conducted by an independent researcher under similar conditions
- **Analysis** of funding mechanisms and metrics and their impact on culture.

The Haldane Principle

The Haldane Principle originated in a 1918 report on the machinery of government, and was restated in 2010 through a Written Ministerial Statement by the Universities and Science Minister David Willetts. The key concept, which has developed since 1918, is that decisions on individual research proposals are best taken by researchers themselves through peer review. This involves evaluating the quality, excellence and likely impact of science and research programmes and ensuring subsidiarity in decision-making. Ministers are responsible for setting high-level allocations between research themes, agreeing strategic priorities, and considering major funding questions on national infrastructure and broader sector sustainability, but more detailed decisions, for example the awarding of grants for specific research activities, should not be taken by Ministers or central government.

Founded 100 years after Viscount Haldane's report, UK Research and Innovation will host a conference in late 2018 which will examine how the recommendations of this seminal report have shaped the way research is commissioned and performed in the UK, and how the creation of UK Research and Innovation enables us to look to the future in all of the work that we do and support.

04

Openness and transparency

The public has every 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 maximising that impact. It is accessible, transparent and cooperative. It produces better quality outputs, more efficiently and in ways that can be readily shared. Open research has two components:

- **Open access:** 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 economic.

UK Research and Innovation will participate in the work of the Open Research Data Task Force to develop a roadmap for open research data in the UK. We will review our open access policies to assess their effectiveness and make recommendations in 2019.

We will:

- Identify the highest value areas where UKRI can drive improvements to the open research system in the near to mid-term.
- Build on the expertise of Councils and the wider community to identify technological innovations that could transform open research.
- Engage with Government and external groups to ensure the UK continues to play a leading role in the international open research movement.

CASE STUDIES

PhD student mental health and wellbeing

Research England are supporting research into the wellbeing and mental health of post-graduate students. The work involves an in-depth study of a sample of English higher education institutions and intends to:

- depict the landscape of mental health support offered to post-graduates and identify any barriers that hinder access;
- provide insights into how these findings may vary by student and study characteristics and whether any sub-groups may be at higher risk; and
- make recommendations for future research to inform policy interventions to improve this aspect of the higher education experience.

Alongside undertaking this study, the former HEFCE issued a catalyst call inviting applications for projects from institutions with post-graduate student populations to develop and implement sustainable approaches to supporting mental health and wellbeing for these students.

Proposed projects covered a range of areas including:

- prevention and early intervention approaches which reach a broad range of students;
- developing and implementing new practice for pastoral support;
- enhanced staff training across the institution;
- working in partnership with statutory health services and third-party organisations to deliver improved support; and
- considering the whole postgraduate researcher experience and cultural change rather than focusing solely on student service-based interventions.

Women in Innovation

The Women in Innovation campaign was launched on 1 June 2016 to address the under-representation of women engaging with Innovate UK, to get more women with excellent ideas innovating in UK businesses, and to boost the economy.

Prior to launching the campaign we commissioned research on Women in Innovation to help improve our understanding of the challenges and opportunities facing women in business.

The campaign was kicked off by opening our Women in Innovation Awards programme. The awards were about finding women with potential to be future leaders in innovation with great ideas. 41 women received a tailored package of support including a senior business mentor, expert advice and training/workshops.

We ran a photography exhibition in partnership with Getty Images to address the recognised issue of a lack of relatable role models for women in innovation and to challenge stereotypes/perceptions.

In partnership with the British Consulate in Boston and the Digital Catapult, we took a cohort of female entrepreneurs on an entrepreneurial mission to Boston to showcase women-led business from the UK.

We have increased the number of women engaging with Innovate UK from 14% to 24%. This has been Innovate UK's most successful ever communications campaign, but we will do more. Our continued commitment to women in innovation includes:

· Our Women in Innovation Awards in 2018, which are aligned to the 4 Industrial Strategy Grand Challenges

· Quarterly Innovation Accelerator Workshops for the wider women in innovation community

· A review of Innovate programmes and ways of working to promote greater diversity and inclusion

Pushing the frontiers of human knowledge and understanding

Knowledge is valuable in its own right. Curiosity motivates and engages researchers, innovators and the public alike. Whether it be exploring the structure of the universe or the atom, the biology of our brains or the philosophy of what it is to be human, knowledge helps to expand the horizon of human understanding and imagination.

The UK is one of the world's most successful research nations. Despite having less than 1% of the world's population, and only 2.7% of global spending on research and development, the UK produces 15.2% of the world's most highly cited research papers[2]. The UK has overtaken the US to rank first by field-weighted citation impact. We are second in the world for the quality of our scientific institutions and are among the world's best at attracting overseas students.

Funding for research and innovation in the UK is spent in a highly effective way. Evidence shows that the UK has a broad range of research strengths and demonstrates excellence in diverse research fields.

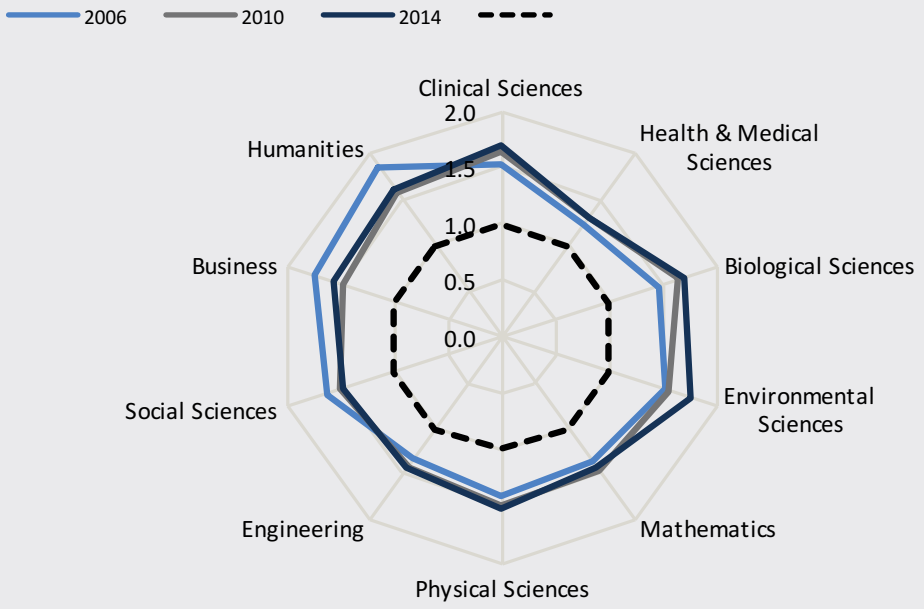
However, the world is changing and there are new challenges, opportunities and priorities for UK researchers and innovators. Real-world problems are inherently multi- and interdisciplinary, and we need to be able to act quickly to respond to new opportunities and initiatives by collaborating across disciplinary, organisational and national boundaries. New tools are changing the way we explore the world. The search for new knowledge and solutions is further blurring the distinction between disciplines and sectors.

The globalisation of research and development creates an intensely competitive international environment. While the UK has maintained its high performance, other countries are catching up, growing their research base at a faster rate than the UK.

UK Research and Innovation will work closely with our stakeholders and communities to shape and drive a strategic approach to research and innovation funding. We will continue to support excellent proposals from talented researchers and innovators. We will also work with researchers, innovators and other stakeholders to identify challenges and opportunities which could lead to new research breakthroughs, tools and methods.

2 Elsevier, International Comparative Performance of the UK Research Base 2016.

UK relative performance share of total article output across subject fields, relative to the global share of articles in the same subject fields



We will build on our existing strengths to ensure the system is sufficiently integrated, strategic and agile, and will continue to grow our national capability to drive discovery and growth. We will:

- Reward excellence with funding that is competitive on the basis of judgements made by expert reviewers. We will invest in the highest-quality research and innovation across the UK, wherever it is found.
- Support a balanced dual support funding system for higher education so that universities can play their part in identifying and supporting areas where we have significant potential to be world-leading, and to ensure the system remains sustainable, efficient and effective. We will work closely with the devolved administrations and their funding bodies to achieve this across the UK.
- Support the autonomy of individual councils when they are working within their subject domains, and facilitate and encourage collective working to support cross-cutting opportunities, including with the other UK funding bodies, ensuring that the “whole is greater than the sum of the parts”.
- Engage with users of research and innovative companies to make sure our activities are targeted where they will make a difference.
- Drive a strong culture of efficiency and evaluation to ensure we can understand what works, drive the benefits of investment, identify opportunities to get the most from our investments and ensure that future decisions are based on the best possible evidence.

Responsive and strategic grants

We invest around £6 billion every year in world-leading research, covering all disciplines and sectors. We will continue to champion both responsive and strategic modes of funding to enable discovery-led research to flourish in the UK and drive impact from new knowledge and breakthroughs.

As we prepare to advise Ministers on how best to achieve the 2.4% ambition, we will consider how we undertake long-term funding allocations to UK Research and Innovation's councils to ensure we maintain our position as a world leader in research and innovation, and realise the aims of the Industrial Strategy to become the best country in the world for innovation and grow prosperity across the UK.

