ROYAL ACADEMY OF ENGINEERING

Engineering the Future

Engineering a future outside the EU

securing the best outcome for the UK

October 2016

Contents

www.raeng.org.uk/UKEngineeringFuture

ISBN: 978-1-909327-29-0

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Executive summary

Engineering is at the core of our modern society, underpinning every sector from communication and entertainment to finance and healthcare, as well as its more visible applications in construction, manufacturing, energy, defence and transport.

Engineering turns research into wealth, improving lives and driving economic and social progress. Engineering-related sectors contribute at least £280 billion in gross value added to the UK economy – 20% of the total. In comparison, UK public sector investment in engineering R&D was £1.5-3.1 billion. It is therefore critical that in negotiating the UK's exit from the EU, and in the trade negotiations that will follow, government is fully conversant with the key issues that affect the UK's engineering performance.

The process of the UK leaving the EU will certainly present challenges but it is also an opportunity to reinforce the UK's position as a leading nation of global influence in terms of trade, knowledge and innovation. Engineering, with its world-class talent, universities, companies and facilities, will be at the heart of delivering renewed prosperity to the UK through close partnership with government. With the right climate and conditions, engineering will be in a strong position to make an even greater contribution to the UK.

The 38 professional engineering organisations, representing all disciplines of UK engineering, have joined forces under the leadership of the Royal Academy of Engineering to provide evidence-based advice to government on the opportunities and risks associated with leaving the EU. The objective is to support government in securing from the negotiations the best possible outcome for the UK, with job creation and economic prosperity foremost in our considerations. This report represents the first phase of evidence gathering and emerging findings in what will be an ongoing dialogue with government.

For ease of understanding of a complex and broad subject, we have grouped our report into three themes: people and skills, finance and markets, and standards and legislation.

Three overarching points emerged most strongly from our consultation:

- The UK engineering community is committed to building on its international reputation to make the most of global opportunities in research, trade and investment. The UK must continue to be welcoming and open for business.
- Government needs to continue to engage with leaders and opinion formers throughout industry and academia to create a shared vision for the UK in the world, building confidence and managing the inevitable uncertainty brought about by the referendum result.
- A new industrial strategy, based on strong partnerships between industry, academia and government, will be key to maximising opportunities for wealth creation and to enable engineering to contribute effectively to economic development and social progress (see Box 3).

People and skills

Engineering success is based on people – the best and brightest at all levels – and the UK has a world-class research base and world-renowned engineers across all sectors. However, the UK is already experiencing a serious engineering skills crisis and the impact on this of leaving the EU needs to be carefully managed.

Government and the engineering community must:

- seize the opportunity to use the combination of leaving the EU and the commitment to a new industrial strategy to take decisive action on the UK's engineering skills crisis
- work with industry to identify the gaps in essential skilled engineering occupations that cannot be filled domestically in the short term and develop straightforward and cost-effective solutions.

In negotiating the UK's exit from the EU, government should aim to:

- maintain ease of intra-company transfers, recognising that many companies require their engineers to move freely to support and fulfil contracts
- ensure that talented students, academics and practising engineers have certainty about the opportunities to study and work in the UK
- enhance support to enable UK students, academics and practising engineers to gain international experience including in the EU.

Finance and markets

UK engineering already competes successfully in the global marketplace. It has the talent and reputation needed to grow even stronger in world markets if given the right conditions and support. The new industrial strategy should provide the perfect framework to enable UK industry and innovation to prosper and the UK engineering community is eager to partner with government to help shape the conditions needed for this to happen.

In general, to support investor confidence, the government will need to:

- state a clear direction that includes a policy framework for both tariff and non-tariff barriers
- create the conditions for the UK to continue to attract a high level of foreign direct investment (FDI) by ensuring that the

costs, regulatory frameworks and future international trade deals make the UK an attractive place to do business.

During negotiations with the EU, the government should aim to:

- continue membership of the Energy Community and alignment with the Digital Single Market
- mitigate the impact of the potential loss of European Investment Bank loans for UK infrastructure projects and provide possible alternative sources of low-cost finance
- maintain data protection and cybersecurity policies equivalent to those of the EU to avoid barriers to trade.

In terms of funding, government needs to:

- seek the closest achievable association with EU research and innovation programmes and ensure that, if needed, long-term UK funding programmes are available that complement current UK funding streams. These should focus on supporting international mobility and collaboration, including academic and industry partnerships
- recognise that European funding streams and collaboration frameworks provide crucial sources of innovation support for UK businesses, of all sizes, that will need to be replaced if no longer available
- consider the impact on funding streams for regional development and the devolved nations and identify a future system that will deliver effective, targeted regional development and support.

Standards and legislation

The UK has always played a leading role in shaping the standards and legislation behind the EU's single market and UK engineering has invested heavily in the setting of industry standards that define our products and services. It is vital that this level of influence is maintained and built upon.

In terms of trade negotiations, the government should aim to:

- avoid, as far as possible, barriers or dual regulatory burdens that would increase costs for UK business and make the UK a less attractive trading partner.

The issue of Regulations, Directives and other EU law applicable in the UK will initially be dealt with by what the Prime Minister has called the 'Great Repeal Bill'. The details of the Bill are still to be determined but consideration will need to be given to:

- avoiding, as far as possible, divergence from EU legislation that would discourage trade and investment, lose consumer safeguards and raise costs for the consumer
- identifying those areas where the loss of or divergence from EU legislation might cause legal complications either at a national or devolved level
- a review of public procurement and state aid rules as part of the industrial strategy to remove complexity and enable a much more productive partnership between government, academia and industry.

It will be important to retain as much influence as possible on setting standards and legislation. In particular, it is important for government to:

- support UK national standards bodies in continuing to exert influence on setting standards through membership of European Standards Organisations and maintain the UK's commitment to the 'single standard model'
- maintain and encourage the participation of UK people and organisations on expert groups that advise on EU policy and legislation.

Background

Engineering is pervasive in our modern society, underpinning every sector from communication and entertainment to finance and healthcare, as well as its more visible applications in construction, manufacturing, energy and transport. Engineering also plays a significant role in humanitarian aid, disaster recovery and achieving international sustainable development goals.

Engineering-related sectors contribute at least £280 billion to the UK's gross value added – that is 20% of the total[1]. Engineering businesses employ 5.5 million people in the UK[2] and account for half of all exports[3]. UK businesses invest at least £9.5 billion per year in engineering research and development, while the UK government spends £1.5–3.1 billion. This indicates that the UK achieves significant leverage on its public investment, which generates substantial benefits for the nation[4]. Engineering turns ideas and research into wealth-creating innovation that improves lives and drives economic and social progress. It is therefore critical that government, in negotiating the UK's exit from the EU, is fully conversant with the key issues that affect the UK's engineering performance.

"The UK should now accelerate progress with developing and delivering an industrial strategy, which can help the UK build on its strengths across key technologies and sectors."

Paul Kahn CEO UK, Airbus Group

The 38 professional organisations in UK engineering have joined forces to provide evidence-based advice to government on the opportunities and risks associated with leaving the EU for the engineering community, in order to support government in securing the best possible outcome for the UK from the negotiations. The organisations represented in this alliance bring together engineers from all branches of engineering and technology, all career stages, and from across academia, industry and the public sector.

Led by the Royal Academy of Engineering, this project has involved wide consultation across engineering and beyond (see Appendix 1) to gather evidence and analyse the risks and opportunities that the UK leaving the EU will bring. We consider that the insights that this report offers into the factors that underpin engineering capacity and performance will be useful for those leading exit negotiations, developing new approaches to international trade and shaping the government's new industrial strategy.

However, given that the government's approaches to these important areas of policy are in the process of being developed and, further, given the complexity and interdependence of the issues we have identified, we recognise that there is likely to be more work we need to do to inform negotiations and support the government going forward.

In drawing together the material for this report, we have been impressed by the positive engagement of the engineering community, which has been prepared to take a broad view of the issues. This wealth of expertise and enthusiasm from both industry and academia is available to complement public sector knowledge as government takes forward its critical task.

Box 1. Engineering perspectives

While engineering faces many of the same issues as other parts of the economy, there are some features that are distinctive to or more pronounced in engineering. These include the following perspectives:

Engineering has a particularly mobile workforce. This is true in both industry and academia and across all skill levels. Engineering companies tend to recruit from a global talent pool; UK engineers are in high demand internationally and can readily secure employment in other countries[5].

