ROYAL ACADEMY OF ENGINEERING

# Leaving the EU: implications and opportunities for science and research

House of Commons Science and Technology Committee

Submission from the Royal Academy of Engineering

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***About the Royal Academy of Engineering***

*As the UK's national academy for engineering, we bring together the most successful and talented engineers for a shared purpose: to advance and promote excellence in engineering.*

**Leaving the EU: implications and opportunities for science and research**

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**Summary**

- The result of the EU referendum presents a challenge to maintaining the UK's excellence in engineering and supporting the concomitant growth of the UK economy. However, with challenges come opportunities and the Academy urge the government to use the referendum result as a stimulus to accelerate progress towards delivering a technically advanced, globally engaged and competitive economy, and to ensure the Industrial Strategy serves as a roadmap to deliver this vision.

- EU research and innovation programmes have contributed significantly to the UK's globally excellent and highly productive research and innovation base. The Academy therefore urge the government to seek the closest achievable association with EU research programmes.[1] If the UK was to establish replacement research and innovation funds, these should replicate the successful and unique aspects of EU programmes, specifically support for international and industrial collaboration, plus long term visibility of themes and subject areas.

- The UK faces an engineering skills crisis, needing more than a million new engineers and technicians by 2020.[2] Engineering in the UK is highly dependent on non-UK nationals, with UK nationals comprising only 30.9% of engineering and technology postgraduate students in 2014/15, rising to 67.8% for undergraduates. The result of the EU referendum presents an opportunity to refocus efforts on boosting the supply of UK home gown talent to tackle the skills crisis. Nevertheless, inward migration to the UK of talented individuals who can contribute to filling the skills gap will be essential for the foreseeable future.

- Given that talented individuals from around the world are essential to the UK's success in engineering, research and innovation the UK government should ensure that any changes resulting from the referendum vote do not impede the ability of UK institutions to attract these world-class researchers. This should include ensuring that talented researchers from non-UK EU countries have certainty, both near-term and long-term, about the opportunities to work in the UK and likewise for UK researchers to work in other EU countries. Furthermore, non-UK EU researchers currently based in the UK need assurance that they will be able to continue to live and work in the UK.

- The result of the EU referendum has created significant uncertainty, both within the UK, but also for our European partners and stakeholders. Such uncertainty is likely to continue until the negotiations are finalised and the UK's new position in the world is established. To help the research and innovation community effectively navigate uncertainty and minimise its detrimental impacts, the UK government should embark on a campaign aimed at transmitting a positive and assertive message, particularly to

[1] Research and Innovation: After the EU Referendum, UK National Academies, 2016
[2] The Universe of Engineering, Engineering the Future, Royal Academy of Engineering, October 2014

European stakeholders, that the UK is still a research and innovation powerhouse and is welcoming and open for business with international partners.

## 1. Introduction

1.1. The Royal Academy of Engineering welcomes the opportunity to submit evidence to the House of Commons Science and Technology Committee inquiry on leaving the EU: implications and opportunities for science and research. Following the EU referendum the alliance of 38 professional engineering institutions and national organisations that represent the engineering profession, known as Engineering the Future (EtF), agreed to work in the national interest to support government in the forthcoming negotiations to secure the best possible outcome for the UK. The Royal Academy of Engineering is co-ordinating this project on behalf of EtF, with the aim of providing evidence-based advice to government and ensuring that the needs of all sectors that have a dependence on engineering are understood and represented in the negotiations.

1.2. The Academy is also working closely with its sister national academies to explore how best to support government in the task ahead with regard to issues related to research and innovation. This submission builds upon the joint statement issued by the seven national academies following the EU referendum result[3]; and the Academy's 2015 submission to the House of Lords Science and Technology Committee inquiry on the relationship between EU membership and the effectiveness of science, research and innovation in the UK.[4]

1.3. The UK has world-class universities, an excellent and highly productive research base, an extraordinary history of invention and innovation and many world-leading science and engineering-based companies, to which EU support, both financial and non-financial, has contributed. Engineering is instrumental to delivering the economic and productivity gains associated with investment in research and provides the means to convert excellent research into new and improved products and services that can and do make a substantial contribution to the UK economy. With engineering contributing at least 20% of the UK's gross value added, accounting for half of the UK's exports,[5] and underpinning much innovation activity, it is essential that the negotiations for leaving the EU are fully informed by an understanding of the risks and opportunities for UK engineering.

