Science priorities for Brexit – Evidence report

Stephen Metcalfe MP, Chair of the Commons Science and Technology Committee and the Parliamentary and Scientific Committee has produced a statement of the Science priorities for Brexit.

This evidence report details some of the advice and evidence provided by the research and innovation community that informed this statement. It has been drawn from a number of sources, including both seminars and written submissions.

Those organisations engaged with are listed at the back of this document. The statement and this evidence report do not represent a formal policy position of these organisations.

UK research and innovation

It is widely recognised that scientific research is an international endeavour and Britain is a hub of research and innovation with the infrastructure and regulatory environment that attracts investment and supports a diverse mix of entrepreneurs and researchers from at home and abroad.

This ecosystem drives excellent research and innovation at our leading universities; world-class businesses and globally admired institutes, enabling UK-based researchers and innovators to work with the best organisations and facilities, wherever they are in the world.

It also underpins our prosperity, gives all UK citizens access to the best, innovative services and the opportunity to be part of a highly skilled workforce with rewarding, productive jobs that contribute to a culturally diverse nation and support our global ambitions.

UK research and innovation allows us to compete on the global stage as an outward-looking nation that works with others around the world to tackle global challenges such as climate change and antimicrobial resistance and develop technologies and products that improve people's lives around the globe.

The strength of UK research and innovation can be maintained and grown with the right mix of skilled people, investment, networks and collaboration and regulation and trade.

Supporting information:

- With less than 1% of the world's population and 3.2% of global R&D expenditure, we produce 15.9% of the world's most highly cited research papers.
- In the 2016 Global Innovation Index, the UK was ranked 3rd overall out of 128 countries.[1]
- The UK pharmaceutical industry generates exports worth £24 billion[2]. The healthcare industry invests nearly half (48%) of total corporate R&D spend.[3]
- The UK creative economy comprises an estimated 2.9 million jobs, or 1 in 11 of all UK jobs[4]
- The UK digital sector is growing over 32% faster than the wider economy, and is creating jobs 2.8 times faster with an estimated turnover of £161 billion in 2014[5]
- The service sectors represent 79% of the UK's economy. They are core areas of innovation underpinned by research and development[6]
- The food and drink sector is the largest UK manufacturing sector, contributing £108 billion to the economy and employing nearly 4 million people. For every £1 invested in farming, it contributes £7.40 back to the country's economy.[7]
- UK Life Science contributed £30.7 bn to the economy in 2015.[8]
- Each Life Sciences job supports 2.5 jobs elsewhere in the UK economy, meaning the sector supports a total of 482,000 jobs.[9]
- Every £1 of public or charity investment in medical research generates annual monetised health benefits of 10p in perpetuity as well as additional spill over benefits.[10]

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[1] The Global Innovation Index 2016
[2] BIA, UK Life sciences manifesto 2015-20
[3] Financial Times, *Pharma makes up half of UK's £16.5bn R&D spending, survey says*
[4] Creative Industries Council 2016
[5] TechCity in partnership with NESTA, TECHNATION 2016
[6] ONS (2016) Statistical bulletin UK index of services (July 2016)
[7] Development Economics (2017) *Contributions of UK Agriculture*
[8] PWC (2017) *The Economic Contribution of the UK Life Sciences Industry*
[9] PWC (2017) *The Economic Contribution of the UK Life Sciences Industry*
[10] RAND Europe, Health Economics Research Group at Brunel University and King's College London (2014) Medical Research: What's it worth? Estimating the economic benefits of cancer-related research in the UK. Commissioned by: Academy of Medical Sciences, Cancer Research UK, the Department of Health and the Wellcome Trust

- The arts, humanities and social sciences make up 37% of academic staff, 54% of undergraduate students and 59% of Postgraduate students.[11]
- Social science alone is worth roughly £24 billion annually to the economy and accounts for much of the service economy the UK depends on.[12]
- More than 2 million people were employed in the physics-based industries in the UK in 2015 - that's 6.7% of the total workforce[13].
- The physics-based industries contributed £177 billion to the UK economy in GVA in 2014[14].
- £106 bn of physics-based goods and services were exported from the UK in 2013[15].

[11] HESA 2014-15 data (Academic staff) and 2015-16 data (Undergraduate and postgraduate) https://www.hesa.ac.uk/data-and-analysis/publications/staff-2014-15/introduction and https://www.hesa.ac.uk/data-and-analysis/publications/students-2015-16/introduction

[12] Simon Bastow, Patrick Dunleavy, and Jane Tinkler (2014). *The Impact of the Social Sciences: How Academics and their Research Make a Difference*. Sage: London. See also: http://www.lse.ac.uk/website-archive/newsAndMedia/news/archives/2014/01/ImpactofSocialSciences.aspx

[13] Cebr for the IOP - The role of physics in driving UK economic growth and prosperity (full report not yet published)

[14] Cebr for the IOP - The role of physics in driving UK economic growth and prosperity (full report not yet published)

[15] Cebr for the IOP - The role of physics in driving UK economic growth and prosperity (full report not yet published)

People

Principle: It is in the UK's national interest to attract diverse individuals from around the world with strategically valuable skills as well as give every one of its citizens the opportunity to develop the skills that the UK needs. Individuals with strategically valuable skills to the UK include successful leaders in research fields, early-stage researchers, technologists, technicians and those with entrepreneurial and management skills.

Asks:

Immediate actions:

- Provide certainty and stability for researchers and innovators that are EEA nationals currently working in the UK.
- Fill evidence gaps about the mobility of those with strategically valuable skills to the UK to inform future immigration policy.
- Develop and implement a communications strategy that champions Britain as a hub of research and innovation that welcomes a diverse mix of entrepreneurs and researchers from at home and abroad.