Engineering is a team-based activity that is inherently collaborative and interdisciplinary. There is evidence to show that diverse teams deliver better results, including in terms of innovation[6].

UK university engineering departments have higher proportions of international students and researchers, including from EU countries, than the average for all subjects. In addition to contributing to the excellence of UK higher education, this has financial consequences.

The UK faces an engineering skills crisis, with EngineeringUK finding that we need 182,000 new engineers and technicians per year until 2022[7]. The pace of technology development combined with the length of time it takes to fully train qualified engineers means that it is impossible to fill all engineering skills gaps and shortages by increasing the UK pipeline, although that clearly must be part of the response to leaving the EU.

Delivery of major infrastructure projects often depends on the availability of large numbers of people with specific skills for a fixed period. At present, the EU is an important source of engineers deployed on UK projects and companies rely on the ability to move their engineers between EU countries.

The value of engineering to the economy is felt in the scale of operations and the markets to which it has access. The EU is the world's biggest single market and many engineering and technology companies currently see access to that market as an important benefit of being based in the UK – although clearly other global markets are also of importance to UK companies.

1 ***Assessing the economic returns of engineering research and postgraduate training in the UK***, Technolopolis Group, 2015, p1

2 ***Engineering UK 2016, The state of engineering***, EngineeringUK, 2016, p11

3 ***Assessing the economic returns of engineering research and postgraduate training in the UK***, Technopolis Group, 2015, p2

4 ***Assessing the economic returns of engineering research and postgraduate training in the UK***, Technopolis Group, 2015, p2

5 **Global migrants: Which are the most wanted professions?**, BBC, 2013

6 ***Diversity and Innovation: A Business Opportunity for All***, European Commission

7 Demand for occupations most likely to require intermediate or higher engineering skills is approximately 182,000 per year: ***Engineering UK 2016, The state of engineering***, Engineering UK, 2016, pII

Key findings

For ease of understanding a complex and broad subject, we have grouped our further analysis into three main themes: people and skills, finance and markets, and standards and legislation. However, the opportunities and risks outlined within each theme are not mutually exclusive and are, in fact, highly interconnected and dependent upon each other.

There are, in addition, certain messages that emerged strongly under each of the three themes. In particular, the overriding concern expressed throughout our evidence gathering has been about uncertainty.

The impact of uncertainty is already being felt in many aspects of engineering including funding, investment, collaboration, environment, employment and in the seeking of new markets. Such uncertainty is likely to continue until the negotiations are finalised and the UK's new position in the world is established.

Compounding the sense of uncertainty is the extended timescale of the process. The referendum result has had an immediate impact despite the fact that the UK's position has not, in theory, changed. There will follow a transitional period from when Article 50 is triggered to when the UK actually leaves the EU. At that stage, we should have identified a direction of travel for a new political and economic position for the UK in relation to Europe and the rest of the world.

"We need to understand the timetable for decisions and the direction of travel as soon as possible."

Jane Wernick CBE FREng, Director, engineersHRW

Given the complexity of the negotiations, it is likely that transitional arrangements will continue past the point of exiting the EU. All these different periods – from now, through transition to the point of settlement – will present their own challenges. However, there are common threads to how government can minimise the negative impacts of uncertainty throughout this process:

- Communication will be a critical factor for success. Complete clarity of what will happen is not possible but clear, confident and transparent communications will do much to manage the uncertainty and alleviate concerns.

- Positive and assertive messaging to international partners will be essential to maintain their confidence in the UK as a collaborator and a destination for talent and investment. For example, government should ensure strong representation at key international trade shows, on trade missions and expert delegations.

- While government cannot remove the uncertainty associated with leaving the EU, it can act to deliver policy coherence and stability in areas not directly impacted by the EU. This will be pivotal to building business confidence and stabilising investment.

- An industrial strategy will be key to maximising opportunities for wealth creation and delivering a stable and conducive environment in which engineering can contribute effectively to economic and social development. In addition, it will provide a foundation for the communication of a positive and welcoming message to both UK and international stakeholders (see Box 3).

"With the new and unique set of challenges we face following the vote on the EU, an industrial strategy will be even more critical for our companies competing in hi-tech global markets."

Sir John Parker GBE FREng, Chair, Anglo-American

A further message that emerged across all the themes is the importance of developing a robust evidence base on which to base interventions. The impacts of leaving the EU are expected to be complex and wide ranging (whether positive or negative), and there could be significant variation regionally and across sectors, technology areas and types of company.

As a first step, government needs to commission a comprehensive audit of current dependencies on the EU. This should include a review of major infrastructure projects that are underway or planned to understand vulnerabilities to changes in access to European funding, labour, collaboration and research and development (R&D). The audit should also provide the basis of a framework for evaluating the success of actions taken to maximise the opportunities and mitigate the risks associated with leaving the EU.

Box 2. Engineering industry survey

A survey on the impact of the UK leaving the EU on engineering was conducted in September 2016, which received 424 responses from across engineering sectors. The results provide an interesting snapshot of views among engineers but should not be considered as a comprehensive picture. A number of questions elicited free text and some allowed more than one answer; not all respondents answered all questions.

The top three sectors represented were energy (42%), transport (33%) and defence (25%). Oil and gas, agriculture and marine were also well represented. Of those that responded, 31% of the companies had a turnover of £100 million or more, with a strong representation of senior and managerial position respondents.

When asked about the significance of the EU to their businesses, working with EU companies was the most common answer at 64%, followed by employing EU citizens (62%) and exporting services to the EU (48%).

When asked about their biggest concern for their company on the UK leaving the EU, 26% highlighted the availability of workforce and free movement of goods. Others highlighted uncertainty, replacement funding (including R&D projects support), standards and regulations, and the impact on the economy and sterling; 15% said they had no concerns.

A significant number (31%) of respondents identified the benefits of leaving the EU as greater freedom, lower exchange rate, fewer regulations and opening trade with the rest of the world. However, 39% of respondents said they could not identify any benefits.

The survey also asked what action companies would take to realise the opportunities inherent in leaving the EU: 19% said they would diversify and increase links with the rest of the world and around 34% said they were either unsure or were not going to take any action.

When asked about the level of confidence in the outlook for their business after leaving the EU, 39% felt positive, with messages including the need for a swift exit, ending uncertainty and clarity on the direction of negotiations. Among the 35% who felt negative, the clear message was the need to ensure continued availability of workforce and free movement of goods.

Box 3. Industrial strategy

With or without the EU referendum vote, the engineering community is strongly supportive of the government's decision to develop a new industrial strategy.

An industrial strategy should be the primary vehicle for taking advantage of global opportunities during and beyond this period of transition. The strategy should:

- be based on, and enable, strong partnership between government, industry, the academic research base and Research and Innovation Organisations (RIOs)
- ensure that the UK has sound supporting infrastructure – physical and digital – with a clear pipeline of major projects and at a price that is affordable and makes it attractive to do business in the UK
- secure the delivery of the skills and knowledge base needed to enable the UK to maximise opportunities outside of the EU
- incorporate policies and frameworks designed to lower the costs of doing business, make the UK an attractive place to invest in and promote the particular advantages of investment in the UK
- adopt a systems approach to the strategy that encompasses national and local government and all regions of the UK and also promotes fair and inclusive economic growth
- align policies across all relevant government departments, including the Foreign & Commonwealth Office, Department for International Trade, Department for Exiting the European Union, the Home Office, Department for Transport, Department for Education, Department for Business, Energy and Industrial Strategy, and HM Treasury
- deliver a powerful message that the UK is forward looking, open for business, and an active and welcoming partner for the international research, innovation and business communities.

Theme one: People and skills

The impacts of leaving the EU on the engineering sector will clearly depend on many factors, including the arrangements for movement of goods, services, labour and capital negotiated between the UK, the EU and the rest of the world. However, the UK already faces a serious engineering skills crisis, which could be exacerbated if access to the European engineering workforce becomes more restricted.

Demand for occupations most likely to require intermediate or higher engineering skills is approximately 182,000 per year[8]. This is particularly acute in infrastructure sectors, which are highly competitive and operate on low profit margins[9]. For example, in 2013/14 in the IT and telecommunications sectors, 12% of vacancies were unfilled. In energy and other utilities, vacancies ran at an average of 11%; for construction, it was around 8%. This compares to an average across the economy of 5%[10].