1.4. With the continual reshaping of global supply chains, the changing location of skilled individuals and improvements in communications, most companies, including those established in the UK, have to make global decisions about where to situate high-value activities. Access to and co-location with excellent research is an acknowledged pull factor influencing why global companies choose to make R&D investments in the UK.[6] Therefore, the Academy urge the UK government to utilise the UK's comparative advantage provided by its research and innovation base and ensure that the community

[3] Research and Innovation: After the EU Referendum, UK National Academies, 2016
[4] Royal Academy of Engineering's submission to the House of Lords Science and Technology Committee inquiry on the relationship between EU Membership and the effectiveness of science, research and innovation in the UK, 2015
[5] Assessing the economic returns of engineering research and postgraduate training in the UK, Technopolis, Royal Academy of Engineering, 2015
[6] Investing in Innovation, Royal Academy of Engineering, 2015.

informs, and is directly represented in, the negotiations as the UK begins discussions to leave the EU.

1.5. Irrespective of the terms ultimately agreed for the UK's departure from the European Union, one of the biggest risks posed to UK research and innovation is the considerable uncertainty created by the referendum result and the lack of clarity regarding what it will mean for the scientific and engineering community, both in the UK and globally. There is anecdotal evidence that this has already impacted on the decisions researchers are taking regarding the attractiveness of the UK as a destination for talent and as a partner for collaboration, as well as on business confidence. In view of the complexity of the task now facing government, it is likely that uncertainty around many policy areas will continue for years to come so it is crucial that government takes all possible steps to build confidence in UK research and innovation and reduce uncertainty where it has the power to do so. The academies have joined forces to promote the 'Science is Global' campaign and we would encourage the government to seize all available opportunities to promote a positive and assertive message that the UK is a global hub for excellence in research and innovation and is very much open to doing business with partners around the world, for example through an international campaign.

1.6. Although the result of the EU referendum poses a number of undeniable risks to the future of UK engineering research and innovation, it also presents potential opportunities. This submission will endeavour to explore the potential risks, mitigating factors, and opportunities associated with the result of the EU referendum result under the broad headings of funding, collaboration, people and regulation. The risks framed under each heading are not mutually exclusive, but are highly interconnected and dependent upon each other.

## 2. Funding

2.1. The current financial pressures and uncertainty facing the UK make it more important than ever that government harnesses the UK's strengths in engineering and innovation to drive economic growth. Investing in research and innovation can help to create high-value jobs and growth, strengthen productivity and improve the efficiency, effectiveness and resilience of public services. For the UK to succeed as it redefines its position in the world, the UK government needs to prioritise stable, coherent and targeted support for research and innovation.

2.2. The UK has strong track record in securing EU research funding. In the European Framework Programme (FP7), which ran from 2007 to 2013, the UK came second only to Germany in terms of number of grants held at 14.9% and in total budget share, at 17.2%, equating to €6,940 million.[7] The UK also does exceptionally well from European Research Council (ERC) funding, which funds excellent investigator-driven research. The UK is consistently the most successful country across every domain (life sciences, physical sciences and engineering, and the social sciences and humanities), for each of the ERC's Starting Grants, Consolidator Grants and Advanced Grants.[8] The UK also received the largest number of ERC Proof-of-Concept grants at 17.8%.[9] EU research funding is of particular importance to engineering research conducted in UK higher

[7] European Commission, Seventh FP7 Monitoring Report 2013, March 2015.
[8] European Commission, Seventh FP7 Monitoring Report 2013, March 2015.
[9] European Commission, Seventh FP7 Monitoring Report 2013, March 2015.

education institutions (HEIs), where the amount of EU research funding received has increased by 50% in value from 2007/08 to 2013/14.[10]

2.3. UK businesses, both big and small, have been successful at securing EU research and innovation funding, with the UK being the third most successful country, behind France and Germany, when assessed by the financial contribution to businesses (€1257 million) and by the number of business participants in FP7 at 4544.[11] UK SMEs do particularly well from EU funding programmes, with SMEs accounting for 13.7% of the UK's total FP7 budget share, while big businesses received only 4.95%.[12] The success of UK businesses has continued with Horizon 2020, with the UK being the biggest beneficiary of the Fast Track to Innovation scheme[13] and second only to Spain for SME Instrument Phase 2 funding.[14] An assessment of the motivations for SME engagement in FP7 concluded that 'access to financial assistance not available nationally or regionally' was rated particularly highly as a motivation for UK SMEs, emphasising the fact that SMEs do not have ready access to support of this nature within the UK.[15]

