HM Government

Collaboration on science and innovation

A FUTURE PARTNERSHIP PAPER

The United Kingdom wants to build a new, deep and special partnership with the European Union.

This paper is part of a series setting out key issues which form part of the Government's vision for that partnership, and which will explore how the UK and the EU, working together, can make this a reality.

Each paper will reflect the engagement the Government has sought from external parties with expertise in these policy areas, and will draw on the very extensive work undertaken across Government since last year's referendum.

Taken together, these papers are an essential step towards building a new partnership to promote our shared interests and values.

Collaboration on science and innovation: a future partnership paper

Executive summary

1. The UK has a strong history of collaborating with European partners on science and innovation through EU, pan-European and other multilateral and bilateral initiatives. This includes working together on groundbreaking research, with examples ranging from the AtlantOS project to create an integrated observing system for the Atlantic Ocean, to the development of a new clinical trials approach for the Ebola vaccine. The UK is committed to building on these successes.

2. In preparing to leave the EU, one of the UK's core objectives is to "seek agreement to continue to collaborate with European partners on major science, research, and technology initiatives".[1] As the Prime Minister has said, "the UK is leaving the European Union, but it is not leaving Europe."[2] The UK wants Europe to maintain its world-leading role in science and innovation, and will continue playing its part in delivering shared European prosperity. It is the UK's ambition to build on its unique relationship with the EU to ensure that together we remain at the forefront of collective endeavours to better understand, and make better, the world in which we live.

3. In this spirit of continued partnership, this paper outlines the UK's objectives for an ambitious science and innovation agreement with the EU. By tackling the most significant research questions of the future together, we will achieve far more than we would working apart, because of the scale and synergies delivered through our future partnership. This paper sets out examples of where the UK sees potential mutual benefit in a close future relationship, exploring precedents for each. The UK looks forward to discussing this with the EU and shaping our future partnership together.

Introduction and context

4. Science and innovation are vital to a country's prosperity, security and wellbeing. Evidence outlined by the National Academies shows that research and innovation has a global reach that benefits everyone, as it underpins industries that are of strategic value, and provides a better quality of life to all.[3] The Government is committed to strengthening the UK's world-leading science base, which includes four of the world's top ten universities,[4] a world-class intellectual property regime,[5] and more Nobel Laureates than any country outside the United States.[6] With only 0.9 per cent of the global population and 4.1 per cent of researchers, the UK accounted for 15.9 per cent of the world's most highly cited articles in 2013.[7]

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[1] 'The Government's negotiating objectives for exiting the EU: PM speech', Prime Minister Theresa May, 17 January 2017.

[2] Ibid.

[3] 'Open for business: A nation of global researchers and innovators', The Academy of Medical Sciences, the British Academy, the Royal Academy of Engineering and the Royal Society, November 2016.

[4] 'QS World University Rankings 2018', QS Top Universities, accessed 30 August 2017.

[5] The UK's intellectual property system is highly rated in international indices. For example, the UK is ranked third in the World in the Global Intellectual Property Index ('Global IP Index', Taylor Wessing, June 2016) and fifth in the World in the Global Innovation Index 2017 ('Global Innovation Index 2017', The Global Innovation Index, 2017).

[6] 'Nobel Laureates and Country of Birth', Nobel Prize, January 2017.

[7] 'International Comparative Performance of the UK Research Base' (page 2), Elsevier, December 2013.

5. The UK's pledge to invest in research and innovation and to capitalise on the UK's strategic strengths was set out in *Building Our Industrial Strategy,*[8] published on 23 January 2017, which confirmed additional funding worth £2 billion per year by 2020-21. Furthermore, this Government's manifesto made a commitment to raise research and development (R&D) spending as a proportion of GDP to 2.4 per cent by 2027, and to 3 per cent over the longer term.[9] In addition to the action the UK is taking domestically, the Government recognises the pivotal role of international collaboration in driving forward the UK's objectives for science and innovation.