Demand for highly skilled engineers is expected to rise further in the years ahead with over 90% of businesses in engineering, science and hi-tech sectors expecting an increase in demand[11]. Some 52% of engineering companies are currently recruiting engineers at technician level and above, with over half of those experiencing difficulties in recruiting the experienced engineers they need[12].

To help address this challenge, government has set out a programme to greatly expand the number of apprenticeships in England to three million by 2020[13]. This is, of course, welcome and the engineering sector is committed to working with government to realise this goal with apprenticeships that work for both trainee and employer. However, training apprentices to the level that engineering businesses require takes time.

Companies relying on engineering skills will also need to do more to address their needs. Currently, 38% of engineering employers have no strategy to recruit the people they need in four to five years' time. Some 8% are planning to recruit from the EU. If this became more difficult because of new immigration rules, employers would have to increase their efforts to attract more UK residents into engineering[14].

Uncertainty around leaving the EU could potentially lead to a lack of investment into the engineering sector, especially from abroad. Any lack of funding may in turn be making the UK a less appealing place to work, meaning it is harder to attract potential employees. Companies have reported that they have already experienced EU candidates dropping out of the recruitment process post referendum, with candidates moving back to their EU countries[15].

The result of the EU referendum and the development of an industrial strategy for the UK create an imperative to refocus efforts on boosting the supply of UK homegrown talent to tackle the skills crisis. However, with similar skills shortages in other sectors, the unemployment rate at an 11-year low of 5%[16], and typically five years' experience required after graduation to achieve chartered engineer status, the skills gap in engineering cannot be addressed quickly domestically.

Workforce mobility

"It is mission critical that we remain open to the talent we need from overseas. We simply don't produce enough engineers in all required disciplines."

Dr Uwe Krueger, CEO, Atkins

Accurate figures are not available for the total number of non-UK EU nationals working as engineers in the UK. Statistics on the proportion of people in employment by industry[17] show that for professional, scientific and technical activities, 84.5% are UK nationals, 5.5% are other EU nationals and 9.9% are from the rest of the world. However, this varies from company to company, with organisations reporting between 10 and 20% EU and between 13 and 50% rest of the world engineering employees.

Following the referendum, 35% of employers surveyed expected their recruitment to be negatively affected while only 5% expected a positive impact, with 36% unsure of how recruitment would be affected and 23% expecting no impact[18].

Most engineering companies with a presence or sales in more than one country move their employees across national borders to provide services and expertise and to develop their staff: it is a core part of managing their business. In some sectors, such as electricity distribution, the movement of engineers quickly across EU borders to supplement local staff is critical to supporting and repairing the UK's infrastructure in times of emergency.

The issue of workforce mobility is of particular significance for Northern Ireland, being the only part of the UK with a land border with part of the EU. In addition to the issues faced by the rest of the UK relating to the movement of people, this results in a much higher number of people who commute daily across the border making up an important portion of the workforce. Any return to a 'hard border' would not be welcomed by the majority of the engineering community in Northern Ireland and the government have made it clear this is not what they want, but maintaining a 'soft border' could create complications for travel

8 ***Engineering UK 2016, The state of engineering***, Engineering UK, 2016, pII
9 ***National Infrastructure Delivery Plan 2016-2021***, Infrastructure and Projects Authority (IPA), 2016, p101
10 ***Engineering UK 2016, The state of engineering***, Engineering UK, 2016, p261
11 ***The Right Combination***, CBI, 2016, p13
12 ***Skills and Demand in Industry Survey***, Institution of Engineering and Technology (IET), 2016, p12-13
13 ***English Apprenticeships: Our 2020 Vision***, HM Government, 2015, p2
14 ***Skills and Demand in Industry Survey***, IET, 2016, p17
15 ***Shrinking Talent Pool May Bind Biotechs After Brexit***, Bloomberg, 2016
16 **UK Labour Market: August 2016**, Office for National Statistics (ONS), 2016
17 Office of National Statistics April 2015 to March 2016
18 ***Skills and Demand in Industry Survey***, Institution of Engineering and Technology (IET), 2016

or customs arrangements between Northern Ireland and the rest of the UK. It is welcome that this issue, along with others relating to Northern Ireland, are the subject of a Parliamentary inquiry by the EU Select Committee[19].

Some companies have now stated that they would move engineering jobs out of the UK if it becomes more difficult or expensive to move engineers around Europe. Engineering companies are already considering the relocation of their UK offices and staff as a method of mitigating the possible effects of the UK leaving the EU. We have evidence of more than one organisation already having taken action, opening a new non-UK office in the EU in order to address concerns expressed by its European customers.

Shortage occupations

The lack of experienced workers (as opposed to trainees) is set out in the Home Office Shortage Occupation List. This details the sectors of the labour market where there is a demonstrable lack of employees from the EEA available to fill positions. Of the 32 standard occupations listed, half are either in engineering sectors such as civil, mechanical and electrical, or in allied professions including physical scientists and environmental professionals[20].

As a minimum, government should put in place a mechanism to identify the gaps in essential skilled occupations that cannot be filled in the short to medium term domestically and develop a system similar to the current Shortage Occupation List or temporary short-term visas for people from EEA member states.

It should be noted that while the current (non-EEA) Shortage Occupation List specifies a minimum salary for each profession (generally over £30,000 for experienced workers), skills gaps tend to be geographically uneven. It can be more difficult to attract people to other locations such as Northern Ireland and the north of England where pay is often lower than in the south, resulting in greater gaps in the supply of high-quality labour across the UK[21]. Therefore, if a Shortage Occupation List were to be developed for EEA countries, attention should also be paid to the risk that a UK-wide minimum salary might exacerbate skills gaps in particular regions.

Intra-company transfers

The most common way for non-EEA skilled workers to gain a visa to work in the UK is through intra-company transfers that allow international companies to move their staff for a limited time to another country, an important measure that helps ensure that businesses can remain competitive[22]. The number of such transfers has been rising over time and is particularly high in the UK relative to other OECD countries[23] and particularly important in engineering.

From 2017, all (non-trainee) intra-company transferees will be required to qualify under a single visa category with a minimum salary threshold of £41,500[24], significantly higher than the average minimum salary on the Shortage Occupation List[25]. Therefore, for UK engineering businesses, it is essential that procedures for intra-company transfer on leaving the EU are extended to cover EEA citizens and remain accessible for skilled engineers and technicians.

Engineering businesses are also reporting that immigration policies are causing problems[26]. Companies estimate the additional direct cost of recruiting an employee from outside the EU is currently between £2-4k and can take up to three months to process the visa application[27]. If similar systems are put in place for EEA citizens after the UK leaves the EU, they could negatively affect UK businesses' access to the flexible, project-based workforces that they need.

It is accepted that the political reality of leaving the EU means there are likely to be some restrictions on the free movement of labour[28]. Nevertheless, for the engineering sector, inward migration to the UK of talented individuals will continue to be necessary for the foreseeable future. It will be essential to maintain the quality of UK engineering through filling both skills gaps and experience shortages across the country, and to safeguard the effectivness of the teams that undertake research, innovation and project management.

Action on UK skills

The engineering community has been engaged in activity to address skills shortages for many years. As the balance between manufacturing and service industries changed, so it became harder to recruit the best and brightest to manufacturing, and the cycle was exacerbated. This has spurred many companies and individuals to invest a great deal in campaigns and activities to inspire the next generation.

Interventions are supported across the UK, the most recent national programme being the Engineering Talent Project. Led by the Royal Academy of Engineering in response to calls from industry, the project will address public perceptions of engineering, policy barriers to engineering education, and expansion of the Tomorrow's Engineers project to help young people experience engineering in schools.