Exit negotiation priorities

- Provide certainty and stability for researchers and innovators that are EEA nationals currently working in the UK.
- Ensure that UK-based researchers can work elsewhere, recognising that the UK benefits from its citizens being able to work elsewhere to develop their expertise and networks, many of whom choose to bring these back to the UK.

UK domestic policy

- Ensure that the Industrial Strategy takes steps to equip people with the skills that they will need to succeed in the workforce of the future.
- Encourage wider uptake of science and mathematics at all stages of education, giving people opportunities to learn new skills throughout their lives.
- Develop an immigration system grounded on the evidence that ensures that UK universities and businesses continue to thrive and can recruit and retain people with the skills that they need, wherever they are from.
- Expand the UK's world-class funding streams to help attract and retain the most talented UK and international researchers to UK research.

Rationale:

Almost a third of academic staff in our universities are from outside the UK, with 16% from other EU countries. A third of UK start-ups were founded by non-UK nationals and 51% of UK start-up employees come from outside the UK.[16]

Overseas academics bring crucial expertise and skills and play a critical role in delivering a highly skilled workforce in the UK to meet labour market demands in the future. In particular, overseas academics play a key role in teaching and research in a range of science, technology, engineering and mathematics (STEM) subjects at our universities which are integral to the UK's ambition to boost productivity and economic growth.

[16] European Start Up Monitor (2015) The European Start Up Monitor represents more than 2300 start-ups with more than 31,000 employees in all 28 European Member States. Data from 13 countries surveyed.

All of these people face an uncertain future, and this influences decisions that they are making now over how and where to develop their careers. This will also be influencing the decisions of those choosing whether to come to the UK to study and work in future.

The UK must give its citizens the opportunity to develop the skills that the UK needs and encourage the world's brightest and best entrepreneurs and researchers from at home and abroad to choose the UK.

Individuals with strategically valuable skills to the UK include successful leaders in research fields, early-stage researchers, technologists, technicians and those with entrepreneurial and management skills.

We cannot realise the full potential benefits of public investment in research and innovation with UK talent alone. Working alongside the best people from across the world enables UK-based researchers to share techniques and approaches and access influential contacts and networks. It also exposes students to a much broader range of ideas and expertise as they learn.

We must send a message to these highly sought after people that they are welcome, and show them the opportunities available in the UK.

The UK also benefits from its citizens being able to work elsewhere to develop their expertise and networks, many of whom choose to bring these back to the UK.

Short and long term migration are both necessary in science and research. Long term migration options with routes to residency ensure that advertised posts are attractive to potential international applicants with strategically valuable skills and can be filled. Likewise, temporary migration options are essential for short term visits, for example to visit a university or access a shared facility. Easy movement of researchers, innovators and specialist technicians gives the UK a competitive advantage by opening up access to skills and international networks.

This flexibility is also important for industry. In the automotive sector, the ability to meet skills shortages, and move employees at short notice for operational reasons, is a considerable strength in the UK automotive industry. Larger companies across many sectors also move staff across their global operations as part of their development programmes. Impacts on this will make the UK a less attractive investment destination.

Supporting information:

The strength of the UK's science base has been helped by being able to attract the best international talent to the UK and currently 16% of academic staff in our universities are from other EU countries with 12% from non-EU countries.

In the life sciences for example, the UK is currently the top destination for individuals from the EU to both pursue their research and career.

International movement is a feature of researchers' careers - 72% of UK-based researchers[17] spent time at non-UK institutions between 1996 and 2012[18]

The CBI's 2016 innovation survey found that access to skills was companies' top priority for ensuring their ability to innovate in the Brexit negotiations, cited by 66% of respondents.[19]

[17] BIS (2014) *Science and innovation system: international benchmarking*
[18] BBSRC and MRC review of vulnerable skills and capabilities - UKCES Reviewing the Requirement for High level STEM skills BBSRC and MRC Review of Vulnerable Skills and Capabilities

[19] CBI (2016) *Innovation survey* available here: http://www.cbi.org.uk/cbi-

Among engineering, science, and hi-tech firms, nearly half (44%) report difficulties in finding experienced recruits with the right STEM skills, particularly high-level STEM skills.[20]

75% of roles on the Home Office's Shortage Occupation List are in STEM.[21]

The proportion of a university's research workforce that is from overseas varies. For example at Russell Group universities, overseas (other EU and non-EU staff) represent 25% of the overall workforce (compared with 18% for all UK universities) and nearly 37% of academics (28% for the sector as a whole).
The proportion of a university's research workforce that is from overseas also varies across disciplines. In the social sciences, 16% of all teaching and research staff are from elsewhere in the European Union (in total 28% of social sciences academic staff are international). For the categories of 'science and maths' and 'engineering and technology' combined, the figures are 19% and 36% respectively[22].

'Engineering and technology' (40%) and biological, mathematical and physical sciences (37%) have the highest share of international academics.[23]

Between 2007 and 2014, the EU's Marie Sklodowska-Curie Actions supported 3454 UK-based researchers to move within the UK, to other EU countries and to non-EU countries. This scheme also funds researchers to come and work in the UK. For example around 800 Chinese nationals were supported to work in the UK, complementing the around 850 UK-based researchers who were funded to work in China.

Between 1996 and 2011 7.6% of UK-affiliated academic researchers worked in other EU countries but not outside the EU for more than two years and 13.3% worked for more than two years outside the EU.