2.4. Given the significant contributions EU research and innovation programmes have made to the UK, losing access to Horizon 2020 and its successor programmes would pose a considerable risk to the quality and quantity of UK research and innovation. The Academy therefore urge the government to seek the closest achievable association with EU research programmes to safeguard access to funding.[16]

2.5. If the UK was unable to secure continued access to EU research and innovation programmes, it would be essential for the UK government to create suitable replacement research and innovation programmes using national funds. Any such replacement programmes should replicate the successful and unique aspects of EU programmes, including support targeted at collaboration and partnership at many different levels, including researchers, universities, large corporates and SMEs, plus long term visibility of themes and subject areas.

2.6. As a member state of the EU, the UK has had the opportunity to shape the EU research and innovation agenda in a way that aligns with UK priorities and strengths. Depending on the outcome of the negotiations there is a possibility that the UK may retain access to Horizon 2020 and its successor programmes, for example as an associated country such as Norway or Israel, or a non-associated third country, but without the means to influence and inform their development or to take a leading position in directing programmes. As a consequence, there is a risk that the programmes will reduce in relevance to the UK, and that the UK's ability to capitalise on its own public research and innovation investments could be undermined.

2.7. EU research and innovation programmes can provide support for UK activities beyond those supported by the UK's research and innovation portfolio. Therefore, the risk of losing access to EU funding sources is likely to impact variably on different research

[10] Campaign for Science and Engineering (CaSE) and the Engineering Professors' Council (EPC) submission to the House of Lords Science and Technology Select Committee Inquiry on the Relationship between EU membership and the Effectiveness of Science, Research and Innovation in the UK, 2015.
[11] European Commission, Seventh FP7 Monitoring Report 2013, March 2015.
[12] European Commission, Seventh FP7 Monitoring Report 2013, March 2015.
[13] https://ec.europa.eu/unitedkingdom/news/uk-once-more-top-beneficiary-eu-innovation-funding_en
[14] https://ec.europa.eu/unitedkingdom/news/%C2%A31m-eu-funding-uk-sme-working-healthcare-data-platform_en
[15] Performance of SMEs within FP7, An interim Evaluation of FP7 components, Vol 1. Main report, 2014
[16] Research and Innovation: After the EU Referendum, UK National Academies, 2016

disciplines, university departments and HEIs. For example, acoustics-related research, which contributes to a number of critical sectors in the UK's economy including defence, manufacturing, and transport, receives 47% of its funding from the EU.[17] Research areas such as these that have a high dependency on EU research funding sources could be severely impacted by a loss of access to EU funding. For the UK to mitigate these risks, a comprehensive understanding of which research disciplines, university departments and HEIs have a high dependency on EU funding sources and why is required. The UK government would then be better equipped to assess priorities for deploying replacement UK funds.

2.8. It will also be critical for the UK government to assess which successful UK commercial sectors have a particular dependency on EU research and innovation programmes and European procurement activities. There is a perception that success in European procurement bids is increased by involvement in EU activities. For example, the UK space sector, which has contributed to creating jobs and growth in the UK economy, with a compound annual growth rate of 8.6% since 2008/09,[18] is seeking clarification of the status of the UK's relationship with EU space programmes.[19] It is also urging government that this be communicated to European stakeholders to ensure bidding activity can continue without loss of momentum with non-EU European bodies such as the European Space Agency.[20]

2.9. International comparisons place the UK as a world leader in research and innovation.[21] Therefore, it is reasonable to expect some EU researchers to consider the EU research and innovation endeavour to be weakened without UK participation in EU research and innovation programmes. If this proves to be the case, the government should give serious consideration to how these UK strengths can be used as leverage in negotiations. However, this needs to be balanced against the reality that researchers and countries operate both in collaboration and competition with each other. Consequently, the potential withdrawal of the UK from EU research and innovation programmes may be considered as an opportunity for other countries to strengthen their own positions.