If the UK is to secure its engineering future, the proposed industrial strategy must support the 'formation' of engineering skills – those skills and habits of mind that can be developed and which make an engineering career possible and desirable. The industrial strategy should reach back into the education system, bolstering subjects such as design and technology,

19 **Brexit: UK-Irish relation enquiry**, EU Select Committee
20 **Tier 2 Shortage Occupation List**, Home Office, 2015
21 **The Labour Market Story: The State of UK Skills**, UKCES, 2014, p7
22 **Immigration: skill shortages**, House of Commons Home Affairs Committee, 2015, p11
23 **Limits to Migration**, Migration Advisory Council, 2012, p9
24 **Migration Advisory Committee reviews of Tier 2**, UK Visas and Immigration, 2016
25 **Tier 2 Shortage Occupation List**, Home Office, 2015
26 ***Immigration: Keeping the UK at the heart of global science and engineering***, CaSE, 2016, p73-74
27 **Visa Processing Times**, The Home Office, 2016
28 See, for example: **Theresa May vows Brexit deal will limit migration whatever the impact on EU trade**, *Daily Telegraph*, 2016 and **No. 10 rules out points-based immigration system for Britain**, *Guardian*, 2016

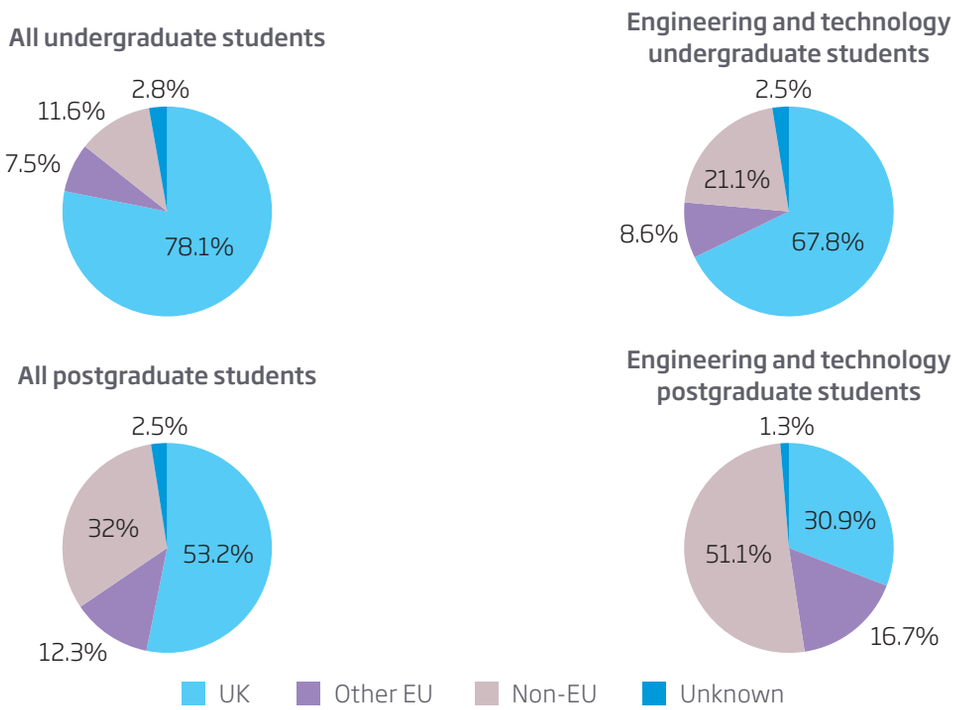


Figure 1. Percentage of higher education students in the UK 2014/15[29]

and supporting teacher training in key subjects. Without this early action, later attempts to convince individuals to enter engineering are difficult, as subject and career choices can quickly close off this opportunity.

It is also imperative that UK engineering boosts its own activities to encourage new entrants to the sector, retain the currency of skills in the existing workforce and improve diversity across all parts of the community. The sector will need to plan carefully for the future, and put in place effective interventions that attract young people to careers in engineering, enable adults to retrain for new careers in engineering, and keep skilled workers in the UK engineering workforce for longer.

Higher education

The UK has world-class universities, an excellent and highly productive research base, a strong history of invention and innovation, and many world-leading R&D-intensive companies to which EU support, both financial and non-financial, has contributed extensively.

Students

The UK's engineering higher education sector depends upon talented individuals from across the world. In 2014/15, 30% of engineering and technology undergraduate students were non-UK nationals, rising to 68% of engineering and technology postgraduate students (see figure 1)[30]. 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 9% for undergraduates and 17% for postgraduates[31]. The proportion appears to increase when considering the quality of the engineering and technology departments, with an average of 13% and 24% non-UK EU undergraduate and postgraduate students respectively in the nine UK universities featured in the *Times Higher Education* Engineering and Technology Top 100 universities[32].

Within engineering, the distribution of non-UK EU students varies according to disciplines, departments and universities. 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% of its total, while Imperial College London had 640, equating to 31%[33].

EU students currently have the same fee level and access to student loans[34] as UK students. It is probable that leaving the EU would result in increases in tuition fees for EU students studying in the UK, while access to student loans could decrease. There may also be an impact on their ability to stay and work in the UK on graduation.

29 HESA data, accessed 28 September 2016, nationality of undergraduates and postgraduates, 2014/15

30 HESA data, accessed 28 September 2016, nationality of undergraduates and postgraduates, 2014/15

31 HESA data, accessed 28 September 2016, nationality of undergraduates and postgraduates, 2014/15

32 HESA data, accessed 26 August 2016 and **Subject Ranking 2015-2016: engineering and technology Top 100**, *Times Higher Education* World University Rankings, 2016

33 HESA data, accessed 24 August 2016, nationality of undergraduates and postgraduates, 2014/15

34 **Home or Overseas fees: the basics**, UK Council for International Student Affairs (UKCISA), 2016 and **EU Nationals and Student Finance in England**, Student Loans Company, 2016

Figure 2. Origins of engineering and technology higher education staff in full-time employment in the UK[33]

It is therefore reasonable to assume that after the UK leaves the EU, many students from EU member states would see studying within the EU as a more attractive option than studying within the UK[35]. It is unclear how this will impact on UK university engineering departments but careful monitoring will be needed to ensure that the financial sustainability of departments that currently educate high numbers of non-UK EU students is not affected.

Research areas and degree courses that 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 is also a reduction in non-EU nationals due to the referendum result affecting the perceptions of the UK as a welcoming destination for students and researchers from non-EU countries.

In addition, consideration needs to be given to the wider benefits that arise from training students who then return to their home countries, or move to other countries, in terms of goodwill towards the UK, an understanding of the UK's culture and respect for the UK's higher education system[37]. UK higher education represents a major export sector[38] that helps to reinforce the UK's reputation as a world-leading knowledge economy. During this period of change and uncertainty, strong support from ministers to promote the message that UK higher education remains world-class and welcoming is needed.

Academic staff

Engineering has proportionally more staff originating from the rest of the EU, at 15% in 2014/15, than across all subjects as a whole, where the proportion is 11% (see Figure 2)[39]. This increases further for the nine UK universities in the *Times Higher Education* Engineering and Technology Top 100, with an average of 22% of engineering and technology staff originating from the rest of the EU[40]. In the engineering faculty at Imperial College London, one of the UK's most successful[41], just under one-third of the staff are non-UK EU nationals[42]. Further work is needed to understand how the result of the referendum might influence the research skills pipeline, for example,

35 **UK fears 'significant' drop in EU student recruitment**, *Times Higher Education* supplement, 2016

36 HESA data accessed 29 September 2016, nationality of staff in engineering and technology, 2014/15

37 **Persuasion and Power in the Modern World**, House of Lords Select Committee on Soft Power and the UK's Influence Report of Session 2013-14, 2014 p15, p132

38 ***International Education - Global Growth and Prosperity: An Accompanying Analytical Narrative***, HM Government, 2013, p59

39 HESA data, accessed 29 September 2016, nationality of staff in engineering and technology, 2014/15.

40 HESA data, accessed 26 August 2016 and **Subject Ranking 2015-2016: engineering and technology Top 100**, *Times Higher Education* World University Rankings, 2016

41 Imperial College London ranks 9th in **Subject Ranking 2015-2016: engineering and technology Top 100**, *Times Higher Education* World University Rankings, 2016

42 HESA data, accessed 26 August 2016, nationality of staff in engineering and technology by institution, 2014/15

whether anecdotal evidence that non-UK nationals are disproportionately represented at the early-stage researcher level is borne out by the evidence.

European project funding for research is discussed in detail in Theme two but it is important to note that specific EU projects are designed to support the international and interdisciplinary mobility of researchers and the UK is successful in competing for them[43].