UK research benefits from the immigration of top foreign researchers to the UK. These include several Nobel Prize winners, such as the Russian physicist Sir Andre Geim FRS, rewarded for his work on graphene. Five of the last 15 UK Nobel Laureates were foreign born

In polling conducted after the referendum, only 12% of people would like to see a reduction in the numbers of highly skilled workers migrating to Britain; nearly four times as many (46%) would like to see more of it, with 42% saying that it should stay the same. Among people who voted Leave in the referendum these numbers remain broadly the same: 45% would like to see an increase, 40% say that the numbers should stay as they are and just 15% would like to see them reduced.[24]

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prod/assets/File/CBI%20Innovation%20Survey%202016_%20results.pdf
[20] CBI (2015) *Inspiring growth: The education and skills survey 2015*
[21] Shortage Occupation List 2015
[22] HESA. *Staff in Higher Education*. (Numbers compiled by Universities UK)
[23] HESA 2014/15 Nationality academic staff by cost centre group,
[24] British Future (2016) http://www.britishfuture.org/wp-content/uploads/2016/09/What-next-after-Brexit.pdf

Investment in research and innovation

Principle: Signal the UK's intention to compete internationally by investing in scientific research and innovation and creating an attractive environment for other investors.

Asks:

Immediate actions:

- Ensure that there is no decline in overall public funding for UK science and innovation, across all disciplines.

Exit negotiation priorities

- Continue UK participation in Horizon 2020 to the end of the programme.
- Communicate the role of the UK and its status in EU programmes to partners across the EU and internationally.
- Seek the closest possible association for the UK with EU research and innovation programmes that support excellence, ensuring that we have both access to and influence over their development.

UK domestic policy

- Set a target of 3% of GDP for combined public and private R&D investment. Support this by investing at least 0.7% of GDP into research and development, and taking steps to encourage greater private and charitable investment.
- Identify opportunities to develop and host strategically valuable international research facilities in the UK.
- Conduct a comprehensive review of all current public funding for UK research and development and conduct contingency planning to ensure that there is no gap, or hiatus, in public funding for people and projects as the UK leaves the EU.
- Ensure that the Industrial Strategy boosts entrepreneurial activity both regionally and nationally.

Rationale:

The UK's uniquely diverse funding system creates flexibility, allowing us to fund in innovative ways, contributing to what is a hugely efficient and cooperative system.

Uncertainty over future EU investment in UK research presents a risk as it currently represents a major source of public investment in UK research.

We know that this is a delicate and interconnected ecosystem. Cuts in one source of funding may have impacts on others. Public investment in research and innovation influences private investment.

And we also know that it is not just the amount of money invested but the nature of funding that is important. Seed corn funding, small amounts of funding in areas where little funding is available, or funding that offers researchers mobility and encourages collaborations can have a bigger impact than monetary values might suggest.

EU Member States have chosen to jointly invest in science. This has enabled ambitious projects such as the creation of the European Research Council that has established a very strong international reputation and attracts researchers from around the world. The EU has a proud tradition of supporting excellence in discovery and applied research and that research makes a considerable long-term contribution to sustainable economic growth. Horizon 2020, the biggest EU Research and Innovation programme to date, continues this tradition.

The UK must signal its intention to compete internationally by investing in scientific research and innovation. Action now will send a strong message that the UK is open for business, stimulating private investment, creating jobs and enhancing the UK's ability to compete on the world stage.

The UK government has taken positive steps towards this:

- The UK government has committed to underwrite the value of any EU grants awarded to UK researchers for the full award period.

- The extra £4.7 billion investment in R&D from 2017-2021 announced by the government at the Autumn statement equates to an extra £2 billion per year for R&D by 2020, which is a substantial increase – around 20 per cent – in total Government R&D spending, putting us around the 0.59% mark as a percentage of UK GDP (up from 0.48 per cent).

- The tenth principle that will guide the government's exit from the EU is "Ensuring the United Kingdom remains the best place for science and innovation" and this notes that, *"As we exit the EU, we would welcome agreement to continue to collaborate with our European partners on major science, research and technology initiatives."*[25]

- The Industrial Strategy Green Paper[26] places research and innovation as its first pillar and states *"we are determined to continue to be one of the best places in the world for science and innovation and will welcome agreement to continue to collaborate with our European partners on major science, research and technology initiatives. As the UK prepares to leave the EU we remain committed to maintaining and building on our strengths in R&D to continue attracting world-class people, skills and foreign investment – as set out in the chapter that follows on trade and investment."*

As well as investing public money, it is important to create an environment that encourages private and charitable investment.

Supporting information:

UK research investment:

The latest 2013 OECD figures put the UK's total spend on R&D at 1.66% of GDP, consisting of 0.48% government spend, 0.77% industry spend and 0.41% other spending on R&D – this includes charitable investment.

Government spending commitments announced at the 2016 Autumn statement will put public investment in UK R&D at around 0.59% of GDP.

The diversity and interdependency of the UK's funding base – businesses, public sector, charities, philanthropists and venture - is a differentiating strength in the UK.

The UK's medical research charity community invested over £1.4 billion of research funding in the UK in 2015, over 94% of which took place in universities. Underpinning funding from Government supports this investment; the Charity Research Support Fund provides funding for the indirect costs of research that charities cannot fund. This vital funding stream protects the sustainability of charity investment and is a key means by which the Government secures investment from the charity sector.