6. International collaboration supports cutting-edge R&D in fields from space exploration to clean energy and medical research (both pharmaceuticals and medical devices) by providing access to infrastructure, expertise, data, and population aggregation at a scale beyond the reach of any individual nation. The principles of excellence and competitiveness that underpin European collaboration drive up the quality of research outputs and contribute to higher skills levels. Partnerships between the UK and other EU Member States significantly increase the impact and influence of EU science and research activity - for example, in the field of medical and health research, the share of EU co-authored publications in the top ten per cent of highly cited publications is higher when collaborating with the UK.[10]

7. The UK has a strong history of collaborating with European partners through EU, pan-European and other multilateral and bilateral initiatives, as outlined by Professor Jos van der Meer at Radboud University Medical Center, The Netherlands: "The UK has excellent organisations and institutions, e.g. the Royal Society, the Academy of Medical Sciences, and the Royal College of Physicians. These institutions have a large arsenal of experts who can be put forward for important committees and boards. In the EU setting, we would miss the UK experts if not available, as they have a lot of quality to offer."[11]

8. The UK is a top five collaboration partner for each of the other 27 Member States,[12] and contributed almost 20 per cent of the total research work carried out within EU health programmes between 2007 and 2016.[13] European collaboration is particularly important in some fields, for example stratified medicine and rare diseases, as it provides access to large and diverse patient groups (including both rare disease and rare variants of common disease) for medical research and clinical trials. All EU Member States benefit from these close relationships, as recognised by the Independent High Level Group chaired by Pascal Lamy[14] in its July 2017 report *Investing in the European future we want.*[15]

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[8] 'Building our Industrial Strategy' (page 33), HM Government, January 2017.

[9] 'Forward Together: Our Plan for a Stronger Britain and a Prosperous Future, The Conservative and Unionist Party Manifesto' (page 19), The Conservative ad Unionist Party, May 2017.

[10] 'The Impact of Collaboration: The Value of UK Medical Research to EU Science and Health' (page 12), Technopolis Group, May 2017.

[11] 'The Impact of Collaboration: The Value of UK Medical Research to EU Science and Health' (page 13), Technopolis Group, May 2017.

[12] 'Research and Innovation Performance and Horizon 2020 Country Participation', European Commission, individual EU Member State country profiles accessed 7 August 2017.

[13] 'The Impact of Collaboration: The Value of UK Medical Research to EU Science and Health' (page 12), Technopolis Group, May 2017.

[14] The High Level Group was set up in December 2016. Its mandate is to provide advice on how to maximise the impact of the EU's investment in research and innovation.

[15] 'LAB-FAB-APP-Investing in the European future we want', Report of the Independent High Level Group on Maximising the Impact of EU Research and Innovation Programmes, July 2017.

9. Box 1 provides one example of the successful collaboration the UK enjoys with European partners in the area of science and innovation.[16]

Box 1 - Collaboration with European partners on medical research

The independently produced report *"The impact of collaboration: the value of UK medical research to EU science and health"* sets out how collaboration between the UK and other EU Member States has helped strengthen scientific cooperation in the field of medical research. The report identifies the main ways in which UK research contributes to medical progress and how this has ultimately improved the health and prosperity of patients and citizens across Europe. The evidence shows the UK has made key contributions in five areas:

i. contribution to advisory bodies, networks and policies that underpin research across the EU and its Member States;

ii. in pan-EU clinical trials, providing notable leadership for rare diseases and paediatric trials;

iii. coordination and hosting of some of Europe's unique large-scale infrastructure for medical research;

iv. development of new therapies and medical technologies that benefit EU patients, backed by a thriving pharmaceutical and biotechnology sector; and

v. training early-career researchers from across the EU, to develop their skills and launch their research careers.

10. The UK and the EU share common fundamental challenges such as dealing with climate change, tackling infectious diseases in people, animals and plants, maintaining growth and security in the face of threats and natural hazards, and supporting developing countries to build societal and economic resilience. These challenges can be best met by continued collaboration amongst the top scientists across Europe and the UK seeks to continue to play its full part in helping European partners meet these fundamental challenges.

11. As set out in the Prime Minister's Lancaster House speech on 17 January 2017, "A Global Britain must also be a country that looks to the future. That means being one of the best places in the world for science and innovation."[17] The Government is clear that the UK will continue to be involved in major scientific endeavours in Europe and across the world. As set out in the following section, the UK will look to build on its special relationship with the EU and establish an ambitious agreement on science and innovation that ensures the valuable research links between us continue to grow.

12. The UK will also continue to collaborate with European partners through international (non-EU) organisations, some examples of which are given in Box 2.