We will engage with stakeholders during this review to perform an in-depth analysis of existing spending plans and ensure we have correctly identified new strategic priorities, keeping in mind Sir Paul Nurse's recommendation that funding should: "improve agility to respond to new initiatives and when necessary promote reallocation of resource".

In advance of this we are launching the Strategic Priorities Fund. This will build on the vision of a 'common research fund' set out in the Nurse Review.

It will:

- **Drive an increase in high-quality multi- and interdisciplinary research and innovation** by encouraging and funding work in areas which previously may have struggled to find a home. It will ensure that good ideas are supported that might once have been more challenged by organisational boundaries. It will give pioneering research the space to develop, laying the foundations for future capability.

- **Ensure that UKRI's investment links up effectively with Government departments' research priorities and opportunities,** encouraging funding for research that crosses boundaries between UKRI councils and government departments. It will foster even closer collaboration between researchers and policymakers in directing the attention of research and innovation communities to the important questions identified by government departments.

- **Ensure the system is able to respond to strategic priorities and opportunities.** The success of UK research is built on the dual support system – a combination of hypothecated and unhypothecated funding which ensures that the strategic insight of UKRI and the local knowledge of universities both help to shape research activity. This will continue. In addition, the Strategic Priorities Fund will ensure that strategically important research and innovation which is not aligned with other funding programmes can seek direct support. The Strategic Priorities Fund will provide a mechanism for increasing agility within the system, enabling funders to respond rapidly and ensure the UK remains at the cutting edge.

Dual Support and Balanced Funding

Under the UK's dual support system, universities receive block grant funding through the four UK higher education funding bodies (including Research England) and, UK-wide competitively-allocated grant funding administered through the Research Councils.

These two streams of funding are complementary and seen internationally as key to the ongoing quality and success of the UK research base.

In England the block grant, known as quality-related research funding (QR), will be administered by Research England within UKRI. QR and its equivalents across the UK are vitally important in providing underpinning funding for our world-leading universities to invest in the excellence and impact of their research and ensure the financial sustainability of our research base.

The complementary funding and decision-making processes of the dual support system give it characteristics that one stream of funding alone could not deliver with the same resources. It sustains a balance between research responding to calls from funders, and research supported directly by institutions. QR (and its equivalent in the devolved administrations) enables universities to provide the long-term stability necessary to attract top talent, and can enable them to pilot new areas of research and innovation. Support for knowledge exchange enables universities to utilise their intellectual assets and distinctive partnerships for innovation, in partnership with the private, public and third sectors.

We will empower university leaders to identify and invest in the opportunities that they are best placed to see, whether through blue skies research or local collaborations. QR explicitly rewards excellence based on the Research Excellence Framework, a world-leading assessment of output, environment and impact which incentivises the application of world-leading research into economic, societal and public outcomes.

The role of UKRI includes advice to Ministers on the balance between the dual support funding streams. We need to take an evidence-based approach, and are therefore undertaking work to analyse and understand what constitutes reasonable balance, and the impact that any changes to the balance could have on the sector. We will continuously build our evidence, responding to new challenges, opportunities and wider changes in the sector to provide the best advice on future funding decisions. Whilst the focus of this work will be on the English dual support system, we will engage closely with the devolved administrations and funding bodies, sharing our evidence as it develops.

The Research Excellence Framework

The Research Excellence Framework (REF) is the UK's system for assessing the quality of research in UK HEIs. Its purpose is three-fold:

- To provide accountability for public investment in research and evidence of the benefits of this investment
- To provide benchmarking information and establish reputational yardsticks, for use within the HE sector and for public information
- To inform the competitive allocation of around £2 billion per year of public funding for research.

The REF is an expert review which assesses the quality of outputs, their impact beyond academia, and the environment that supports research within universities. Following an evaluation of REF 2014 and public consultation, REF 2021 will take a more inclusive approach by assessing the work of all research-active staff, and will further incentivise impact by increasing its weighting to 25%. REF 2021 will also promote open research by requiring submissions to be made available in open access form.

CASE STUDIES

Revolutionising the way we see molecules

Richard Henderson, a molecular biologist and biophysicist at the MRC Laboratory of Molecular Biology (LMB), was the first to successfully work out the three-dimensional structure of a membrane protein in a cell. For this work Henderson was awarded the 2017 Nobel Prize in Chemistry, shared with biophysicists Jacques Dubochet and Joachim Frank.

Working at the Laboratory for Molecular Biology, Henderson collaborated with Nigel Unwin to generate the first three-dimensional image of the membrane protein bacteriorhodopsin using electron microscopy in 1975. Electron microscopes use a beam of electrons to create an image. They are capable of much higher magnifications and resolutions than light microscopes, allowing much smaller objects to be visualised in finer detail. However, historically there have been problems imaging biomolecules without damaging them or causing significant changes to their structure.

Over the next 15 years, Henderson strived to solve the technical issues associated with producing high-resolution images of biomolecules by electron microscopy. This led him to make significant breakthroughs in revolutionising cryo-electron microscopy, a technique developed by Jacques Dubochet and colleagues in the 1980s involving rapidly cooling biomolecules before imaging them, trapping them in their natural shape. Henderson applied this technique and became the first to determine the atomic structure of one of a group of proteins that are critical for cells to function, but whose atomic structure biologists have struggled to investigate previously.

Henderson's work to refine the imaging methods for cryo-electron microscopy has paved the way for researchers to determine the structure of complex proteins.

RAPID programme monitoring Atlantic Ocean currents

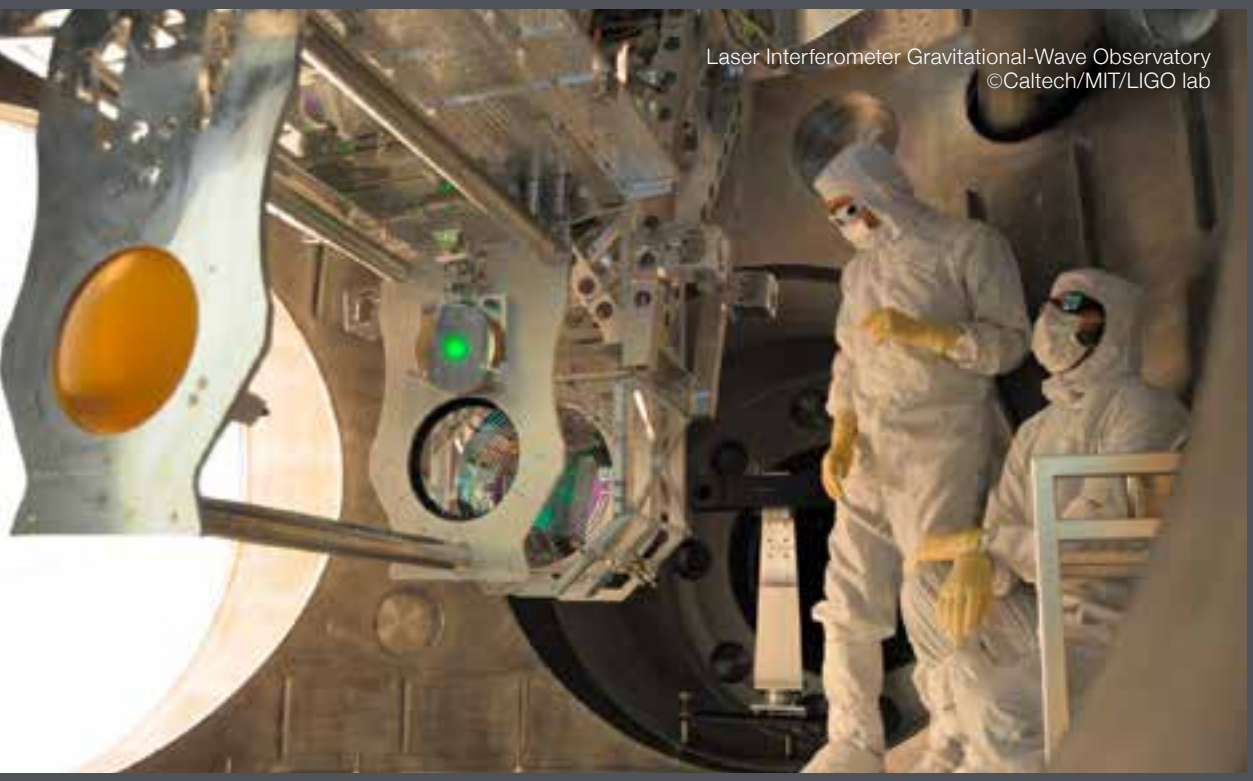
This would not have been possible with X-ray crystallography, the standard method to study the structure of molecules, where x-rays are scattered as they pass through samples, creating patterns that can be analysed. Henderson has received many awards for his research contributions and is an elected Fellow of the Royal Society and the Academy of Medical Sciences. He was also Director of the LMB from 1996-2006.

Monitoring Atlantic currents to predict climate

NERC's world leading discovery science answers fundamental questions and discovers new knowledge about how the world works – past, present and future.