[25] Department for Exiting the European Union (2017), *The United Kingdom's exit from and new partnership with the European Union White Paper*

[26] Department for Business, Energy and Industrial Strategy (2017), *Building our Industrial Strategy*

Since 2010 the CRSF has been fixed at £198 million per annum; a real-terms decrease of £38.7 million over 6 years. This real-terms decrease means that researchers in universities in receipt of high-levels of charity-funding are facing significant shortfalls; the sustainability of medical research charity funding is being put at risk.

In addition to R&D Tax credits, initiatives such as the Enterprise Investment Scheme (EIS) help smaller higher-risk trading companies to raise finance by offering a range of tax reliefs to investors who purchase new shares in those companies.

EU research investment:

It is estimated that the UK received €8.8 billion from the most recently completed EU research programme (2007-2013), having contributed an estimated €5.4 billion.

It is important to recognise that is it not only the scale of funding through Horizon 2020 that is significant, but also the intrinsically collaborative nature of these programmes, including attracting non-EU countries to participate.

How does the EU fund research, development and innovation?

There are two major routes by which the EU directly funds research in the UK – Framework Programme funding and structural funds. The UK is very successful in attracting Framework Programme funding, particularly that allocated for excellence.

Framework Programme funding:
The UK was the second largest recipient in absolute terms after Germany in the most recent Framework Programme (FP7).

The UK is the top performer among participating countries in two substantial Framework Programme funding streams that are awarded solely on the basis of scientific excellence – the European Research Council (ERC) and Marie Skłodowska-Curie Actions (MSCA).

Universities are by far the most successful in attracting Framework Programme funding, taking 71% of the total funds awarded to the UK during Framework Programme 7. UK businesses attracted 18%. By contrast, if we consider the distribution of where research and development is conducted in the UK; 64% conducted by businesses and 26% in universities.[27]

The UK has already received Euro 2.63 billion of funding from participation in Horizon 2020 since the programme began[28]. Recent statistics on UK participation in the scheme showed 18,566 applications were received in 2015 alone, with successful UK applicants receiving 15.9% of funding across the first two years of the programme.[29]

UK business is highly engaged with Horizon 2020. UK SMEs have collectively drawn down more funding than their counterparts from other Member States to date in Horizon 2020. UK industry is second overall and is also consistently engaged and successful across all industrially relevant areas of the programme. The benefits of such support go far beyond funding and are detailed under 'Collaboration and Networks'

Research into rare diseases is particularly reliant on funding from the EU. In 2014, EU grants worth over £190 million led to the investigation of rare diseases; this was more than the funding from the EU for either cancer or brain disorders. Conducting rare disease research at a multi-nation level means that a

[27] Royal Society (2016) *UK research and the European Union The role of the EU in funding UK research*
[28] Universities UK (2016) *Exiting the EU and science and research*
[29] European Commission (2016) *Horizon 2020 two years on*

larger cohort of patients can be accessed and resources pooled.

The European Research Council

The ERC is a pan-European funding body for frontier research. The ERC has rapidly established itself as a world leading funder of excellent research and its funding is highly prized by researchers for the status it confers, the duration of grants and the flexibility and portability of the funding.

By awarding large grants to researchers on a competitive basis, the ERC drives excellence through maximizing competition. The ERC supports frontier research, it does not prescribe policy-driven outputs. The globally-recognised and prestigious nature of these highly competitive grants attracts talented overseas researchers to come to the UK and apply for ERC grants, which then further enhances the UK's science base.

The ERC offers opportunities for researchers at all stages of their careers. The Starting Grants are especially valuable for early-career researchers, allowing them to establish themselves as leaders of research.

Looking at ERC Starting Grants awarded for the period 2007–2015 to UK-based academics, they obtained 19% of awards in the physical sciences & engineering, 17.3% in the life sciences, and 33.3% of all social sciences & humanities awards.[30] UK social science and humanities (SSH) have done particularly well: for the period 2007–2015, UK social scientists obtained a total of 190 ERC Starting Grants, more than double their nearest rivals the Netherlands (with 82) and Germany (with 60).[31] In 2013, the President of the European Research Centre noted that SSH accounts for 17% of the total ERC budget and is directed towards cutting edge research, with the UK holding 'the number one position' for ERC funding of SSH research.[32]

The European Investment Bank

The European Investment Bank is the European Union's bank, providing finance and expertise for sustainable investment projects that contribute to EU policy objectives. It is a significant funder of UK innovation. The total investment of the EIB Group (the European Investment Bank and the European Investment Fund) in the UK in 2016 was EUR 8.1 billion[33]. This included EUR 1.2bn in risk finance for SMEs, made available through the European Investment Fund, and EUR 1bn in innovation loans direct from the EIB.

Via InnovFin Equity, the EIF provides equity investments and co-investments to or alongside funds focusing on companies in their pre-seed, seed, and start-up phases operating in innovative sectors covered by Horizon 2020, including life sciences, clean energy and high-tech. Under InnovFin Equity, EIF targets investments in around 45 funds, mobilising a total amount of EUR 4-5 bn to be invested in enterprises located or active in the EU and Horizon 2020 Associated Countries[34].

Framework Programme 9

[30] Linda Hantrais and Ashley Lenihan (July 2016) The Implications of the EU Referendum for UK Social Science: Post-referendum Options for UK Social Scientists. LSE Centre for International Studies (CIS/2016/03), p. 8.
[31] Linda Hantrais and Ashley Lenihan LSE (July 2016) The Implications of the EU Referendum for UK Social Science: Post-referendum Options for UK Social Scientists. LSE Centre for International Studies (CIS/2016/03), p.8.
[32] Helga Nowotny. (2013) Shifting horizons for Europe's sciences and humanities, The Guardian, 23 September. https://www.theguardian.com/science/political-science/2013/sep/23/europe-social-sciences-humanities
[33] http://www.eib.org/projects/regions/european-union/united-kingdom/index.htm
[34] http://www.eif.europa.eu/what_we_do/equity/single_eu_equity_instrument/innovfin-equity/index.htm

The successor to Horizon 2020, Framework Programme 9, is currently in development. The UK has played a critical role in shaping Horizon 2020 and previous Framework Programmes to prioritise excellence and basic research, and is continuing to engage in the development of FP9.