[16] There are broader initiatives that indirectly support European research and innovation, such as the Life Programme and the European and Developing Countries Clinical Trials Partnership.

[17] 'The Government's negotiating objectives for exiting the EU: PM speech', Prime Minister Theresa May, 17 January 2017.

Box 2 - European, non-EU mechanisms for collaboration

EUREKA This intergovernmental network helps mostly small and medium sized enterprises (SMEs) across Europe and around the world to collaborate on R&D across borders to bring innovative ideas to market. EUREKA has 41 European members and four non-European associate members. The UK will become the Chair of EUREKA in summer 2018.

European Organisation for Nuclear Research (CERN) This is the European platform for collaboration on particle physics and the fundamental laws of nature. The UK was a founding member of CERN, which now includes membership from 22 countries, including Israel.[18]

European Space Agency (ESA) This agency is an international organisation with 22 Member States from across Europe. Canada also sits on the governing council and participates in some projects under a cooperation agreement.[19] The UK was a founding member of the ESA, and European collaboration on space has been an important enabler of innovation and technological development in the UK space sector. The UK will continue to play an active role in the ESA after it leaves the EU.

European Bioinformatics Institute (EBI) This is one of six institutes of the European Molecular Biology Laboratory (EMBL). EMBL, which comprises 23 EU Member States, two associate members, and five additional funding partners, focuses on molecular biology research and services. The EBI focuses on the computational aspect: ensuring that through their platforms, life sciences data is freely available to support researchers across academia, medicine, and industry.

The UK's ambition for the future partnership with the EU

13. It is the UK's ambition to build on its uniquely close relationship with the EU, so that collaboration on science and innovation is not only maintained, but strengthened. Therefore, as part of the new, deep and special partnership, the UK will seek an ambitious science and innovation agreement with the EU that will support and promote science and innovation across Europe both now and in the future.

14. The UK and the EU start from a position of close regulatory alignment, trust in one another's institutions, and a spirit of cooperation stretching back decades. The agreement on science and innovation should provide a framework for future cooperation, with channels for regular dialogue between leading researchers and innovators in the UK and the EU.

15. The scope of the agreement should be broad and make room for new areas of research. The following section sets out precedents for non-EU participation in EU science and innovation programmes, agencies and other bodies. It should be noted that these are not exhaustive. These arrangements vary in their scope of access and influence, and the terms of UK participation would need to be negotiated with the EU and its Member States, recognising what has already been agreed with other non-EU participants. These terms include the size of any financial contribution, which the UK would need to weigh against

[18] 'About CERN', CERN, accessed 10 August 2017. CERN's main research programme is funded by its members, but it also receives EU grants in a number of areas. Absent any special agreement with the EU, CERN members that are not EU Member States can participate in but cannot lead CERN-EU projects or receive EU funding.

[19] 'ESA Member States and Cooperating States', European Space Agency, accessed 1 September 2017.

other spending priorities. Given the UK's unique relationship with European science and innovation, the UK would also like to explore forging a more ambitious and close partnership with the EU than any yet agreed between the EU and a non-EU country.

16. The agreement should also facilitate bilateral and multilateral research relationships, which will be important for maintaining strong links with individual Member States once the UK has left the EU. In particular, the UK and the EU must ensure that their research communities can continue to access the high-level skills that support innovation in science and technology. The Government has made clear that, although freedom of movement will cease to apply in the UK, the UK will continue to welcome the brightest and best, and as such, migration between the UK and the EU will continue after the UK leaves the EU. This Government wants the UK to remain a hub for international talent and its departure from the EU must be seen in this context.[20] For instance, the UK is seeking to agree a continued system for the mutual recognition of professional qualifications.[21] Furthermore, the Government is investing £100 million in the Rutherford Fund to attract highly skilled researchers to the UK by providing fellowships for early-career and senior researchers, both from the developed world and from emerging research powerhouses such as India, China, Brazil and Mexico.[22] The UK will discuss with the EU future arrangements to facilitate the mobility of researchers engaged in cross-border collaboration, described further in Box 3.