## 3. Collaboration

3.1. It is not only the scale of EU research and innovation funding secured by the UK that is significant, but also the nature of the funding: collaboration – a key component of EU research and innovation programmes – allows UK researchers to achieve more than they would alone and builds lasting relationships with researchers across the EU.

3.2. There is widespread agreement across the engineering community that international collaboration brings huge benefits to engineering research and innovation in the UK. Collaboration gives UK researchers and businesses access to a broader range of knowledge, people and facilities than could be obtained in the UK alone. Collaboration

[17] Institute of Acoustics submission to House of Commons Science and Technology Committee Leaving the EU inquiry.
[18] UK Space sector written submission to the House of Lords Science and Technology Committee inquiry on EU Membership, 2015.
[19] Post referendum UKspace statement on behalf of the UK space and satellite industry, 2016
[20] Post referendum UKspace statement on behalf of the UK space and satellite industry, 2016
[21] International Comparative Performance of the UK Research Base – 2013, Elsevier, 2014, and Global Innovation Index, 2016

facilitates innovation as new ideas are generated, shared, refined and challenged. Collaboration between EU member states is frequently a requirement of EU research and innovation funding instruments. The UK's membership of the EU makes collaboration with other EU member states relatively easy, much more so in comparison to collaboration with non-EU countries, where a lack of dedicated funding hinders engagement. EU research and innovation programmes also provide a mechanism for the UK to establish collaboration with non-associated third countries, such as Brazil.

3.3. Collaboration between industrial partners can also be facilitated by EU research and innovation funding, as the creation of common funding frameworks increases the ease with which businesses can engage with each other and work together towards common goals, often for societal benefit. One such example is the Clean Sky aeronautical research programme, which was established in 2008 as a Joint Technology Initiative (JTI), and is now receiving support from Horizon 2020 as a European programme. It addresses the key societal challenge of developing smart, green and integrated transport. Such schemes bring together industrial competitors, along with their supply chains. Such pre-competitive collaborations often require public funds to de-risk the venture and incentivise the businesses, which are frequently competitors, to work together.[22]

3.4. For the UK to maintain its outstanding research and innovation base, and to continue to address global challenges, it is imperative that the UK continues to collaborate with international partners. Establishing the closest achievable association with EU research programmes will ensure the UK is able to maintain and grow its position as a successful international collaborator and build upon already established productive relationships. If access to EU research and innovation programmes is lost it will be essential that the UK provides funding that will continue to promote international collaboration, both with EU partners as well as the wider world.

3.5. As noted above, the result of the EU referendum has created significant uncertainty within the UK, but also for our European partners and stakeholders. The government's recent announcement committing to fully fund Horizon 2020 projects applied for before the UK leaves the EU has been very welcome and should help to provide certainty to UK researchers and businesses of the value of continuing to bid for Horizon 2020 funds. Nevertheless, there is still a concern that UK participation in current and future EU collaborations may decline if UK researchers are considered as less attractive partners by researchers from EU member states. It is important that the messaging from the UK is communicated to the international research and innovation community, particularly the EU member states, that the UK is still a research and innovation powerhouse and is very much welcoming and open for business. The monitoring of application and success rates to EU funding schemes will provide a relatively helpful indication of the impact of the EU referendum result.

3.6. Although it is clear that substantial benefits can be reaped from collaboration, it is sometimes argued that EU research and innovation funding programmes prioritise collaboration to the detriment of research quality. Therefore, there is a potential opportunity for the UK to deploy funds that are focussed on facilitating research that requires collaboration to succeed and to increase research quality.

[22] Investing in Innovation, Royal Academy of Engineering, September 2015,

## 4. People

4.1. The UK cannot realise the potential benefits from its public investment in research and innovation on its own. The UK's excellent research and innovation base was built with the support of talented individuals from across the world. Access to global talent, including from EU member states, is crucial to the UK's international competitiveness.[23] The UK's research base is truly international; 26% of academics in universities are non-UK nationals, with 15% from non-UK EU member states.[24] High-performing institutions have more staff who are from, or have worked, overseas.[25] The combination of the UK's world-class universities, excellent scientific reputation and quality of life, as well as the fact that English is in practice the lingua franca of research, has made the UK a very desirable location for non-UK Europeans to study and pursue their academic careers. These highly skilled individuals bring with them knowledge, ideas and talent, and many go on to contribute to the UK economy outside of the research base, for example working in high growth innovative companies.