An excellent research Framework Programme could include the following:

- Facilitate multi-lateral cross-border collaboration to enable as near frictionless collaboration as possible with the best partners
- Drive, and focus on, excellence through maximising competition, funding the very highest quality research proposals from a wide talent pool
- Tackle global challenges and other issues on a large scale, allowing participants to show global leadership on projects which could not feasibly take place on a national level (or where national level action would be sub-optimal)
- Promote researcher mobility to facilitate academic exchange of ideas and ways of working and allow researchers to gain international experience by working overseas
- Provide a mechanism through which UK researchers can create relationships, networks and partnerships
- Invest in and allow access to key large-scale research infrastructures

European Innovation Council

A key proposal which will be piloted during the final half of Horizon 2020 is the European Innovation Council, which will provide bottom-up support for breakthrough innovation projects, that cut across sectors/technologies, and target market-creating, breakthrough innovations with scale-up potential. The UK has been strongly engaged in the development of the European Innovation Council, a key element of which will be the SME Instrument scheme, in which the UK has also had significant success.

Case Study: Perpetuum

A fast-growing spin-out from Southampton University has used EU research funding and innovation funding through Innovate UK to further develop technology for the rail industry that is improving safety and reliability and delivering significant cost reductions. By joining an EU-financed Framework 7 (FP7) consortium in 2011, Perpetuum was able to build on its core technology to design, develop and commercialise complete systems to monitor train wheel bearings. The next generation of Perpetuum's condition monitoring systems is now being accelerated through a €2.1 millon SME Instrument project. Together, this has established Perpetuum as a global market leader. More than 45% of the company's sales were exported in 2015 and this is expected to rise to 70% or more over the next 3 years.

Structural funding:

The UK receives relatively little structural funding, which is largely targeted at building capacity in the least economically developed regions of the EU. However, in some areas of the UK these funds play an important role in supporting the development of skills, innovation and enterprise capacity – with universities working in partnership with local government, businesses and other providers. Their complete withdrawal would cause significant damage to these areas and efforts to address geographical disparities in UK productivity rates. If both Framework Programme and structural funds for research, development and innovation are taken into account the UK is the fourth largest recipient, behind Germany, Poland and Italy.

Many of the centres that constitute the High Value Manufacturing Catapult were established by the then Regional Development Agencies using structural funds, and such funds have been utilised by both Catapults and private RTOs in the UK to develop capability, capacity and outreach.

EU research funding in UK Universities

Research income from the EU represented 13% of the collective research grant income to Russell Group universities in 2014/15, up from 8% in 2007/8 – equivalent to over half a billion pounds.

Despite a reduction in UK government research funding to universities between 2009/10 and 2013/14, university research income increased over that period. This was largely due to increases in funding from the EU.[35]

Shared research facilities

Research often needs specialised infrastructure, including equipment and buildings, or less tangible infrastructure such as databases, archives, collections and computing systems.

These can be of great scientific value but are sometimes expensive, and as a result are often shared and used by scientists from many different countries. Access to and networking between different pieces of research infrastructure represent an important part of the European and international research landscape. Different countries, including the UK, play host to the headquarters of international research facilities.

Most of the cost of shared research facilities is borne by participating countries, but the EU often provides funding for activities such as planning, strategic coordination, networking and transnational access. The Framework Programme for 2007 – 2013 (FP7) earmarked €1.85 billion for research facilities, and the Framework Programme for 2014 – 2020 (Horizon 2020) will support them with about €2.4 billion.

The UK hosts the headquarters of 6 pan-European research facilities, with facilities distributed across multiple participating countries.

These are:

- High Power Laser Energy research Facility (HiPER) – Harwell, Oxfordshire (Central Laser Facility)57
- ELIXIR (European Life-science Infrastructure for Biological Information) – Hinxton
- Integrated Structural Biology Infrastructure (INSTRUCT) – Oxford
- Infrastructure for Systems Biology-Europe (ISBE) – London (Imperial College)
- Square Kilometre Array (SKA) – Manchester (Jodrell Bank)
- European Social Survey (ESS ERIC) – London (City University)

Case study: the European Social Survey (ESS ERIC)
The ESS was started by Roger Jowell in 1995 at the National Centre for Social Research in London with support from the European Science Foundation, later obtaining funding from the 5th Framework Programme in 2000. The ESS was awarded the Descartes Prize in 2005 for 'excellence in collaborative scientific research,' and became one of the first Research Infrastructures to be awarded European Research Infrastructure Consortium (ERIC) status in 2013 under the directorship of Rory Fitzgerald at City University in London.[36]

The UK also hosts 10 facilities that are part of pan-European research facilities headquartered in other European countries and is a member of pan-European research facilities entirely based beyond its

[35] Royal Society (2016) *UK research and the European Union: The role of the EU in funding UK research*

[36] House of Lords. (2016) EU Membership and UK Science, Select Committee on Science and Technology, 2nd Report of Sessions 2015–2016, HL Paper 127, p. 56. http://www.publications.parliament.uk/pa/ld201516/ldselect/ldsctech/127/127.pdf.

borders, such as the European Hard X-Ray Free Electron Laser (European XFEL) based in Germany

Case study: the European Space Agency (ESA)

ESA is not an agency or body of the EU. However, ESA maintains close ties with the EU and the two organisations have jointly developed a European Space Policy. Roughly 23% of ESA's funding in 2015 was provided by the EU, which is more than any individual member nation.