17. The UK's strength in science and innovation is spread across the four nations. Scotland has a significant interest in this area, being home to three universities in the world's top 100[23] and several international research centres. These centres include the Fraunhofer Centre for Applied Photonics at the University of Strathclyde – a world-leading centre in applied laser research and development,[24] and the world's first international Max-Planck Partnership. The latter brings together leading physics research groups across Scotland and Germany to further research in quantum technologies used in hi-tech sectors such as oil exploration and computing.[25] Welsh leadership in the compound semiconductor (CS) market is well recognised and it was announced last year that the new Compound Semiconductor Applications Catapult will be based in Wales.[26] Two years ago, Cardiff University, IQE, the Welsh Government and the UK Government aligned their visions for CS innovation by committing over £80 million in collective investments aimed at creating the

[20] The Government has commissioned the independent Migration Advisory Committee (MAC) to gather evidence on patterns of EU migration and the role of migration in the economy. The MAC commission will provide a clear channel for business and other employers to inform decisions about immigration arrangements post EU exit.

[21] Mutual recognition agreements related to professional qualifications can reduce barriers to the movement of skilled professionals, such as those in scientific and technical professions.

[22] '£100 million Rutherford Fund to attract best researchers to the UK', HM Government, July 2017.

[23] 'QS World University Rankings 2018', QS Top Universities, accessed 30 August 2017.

[24] 'Fraunhofer CAP', Fraunhofer Centre for Applied Photonics, accessed 1 September 2017. The Fraunhofer CAP is a world-leading centre in the field of applied laser research and development, which is involved in a wide range of photonics applications including energy, security, environmental, sensing, space, life sciences and quantum technologies.

[25] 'World's First International Max-Planck Partnership launched by Scottish Universities', University of Glasgow, accessed 1 September 2017. The Max-Planck Partnership brings together leading physics research groups from the universities of Glasgow, Strathclyde, St Andrews, Heriot-Watt and Edinburgh, with The Max Planck Institute (MPI) for Gravitational Physics (Albert Einstein Institute) Hannover; the MPI for the Science of Light (Erlangen), the MPI for Quantum Optics (Garching), the MPI for Chemical Physics (Dresden) and the MPI for Solid State Physics (Stuttgart). It supports research on 'Measurement and Observation at the Quantum Limit' (MOQL).

[26] 'Compound semiconductors: new Catapult centre in Wales', HM Government, January 2016. The Catapults are a network of world-leading centres designed to transform the UK's capability for innovation in specific areas and drive economic growth.

world's first CS technology cluster in South Wales.[27] In Northern Ireland, both Queen's University Belfast (QUB) and Ulster University have 'Internationalisation Strategies' to develop overseas institutional partnerships, including research collaborations. One example from QUB is the Pioneer Research Programme in Sustainable Energy, which aims to advance the application of innovative local and global technologies and management practices to promote sustainable technologies in energy.[28] This involves partners from the USA, Australia, China and Europe.

18. The Government will work closely with the Devolved Administrations, as well as the governments of Gibraltar, the other Overseas Territories and the Crown Dependencies on the detail of proposals for collaboration with the EU on science and innovation, to ensure their priorities are taken into account.

Box 3 - Marie Skłodowska-Curie Actions

Researcher mobility is associated with better international networks, more research outputs, higher-quality outputs and for most, better career outcomes.[29] A report by Rand Europe on the international mobility of researchers found that, in the UK, the proportion of researchers and doctoral candidates who are from outside the UK is rising.[30] This suggests that the UK is an increasingly attractive destination for researchers across the globe.

Both the UK and the EU are leading destinations for doctoral training. The UK has led the EU in hosting researchers funded by the European Research Council as well as Marie Skłodowska-Curie Actions (MSCA) researchers. Over 2,200 researchers from across the world have come to the UK as part of MSCA.[31]

The EU has introduced measures designed to facilitate the movement of researchers - including those from third countries - across the EU. In addition to funding exchanges, the EU facilitates mobility for researchers in the UK and across Europe through the European Research Area (ERA) which aims to address barriers to mobility and make Europe a more attractive research destination, acting as an open labour market for researchers. The UK would welcome discussion as to how this might apply in future.

Collaboration through EU and European Atomic Energy Community (Euratom) programmes

19. EU programmes have helped foster European scientific collaboration and the UK has been a key contributor to their success. The UK remains a full member of the EU and will be subject to all rights and obligations set out in the Treaties and under EU law, including the principle of sincere cooperation, until it leaves the EU. In that context, and looking ahead to a strong future relationship, both the UK and the European Commission have been clear that they expect the fair treatment of UK researchers and firms. The UK and EU should also work together to provide continuity of collaborative relationships.