The Rapid climate change programme (RAPID) has, for the last 10 years, been using ground-breaking equipment to monitor the circulation of Atlantic Ocean currents (Atlantic Meridional Overturning Circulation - AMOC) to test their sensitivity to global warming. Monitoring changes to AMOC is important because of the role it plays in Earth's climate system. It transports heat from the tropical Atlantic to higher latitudes and helps to give Western Europe its mild winter climate. Changes to, or collapse of, AMOC could lead to significant temperature changes across Europe. The programme is half-way through its monitoring period, but is already providing important advice to policy makers by reducing uncertainty in regional climate predictions.

CASE STUDIES



Laser Interferometer Gravitational-Wave Observatory
©Caltech/MIT/LIGO lab

Discovery of gravitational waves opens entirely new areas of science

In 2016 the LIGO (Laser Interferometer Gravitational wave Observatory) international science collaboration announced the first-ever direct detection of gravitational waves – the final remaining unconfirmed major component of Einstein's general theory of relativity. The work was rewarded with the 2017 Nobel Prize for Physics, with the UK playing a key role in the technological and computing advances that enabled the advance. This was followed, in October 2017, by the announcement of the detection of a neutron star collision. The aftermath was also observed by space and ground-based telescopes - the first detection of both gravitational waves and electromagnetic radiation.

The recent technical improvements to LIGO relied heavily on expertise from UK universities and STFC's laboratories, increasing the sensitivity of its detectors ten-fold and making the discovery possible. STFC-funded researchers have since used the technology, expertise and knowledge developed for LIGO to develop commercial applications including a low cost and portable Micro Electromechanical System gravimeter, approximately 100,000 times more sensitive than those in current use in the best smartphones.

Delivering economic impact

Sustainable economic growth for developed economies like the UK can only come from innovation – the application of new ideas and knowledge.

This is one of the UK's strengths, but there is enormous potential to go further by unlocking greater economic benefit from our world-class research base and by supporting business to stay at the cutting edge.

UKRI has an important role to play in supporting the UK to become an even stronger knowledge-driven economy. We must support the most innovative entrepreneurs and businesses to succeed. We must also create an ecosystem in which we nurture new innovators to start businesses, grow and flourish.

Encouraging even greater collaboration between business and the research base is key to achieving this ambition. Valuable research and innovation is undertaken in businesses, universities and other research and innovation organisations throughout the UK. We want to enable places right across the UK to use their research and innovation assets to drive economic growth.

Delivering economic growth is a team effort. UKRI will make it easier for businesses and research organisations to collaborate, to exchange knowledge, people and ideas, and to produce innovative products, services and markets. A number of different approaches are needed to address this:

- Use **mission-orientated approaches** to tackle specific challenges or opportunities for the UK. We will catalyse different communities to work together towards clear, shared goals.
- We will complement this with **competitive programmes** that enable important opportunities identified by businesses and researchers at the front line of innovation to succeed.
- One important role for us in promoting innovation is backing new general purpose **technologies** on their route to market.
- We will champion **business-led innovation**. We will support the best innovative businesses from all sectors and help them to find the finance they need to grow. We will help businesses to find and connect with the most promising ideas emerging from the research base.
- We will support and encourage universities and other research institutions to make **knowledge exchange and commercialisation** an equal priority alongside their teaching and research missions. We will aim to enable all parts of the UK to realise their potential for innovation-led growth.

We want UKRI to deliver a step change in our understanding of how to deliver greater economic productivity in tandem with building the UK's excellent research base. So, as well as evaluating the outcomes of the work that we support, we will also support research to strengthen the evidence base on the efficacy of policy, financial and other interventions to support innovation. We will make our systems and processes straightforward to navigate, particularly for organisations less accustomed to working with us.

Building a culture of evaluation

All UKRI councils are committed to rigorously evaluating the impact of our investments. We want to build on existing strengths and use the creation of UKRI as an opportunity to raise our level of ambition, using data in new ways to look across the research and innovation landscape to understand the impact of our investments and maximise the return we get.

Robust evaluation of the return on investment in science and innovation is notoriously difficult, for example due to long lags, difficulties in obtaining a true baseline, and difficulties in correctly attributing benefits. However, within UKRI we have extensive experience of evaluating science and innovation investments, and will use a range of tools and approaches to develop a rounded understanding of impact to ensure that our future decisions are based on the best possible evidence.

For new programmes, we will build monitoring and evaluation best practice into the heart of programme design. But this is not just about new programmes – we are also committed to robustly evaluating the impact of our previous investments.

Aside from learning lessons on how best to run programmes, this will also help us demonstrate the economic and social impact of R&D funding, strengthening the evidence base for future decisions.

As part of this, we will develop effective data and metrics to understand the research and innovation landscape in different sectors, technology domains and places, taking into account the role of businesses as well as research institutions. We will seek to go beyond project- or programme-level evaluation, making links and joining up data collection processes to strengthen our understanding of the wider impacts of our investments the UK's innovation landscape, and our progress towards significant missions, such as the Grand Challenges. To do this, we will work closely with colleagues across the civil service, public sector and beyond.

All parts of UK Research and Innovation are important to this element of our mission:

- Innovate UK will continue to champion and focus on business-led innovation
- The Research Councils will enable researchers to partner with businesses to help to realise the economic potential of their work
- Research England will support and challenge universities to engage with businesses and provide the capacity and capability to support research commercialisation. In doing this it will liaise and work with its counterparts in the devolved administrations.

We are also developing programmes which span multiple councils in order to capitalise on the opportunities from the creation of UK Research and Innovation. These include the Industrial Strategy Challenge Fund and the Strength in Places Fund.

The Industrial Strategy Challenge Fund (ISCF)

The ISCF is a new and ambitious programme that brings together world-class UK research with business investment to tackle the major industrial and societal challenges facing the UK. It will develop technologies that will transform existing industries and create new ones.

It will support the four 'Grand Challenges' set out in the Government's Industrial Strategy:

- AI and Data Economy
- Future of Mobility
- Clean Growth
- Ageing Society

Through these Grand Challenges, the Government seeks to:

- Put the UK at the forefront of the artificial intelligence and data revolution
- Maximise the advantages for UK industry from the global shift to clean growth
- Become a world leader in shaping the future of mobility
- Harness the power of innovation to help meet the needs of an ageing society.

Industrial Strategy Challenge Fund challenges

Clean growth

Transforming construction

We need to transform construction so that we can create affordable buildings to live and work in that are safer, healthier and use less energy. By taking a lead in the UK, we can increase our ability to export: global demand for efficient buildings is rising rapidly, driven by the pressures of urbanisation, affordability, and the need to cut emissions.

Prospering from the energy revolution

For the majority of our energy to be clean and affordable, we need more intelligent systems. Smart systems can link energy supply, storage and use, and join up power, heating and transport – to dramatically increase efficiency. By developing these world-leading systems in the UK, we can cut bills while creating high value jobs for the future.

Transforming food production

The world will need 60 per cent more food by 2050 to allow us to feed nine billion people. For this to be possible, the way we produce our food needs to be significantly more efficient and sustainable. By putting the UK at the forefront of this global farming revolution, we will deliver benefits to farmers, the environment and consumers.

Ageing Society

Medicines manufacturing

After years dedicated to their discovery, as each new medicine progresses through the stages of clinical testing towards approval, the challenge moves on to how they can be manufactured so that greater numbers of patients can access new drugs and treatments more quickly.

From data to early diagnosis and precision medicine

The challenge is to combine the wealth of data created by UK researchers with real-world evidence from our health service. This will allow industry to create new products and services that will diagnose diseases earlier and help clinicians choose the best treatment for individual patients. This will save lives and set the UK at the forefront of a growing global market in diagnostics.

Healthy ageing

The challenge is to develop new products and services that offer choice, meet the aspirations of older people, and support an independent lifestyle through better, more effective care. By working together, the Government and industry can address the challenges of ageing whilst capturing a growing global market.

INDUSTRIAL STRATEGY

Future of mobility

Faraday battery challenge

The Faraday Battery Challenge aims to develop world-leading batteries, designed and manufactured in the UK, to fully exploit the industrial opportunity of vehicle electrification. It will tackle air pollution as well as enable UK businesses to make the most of the opportunities presented by the low carbon economy.

Extreme robotics

Robotics and artificial intelligence have the potential to revolutionise our public services and infrastructure, and hugely benefit industries working in extreme conditions such as nuclear energy, offshore energy, deep mining and space sector. The aim is to create a safer working world for people; improve productivity; and support advances in industry and public services.

National satellite test facility

A satellite test facility will be established. This will support new launch technologies, manufacturing and testing capabilities to construct future satellites and deliver payloads into orbit.

AI & data economy

Audience of the future

The challenge is to bring together creative companies, researchers and technologists to create striking new experiences that are accessible to the public. This can create the next-generation products, services and experiences that will capture the world's attention and position the UK as the global leader in immersive technologies.

Next generation services

Pioneer funding will help service industries to identify how application of technologies can transform their operations. This will help to place UK service industries at the forefront of developing and using innovations.