If such projects are not available at UK universities to the same extent, or if the UK is no longer able to access other European research funding programmes, the UK is likely to become a less attractive destination for the brightest and best students and researchers. It is also important that the broader role of European research projects in providing opportunities to develop UK academic staff, such as by enabling them to transfer between institutions and into industry, is understood.

The ability of the UK to attract the best researchers in a field is critical to the maintenance of the UK's excellence in research and higher education. The evidence demonstrates that the primary driver of research excellence is exceptional researchers[44]. The significance of international mobility and engagement is also reflected in the fact that international outlook is one of the five groups of indicators underpinning the *Times Higher Education* World University Rankings[45].

During the course of the consultation with the engineering community, several individuals mentioned aspects of the UK leaving the EU not linked directly to government negotiations or national policy, but instead focused on perception and experience of how it now felt to be a non-UK EU national living and working in the UK.

"In Wales, we are already hearing of academic staff planning to relocate to their European home countries because they no longer feel welcome here."

Professor Karen Holford FREng, Pro Vice-Chancellor, Head of College of Physical Sciences and Engineering, Cardiff University

Furthermore, it has been well documented that there has been an increase in reports of incidents of racial abuse and hate crimes in the UK in the run up to and immediately following the EU referendum[46]. This news, combined with the referendum result itself, risks increasing the perception that the UK no longer welcomes international talent from the EU and the rest of the world.

The government must ensure that any changes resulting from leaving the EU do not impede the ability of UK institutions to attract world-class researchers. This should include strong messaging that the UK is a welcoming, outward-facing country and ensuring talented researchers from non-UK EU countries have certainty about the opportunities to work and live in the UK.

Outward migration in higher education and research

It is equally important that UK students and researchers retain opportunities to gain international experience, including in the EU. The Erasmus scheme has enabled UK undergraduates to undertake part of their studies in EU countries, with 15,566 UK students completing work or study placements in 2013/14[47]. UK research will also be diminished if UK academics can no longer readily spend time undertaking research in European countries.

Marie Skłodowska-Curie Actions (MSCAs) fund activities to encourage the development of skills for innovation in all scientific disciplines, through worldwide and cross-sector mobility, including supporting international training networks for PhD and early-career researchers, international mobility fellowships for experienced researchers, and international exchanges of research staff[48]. Between 2007 and 2014, 3,454 UK-based researchers received funding from MSCAs to work in different countries, sectors or disciplines[49].

Individual students and researchers and the UK as a whole gain substantial benefit from international mobility. If the UK can no longer access EU support for mobility, alternative mechanisms must be put in place to enable UK students and researchers to gain international experience.

Research and innovation facilities and infrastructures

The EU member states host a variety of world-class science and engineering research facilities. These facilities and the UK's access to them, are partly supported by the EU. Although most national facilities are built, funded and managed at the national level, the EU supports transnational and virtual access, networking and joint research activities[50]. From 2007 to 2013, the EU supported 3,539 UK-based researchers to access over 1,055 European facilities and assisted international researchers in accessing 107 UK national research facilities[51].

The European Strategy Forum on Research Infrastructures aims to support a coherent and strategy-led approach to policymaking on research infrastructures in Europe and plays a major role in decisions about the planning and implementation of new or improved research infrastructures across Europe.

43 ***The role of European Union membership in UK science and engineering research***, CaSE, 2016, p12

44 ***Growing the best and the brightest: The drivers of research excellence***, Economic Insight, 2014, p5

45 Indicators within the international outlook group in the THE World University Rankings include: international-to-domestic student ratio; international-to-domestic staff ratio; international collaboration. These account for 7.5% of the overall score: **World University Rankings 2015-2016 methodology**, *Times Higher Education*, 2015

46 3,076 incidents were recorded across the UK between 16 and 30 June, an increase from 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

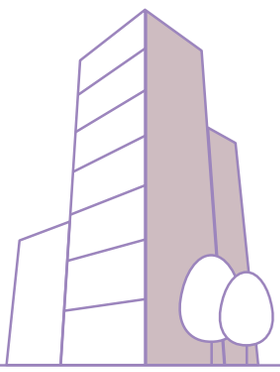
47 **Erasmus+ statistics 2014**, European Commission, 2015, p2

48 ***Marie Sklodowska-Curie actions, A pocket guide***, European Commission, 2014

49 **FP7 – People Marie Curie Actions, Country fact sheet: United Kingdom**, Marie Sklodowska-Curie Actions, 2015, p1

50 ***UK research and the European Union, The role of the EU in funding EU research***, Royal Society, 2015, p20

51 ***UK research and the European Union, The role of the EU in funding EU research***, Royal Society, 2015, p20



From 2007 to 2013 the EU supported

3,539

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to access over

1,055

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Several intergovernmental organisations are part of the European research landscape and are largely independent of the EU, such as CERN and EMBO, while others are directly managed by the EU such as the International Thermonuclear Experimental Reactor (ITER).

Continued access to, and sustainable financial support for, such world-class science and engineering research facilities, including those based in the EU, is essential for UK research and innovation. It will be crucial to understand the extent of the UK's engagement with research and innovation facilities and infrastructures and the role of the EU in these interactions.

Innovation

Innovation is critical to the UK's economy and productivity[52]. There is widespread agreement across the UK engineering community that international collaboration brings major benefits to engineering innovation[53]. Collaboration gives UK businesses and organisations that specialise in innovation, such as the Catapult centres and RTOs, access to a broader range of knowledge, people and facilities than could be obtained in the UK alone, and enables new ideas to be generated, shared and refined.

Innovation also has a key role to play in increasing productivity; human capital, in the form of individual and organisational skills, is, in turn, crucial to innovation[54]. Sectors with high concentrations of graduate engineers report greater than average levels of innovation activity and innovation-related income alongside greater productivity[55]. The significant role that EU funding has played in supporting innovation in UK-based companies is set out in Theme two.

Start-ups

Early-stage companies have an important role in the innovation ecosystem and the UK is home to some of Europe's most successful cities for engineering and tech start-ups[56]. The European Startup Monitor, which represents more than 2,300 start-ups with more than 31,000 employees in all 28 European member states, showed that 25% of UK start-ups were founded by non-UK EU nationals and 45% of UK start-up employees come from non-UK EU countries – the highest proportion of non-own country EU nationals employed across the 13 countries surveyed (the average was 21%[57]). Consistent with this, Dr Hermann Hauser KBE FREng FRS, Co-founder of Amadeus Capital Partners, reports that 40% of CEOs of Amadeus portfolio companies are from outside the UK.

A TechCity UK survey of founders and leaders of early-stage tech businesses found that 51% believed that it would get more difficult to recruit and retain the best people following the UK's exit from the EU; 70% wanted to hear a clear message on EU residents' ability to live and work in the UK; 79% wanted improvements to the visa system; and 22% expected to scale back their planned growth ambitions following the referendum vote[58].

Other countries in the EU have been quick to seize the initiative in this period of uncertainty, encouraging UK-based start-ups to relocate. Berlin has been especially proactive, with the Berlin Senator for Economics, Technology and Research writing directly to a number of new businesses and opening an office in London to target start-ups considering relocation[59].

While it is unclear how collaborations involving UK companies will be affected by leaving the EU, there is an opportunity to develop new programmes to facilitate truly global partnerships rather than those focused only on EU-based organisations.

With its strong reputation for innovation, the UK is starting from a strong position; nevertheless, enabling collaboration will require proactive government action to determine clear objectives and establish a strategic policy framework and funding mechanisms for achieving them.

52 ***Investing in Innovation***, Royal Academy of Engineering, 2015, p2

53 **Submission to House of Lords Select Committee on Science and Technology: The Relationship between EU Membership and the Effectiveness of Science, Research and Innovation in the UK**, Royal Academy of Engineering, 2015, p5

54 ***Innovation matters: Reviving the growth engine***, McKinsey & Co., 2013

55 ***Assessing the economic returns of engineering research and postgraduate training in the UK***, Technopolis Group, 2015

56 ***The Global Startup Ecosystem Ranking 2015***, Compass, 2015, p57-61 and **European Digital City Index 2015**, Nesta /, European Digital Forum, 2015

57 **European Startup Monitor**, 2015

58 **Cause for Optimism as UK Tech Rises to Brexit Challenge**, Tech City, 2016

59 **Germany is writing to UK startups to try and persuade them to move to Berlin after Brexit**, Business Insider UK, 2016

Major projects and infrastructure

Ensuring progress towards the government's vision of driving economic growth through investing in infrastructure[60] will need coherent policies on skills. UK infrastructure businesses employ many thousands of EU citizens and rely on the ability to bring in specialists. The construction sector also depends on a transitory EU workforce. Skilled labour from other EU countries makes up 9% of the UK construction workforce (the third most reliant sector after hospitality and manufacturing)[61].