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[27] 'Letter from Cabinet Secretary for Economy and Infrastructure in Welsh Government to All Assembly Members' (page 1), Welsh Government, 24 August 2017.

[28] 'Innovation Strategy Progress Report' (page 25), Northern Ireland Government Department for the Economy, accessed 1 September 2017.

[29] 'International mobility of researchers: A review of the literature' (page 32), Rand Europe, May 2017. However, as the report states, it is difficult to determine whether these are benefits of mobility itself, or just reflective of inherent attributes of mobile versus non-mobile researchers (page vi).

[30] International mobility of researchers: A review of the literature' (page v), Rand Europe, May 2017.

[31] 'H2020 - Marie Skłowdowska-Curie Actions: Country Fact Sheet United Kingdom' (page 1, Table 1), European Commission, June 2017.

20. Precedents for non-EU participation in key EU science and innovation programmes are described below. The terms of UK participation would need to be negotiated with the EU and its Member States, recognising the mutual benefits from past collaboration. The UK would welcome discussion on the following programmes in particular:

- Research and Innovation (R&I) Framework Programmes;
- the Space programmes;
- Nuclear R&D; and
- Defence R&D.

Research and Innovation (R&I) Framework Programmes

21. R&I Framework Programmes are the central EU platform for research and innovation. Horizon 2020 is the largest Framework Programme to date, with nearly €80 billion of funding available over seven years (2014 to 2020).[32] Non-EU countries currently participate in Horizon 2020 either with associated country status[33] or with automatic third country status.[34]

22. Currently, associated countries have the same level of access to Horizon 2020 as EU Member States. Associated countries do not have a formal vote over the work programme, but can attend programme committees, which provides them with a degree of influence. Terms of association (including financial contributions) vary, and are determined by international agreements with the EU.[35] All third countries without formal associate status can participate in specific parts of the programme, with some restrictions.[36] Apart from a few exceptions, these third countries are not eligible for EU funding and usually fund their own participation.

[32] 'Factsheet: Horizon 2020 budget' (page 1), European Commission, November 2013.

[33] There are currently sixteen countries associated to Horizon 2020, including Albania, Armenia, Bosnia and Herzegovina, Faroe Islands, Georgia, Iceland, Israel, Moldova, Montenegro, Norway, Serbia, Switzerland, the former Yugoslav Republic of Macedonia, Tunisia, Turkey and Ukraine. 'Countries associated to Horizon 2020 Framework Programme (2014-2020)', European Commission, January 2017.

[34] "Guidance note - Funding of applicants from non-EU countries & international organisations", European Commission, August 2017.

[35] 'Associated countries', European Commission, January 2017. There are currently 16 countries associated to Horizon 2020, mainly within the wider European region.

[36] Notably, some projects require a minimum of EU or associated countries before they can go ahead. Also, third countries without Associate status cannot host European Research Infrastructure Consortia (ERICs), which are outlined in the next section.

Box 4 - Horizon 2020

Horizon 2020 facilitates researcher collaboration with an emphasis on excellent science, industrial leadership and tackling societal challenges. Horizon 2020 provides grant support along the entire research and development chain, from groundbreaking research to close-to-market activity. Importantly for the UK, Horizon 2020 awards funding based on excellence and competition.

Key to Europe's success as a knowledge-based society and innovation leader is frontier research aimed at meeting global challenges. At the EU level this fundamental research is funded by the European Research Council (ERC), as part of Horizon 2020. To ensure scientific excellence, the ERC funds investigator-driven research through open competition, supporting both established researchers and the next generation. The UK has played a key role in the ERC.

The UK is a highly active participant in Horizon 2020. It ranks first across the EU in the number of participants with signed contracts, with 7,360 so far.[37] This includes 318 from Cambridge University, 303 participants from Oxford University and, in Scotland, 172 from Edinburgh University.[38] The UK also has 2,025 MSCA fellows supported by Horizon 2020.[39] The UK has collaborated with EU and international partners on a range of projects, from taking hydrogen fuel cell vehicles to market (HYFIVE), to building robots that interact with children to help manage their diabetes (PAL), to training young researchers to exploit big data (LONGPOP) and developing the reference epigenome maps of blood cells (BLUEPRINT).