Case study: the Culham Centre for Fusion Energy (CCFE)

The UK is currently a world leader in nuclear fusion research.[37] The Joint European Torus (JET) cited at the Culham Centre for Fusion Energy (CCFE) is one of Euratom's most important research facilities. JET is performing ground-breaking research in the pursuit of fusion energy; is the only tokamak worldwide currently capable of running energy-producing deuterium-tritium reactions and holds the world record for fusion power production.

A €238 million operation contract signed between the European Commission and CCFE in July 2014 secures JET operation until 2018. Fusion projects at CCFE are funded jointly by Euratom and by the UK Engineering and Physical Sciences Research Council (EPSRC). JET currently receives around €56 million / £48 million annually from Euratom[38][2] through Horizon 2020 funding as part of a contract running until the end of 2018. Negotiations around an extension to 2020 are ongoing and will be affected by the UK leaving the EU and Euratom.

[37] EPSRC (2016) E*PSRC Independent Review of Fission and Fusion*

[38] Nature (2017*) Researchers shocked at UK's plan to exit EU nuclear agency*

Collaboration and networks

Principle: To realise the UK's ambition to remain one of the best places in the world to do research, to innovate and grow business, UK-based researchers must be able to engage with the brightest minds, the best organisations and facilities, wherever they are in the world.

Asks:

Immediate actions:

- Champion the UK's ambition to remain a world-class scientific collaborator and innovation partner when engaging with countries around the world.

Exit negotiation priorities

- Maintain access for UK and EEA researchers to a full range of world-class research facilities, both in the UK and internationally.
- Secure access to international networks and collaborations that support international mobility and collaboration.

UK domestic policy

- Develop an international strategy setting out the UK's ambition to remain a world-class scientific and innovative collaborator.
- Provide funding and infrastructure to create new bilateral and multilateral partnerships that enable UK-based researchers and innovators to work with the best people in the world, wherever they are based.
- Continue to make an authoritative contribution to international research strategy and policy development through the UK's membership and participation in international fora.
- Continue to collaborate internationally on global challenges such as climate change and antimicrobial resistance.

Rationale:

The UK should remain one of the best places in the world to do research, to innovate and grow business. This ambition can only be realised if UK researchers are able to engage with the brightest minds, the best organisations and facilities wherever they are placed in the world.

Mobility and collaboration give UK businesses, universities and research and innovation organisations access to a broader range of knowledge, people and facilities than could be obtained in the UK alone. This enables new ideas to be generated, shared and refined and has helped build the UK into the global powerhouse it is today.

An increasing proportion of UK research is published with partners across the world, and EU partners are involved in an increasing share of this work. Many global challenges can only be tackled by researchers in many countries working together in large-scale collaborations. Initiatives such as Horizon 2020 that encourage and facilitate researchers, scientific knowledge and technology to circulate are hugely valuable in hastening scientific progress, pooling resources to tackle challenges such as climate change and global pandemics, and create an environment where innovators and entrepreneurs can thrive. Its investment in excellence has enabled the European Research Council to act as a beacon that not only supports the best EU scientists but also attracts the best researchers from the rest of the world.

Supporting information:

Collaboration enhances the quality of scientific research, improves the efficiency and effectiveness of that research, and is increasingly necessary, as the scale of both budgets and research challenges grow.

However, the primary driver of most collaboration is the scientists themselves. In developing their research and finding answers, scientists are seeking to work with the best people, institutions and equipment which complement their research, wherever they may be.[39]

Horizon 2020 is the biggest EU Research and Innovation programme to date and the majority of this funding requires international collaboration.

Over half of the UK's research output in 2015 was the result of international collaboration and 60% of that included EU partners.

While UK researchers most frequently collaborate with the US, the rate of collaboration with EU partners is increasing at a faster rate.

UK-based researchers have broad and deep networks across Europe with seven EU countries among the UK's top ten strongest collaborators. However looking at individual countries, UK-based researchers most frequently partner with scientists from the US.[40]

UK-based medical research charities fund research across the EU, in 19 of the 28 Member States. Over a third of the grants that AMRC members fund involve active partnerships with external institutions; just under a quarter of these are based in EU member states, by far the most frequent partner location outside the UK

Many disease areas have a European network that is affiliated with EU funding programmes and schemes. Examples include: the EU Joint Programme on Neurodegenerative Disease Research (JPND); the Stroke Alliance for Europe (SAFE); TREAT-NMD Neuromuscular Network (part of EUCERD - European Union Committee of Experts on Rare Diseases); and ERA-Net for Research Programmes on Rare Diseases

The European Research Council (ERC), which is part of Horizon 2020 and funds frontier research purely on the basis of scientific excellence, has established a very strong international reputation. The UK is the top performer among participating countries in accessing these funds. Researchers from around the world can access ERC funding to carry out research in its participating countries and the ERC encourages researchers from outside the EU to apply for grants to work in these countries. Although this funding stream does not require international collaboration, 58% of papers with ERC funding have coauthors who are based in other countries.