Quantum technology

Pioneer support will help us understand how a new set of products can be developed from medical devices to sensors, and safer communication systems. The potential is huge, but still largely in the lab environment. We will bring new disruptive companies together with existing businesses to understand how this emerging technology can be turned into products.

Business-led Innovation

Within UK Research and Innovation, Innovate UK's role remains focused on innovative businesses, enabling them to achieve their ambitions to increase productivity and tap into growing markets.

Funding, in the form of grants and loans, provides opportunities for business-led, high-value innovation in any sector. Innovation and business networks, supported by Innovate UK, enhance connectivity between innovators, researchers, investors, sectors, government, and potential customers in the UK and around the world.

We will continue to promote and accelerate the commercialisation of the best ideas across sectors by:

- Investing in open programmes to support the best innovative ideas from all sectors of the UK economy
- Investing in the Catapult Network, to attract private investment into innovation
- Improving business access to investors through our investor accelerator programme
- Increasing the talent pool of innovators developing exciting ideas in the UK through diversity campaigns
- Piloting a £50 million programme of loan commitments from 2017-2020, deployed over up to three years with terms extending up to 10 years.

Knowledge Exchange

UK Research and Innovation is committed to enhancing the contributions made to the economy and society by the research and innovation we fund. A core role of universities and other higher education and research institutions is engagement with the outside world. They import, educate, train and export skilled people locally, nationally and internationally. They make the knowledge that they generate useful to society.

Substantially increased support for higher education institutions in England, through Higher Education Innovation Funding, will enable universities to increase their capabilities and the commercial exploitation of their knowledge and expertise. We will use the new Knowledge Exchange Framework to provide more information for the public and businesses on the performance of universities in knowledge exchange – how they share knowledge, expertise and other assets for the benefit of the economy and society. Complementing this, UK Research and Innovation will continue to support individual academics with commercially promising ideas to move out of the lab and into the marketplace through an extension and expansion of Innovate UK's ICURe pilot.

ICURe helps to bridge the gap between research, innovation and commercialisation by providing academics with the necessary training, support and space to determine the right route to market for their commercially promising ideas.

UKRI is open for business

- Through ISCF challenges UKRI, will continue to support business-led innovation across the Industrial Strategy Grand Challenge areas
- With an emphasis on growing and scaling businesses, Innovate UK will continue to offer financial support for business-led innovation through initiatives including collaborative research and development grants
- Innovate UK will offer Innovation Loans to transform ambitious business looking to grow and scale, and will provide connectivity through its business networks, such as the KTN and EEN.
- The Catapult Network will continue to provide collaborative assistance for businesses seeking to unlock sector specific barriers
- UKRI will provide business leaders with easier access to leading-edge research in academia, and be a single voice to enable better connectivity to policy makers.
- UKRI will make it easier for businesses and research organisations to exchange and translate ideas, know-how and people from across the UK and all sectors, and to unlock more value from them for economic and societal benefits.
- UKRI will support the UK research and innovation community to tackle sector and societal challenges and to turn these into significant market and export opportunities for UK businesses.
- UKRI is primed to position the UK as a leader on the global stage and make it more attractive attractive to international partners and investors.

Supporting Growth across the UK

World-class research and innovation is undertaken in universities, research organisations and businesses throughout the UK and we are determined to support this excellence to grow. We want to enable regions right across the UK to realise their potential to drive innovation-led economic growth. That is why we are launching the Strength in Places Fund.

This is a new UK wide competitive programme that will take a place-based approach to research and innovation funding. It will build on local business strengths and pockets of research excellence, supporting collaborative proposals from consortia of publicly-funded research organisations, businesses and local civic leaders to undertake research and innovation that will have a demonstrable impact on local economic growth.

We are learning from the valuable evidence base provided by the Science and Innovation Audits, which help us understand where the opportunities lie for investment in research and innovation to drive growth. We will continue to support locally-focused activity of our research institutes and science and innovation campuses, and ensure the UK's excellent research infrastructure has the support it needs to make an even greater impact on local economies across the UK.

We will engage with government and other partners to drive the impact of our investments, and further develop our place-focused policies through, for example, local industrial strategies.

CASE STUDIES


Optoelectronics Research Centre

Optoelectronics Research Centre – a world leader in photonics for over 29 years

The UK has world leading photonics clusters across the country from Scotland to Oxford and Southampton. The Optoelectronics Research Centre (ORC) at the University of Southampton is a world leader in photonics, optical telecommunication, optical materials and high-power lasers. EPSRC has supported the Centre through long-term investments dating back four decades, totalling over £20 million. This has been complemented by major investments from industrial partners such as Microsoft, Pirelli, Rockley Photonics and SPI Lasers.

ORC staff have founded 11 companies, generating revenue in excess of £200M and creating over 600 jobs. The centre has developed a suite of technologies at the cutting edge of global manufacturing, healthcare and commerce. Its fibre lasers are in use worldwide, cutting inch-thick steel, welding cars in state-of-the-art factories, performing delicate eye surgery, and even marking the date on the fruit we buy in the supermarket.

More than one billion internet users now exchange over 2,000 petabytes of data every month. Most of this travels through optical amplifiers invented at the ORC.

Research and Knowledge Exchange for Economic Growth in the Creative Industries

Britain's creative industries are worth £92 billion, employ 2 million people and are growing twice as fast as the rest of the economy. AHRC is catalysing innovation and growth by building a strong research community and able to work directly with industry. Their Knowledge Exchange Hubs for the Creative Economy successfully stimulated greater collaboration between excellent arts and humanities research and the creative industries. The Hubs, which are based in Bristol, Dundee, London and Lancaster, saw 29 Universities working with 1,700 innovators to create new jobs, companies and innovative new products and services.

This model is now being carried forward by AHRC and Innovate UK to catalyse research and industrial partnerships around immersive technologies, leading to a new major ISCF programme called Audiences of the Future, which aims to help the UK take a leading position internationally in understanding and developing this fast-growing industry.

Investment accelerator funds corrosion sensor for oil and gas pipelines

The oil and gas industry spends around £3.5 billion managing corrosion every year. A Midlands-based company that develops remote sensors for monitoring corrosion in oil and gas pipelines has secured £250,000 of investment from early-stage technology investor, Mercia Fund Managers. This has been met with a further £104,000 from Innovate UK's Investment Accelerator pilot programme. The investment will support CorrosionRADAR with developing its technology and business to secure commercial partners for initial field tests.

Investment Accelerator is a new approach to finance innovation, highlighting the potential to scale by attracting significant private sector funding into UK R&D from both domestic and foreign investors.

Salford Media City

UK Competitiveness Index

ESRC-funded research by Professor Robert Huggins at Cardiff Universitydeveloped the UK Competitiveness Index (UKCI) to measure how attractive different regions of the UK are to businesses and firms, the economic welfare of individuals and the value of business success for citizens. UKCI has been used by policymakers across the world and cited by 80 authorities in the UK alone. The York Economic Partnership drew on the UKCI when they developed their 2011 economic strategy for York – with a goal of 1,000 new jobs and 75 new business start-ups each year by late 2015. The UK Commission for Employment and Skills used UKCI findings to inform its 2010 report Ambition 2020.

Creating social and cultural impact

Research and innovation must evolve if they are to meet the changing needs of society. The population of the planet is growing at an unprecedented rate and, in many countries including the UK, people are living longer than ever before.

Globalisation, ageing, advances in technology and the role of social media present new opportunities and challenges. Public services require high quality research and innovation to deliver effectively.

These challenges call for policy and solutions that take account of evidence from the research community and innovative solutions from our businesses and charities. They increasingly require multidisciplinary and interdisciplinary approaches, as well as enhanced collaboration across traditional boundaries and organisations. We need a research and innovation system fit for the future and able to respond to demographic, economic and environmental change on a global scale.

Viscount Haldane, in his report of 1918, called for regular discussion between the funders of research and those in government departments responsible for policy and research. This call was echoed in the report by Sir Paul Nurse that recommended the creation of UK Research and Innovation. We will work closely with government departments and encourage and support all of those in the research and innovation community to maximise the benefits of collaboration.

The UK Research Councils have a long and distinguished history of supporting research and innovation in low and middle income countries, an integral part of the UK's development assistance goals. Their support has also played an extremely important role in training researchers in these countries. This long-standing record of international collaboration has engendered important goodwill, enabling UK researchers to become involved rapidly and effectively in international emergencies including the outbreaks of Ebola fever in West Africa in 2014-15, the Zika epidemic in South America in 2015-16 and the earthquake in Nepal in 2015.

Knowledge cannot be contained in a vacuum. It must be shared. New knowledge is fascinating, empowering and potentially life changing. And the cultural richness of our country depends on our valuing the art, literature and history of the UK and of other countries around the world.

UK Research and Innovation will take a leading role in generating and putting into use knowledge to address societal challenges, both here in the UK and globally, and maximising the cultural impact of knowledge.