Horizon 2020 also supports a range of public-private partnerships, which the UK is involved in. For example, the Innovative Medicines Initiative (IMI), the world's largest medical research public-private partnership, brings together the pharmaceutical industry with academia, SMEs and other stakeholders to accelerate the discovery and development of new medicines.[40] The UK has participated extensively in the IMI – over 90 per cent of IMI projects have involved at least one UK institution.[41] For example, UK researchers and companies have collaborated to improve the treatment of patients with chronic pain (Europain), shorten clinical trials on diabetes, making new treatments available to patients sooner (SUMMIT), to revolutionise clinical trials of drugs designed to prevent Alzheimer's dementia (EPAD), and to tackle the global problem of antibiotic resistance (New Drugs for Bad Bugs - ND4BB).

The UK recognises the need to provide certainty to all stakeholders wherever possible. This is why the Government has committed to underwrite bids for Horizon 2020 projects submitted while the UK is still a member of the EU. The UK will work with the Commission to ensure payments when funds are awarded, and Horizon 2020 participants should continue to collaborate as normal. The UK Government will continue to work closely with the Devolved Administrations who play an important role in administering Horizon 2020.

[37] 'Horizon 2020 Country Profile: United Kingdom' (page 1), European Commission, July 2017.

[38] 'Horizon 2020 Country Profile: United Kingdom' (page 2), European Commission, July 2017.

[39] 'Horizon 2020 Country Profile: United Kingdom' (page 2), European Commission, July 2017.

[40] IMI funding is provided jointly from Horizon 2020 and in-kind contribution from pharmaceutical companies and other industry sectors.

[41] 'UK participation in the Innovative Medicines Initiative' (Page 6), Association of the British Pharmaceutical Industry, September 2016.

23. Future association arrangements will be discussed as part of the EU's negotiations on the next Framework Programme. The recent report by the Pascal Lamy chaired High Level Group called for association to be open to all parts of the world on the basis of excellence.[42] A number of non-associated third countries, such as South Korea and Canada, have already made provisions under their science and technology agreements with the EU to increase cooperation through Horizon 2020, for example, through co-funding mechanisms for specified research projects.

The space programmes

24. The UK space sector has played a major role in the development of the main EU space programmes by providing highly skilled personnel and technology. Participation provides important commercial opportunities to UK industry. Space is inherently collaborative and the relevant EU legislation makes express provision for non-EU countries to participate in Galileo and Copernicus, although there is no standard framework for participation.

Box 5 - Key EU space programmes

Galileo The EU satellite navigation system akin to the USA's GPS (Global Positioning System), which provides Position, Navigation and Timing (PNT) information. Norway and Switzerland have agreements with the EU to participate in Galileo, and can attend programme committees.[43] The EU is currently negotiating with Norway and the USA to allow access to the Public Regulated Service - the secure signal that Galileo provides.[44] More general cooperation agreements on satellite navigation have been signed with a range of other countries outside the EU, including Israel[45] and Ukraine.[46]

Copernicus The EU Earth Observation programme that monitors the global health of the planet. Data provided by Copernicus is used to manage civil contingencies such as flooding. There are a range of precedents for third-country participation in Copernicus, both within and outside Europe.[47]

Space Surveillance and Tracking (SST) The new orbital tracking programme that detects and monitors objects in space. This is a new programme, and there is currently no third country participation.

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[42] 'LAB-FAB-APP-Investing in the European future we want', Report of the Independent High Level Group on Maximising the Impact of EU Research and Innovation Programmes, July 2017.

[43] Norway's cooperation agreement with the EU complements the EEA agreement. Cooperation Agreement on Satellite Navigation between the European Union and its Member States and the Kingdom of Norway', HM Government, September 2010; Cooperation Agreement between the European Union and its Member States, of the one part, and the Swiss Confederation, of the other, on the European Satellite Navigation Programmes, HM Government, December 2013 (not yet fully in force).

[44] 'Council of the European Union Communication' (point 5), Council of the European Union, July 2017.

[45] 'EU and Israel seal their agreement on Galileo', European Commission Press Release, 14 July 2004.

[46] 'EU and Ukraine seal Galileo and aviation agreement', European Commission Press Release, 3 June 2005.