There is also some evidence that suggests that EU research funding is associated with increased impact. In 2016, the Royal Society commissioned an analysis by Thomson Reuter of the impact of UK-based researchers' papers. Reviewing publication data between 2005 and 2014, this found that for both papers published by UK-only authors and UK-EU co-authored papers, those acknowledging any type of EU funding have more impact than the average paper, and where that funding came from the European Research Council (ERC) in particular, papers have the highest impact of all[41].

In the CBI's 2016 innovation survey[42], 78% of respondents described universities as very important for improving the UK's wider innovation landscape. The UK has a global reputation for the strength of its research base but this is only achieved through building strong collaborations across industry and academia. 65% of respondents to the CBI innovation survey saw collaboration and partnering as

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[39] Royal Society (2011) *Knowledge, Network and Nations*

[40] Royal Society (2016) *UK research and the European Union: The role of the EU in international research collaboration and researcher mobility*

[41] Royal Society (2016) *UK research and the European Union: The role of the EU in international collaboration and researcher mobility*

[42] CBI (2016) *Innovation survey* available here: http://www.cbi.org.uk/cbi-prod/assets/File/CBI%20Innovation%20Survey%202016_%20results.pdf

something that would help them innovate more.

Furthermore, with some 95% of R&D and innovation conducted outside of the UK, access to knowledge, markets, skills and partners is increasingly taking place on a global basis. There is also a strong positive correlation between companies that internationalise and their subsequent growth trajectory. European programmes have offered companies a significant opportunity to access new knowledge, markets, customers and suppliers (supply/value chains), and in doing so, complement and provide additional value to national initiatives. By way of example:

- **Attracting investment**: The Innovative Medicines Initiative (IMI) is a €3.3bn (2014-2024) public private partnership focused on speeding up the development of better and safer medicines. UK entities are currently leading the highest number of IMI projects, and a number of strategic projects have already been secured including the €35m European Bank for induced Stem Cells (EBiSC).
- **Access to Customers and End Users**: H2020 provides a valuable route by which SMEs can work with cross border agencies such as Frontex and Interpol and end-users across EU Member States in the area of Security.
- **Route to market**: In the area of Electronics, Sensors and Photonics: European funding has been a significant source of financial support, and partnership provides a route to market, as the UK lacks large vertically integrated companies and where 99% of the UK companies are SMEs.
- **Leveraging know how and investments**: large scale international projects (usually €5-7m per project) in the area of advanced manufacturing and materials give access to broader technical development, more end applications/customers, skillsets, wider supply chains and also facilitate the development of standards that will influence the future of many areas – additive and hybrid manufacture is now for example maturing to the point where standards are starting to be set and moving towards full industrialisation. UK SMEs have gained particular benefit from the support offered for pilot lines/plants, but this also helps rationalise investment across Europe and minimises duplication of investment in similar infrastructure.
- **Integrating supply chains**: Clean Sky, a €4bn Public Private Partnership that has a strong focus on integrating breakthrough technologies at aircraft level, allows UK companies in this interconnected European sector to develop systems and solutions in partnership with the customer community, bringing greater leverage to the export market that has been pre-seeded to require these specific systems.

Factbox – European Research Area

Work is underway to create a European Research Area (ERA). This is intended to be:

"a unified research area open to the world based on the Internal Market, in which researchers, scientific knowledge and technology circulate freely and through which the Union and its Member States strengthen their scientific and technological bases, their competitiveness and their capacity to collectively address grand challenges."

The aim of the ERA is to maximise the return on research investment for both the EU and its individual Member States; avoid unnecessary duplication of research and infrastructure investment at national level; and improve the effectiveness and efficiency of the European research community

List of international infrastructure that the UK participates in

The UK's participation in major European partnerships that are not part of EU institutions will not be directly affected by a change in the UK's relationship with the EU. These include CERN, the European Southern Observatory (ESO), European Space Agency (ESA), Institut Laue-Langevin (ILL), European Spallation Source (ESS) and European Synchrotron Radiation Facility (ESRF). (RCUK)

Regulation and trade

Principle: UK regulation should continue to support cutting-edge science and trade, while keeping people and the environment safe and earning public confidence

Asks:

Immediate actions:

- Appoint scientific advisers to all UK government departments, including the Department for Exiting the European Union, and draw on research expertise throughout the process of the UK leaving the EU.

Exit negotiation priorities

- Maintain a close relationship with international regulators and agencies that enable researchers to collaborate and UK markets to operate across borders.
- Ensure that there is no 'legislative limbo' where pending EU regulations that are not currently on the statute in the UK are lost as the UK leaves the EU.

UK domestic policy

- Optimise the UK's current regulatory processes to ensure that these support cutting-edge science and trade while keeping people and the environment safe and earning public confidence.
- Conduct a comprehensive review of the current regulatory environment, working with the Scottish, Welsh and Northern Irish governments as appropriate. This should identify areas of regulation where alignment with EU rules is important for the UK's competitiveness, avoiding increased costs for UK business that would make the UK a less attractive trading partner, while also exploring where developing new regulatory approaches could enable the UK to take a leading position in the development and commercialisation of new products.
- Where the UK aligns with international regulation, UK experts must remain fully engaged in the development of standards and regulation.
- Where the UK diverges from international regulations, this must not prejudice engagement in international research collaborations, or place the UK at a competitive disadvantage.

Rationale:

Harmonised regulation that supports research and innovation over multiple countries can provide valuable consistency for research and trade, whilst providing protections to people and the environment. UK-based researchers can collaborate with researchers around the world, but it is much easier to collaborate with those that share the same regulatory framework, facilitating the exchange of ideas, research samples and data.

> Cancer Research UK directly fund over 200 clinical trials. More than a quarter (28%) of these trials involve at least one other EU country.