The 2016 National Infrastructure Pipeline (NIP) details 602 major economic infrastructure projects and programmes planned to 2021, including 24 individual developments valued at £1 billion or over[62]. Delivery of the programmes and projects in the NIP will need innovative and productive techniques that will require new and different mixes of skills and experience[63].

The projects and programmes in the NIP are forecast to create a demand to recruit and train nearly 100,000 additional workers by the end of the decade. In addition, the mix of skills required to deliver the investment plans will change over time, leading to a need to also retrain and upskill around 250,000 of the existing workforce over the next 10 years[64].

There can be no doubt that the country needs skilled workers to build, maintain and operate its economic infrastructure. Uncertainty about the status of EU workers in the UK is likely to exacerbate recruitment difficulties, resulting in increasing costs where demand for labour outstrips supply and the risk of project delays[65]. This will be particularly relevant for major developments such as High Speed 2, Thames Tideway and electricity generation projects, such as Hinkley Point C.

Government capacity

The government faces major new challenges as it seeks to manage the UK's exit from the EU, explore new approaches to boosting international trade and develop an industrial strategy.

"There is a now a real opportunity for government to transform the way it does things, to be imaginative, agile and innovative."

Sir Martin Sweeting OBE FREng FRS, Founder, Surrey Satellite Technology

Nevertheless, the government is likely to need to acquire new capabilities to replace functions previously delegated to the European Commission or associated bodies. For example, the European Aviation Safety Authority (EASA) regulates the EU's civil aviation market and is also responsible for safety, airworthiness and certification, which the UK has been heavily involved in. Once the UK leaves the EU, if EASA regulation no longer applies, ADS (the trade body for British aerospace) estimates it would take a minimum of 10 years for the UK authorities to build up sufficient capacity.

Even assessing which competencies the UK needs to build up will require expertise within the civil service that may not currently exist. As Colin Smith CBE FREng FRS, Group President, Rolls Royce, says: *"It is crucial that we maintain membership of, and regulation by, the European Aviation Safety Agency. Anything else will bring cost and confusion in equal measure."*

Although the EASA regulation will no longer apply as a matter of EU law, it should be possible to arrive at a workable alternative arrangement ensuring the UK's continued participation, albeit on a different basis. EASA has non-EU members, such as Norway and Switzerland, although they do not have a vote, and there are Working Arrangements with Pan-European Partners, such as Turkey.

Government capacity over the coming years is likely to be pressured to an unprecedented degree and the engineering profession stands ready to assist government in any way that it can to help meet this increase in the demands on government, particularly in areas where technical expertise is required.

Box 4. ITER case study

The International Thermonuclear Experimental Reactor (ITER) is an international collaborative project to demonstrate the potential of nuclear fusion as an energy source. Its results could dramatically change the world's energy landscape, opening the way to a safe, affordable, inexhaustible and CO_2-free source of energy. ITER is currently under construction at Cadarache in France. Among its seven members (EU, USA, China, Japan, India, Russia and South Korea), the EU is the largest contributor.

UK industry has been able to win contracts worth around €200 million to deliver components for the project. This benefits the economy directly, through spin-out technologies, such as robotics and advanced materials, and skills development. For example, Atkins is the architect-engineer responsible for the design, procurement and construction management of all the buildings, site infrastructure and services, employing around 60 staff on the project.

The UK's involvement in ITER is not conditional on being an EU member state but being part of a bigger grouping allows more influence over the project than there would be as an individual country. As such, it is critically important that the UK communicates a positive and assertive message to international partners to maintain their confidence in the UK as a collaborator, active partner and innovator.

60 **Budget 2016**, HM Treasury, 2016, para 1.6
61 ***Brexit: impact across policy areas***, House of Commons Library, 2016, p375
62 **National Infrastructure Pipeline Spring 2016**, HM Treasury/IPA, 2016
63 ***National Infrastructure Delivery Plan 2016–2021***, IPA, 2016, p102
64 **National Infrastructure Pipeline 2016**, HM Treasury/IPA, 2016 p102
65 ***Infrastructure 2050***, Balfour Beatty, 2016, p2

Recommendations

Engineering success is based on people at all levels, from technicians, researchers and specialists through to business and university leaders. The engineering workforce is highly mobile and thrives on collaboration. The UK has a world-class research base and world-renowned engineers across all sectors. However, the UK along with many other nations, is already experiencing a serious engineering skills crisis and the impact on this of leaving the EU needs to be carefully managed.

It is important that the UK continues to be welcoming, open for business, and an active and leading part of the international research, innovation and business communities. To foster this, government and the engineering community must:

- seize the opportunity to use the combination of leaving the EU and the commitment to a new industrial strategy to take decisive action on the UK's engineering skills crisis

- work with industry to identify the gaps in essential skilled engineering occupations that cannot be filled domestically in the short term and develop straightforward and cost-effective solutions.

In negotiating the UK's exit from the EU, government should aim to:

- maintain ease of intra-company transfers, recognising that many companies require their engineers to move freely to support and fulfil contracts

- ensure that talented students, academics and practising engineers have certainty about the opportunities to study and work in the UK

- maintain or enhance support to enable UK students, academics and practising engineers to gain international experience including in the EU.

Theme two: Finance and markets

Given that engineering contributes at least 20% of gross value added to the UK economy and accounts for half of the UK's exports[66], a vibrant engineering profession can play a key role in supporting UK economic and social development after the UK leaves the EU, as well as during the period of transition.

Investors and financiers may delay their decisions because of the potential scale of change and uncertainties, such as the extent to which the UK would choose to modify EU Directives or standards[67].

The effects of the UK leaving the EU are unlikely to be evenly spread across the country. Northern Ireland, Wales and Cornwall in particular are significant beneficiaries from the EU budget, much of which is allocated on regional bases.

Single market(s)

The single market refers to the EU as one territory without any internal borders or other regulatory obstacles to the free movement of goods and services. It has been an important feature of the UK's involvement in the EU[68].The single market addresses non-tariff measures such as standards and other regulatory barriers to trade. This is important for the UK as trade in services does not tend to be affected by tariffs or customs checks.

Recently, the EU has intensified efforts to integrate markets in areas where engineers are particularly active, for example by further developing the Energy Single Market and the Digital Single Market. Access to specific elements of the EU's single market, such as energy and digital, has clear benefits to the UK. The UK has had significant influence in the development of both, successfully advocating for approaches that emphasise the need for market liberalisation rather than intervention. This means that whatever the shape of the future relationship, it will be important to maximise access to these single markets. Therefore, irrespective of other outcomes, the UK government should strive to continue its membership of the Energy Community and seek collaboration in the Digital Single Market.

Energy Single Market

UK energy industries account for 3% of gross domestic product (GDP), 12% of total investment and 35% of industrial investment. In the UK, 159,000 people are directly employed in energy industries and an estimated 160,000 indirectly by UK oil and gas production[69].

Establishing a fully integrated internal energy market is a priority policy area for the EU, focused on redesigning its energy systems to remove technical and regulatory barriers and move towards an energy union. EU legislation regulates access to this single market.

The UK has been a leader in the development of the internal energy market and EU policy is consistent with the UK's emphasis on unbundling and renewables. The UK has also been successful in ensuring a focus on the economic benefits of the single market but less so on accompanying regulation[70]. If the UK is outside the EEA and/or Energy Community as policy develops to a fully integrated market, this is likely to change and such arrangements will involve significantly less UK political influence over regulation.

One intention of the Energy Single Market is to foster security of supply through greater harmonisation and further physical interconnection. Given the increasingly multinational nature of energy generation, distribution and supply – particularly in the UK – withdrawal from the EU itself would probably not affect progress towards integration[71]. However, the precise impact depends on the terms of new relations with the EU.

Box 5. Energy Community

Established in 2005, the Energy Community extends the EU's energy market to accession and neighbouring states with an aim to create an integrated energy market between the EU and eight 'contracting parties', including Ukraine and Serbia. Energy Community members adopt the EU's energy legislation and regulations without the ability to influence future rules.