4.2. The UK's engineering base is no exception and depends upon talented individuals from across the world. In 2014/15 29.7% of engineering and technology undergraduate students were non-UK nationals, rising to 67.8% of engineering and technology postgraduate students.[26] While the majority of the engineering and technology students who are non-UK nationals are not from EU countries, non-UK EU nationals still make up a significant proportion, at 8.6% for undergraduates and 16.7% for postgraduates.[27] Similarly, non-UK EU nationals comprised 15.3% of all engineering and technology staff in UK HEIs in 2014/15.[28]

4.3. Within engineering the distribution of non-UK EU nationals as staff and students varies according to research disciplines, university departments and HEIs, including within engineering. For example, for 2014/15 Cranfield University had the greatest number of non-UK EU engineering and technology postgraduate students at 820, equating to 34.1% of their total; Imperial College London came in second with 640, equating to 31.3%; the University of Manchester had 125 non-UK EU engineering and technology postgraduate students which equated to 6.5%.[29] Research areas and degree courses which have a high dependency on non-UK nationals may not be sustainable if the number of non-UK EU nationals coming to work and study engineering in the UK reduces. This risk could be further exacerbated if there was also a reduction of non-EU nationals due to the referendum result affecting the UK's attractiveness for students and researchers from non-EU countries (see paragraphs 4.6 and 4.7).

4.4. Furthermore, the UK faces an engineering skills crisis, needing more than a million new engineers and technicians by 2020.[30] Although efforts to boost the supply of UK engineers are underway, the result of the referendum increases the urgency with which this needs to be done. The government and the engineering community will need to work closely together to seize this opportunity to redouble efforts and harness

[23] Joint National Academies' letter to government regarding changes to the Tier 2 visa route, 2016
[24] Staff in Higher Education 2013/14, Higher Education Statistics Agency, 2015
[25] Characteristics of high-performing research units, Kings College London, 2015
[26] HESA data, accessed 24 August 2016, for a small number of students have their nationality recorded as unknown.
[27] HESA data, accessed 24 August 2016
[28] HESA data, accessed 24 August 2016
[29] HESA data, accessed 24 August 2016
[30] The Universe of Engineering, Engineering the Future, Royal Academy of Engineering, October 2014

momentum to increase home gown talent and tackle the skills crisis in engineering. These efforts to attract young people into engineering must start with a coordinated, inspiring messaging to the public that truly captures the real nature and breadth of engineering in the 21st Century: the Academy and wider profession are working hard to develop and deliver this.[31] Nevertheless, even if such efforts are successful, inward migration to the UK of talented individuals who can contribute to filling the skills gap will be essential in both the short and longer term.

4.5. Given that talented individuals from around the world are critical to the UK's success in engineering, research and innovation, the UK government should ensure that any changes resulting from the referendum vote do not impede the ability of UK institutions to attract these world-class researchers and engineers. This should include ensuring that talented researchers and engineers from non-UK EU countries have certainty about the opportunities to work in the UK, including assurance for non-UK EU researchers currently based in the UK that they will be able to continue to live and work here. Likewise, the ability for UK researchers and engineers to work in other EU countries must be safeguarded.[32]

4.6. Nevertheless, the UK government must also take action to mitigate against a potential fall in talented non-UK nationals coming to work and study in the UK. It will be important for the government to understand which research disciplines, degree courses, university departments, HEIs and sectors are particularly dependent on non-UK nationals, and why. Similarly, it will also be necessary to understand the potential reasons why non-UK nationals may decide to no longer come to the UK. Reasons may include: uncertainty around student fees and access to student loans, concerns that it will be more difficult to access research funding, uncertainty about their future UK status, uncertainty about future eligibility for British citizenship, uncertainties about future status of dependents, and a perception that the UK is no longer prioritising research and innovation and that it may become isolated to the detriment of its research quality.

4.7. It has been well documented nationally and internationally that the UK has seen an increase in reports of incidents of racial abuse and hate crimes in the run up to and following the EU referendum.[33] This news, combined with the referendum result itself, is at risk of increasing the perception that the UK no longer welcomes international talent, from the EU and the rest of the world. Considering the UK's engineering base's dependence on non-UK talent, any reduction in EU and international talent poses a serious risk to the UK. However, it also presents the opportunity for the UK government to reaffirm its position as a country with a global aspiration. Government should coordinate and communicate strong messaging that the UK is a welcoming, outward facing country and that the UK research and innovation community is open to global talent. Such messaging is critical to counter the potential damage being done by negative news stories.