This is particularly important for research into rare disease populations where multi-nation, multi-centre studies are the only way to access the number of patients needed for robust research. In addition, access to international research funding programmes such as Horizon 2020, often require regulatory and standards equivalence with other countries.

The ability to sell to an attractive, sizable market is also a strong incentive to conduct research and develop new products. Working within a globally recognised and established regulatory framework such as the EU can ensure access to a sizable market. The EU represents 25% of the global pharmaceutical sales market, compared to the UK's 3% share in isolation. This can also benefit people living within the market, who will be more likely to get access to new products, such as innovative new medical

treatments, faster.

However poorly designed policy at a national, EU or global level can be damaging, whether applied consistently or inconsistently. The EU is not a static organisation and its regulatory framework will continue to evolve after the UK leaves. This presents numerous challenges. It is not in the UK's interests to be a rule taker. It is also important to recognise that some areas of regulation are devolved within the UK.

A clear plan is needed for regulation that gives certainty in the short-term, and in the long-term balances influence, access and opportunity.

Supporting information:

International collaboration is aided by consistent policy and regulation and the UK currently plays a strong role in helping shape effective EU policy, such as the directive governing the use of animals in research. In many cases such as this, the EU has set regulation that supports effective collaboration. However, there have also been examples where EU regulation, along with other factors, has been detrimental to the progress of good science such as in relation to GM crops.

The UK is respected around the world for its proportionate approach to regulating emerging technologies, such as the application of embryology research to reproductive technologies, in a way that balances emerging scientific understanding and competing values. This has enabled new techniques to be researched and made available to patients in the UK with public confidence.

The ability to shape and influence EU regulations also remains extremely important to the UK's Research and Technology Organisations, as many of these organisations and their clients seek to collaborate with and export products and services to the EU. Furthermore, some of these organisations are also Notified Bodies whose business could be affected because Notified Bodies need to be based in an EU State to operate with EU clients.

Entities such as the Cell and Gene Therapy Catapult also work with regulatory authorities in the UK and Europe to provide clarity on the regulatory path for the development of cell therapies and works with developers of cellular-based advanced therapy medicinal products (ATMP) to provide timely advice and support to achieve a European Marketing Authorisation.

The European Aviation Safety Agency (EASA) certifies the safety of aircraft products for use and sale. It also informs standards for R&D projects, environmental regulations and new markets. As a member of EASA, the UK currently benefits from working to a single set of regulations when exporting across Europe, and the bilateral agreements concluded with key markets including the US and Canada.

Regulatory cooperation on medicines and medical technology provides stability and certainty for the life sciences sector. In the global pharmaceutical market, national systems of medicines regulation can result in slower access to treatments for patients – drugs in Australia and Canada come to market 6-12 months later on average than those in the EU and USA.

The UK has also strongly contributed to the evidence base that underpins international regulation. The UK has acted as a member state rapporteur for 16% of all Draft Assessment Reports for active substances that are evaluated for inclusion in plant protection products that are used across the EU – more than any other country.

Successful UK exports include UK universities, with international students' spending worth £7.3 billion a year to the economy. In regions outside of London, this export activity supports tens of thousands of businesses and hundreds of thousands of jobs in local economies.

For example, 83% of the UK's publicly funded universities offer degree programmes overseas (transnational education - TNE). TNE has grown by c6% each year for the last 3 years, reaching 701,000 students in 2015-16. The export value of TNE was £496m in 2012/13, with a further £711m through articulation and a £42m halo effect. TNE is a critical means to growing the global reach of our universities, embracing international outlooks, developing and maintaining critical partnerships and contributing to our economy.

ESA: Access to nuclear fuel and radioisotopes for medicine

The Euratom Supply Agency (ESA), established by the Euratom treaty, applies a supply policy based on the principle of equal access of all users to ores and nuclear fuel. This includes monitoring the market to make sure the activities of individual users reflect the values of Euratom**.** The ESA concludes supply contracts for nuclear material and has a right to purchase nuclear materials produced in the member states. It also monitors transactions involving services in the nuclear fuel cycle and provides economic analysis of the EU market.

The ESA also includes the European Observatory on the supply of medical radioisotopes. The ESA produces an annual update on its activities, which informs on nuclear energy developments in the EU, the world nuclear market, supply and demand for fuel and security of supply (including for medical radioisotopes).

Muscular Dystrophy UK: accelerate patient access to emerging treatments

Duchenne muscular dystrophy is a severe type of muscular dystrophy and is a life-limiting muscle-wasting condition; there is no cure and there are currently limited treatment options available. However there are several promising treatments progressing through the clinical trials process, and a number of these are awaiting authorisation by the EMA. If successful, these drugs could effectively slow down the progression of the condition and result in significant benefits to those affected. If the EMA licensing were to no longer to apply to the UK this could cause major disruption to treatments currently in the pipeline and could potentially result in individuals affected by Duchenne muscular dystrophy in the UK having slower access to innovative treatment options.

List of organisations engaged with for the development of this statement:

Academy of Medical Sciences

Association of Medical Research Charities

BioIndustry Association

BMA

British Academy

Campaign for Science and Engineering

Campaign for Social Science

Cancer Research UK

CBI

Council of Mathematical Sciences

NFU

Innovate UK

Institute of Physics

Learned Society of Wales

Royal College of Nursing

Royal Academy of Engineering

Royal Society of Biology

Royal Society of Chemistry

Royal Society

Royal Society of Edinburgh

Russell Group

Science is Vital

Scientists for EU

TechUK

Universities UK

University Alliance

Wellcome