By retaining membership of the Energy Community on exiting the EU, the UK could maintain access to the EU's energy market. Membership is likely to involve the UK setting its own renewables and other targets in line with the EU's.

In an extra-EEA/Energy Community situation, the UK would likely cease to be a member of the Agency for the Cooperation of Energy Regulators (an EU agency) and the Council of European Energy Regulators (a not-for-profit association), which have considerable influence in forming regulatory frameworks.

As energy systems become more physically and financially interconnected, it is clear that from an energy security and cost point of view, the UK would be best served by retaining membership of the Energy Community, irrespective of other aspects of its relations with the EU.

"We are fully involved with EU institutions and statutory bodies that maintain and develop an effective EU energy market. It could be detrimental for UK energy imports and exports if we were to be outside these arrangements. Therefore, we should look to maintain tariff free trade and harmonised markets in energy with the EU."

Michael Jenner, Head of Policy at National Grid

66 ***Assessing the economic returns of engineering research and postgraduate training in the UK***, Technopolis, 2015, p2

67 See, for example: **U.K. Construction Shrinks as Brexit Delays Investment Projects**, Bloomberg, 2016 and **UPDATE 3-Britain's Capita feels Brexit chill as profits, shares take a hit**, Reuters, 2016

68 **The EU single market: the value of membership versus access to the UK**, Institute for Fiscal Studies (IFS), 2016

69 **UK Energy in Brief**, Department for Business, Energy and Industrial Strategy (BEIS)/ONS, 2016, p4

70 ***Liberalisation, harmonisation and mutual recognition: Time to rethink the balance of competences between the EU and Member States?***, Fantzou, E., 2014, p3

71 ***Brexit: impact across policy areas***, House of Commons Library, 2016, p92

Digital Single Market

One of the few areas where there are barriers to free movement in the single market is around digital goods and services. The European Commission first published its strategy on a Digital Single Market in 2015, as part of its *Digital Agenda for Europe*[72]. The Digital Single Market is based on three main pillars: access to digital goods and services, regulation of networks, and industrial growth[73]. It seeks to move to a digitally centred economy, further harmonising EU member states' regulation and simplifying trading between member states.

Mobile telecommunications and the internet have been two of the greatest technical successes of recent times and the UK remains at the heart of their development. The internet now makes the second largest contribution to the UK economy behind the property sector, having overtaken manufacturing and retail. In 2015, the internet economy contributed 8% of GDP, a greater proportion than in any other G20 country [74].

In 2015, the internet economy contributed 8% of GDP, a greater proportion than in any other G20 country

A main objective of the Digital Single Market is to improve investment opportunities for research and innovative business and expand prospects for trade in digital services. In its contribution to the development of the Digital Single Market, the UK has taken the position that market principles should be applied equally online as elsewhere[75], using a light touch and leaving developments to the markets[76].

The Digital Single Market is of particular relevance to services that are of relatively great importance to the UK[77]. For example, in the financial technology sector there have been recent regulatory initiatives led by the Financial Conduct Authority, including Project Innovate, which seeks to introduce innovative financial products and services to the market. The decision to leave the EU risks undermining the UK's dominance and influence in this policy area.

While still in development, the Digital Single Market, or at least the research aspects of it such as the European Commission's Internet of Things Large Scale Pilots[78] and e-SENS, which aims to facilitate the deployment of cross-border digital public services[79], are open to the Associated Countries.

In the digital sector, the UK is one of the leading member countries in developing a regulatory context designed to enable technology businesses to succeed[80]. Investors will be monitoring how the evolving exit discussions, process and related trade agreements will affect the attractiveness of UK hi-tech businesses compared with EU and global competition.

No matter what form the UK's future relationship with the EU takes, cross-border e-commerce will continue to be of great importance to the UK. Therefore, if businesses are to continue to innovate and consumers benefit from access to goods and services, the right frameworks must be put in place to maintain digital access to the EU.

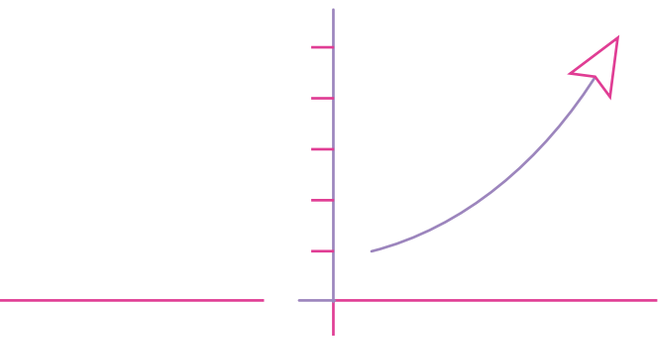
Cybersecurity

2018 is due to be an important year in the EU for cybersecurity as the General Data Protection Regulation (GDPR) and the Directive on security of network and information systems (NIS Directive), the 'Cyber Directive', come into force. The purpose of GDPR is to establish commonality of data protection for EU citizens[81] whereas the NIS Directive aims to ensure capacity building and planning requirements, exchange of information, cooperation and common security requirements[82].

As it is likely that the UK will not have left the EU by 2018, it will apply to the UK. As an EU Regulation, the GDPR will automatically come into effect in the UK, but the NIS Directive will require primary or secondary legislation to be passed by Parliament.

Whether the UK could rescind the legislation on leaving depends on the outcome of negotiations. Nevertheless, as the UK will continue to trade with the EU, closely comparable data protection and cybersecurity laws will be necessary to avoid barriers to trade.

72 ***Digital Agenda for Europe***, Eur-Lex, 2010
73 **Digital Single Market**, European Commission, 2016
74 **The Internet Economy in the G20**, Boston Consulting Group, 2015, p8
75 ***UK vision for the EU's digital economy***, Prime Minister's Office, 2014, p2
76 ***The United Kingdom and the (Digital) Single Market***, Institute for European Studies, 2016 p2
77 **Everything you might want to know about the UK's trade with the EU**, Full Fact, 2016
78 **Which EU Internet of Things Large Scale Pilots? Consultation and Invitation for Commitment**, European Commission, 2014
79 **e-SENS project extended: building the European Digital Market through innovative ICT solutions**, European Commission, 2016
80 **Brexit: Impact on the technology sector**, DLA Piper, 2016
81 **Regulation (EU) 2016/679 of the European Parliament and of the Council**, EUR-Lex, 2016
82 **The Directive on security of network and information systems (NIS Directive)**, European Commission, 2016



The EIB has invested €76 billion in 509 UK projects since 2000.

The greatest two sectoral beneficiaries have been energy with 109 projects and education with 67

European Investment Bank

Investment in infrastructure is capital intensive with long rates of return. The uncertainty around the nature of leaving the EU could potentially postpone investment decisions until the relationship becomes clearer.

One major source of capital finance for economic infrastructure is the European Investment Bank (EIB), where the UK has a 16% shareholding. The EIB has invested €76 billion in 509 UK projects since 2000. The greatest two sectoral beneficiaries have been energy with 109 projects and education with 67[83].

Financing has included a £525 million loan for the Beatrice Offshore Windfarm off the coast of Caithness, upgrading of the M8 between Glasgow and Edinburgh, and a £700 million loan for the Thames Tideway tunnel. Most recently, in September 2016, the EIB announced it was committing £82 million for the Humber Gateway windfarm transmission link. There are 18 projects in the UK awaiting decisions on EIB financing, from rolling stock for the East Anglia franchise (£200 million requested) to Welsh gas pipelines (£150 million)[84].

Shareholders in the EIB must be EU member states. Therefore, the likelihood is that the UK would have to relinquish its equity and role in making lending decisions. This would suggest that EIB finance for UK projects would decrease but if the UK became a member of the European Free Trade Association (EFTA) it would be eligible for access to the EIB's EFTA Loan Facility[85].

The EIB currently represents an important source of infrastructure financing for projects in different regions of the UK. If the UK no longer had access to this, it would be vital to ensure that other financing mechanisms were in place.

EU research and innovation funding programmes

Engineering is instrumental to delivering the economic and productivity gains associated with investment in research. It provides the means to convert research into new and improved products and services that can (and do) make a substantial contribution to the UK economy[86]. With its net financial benefit to the UK, losing access to the EU's research and innovation funding programmes could pose a considerable risk to the quality and quantity of UK research and innovation[87].