CASE STUDIES

Unlocking the secrets of the world's ancient past and beliefs and inspiring technological breakthroughs

From Britain's pre-historic monuments of Avebury and Stonehenge to 3rd century monasteries in Sri Lanka and the maritime port of Imperial Rome, AHRC's archaeologists, historians and scholars of religion and beliefs are making new discoveries. AHRC researchers are at the forefront of transforming our understanding of the 'Beaker People'. 'Recent analysis of the skeletal remains of 264 people from the British Chalcolithic–Early Bronze Age has revealed new information about their diet, migration patterns and degrees of mobility between childhood and death, mostly within Britain but also across Europe. The published findings received significant peer recognition winning the 2017 Antiquity Ben Cullen Prize.

Beyond enriching our understanding of the world of our ancestors, these initiatives are supporting sustainable heritage strategies, creating new technological advancements in imaging and motion capture, and, significantly enhancing tourism revenue. AHRC research resulted in £4.5m worth of extra ticket sales, and 40,000 extra visitors per year at Stonehenge. This was as a direct result of expanding the Stonehenge site by unearthing a huge settlement at Durrington Walls and a lost stone circle on the bank of the River Avon. That research resulted in more than a dozen documentaries about the research on CNN, BBC, Channel 4 and National Geographic.

Researchers working at Stonehenge

Research for the Financial Conduct Authority led to a price cap for payday loans

Protecting more than four million payday loan customers from punitive interest fees associated with greater debt and financial hardship.

The world's largest study of the behaviour of households that use payday loan services was undertaken in partnership with the Financial Conduct Authority (FCA), leading to recommendations for setting the level of a loan price cap. FCA consumer credit policy was shaped by the study, helping protect 4.3 million people from irresponsible loan practices in the UK. New FCA regulations came into force in January 2015, limiting interest and charges on payday loans to 0.8% per day and introducing new standards for affordable credit.

One year after the introduction of the policy, the number of payday lenders dropped from 400 to below 150. The remaining firms withdrew from the market. Within three months of the regulations coming into force, the number of loan-related problems handled by Citizens Advice dropped by 50%.

We will:

- Identify and tackle the complex societal challenges that matter most to people, in partnership with them;
- collaborate with like-minded partners in the UK and around the world, including government, non-governmental organisations and charitable foundations to support and strengthen research, innovation and capacity building in low and middle income countries;
- provide agile responses to sudden emergencies where there is an urgent research and innovation need;
- collaborate with other government departments to tackle societal challenges and to generate further knowledge to assist policy making across government;
- work closely with the public, to understand their concerns and aspirations, build trust and appreciation of the importance of knowledge, and inspire future researchers and innovators with the aim of delivering maximum societal value.

Official Development Assistance

We will continue to support cutting-edge research and innovation addressing global issues affecting developing countries through the Global Challenges Research Fund (GCRF) and the Newton Fund, both of which form part of the UK's Official Development Assistance.

The **Global Challenges Research Fund (GCRF)** is a five-year £1.5 billion fund which generates solutions to the complex problems faced by developing countries. It achieves this through challenge-led disciplinary and interdisciplinary research, strengthening research and innovation capacity within the UK and developing countries. This fund can provide an agile response to emergencies where there is an urgent research need. UK Research and Innovation will continue to work with government, including the devolved administrations, to fund research that will generate innovative solutions to important development issues and to 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.

The **Newton Fund** is focused on building research and innovation partnerships between the UK and emerging knowledge economies to support their research and innovation capacity to solve development challenges. The fund covers three broad activities:

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

UKRI will work strategically with partner countries to foster research that can address challenges defined by the overarching ambitions of the Newton Fund. We will continue to identify opportunities for longer-term engagement and collaboration.

Working with the whole of government

To have most impact, a strategic approach to R&D across the whole of government, including the devolved administrations, is crucial. UKRI's strategic objectives align and complement government departments' aims for R&D. We will use our funding, expertise and convening power to work with the Government Office for Science and other departments to have the most influence and impact, whilst respecting individual departments' ownership and funding of their core priorities.

We want to build strong relationships with the devolved administrations on matters of national research and innovation strategy to ensure that funders across the UK can work effectively together on joint agendas, in a way that is sensitive to the differing policy contexts in the devolved nations.

We will support cross-government working using funding as a catalyst, and drive the closer alignment of R&D needs and priorities across government. We will:

- Use the Strategic Priorities Fund to align shared research priorities
- Support the Government Office for Science to ensure that departments' statements of need are clear and useful
- Engage with the departmental and devolved administration Chief Scientific Advisors to help ensure that the priorities of UK and devolved government departments are aligned with their delivery plans

Communication and public engagement

The UK is proud of its rich research heritage, its spirit of innovation and its international reputation. Our vision is to ensure that with public support this continues to flourish.

To realise our vision we must engage with communities across the UK and across the globe.

We must forge strong collaborations, strengthen trust and build understanding, and

- listen and respond to a diverse range of views and aspirations about what people want research and innovation to do for them. We will ensure today's discoveries ignite and excite a new generation capable of addressing tomorrow's questions
- build public understanding and earn and retain trust in UK research and innovation
- inspire people of all ages to participate in research and innovation in partnership with our stakeholders
- promote, support and encourage researchers and innovators to engage with the public as they shape and conduct their work
- sustain strong public dialogue to ensure people are engaged and involved with research and innovation, with the issues, the opportunities and the implications
- engage with research communities, businesses, civic society and policymakers to foster strong partnerships and collaborations and ensure our investment can deliver impact.

In the coming months we will continue successful public engagement programmes across UKRI, providing opportunities for informing, involving and inspiring the public in UK research and innovation.

We will run an open call for proposals from consortia of higher education institutes, research institutes and external stakeholders to support a small number of high quality research projects that place citizen participation at their heart.

We will review our public engagement programmes and develop a new public engagement vision and strategy by March 2019. We will review our social media strategies and implement new approaches.

CASE STUDIES

Microscopic image of methicillin-resistant Staphylococcus aureus (MRSA)

Anti-microbial resistance

The overuse and misuse of antibiotics in agriculture and medicine has led to a growing number of bacteria in humans, animals and the environment that are resistant to antibiotics.

Without effective antibiotics, animal welfare and food supplies are threatened, and most medical practices, including routine surgery, emergency operations, transplants, and chemotherapy will be less safe. Tackling antimicrobial resistance (AMR) therefore requires a cross-disciplinary and global approach.

The MRC-led cross-council initiative has supported 78 projects with just under £44m. Awards span a wide range of topics from how building design can enable infection control, to how innovation in diagnostics can improve antibiotic use in farming.

Work with international partners has leveraged additional funding and enabled global impact, including with 20 partners across Europe and North America through the Joint Programme Initiative in AMR, with India and China through Newton funded calls, and in low income countries using GCRF support.

Fire and Rescue Service

Behavioural neuroscience improved firefighter decision-making

BBSRC-funded behavioural neuroscience research at Cardiff University has underpinned changes to the national guidance provided to Incident Commanders in the UK Fire and Rescue Services. The guidance provides a rapid mental checklist that aims to ensure Incident Commanders are making the best decisions to protect firefighters and meet incident objectives. An associated ESRC-funded secondment explored how fire services use the checklist and developed a training protocol.

The new decision control process has also been incorporated into the doctrine of the Joint Emergency Services Interoperability Procedures used when UK emergency services come together to tackle large complex incidents. It has also attracted significant interest from Fire and Rescue Services in other countries.

Engineering a plastic-eating enzyme

The UK government is committed to a clean growth strategy and to eliminating avoidable plastic waste by 2042. Reducing the harmful pollution caused by plastic waste will drive research and innovation towards greater resource efficiency and a more circular economy – thereby delivering productivity, growth and environmental benefits across the UK.

UKRI supported scientists have engineered an enzyme which can digest some of our most commonly polluting plastics, providing a potential solution to one of the world's biggest environmental problems. The discovery could result in a recycling solution for millions of tonnes of plastic bottles, made of polyethylene terephthalate, or PET, which currently persists for hundreds of years in the environment.

Professor John McGeehan at the University of Portsmouth and Dr Gregg Beckham at NREL solved the crystal structure of PETase - a recently discovered enzyme that digests PET - and used this 3D information to understand how it works. During this study, they inadvertently engineered an enzyme that is even better at degrading the plastic than the one that evolved in nature.

The University of Portsmouth and NREL collaborated with scientists at the Diamond Light Source to create an ultra-high-resolution 3D model of the enzyme with the synchrotron that uses intense beams of X-rays to act as a microscope powerful enough to see individual atoms.

Illustration of five forgotten female composers

Celebration and Discovery: Forgotten Female Composers

A collaboration between BBC Radio 3 and the AHRC has shone light on the significant achievements of five neglected female composers and provided a platform for fresh academic research into the remarkable history and music of these women.

The research focuses on five composers, including Leokadiya Kashperova, who taught Stravinsky, and Florence B. Price, an esteemed African-American symphonist in the first half of the 20th century whose work then fell into obscurity.

Research by five AHRC-funded musicologists led to the rediscovery and reconstruction of scores enabling music by all five women to be performed by the BBC Concert Orchestra on 8 March 2018, International Women's Day, on BBC Radio 3.