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[31] The Universe of Engineering, Engineering the Future, Royal Academy of Engineering, October 2014

[32] Research and Innovation: After the EU Referendum, UK National Academies, 2016

[33] 3,076 incidents were recorded across the UK between 16 and 3.0 June, compared to 915 reports recorded over the same period in 2015. Hate crime undermines the diversity and tolerance we should instead be celebrating. National Police Chief's Council, 2016

## 5. Regulations

5.1. Engineering is a pervasive force in almost every economic sector, from advanced manufacturing to software, from financial services through to the media and medical sector. Consequently, there are numerous regulatory frameworks that affect the engineering community. Regulatory frameworks can help to improve and harmonise conduct across the EU and have the potential to become internationally adopted. There is a sense in the engineering community that the burden of regulation is unlikely to be substantially changed by the UK leaving the EU, due to the relationship between abiding by regulations and market access. It is possible that an increased dissociation for the UK from EU regulations may provide a limited number of specific opportunities for the UK, for example, in facilitating innovation. However, movement away from common rules may increase the time and cost to UK engineering research, scholarship and innovation.

5.2. As a member of the EU the UK has been involved in the development of regulations; in doing so the UK has had the potential to ensure that regulations do not adversely affect the development and delivery of UK products and services. It will be essential that the areas of regulation where alignment with EU rules is most important for the UK's competiveness are identified, and that UK experts remain fully engaged in shaping the development of standards and regulations.[34]

5.3. The government will also need to ensure it is suitably equipped with individuals qualified with the relevant skills, knowledge and expertise to support UK businesses to navigate the regulatory frameworks. Previously many of these roles have been the responsibility of EU officials.

5.4. Irrespective of the deal ultimately negotiated for the UK to leave the EU, UK businesses that trade with the EU will continue to follow European standards. Membership of the official recognised European Standardisation Organisations is not directly dependent on EU membership, but it will be essential for the UK to be a leading player in the development of European standards by retaining membership of these bodies. There are also specific organisations and functions related to both European standardisation and procurement where it is not yet clear how the UK could be impacted by exiting the EU.

## 6. Industrial Strategy

6.1. The Academy is working to support government in its efforts to ensure that the UK maintains its position as a centre of world-class engineering research and innovation and that it provides the environment for the creation and growth of successful engineering businesses. The seven national academies' joint post-referendum statement urges the UK government to safeguard the UK's assets in research, scholarship and innovation by 'a) seeking the closest achievable association with the EU research programmes; b) ensuring that talented researchers from other EU countries have certainty about the opportunities to work in the UK and likewise for UK researchers to work in other EU countries; and c) providing funding that will continue to

[34] Research and Innovation: After the EU Referendum, UK National Academies, 2016

promote international collaboration.'[35] However, regardless of the outcome of the UK's future relationship with the EU, the UK can still work towards realising its vision of building a strong, confident and successful country.

6.2. Long-term commitment to an Industrial Strategy is one of the most effective ways of encouraging private sector investment in priority sector and technology areas, thus the Prime Minister's commitment to Industrial Strategy was welcomed by the engineering community. An Industrial Strategy, if deployed successfully, will help the UK to exploit the opportunities and mitigate many of the risks that face the country as a consequence of exiting the EU. The Academy want to ensure that engineering businesses, large and small, feature strongly in the industrial strategy and can access the talented workforce they need. We would direct the Committee's attention to a forthcoming submission from the Royal Academy of Engineering to the Business, Innovation and Skills Committee inquiry on the Industrial Strategy. Furthermore, the creation of UK Research and Innovation (UKRI) offers the opportunity for an agile research and innovation system that invests strategically in areas of future growth and brings greater coherence to research and innovation funding.

6.3. Notwithstanding the risks associated with the referendum result, the government needs to use this decision as a stimulus to develop a clear and compelling, dynamic and competitive economy and to ensure that the Industrial Strategy serves as a roadmap to deliver this vision.

[35] Research and Innovation: After the EU Referendum, UK National Academies, 2016