[47] European Economic Area (EEA) states Norway and Iceland enjoy full access to data and services and the right for industry to bid into the programme, without programme voting rights. Switzerland is negotiating similar access. The USA and Australia have signed cooperation agreements with the EU offering mirror sites to store and distribute data, with no exchange of funds. The USA also benefits from a reciprocal open data agreement as most of NASA's earth observation data is openly available.

25. The UK has been especially involved in the development of the Galileo security modules and encryption, which are integral to a secure and resilient system. The UK is also recognised for its specialist capability in the area of earth observation. The space surveillance services provided by the new SST programme will underpin an innovative launch capability which the UK is looking to develop. Given the unique nature of the space programmes' applications to security in addition to science and innovation, and the extent of the UK's involvement, the EU and UK should discuss all options for future cooperation, including new arrangements.

Nuclear R&D

26. The **European Atomic Energy Community (Euratom) Research and Training (R&T) Programme**, in which the UK participates as a member of Euratom,[48] funds civil nuclear R&D. The UK invoked Article 106(a) of the Treaty establishing the Euratom at the same time it invoked Article 50 of the Treaty on European Union. However, the UK will seek to build on its extensive history of working with EU partners on nuclear research. There is precedent for third-party involvement in fusion research via participation in the Euratom R&T Programme and the Joint Undertaking for ITER (known as Fusion for Energy).

Box 6 - Collaboration with the EU on nuclear research

The UK is recognised as a world leader in the development of fusion technology and associated disciplines. The UK hopes to find a way to continue working with the EU on nuclear R&D, including the JET and ITER programmes:

- **The Joint European Torus (JET)** is currently the world's leading Fusion project, although its successor (ITER), based in France, is due to be operational around 2025. JET is based in the UK and is largely funded by Euratom. The expertise and research undertaken at JET contributes significantly to the preparatory work for ITER. An EU decision is pending on whether to extend the existing contract, which expires in 2018, to 2020. The Government has confirmed that, should the Commission agree to extend the JET contract, the UK will underwrite its share of JET contract costs after it leaves the EU.
- The **International Thermonuclear Experimental Reactor (ITER)** is an international programme exploring nuclear fusion-based energy. The UK currently participates in this programme via membership of Euratom. ITER differs notably in that it is an intergovernmental organisation with seven members, including the EU and international partners from outside of the Euratom Community, such as the USA, India and Japan.

Defence R&D

27. The Commission is planning a **European Defence Research Programme** in the next Multiannual Financial Framework, which is expected to invest €500 million per year in industry and academia from participating countries.[49] To prepare for this, a three-year Action was launched in 2017 and the UK has been instrumental in defining its work programme. The UK would welcome dialogue with the EU and its Member States on the future of this programme and terms for non-EU involvement, noting that Norway will have third-party association in this preparatory phase.

[48] The European Atomic Energy Community.

[49] 'A European Defence Fund: €5.5 billion per year to boost Europe's defence capabilities', European Commission: Press Release, June 2017.

Membership of EU science and innovation agencies and other bodies

28. Cooperation with EU agencies and other bodies plays a role in the important contribution UK scientific agencies such as the Met Office, Public Health England and the British Geological Survey make to resilience in the UK.

29. The **European Medicines Agency (EMA)** is an agency of the EU, which protects human and animal health in the EU and across the European Economic Area (EEA) by ensuring that all medicines available on the EU market are safe, effective and of high quality. The UK Government's aim is to ensure that patients in the UK and across the EU continue to be able to access the best and most innovative medicines and be assured that their safety is protected by the strongest regulatory framework and sharing of data. In this context, the UK is fully committed to continuing the close working relationship with our European partners, in the interests of public health and safety. Drug development and clinical trials are a global business, and the UK believes a deep and special relationship with the EU remains the best way to promote improved patient and animal health outcomes, both in Europe and globally.

30. The UK will therefore look to continue to work closely with the EMA and other international partners. In areas such as inspections, safety of medicines and exchange of information, the EMA cooperates with regulatory bodies around the world and the EU has specific agreements in place with the USA, Canada, Japan, Switzerland, Australia, New Zealand and Israel that enable this.[50] These provide precedents which the UK and the EU could seek to build on.