How we will deliver and be accountable

UKRI's investment in research and development

UKRI is responsible for a large and growing budget. In 2018 alone, it accounts for over £6 billion of investment in research and innovation, the majority of UK public expenditure on R&D.

Each UKRI council has a unique role in supporting the UK's world-class research base, and UKRI is dedicated to continuing to invest in research across the full spectrum of academic disciplines. The chart sets out the breakdown of 2018/19 funding allocations between UKRI councils[3].

As set out in its Industrial Strategy, the government allocated £7bn to the National Productivity Investment Fund (NPIF) over the period 2017/19 to 2021/22. UKRI has a key role in delivering this investment. This will provide a welcome and substantive boost to UKRI's funding, representing the biggest-ever increase in public funding of R&D.

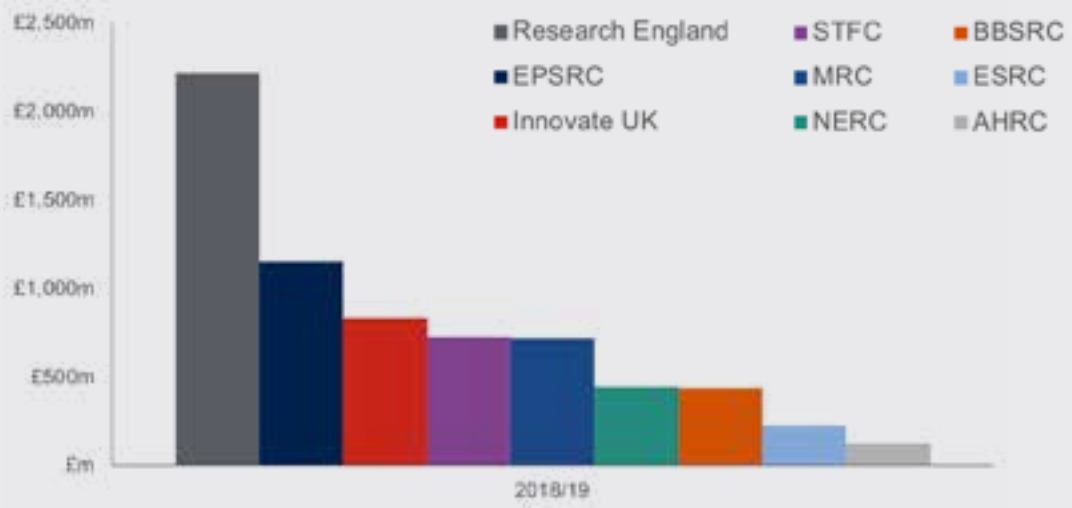
Split between themes, the NPIF funding package balances both discovery-led and challenge-based research and innovation. This funding allows us to:

- Tackle the grand challenges of our time by bringing together the UK's world-leading research with business through the Industrial Strategy Challenge Fund
- Ensure the UK continues to lead the world in pushing the frontiers of human knowledge by creating a new competitive and strategic fund that builds on the vision set out in Paul Nurse's review
- Support local economic growth across the country by launching a new Strength in Places Fund
- Ensure we have the highly-skilled and diverse workforce needed for a growing and innovative economy
- Drive commercialisation of research by strengthening collaborative links between business and academia, and work with the HE sector to develop the Knowledge Exchange Framework
- Ensure the UK remains a leading nation on the world stage by building strong international partnerships and attracting the best international talent

In addition to the UKRI funded programmes outlined in the charts, UKRI will also advise on and have access to the Strategic Priorities Fund; this fund will ensure that strategically important research and innovation which isn't aligned with other funding programmes can seek direct support.

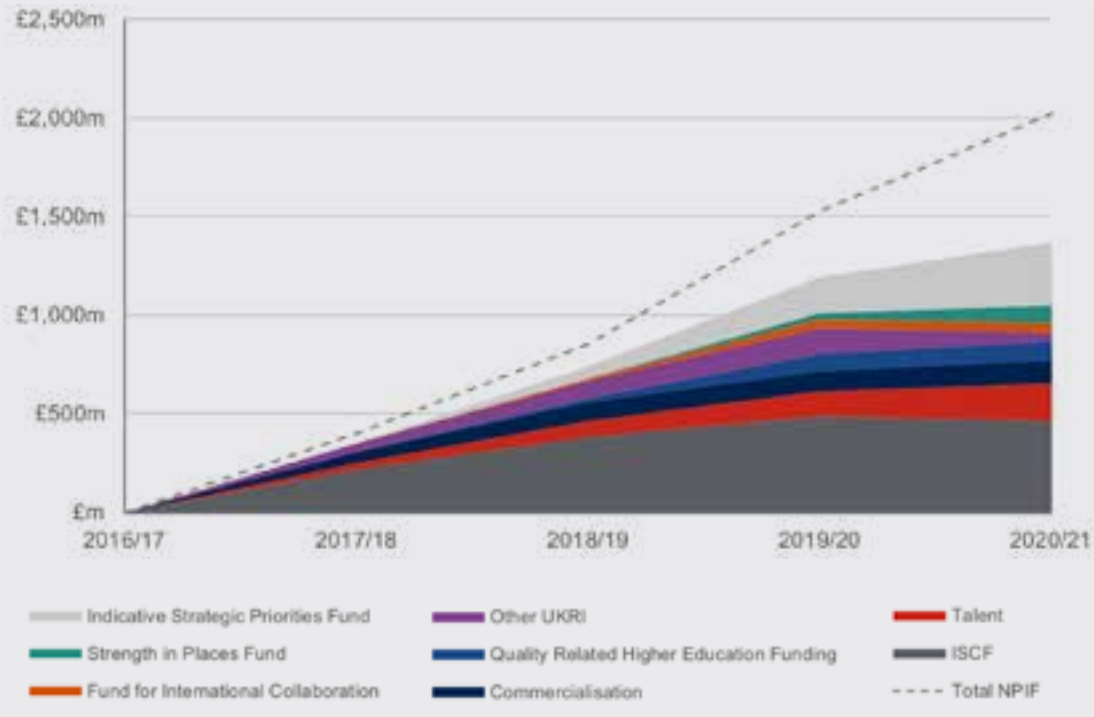
Further detail on how this funding will be allocated to individual programmes and research areas will be published by the Department for Business, Energy and Industrial Strategy.

UK Research and Innovation 2018/19 allocation, by council



Council allocation figures include funds for cross- council programmes that individual councils will manage on behalf of UKRI. The chart does not include centrally held UKRI funds.

National Productivity Investment Fund allocation, by programme



Figures represent planning allocations to UKRI, including some projects that are subject to business case approval by the Department for Business, Energy and Industrial Strategy and Her Majesty's Treasury.

The ISCF includes allocations for wave 1 and wave 2 challenges carried out by UKRI councils. UKRI are currently considering bids for wave 3 of the ISCF, which will be funded from the unallocated NPIF in 19/20 onwards.

Measuring success

To meet our objectives we need to know what success looks like, and how we will measure it.

In the short term we must transform the way we work without losing focus on achieving our longer-term goals across the three pillars of knowledge, economy and society.

Following best practice examples in existing funding organisations, we have developed a framework for tracking and reporting UK Research and Innovation performance. We will use this framework to identify successes and areas for improvement, and to analyse areas where new action and interventions are required.

The framework will be used to track performance across all of our activities, as well as within specific areas of strategic importance such as Place, Talent, and Infrastructure.

We will monitor:

- The **successful transition** from our existing structures to UK Research and Innovation in April 2018, focusing on leadership and governance, staff transfer, and continuity of corporate services
- The **successful transformation** to a new organisation in the medium term, focusing on enhanced decision making, efficient and effective delivery, and enhanced communications and public engagement
- The **successful impact** of our inputs and activities on knowledge, economy and society.

To measure our performance against our long-term ambitions, we will monitor a broad set of outcomes with a wide range of quantitative and qualitative indicators:

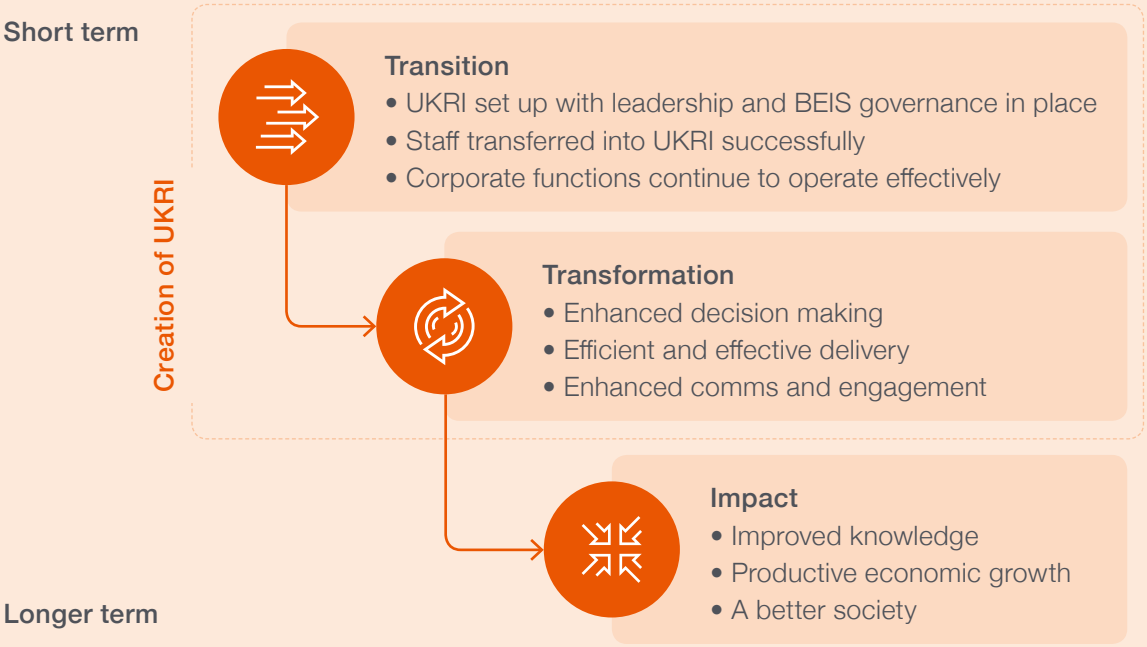
- Pushing the frontiers of human knowledge and understanding: New research, tools, and methods; high quality people; and improved knowledge sharing
- Delivering economic impact: New products, businesses and services; increased business growth and jobs; links between the research and the innovation, business and investment communities
- Creating social and cultural impact: Improved wellbeing; health outcomes; improved policymaking and public services; improved security, resilience, and cost avoidance.

To enable full reporting against this framework, we will transform the way we work with data. The new UKRI Data Hub will bring together our collective evidence base and provide new analytical tools that allow us to perform innovative analysis and gain deeper understanding of our activities and their impacts.

There are strong links between this framework and the monitoring and evaluation activity that we are committed to carrying out across UKRI's programmes and activities. We are committed to understanding the impact of our funding – both legacy and new – and data and evidence collected for programme-level evaluations will be used to help measure UKRI-wide performance as appropriate. Our ambition as UKRI is to deliver a step change in understanding how R&D investments can best drive productivity and economic growth in the UK.

Measuring success

Transition, transformation and impact



Inputs, outcomes and impact

Achieving our vision – our corporate priorities

The way in which we operate is as important as what we are striving to deliver – our operational approach will determine how successful we are.

We want to make it as easy as possible for the research and innovation community to lead the way globally on interdisciplinary research. Together we will develop efficient and effective services that support our communities whilst ensuring we are flexible enough to respond quickly to new priorities.

To enable this we will first focus on:

- Our organisation and people
- Processes
- Systems

We will produce a detailed multi-year corporate plan on an annual basis, expanding on the detail introduced here.

Organisation and people

Our people are our biggest asset, and the organisations forming UKRI have an excellent reputation for investing in their staff. UK Research and Innovation is committed to helping its employees develop new skills and undertake continuing professional development. This will include, for example, a UKRI school of learning that will support and identify talent in a leadership training scheme. UKRI will also promote the exchange of talent between its constituent bodies, the research base and business, and encourage our people to grow their careers across the whole organisation.

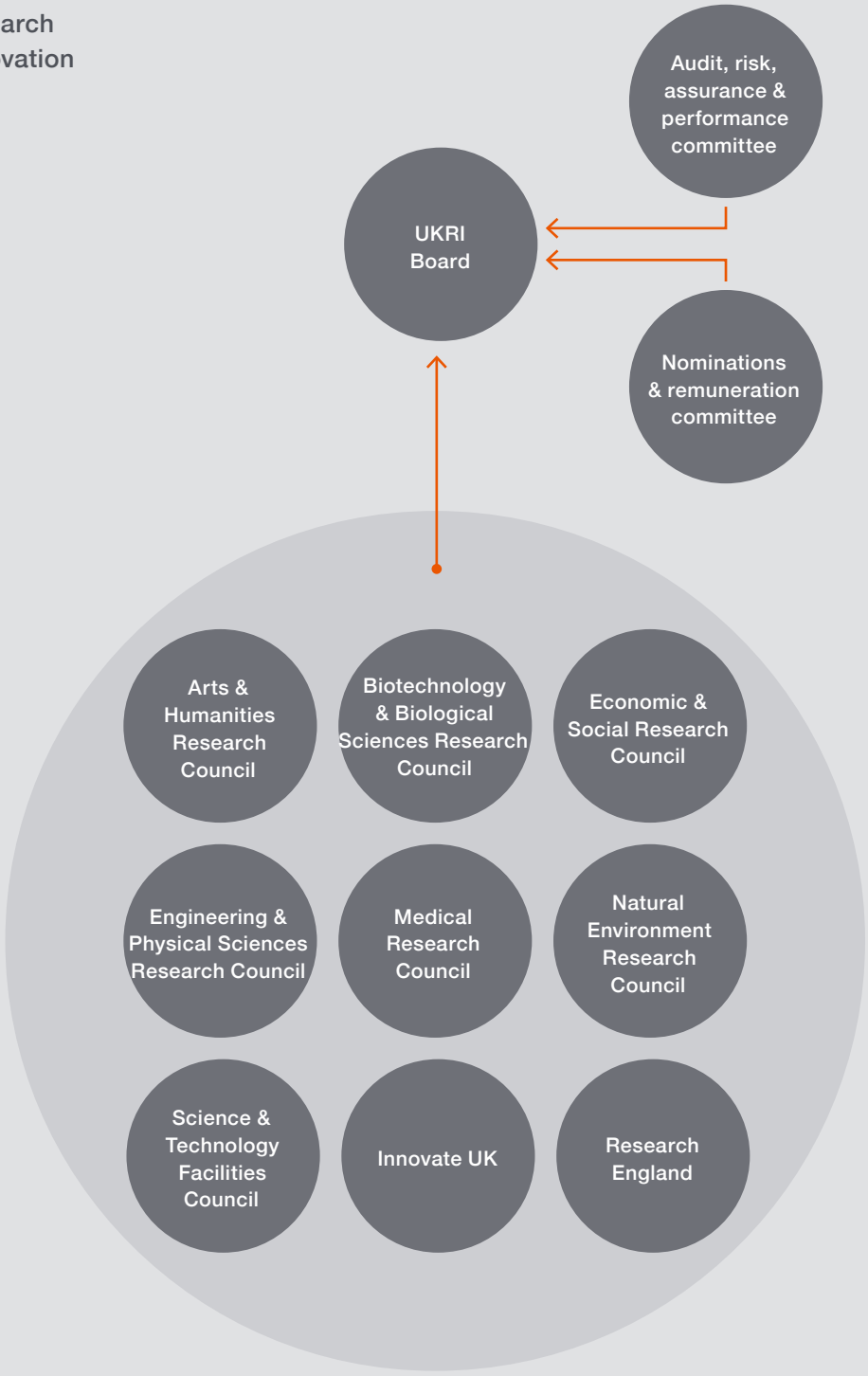
UKRI is comprised of the Board, nine councils that are overseen by the Board and a strategic and corporate centre. The councils and the strategic and corporate centre are coordinated by the Executive Committee, which is led by the Chief Executive and also includes the Chief Finance Officer and Strategy Director. The Board is made up of the UKRI Chair, Chief Executive, Chief Finance Officer and twelve independent members.

The councils are statutory entities, established by the Higher Education and Research Act, which will deliver against their specific discipline focus. Each Council is led by an Executive Chair, and supported by up to 12 independent members. The Executive Chair is a senior member of UKRI staff, and line managed by the Chief Executive. They have delegated financial authority from the Chief Executive to make commitments on behalf of their Council.

UK Research and Innovation Board and Councils

→ Reporting line

UK Research and Innovation



UK Research and Innovation Executive Reporting

● Individuals ● Board, committee, advisory group

*Principal Accounting Officer

** Chair of Executive Committee and UKRI Accounting Officer

Services

A substantial amount of our activity is concerned with delivering financial support through efficient funding and investment services. To be successful, our processes must be flexible and enable us to respond quickly to change. They must also help to maximise the time that colleagues in the research and innovation community can spend on delivering outcomes, rather than filling in forms. They should also enable us to measure impact and accurately spread and disseminate best practice on what works.

We will ensure that both the funding and investment services for industry and academia are effective. We will ensure that we are an organisation that is easy to deal with. We will develop our processes and our people to ensure the successful delivery of the Industrial Strategy Challenge Fund and Strategic Priorities Fund, where new ways of working and closer collaboration across councils will be essential.

Through UKRI, we will develop a simple and unified service that flexibly supports our ambitions, builds upon current good practice and partnerships, widens evidence-based decision making, frees up more time for value-added activities and helps achieve world-class outcomes for the UK.