31. The UK is a key player in **European Reference Networks (ERNs)**, which support European cooperation and knowledge sharing in the field of rare diseases, in terms of both clinical care and research. The UK leads a quarter of the 24 thematic networks and participates in nearly all ERNs.[51] EU Reference Laboratories (EU RLs) are responsible for the areas of feed and food and animal health.[52] There are currently seven based in the UK. In addition, the UK and the EU work closely through data sharing and capacity building to protect against common health security threats.

32. There is precedent for non-EU access to both ERNs and EU RLs, for example, Norway, Switzerland and Turkey.[53] Third-country participation enables the EU to gain and share information on disease risk from bordering countries and to access the best scientific expertise. The UK and the EU will need to consider future collaboration through EU RLs.

33. **European Research Infrastructure Consortia (ERICs)** are structures set up to deliver international science and research collaborations in the EU.[54] Countries associated to Horizon 2020 can be members of an ERIC, for example, Norway and Israel. For some

[50] In addition, through the EEA agreement, Norway, Iceland and Lichtenstein participate in EMA procedures and both contribute to and benefit from the peer-review arrangements for scientific assessment.

[51] 'The Impact of Collaboration: The Value of UK Medical Research to EU Science and Health' (page 13), Technopolis Group, May 2017.

[52] The primary purpose of EU RLs is to facilitate trade and delivery of core Government functions such as healthcare and regulation, specifically in terms of EU-wide standards for routine procedures and reliable testing methods.

[53] At present, ERN's are only open to EU Member States and EEA members.

[54] ERICs are separate legal entities with their own statutes, although they report into the EU and are created under an EU Council Regulation.

ERICs, third countries can participate as non-members through a specific bilateral agreement - for example, China.

34. **The European Strategy Forum on Research Infrastructures (ESFRI)** was established in 2002 to support a coherent and strategic approach to multilateral research initiatives by setting out a European Roadmap for research infrastructures for the coming 10 to 20 years. Currently, only EU Member States and countries associated to Horizon 2020 are members of ESFRI.

Facilitating bilateral and multilateral collaboration

35. The UK will continue to strengthen its bilateral and multilateral research relationships with EU Member States and the UK's other international partners around the world. Examples of these relationships are outlined in Box 7. Researcher-to-researcher links, independent of intergovernmental platforms, are important for driving competition and excellence. Governments can facilitate collaboration between researchers in different countries by providing the right frameworks and infrastructure. There are near-term opportunities for increased bilateral cooperation in emerging areas of research such as health and life sciences (including precision medicine and genomics), clean energy, quantum technologies and marine science. The UK would welcome discussion with the EU on ways to facilitate multilateral collaboration between the UK and EU Member States.

Box 7 - Bilateral and multilateral partnerships

Currently, the UK's top research collaboration partners[55] in the EU are Germany, France, Italy, the Netherlands and Spain. Some of the UK's most important collaborators lie outside the EU, notably the USA (as the UK's top research partner) Australia, China, Canada and Japan.[56]

The EU has concluded bilateral Scientific and Technological Partnership agreements (STPs) with 20 individual countries, such as Canada and the USA. These agreements constitute a framework and a 'privileged forum' to identify common interests, priorities, policy dialogue, and the necessary tools for science and technological collaboration. Activities conducted through an STP can include researcher exchanges, sharing of research facilities, and joint research projects.

Climate change is one area where the UK has developed effective research relationships with individual European partners. This is demonstrated by the strong links that the UK Met Office's Hadley Centre has developed with other European climate research centres, and a range of initiatives aimed at promoting low carbon research and innovation, including a trilateral working group with France and Germany in partnership with the European Association for the Storage of Energy.

[55] As measured by the number of co-authored publications.

[56] 'International research collaboration after the UK leaves the European Union' (page 8, Table 1), Universities UK, April 2017.

Conclusions

36. The UK wants to continue playing a major role in creating a brighter future for all European citizens by strengthening collaboration with European partners in science and innovation.

37. To this end, the UK will seek to agree a far-reaching science and innovation agreement with the EU that establishes a framework for future collaboration. There are a range of existing precedents for collaboration that the UK and the EU can build on, but our uniquely close relationship means there may be merit in designing a more ambitious agreement. The UK hopes to have a full and open discussion with the EU about all of these options as part of the negotiations on our future partnership.

38. The UK would welcome dialogue with the EU on the shape of a future science and innovation agreement, reflecting our joint interest in promoting continued close cooperation, for the benefit of UK and European prosperity.