Our people and services need to be supported by the most effective systems. There is a complex landscape of legacy information technology systems and approaches across the organisations forming UKRI. We will improve efficiency and productivity by developing an infrastructure that delivers an advanced information technology service provision for UKRI that better meets the needs of the constituent councils and our new ways of working.

We will invest in new technology that allows us to reduce our overall costs or improve our operational efficiency. This will include new digital solutions that will capture the information needed to demonstrate economic, social and cultural impact, and will give us the evidence to support our increased expenditure. We also need to explore how best to invest in effective grant management, finance and HR systems, making it possible for our people and users to be connected to the right systems wherever they are in the organisation.

Best environment for research and innovation

At a time of national and global change it is crucial that the UK continues to provide the best possible environment for research and innovation to flourish.

We will work in partnership with government, universities, research organisations and businesses to achieve this. Both UKRI and the organisations we fund need to foster collaboration with countries and institutions around the world so that we leverage the best talent, ideas and resources. Researchers and innovators need partnerships to succeed, but they also need access to the right facilities and infrastructure.

Global Britain

Global cooperation and collaboration enhances the quality of research and innovation, avoiding duplication, providing economies of scale, and leveraging diverse and outstanding talent across disciplines and geographies. It creates new opportunities to export and attract inward investment, and provides a pull for the best international talent. It is a source of soft power for the UK on the global stage and, following the UK's exit from the EU, presents an opportunity both to support continued collaboration with our European partners and grow our global connections.

We welcome the Government's intention to continue to collaborate with the EU on science and innovation. The UK is a top five collaboration partner for each of the other 27 Member States, and we want to maintain and strengthen this relationship.

We will support the Government to establish an agreement on science and innovation that ensures the valuable links between us continue to grow, specifically in exploring the successor programmes to Horizon 2020 and Euratom Research and training.

UKRI will apply four principles to identify the best opportunities for international collaboration:

1. **Excellence and impact:** How the partnership would increase the quality of research and innovation outputs and any complementarity with UK priorities

2. **Alignment:** Openness of the partner country to collaboration with the UK, including alignment of funding and support systems, ethical standards and legal protections

3. **Additionality:** Whether government, working with the sector, can add value to the collaborative relationship

4. **Foreign policy:** Including the role of research and innovation in diplomacy and reinforcing the UK's influence across the world.

UK Research and Innovation will maintain the UK's reputation for research and innovation excellence and will work to increase international collaborations by:

- Promoting the UK as a world-class destination to generate and access research and innovation
- Developing existing and creating new collaborative research and innovation programmes that target countries with high performing research and innovation sectors to engage in joint-funded bilateral or multilateral agreements
- Using the Newton Fund and Global Challenges Research Fund to develop relationships with international partners
- Building the capacity and capability of UK-based institutions, researchers and innovators to stimulate, consolidate and grow their international collaborative activity.

To support these existing activities we aim to implement a new Fund for International Collaboration, a non-ODA fund of £110m over three years to focus on establishing partnerships and conducting activities with developed countries. We will support the government to agree a far-reaching science and innovation agreement with the EU that establishes a framework for future collaboration following the UK's exit from the EU.

CASE STUDIES

WrightBus operating in London

International Collaboration to deliver new electric vehicles

An EPSRC-NSFC innovate partnership under the Low Carbon Innovation Programme between Queen's University of Belfast and Harbin University of Technology has led to the development of an innovative lab looking at novel vehicle battery technology. A partnership with Northern Ireland's leading bus operator WrightBus is now developing a new fleet of zero-emissions buses for Belfast, demonstrating a capability to produce commercially viable green battery technology, a priority of the UK Government's Industrial Strategy.

WrightBus has also received funding from Innovate UK for the development of mild hybrid architecture for fuel efficient buses.

Transforming disease control across Africa

Sir Brian Greenwood, an MRC-funded Professor of Clinical Tropical Medicine at the London School of Hygiene & Tropical Medicine (LSHTM), spent 50 years of his career as a researcher in Africa. His research has influenced national and international public health policies dealing with some of the major killers of children in Africa, from malaria control across Africa to demonstrating the potential of vaccination to eliminate Haemophilus influenzae B infection.

Sir Brian spent 15 years directing what is now called MRC Unit The Gambia at the LSHTM. After noticing that people in the local villages used bed nets, he compared the rates of malaria between people who did and did not use bed nets. Using a standard bed net did reduce malaria, but insecticide-treated nets gave villagers up to 70% extra protection. Looking at a much larger group he found that using insecticide-treated nets led to a 30% reduction in child deaths. Deaths from malaria halved between 2001 and 2013, largely down to the use of insecticide-treated nets.

Greenwood studied artemisinin-based combination therapies, now widely adopted as a first-line treatment for malaria, and set-up large-scale clinical trials of vaccines against pneumococcus, a common cause of pneumonia and meningitis in children. He also made significant contributions to malaria vaccine trials and the development of meningococcal vaccines.

Infrastructure

The UK's global stature in research and innovation is founded on the availability of internationally-competitive infrastructure. From the Diamond Light Source to the Royal Research Ship (RRS) David Attenborough, the facilities, resources and services used by the research and innovation communities to conduct research and foster innovation in their fields 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.

Access to world-leading infrastructure supports research activity at all scales, from individual research teams to large international collaborations. For the UK research community, businesses and other users to deliver against our ambitions, we need to secure cost-effective access to key national and international facilities and capabilities that would be difficult or impossible to resource through individual organisations.

UKRI has launched a programme to create a long-term research and innovation infrastructure roadmap looking forward to 2030. This will chart our existing UK infrastructure (and key international facilities in which the UK participates), future needs (research, economic and social), and resulting investment priorities.

In addition the roadmap will:

- Identify future research and innovation capability priorities
- Identify opportunities for increasing inter-connectivity
- Support development of our long-term investment plan
- Promote the UK as a global leader in research and innovation
- Set out the major steps needed to realise the long-term vision.

This strategic approach to infrastructure will strengthen the UK research and innovation system and improve capital planning to prioritise resources for longer-term investment.

The roadmap programme extends beyond UK Research and Innovation. We will work with other key partners across government (such as the Met Office and the National Physical Laboratory), devolved administrations, academia and industry to understand and showcase the breadth of UK capability.

CASE STUDIES


The Square Kilometre Array

UK Research Partnership Investment Fund

University of Dundee - Centre for Translational and Interdisciplinary Research

The University of Dundee was awarded £12 million in the first round of the UK Research Partnership Investment Fund for the Discovery Centre for Translational and Interdisciplinary Research, attracting in excess of £25 million in co-investment.

Although construction of the centre was underway, the university was only able to furnish half of the space. The UKRPIF award catalysed further investment, including £14 million by the Wellcome Trust to establish the Wellcome Centre for Anti-Infectives Research and £8 million to power drug discovery programmes in close partnership with GlaxoSmithKline. This extra investment also enabled the building to be fully equipped.

The main 'translation' force is the Drug Discovery Unit, occupying two floors of the centre and housing over 100 staff. This unit translates discovery science into potential drugs for infectious diseases like malaria, tuberculosis and leishmaniasis, and also into targets for other conditions like Alzheimer's, skin diseases and cancer.

The Square Kilometre Array

The Square Kilometre Array (SKA) is set to become the world's most advanced radio telescope – 10,000 times more powerful than current telescopes. It will enable scientists to test some of the key questions in physics, and learn more about the nature of the Universe. Using thousands of antennae and dishes located in Australia and South Africa, this project will provide more than one million square metres of collecting area, using the fastest-ever communications network in the field of astronomy. Scientists at the project's headquarters in Jodrell Bank, UK co-ordinate and collaborate with a global team of technical experts in radio astronomy, connecting institutions from more than 20 countries.

Once completed, it is hoped that the SKA will remain operational for up to 50 years. The first science observations are expected in the early 2020s. The UK is contributing £100 million towards the construction of the SKA. STFC represents the UK as part of the SKA consortium, and is the central point of contact for engagement with industry. UK industry is already actively engaged in the project, working with UK and foreign universities and institutes to deliver the SKA design, and UK companies have already been awarded contracts in areas such as systems engineering, project management and software development.

Delivering together

The UK is at a crossroads. We face unprecedented change, both in our future outside the European Union, and also as a result of pressing and complex global challenges such as climate change and our ageing society.

At the same time, we are witnessing a seismic shift; experiencing a new industrial revolution as we move to embrace new technologies such as AI.

UK Research and Innovation is a new organisation, but the building blocks that have come together to create it – our councils - are world renowned. We are proud of the trust placed in our organisation to help deliver the Industrial Strategy and create a forward-looking knowledge economy that will power our nation in the 21st century.

But we cannot succeed in this vital mission alone. UKRI employs over 7000 people including researchers in facilities, centres and units across the UK, but this is dwarfed by the number of people we support in institutions and businesses.

We are part of a much wider research and innovation community, from the learned societies to the great charitable funders, from our celebrated universities to our vibrant R&D intensive businesses and agile and creative SMEs. It is the richness and diversity of this system which is the key to the UK's success. We recognise we are just one part of this great enterprise and are determined to serve it well.

UK Research
and Innovation

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