Research funding

The UK has a strong track record in securing EU research funding. In the seventh European Framework Programme (FP7), which ran from 2007 to 2013, the UK came second only to Germany in terms of grants held at 15% and in total budget share, at 17%, equating to €7 billion[88].

The UK also does exceptionally well from European Research Council (ERC) funding, which backs investigator-driven research. The UK accounted for 17% of ERC-funded principal investigators during FP7 and four out of the top 10 host institutions, more than any other country[89]. UK-based academics working within the physical sciences and engineering domain won 12%, 20% and 15% of the ERC Starting, Consolidator and Advanced Grants respectively, substantially more than those won by other participant countries, with the exception of France and Germany[90].

UK higher education institutions (HEIs) receive a significant proportion of their funding from the EU, with more than half of the UK's HEIs drawing 20% or more of their external research income from the European Commission according to the Higher Education Funding Council for England[91] (see Theme one). EU funding is of particular importance to engineering research conducted in UK HEIs, where the amount of EU government funding has doubled in value from 2007/08 to 2013/14[92].

However, EU funding is not evenly distributed, either by HEIs or even within different engineering areas. For example, IT, systems sciences and computer software engineering received 30.9% of their research income from EU government bodies in 2012/13, equating to £136,424 million, and positioning these subjects as the second most dependent discipline when analysed according to the 45 Higher Education Statistics Authority (HESA) cost centres[93].

83 **Finance contracts signed - European Union: Breakdown by Country**, EIB, 2016

84 **United Kingdom Finance Contracts Signed**, EIB, 2016

85 **The European Free Trade Association**, EIB, 2016

86 ***Assessing the economic returns of engineering research and postgraduate training in the UK***, Technopolis Group, 2015, p6

87 **Research and Innovation: After the EU Referendum**, UK National Academies, 2016

88 **Seventh FP7 Monitoring Report 2013**, European Commission, 2015, p171

89 **Seventh FP7 Monitoring Report 2013**, European Commission, 2015

90 **European Research Council**, European Commission, 2015

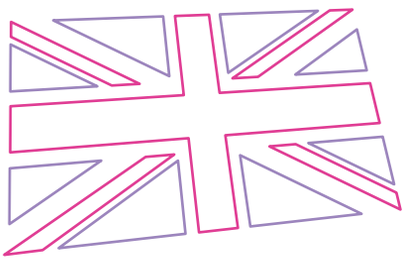
91 **Written evidence submitted by the Higher Education Funding Council for England (HEFCE) (LEA0230)**, HEFCE, 2016

92 **The role of the European Union membership in UK science and engineering research**, Engineering Professors' Council and Campaign for Science and Engineering, 2015

93 **Submission to House of Commons Science and Technology Committee inquiry on Leaving the EU**, Research Councils UK, 2016

It is too early for quantifiable evidence but surveys of academic institutions and anecdotal reports suggest that EU collaboration with UK researchers is being put on hold or has been scaled back since the referendum[94]. The recent announcement that the UK government will guarantee project funding and underwrite bids[95] is, of course, welcome in maintaining confidence until 2020.

providing platforms for companies to collaborate across competitive boundaries[102]. This matters because, as BT has pointed out: *"In global markets, like ICT, today's collaborative research is tomorrow's area of commercial competition"*[103].



UK SMEs are particularly successful in accessing EU funding programmes to support innovation, with SMEs accounting for 13% of the UK's total FP7 budget share while corporates received only 5%

Innovation

UK SMEs are particularly successful in accessing EU funding programmes to support innovation. SMEs accounted for 13% of the UK's total FP7 budget share while corporates received only 5%[96]. The success of UK businesses and organisations in securing funding has continued with Horizon 2020, the EU's largest research and innovation programme, which is providing €80 billion of funding from 2014 to 2020[97]. Here, the UK has been the greatest beneficiary of the Fast Track to Innovation scheme[98] and second only to Spain for SME Instrument Phase 2 funding[99]. Overall, only Germany has secured more funding for industry than the UK from Horizon 2020 competitions[100].

A European Commission assessment of the motivations for SME engagement in FP7 concluded that "access to financial assistance not available nationally or regionally" was a particular motivation for UK SMEs applying for EU funds[101]. The UK's proposed industrial strategy should ensure smaller firms are fully involved in the research, development, demonstration, and deployment process.

It is also important to note that the benefits of EU membership to UK innovation have been greater than simply access to funding from EU programmes. EU collaboration helps drive forward innovation targeted at addressing 'grand challenges', such as climate change and securing critical resources, by

Multi-year programmes

While the level of EU funding for both UK research and innovation is significant, the multi-year investment cycle also benefits the UK. The seven-year programmes allow greater certainty of funding and opportunities to cross-link with other projects than is the case for one-off grants. The funding cycles characterised by these Multiannual Financial Frameworks, such as FP7 and Horizon 2020, are stable and longer than most of the UK's national programmes. This enables UK researchers, institutions and businesses to deliver research and innovation excellence with long-term planning, and can have a positive impact on leverage as the long-term visibility can give investors greater confidence.

The government's attention must also focus, as a priority, on addressing and planning for potential funding gaps beyond 2020. UK access to future EU funding for research and innovation is dependent not only on the determination of exit conditions but also the nature of the next framework programme covering 2021 to 2027. Negotiations are due to be officially initiated by the European Commission in 2018, when the UK is expected to still be a full member of the EU and therefore, according to current policy, will still formally be able to influence decisions[104].

94 **UK scientists dropped from EU projects because of post-Brexit funding fears**, Guardian, 2016

95 **Chancellor Philip Hammond guarantees EU funding beyond date UK leaves the EU**, HM Treasury, 2016

96 **Seventh FP7 Monitoring Report 2013, European Commission**, 2015, p171

97 ***What is Horizon 2020?***, European Commission,

98 **The UK is once more the top beneficiary of EU innovation funding**, European Commission, 2016

99 **£1m EU funding for UK SME working on a healthcare data platform**, European Commission, 2016

100 Kevin Baughan, Chief Development Officer, Innovate UK, **Oral evidence: Leave the EU: implications and opportunities for science and research**, House of Commons Science and Technology Committee, 13 July 2016

101 **Performance of SMEs within FP7, An interim Evaluation of FP7 components, Vol 1. Main Report**, European, Commission, 2014, p135

102 ***The role of European Union membership in UK Science and engineering research***, CaSE, 2016, p1

103 **Response to the House of Commons Science and Technology Committee call for input on leaving the EU: implications and opportunities for science and research**, BT, 2016

104 **The process for withdrawing from the European Union, HM Government, 2016 p20 and The UK's influence in the EU in the run up to Brexit**, Institute for Government, 2016

Public-private partnerships

Through public–private partnerships (PPP) with industry and member states, EU research and innovation funding pools Europe's resources to tackle the biggest challenges and support sector competitiveness, which develops alliances with national and regional programmes and encourages greater private investment in research and innovation[105], (see Box 6 for an example).

Such PPPs support large-scale multinational research activities, which often have an emphasis on SME participation, in areas of major interest to European industrial competitiveness so that novel products and processes are quickly adopted in the marketplace (see Box 6). Many of the activities facilitated by PPP, such as creating large-scale demonstrators, are often inherently international activities and may be considered too risky for one country to embark on alone. Furthermore, the long-term nature and visibility of PPP encourages strategic R&D investments. The amount of funding provided by the EU, and the leverage this achieves, combined with its ability as a neutral convener to bring together industrial competitors to collaborate and work towards common goals is currently greater in scale than most equivalent UK-driven activities.

Box 6. Clean Sky programme

The Clean Sky aeronautical research programme[106] is a public-private partnership (PPP) that was established in 2008 between the European Commission and the aeronautics industry. This Joint Technology Initiative aimed to reduce the impact of aviation on the environment while safeguarding competitiveness, supporting economic growth of the aeronautical sector in Europe and contributing to targets for reducing emissions and noise in air transport in Europe[107].

Progressing on from Clean Sky, Clean Sky 2 was launched in 2014 with support from Horizon 2020, with the aim of delivering breakthrough technologies to be incorporated into the next generations of aircraft from 2025 onwards[108]. To date, over 600 participants, including large corporates, SMEs and academia from 24 European countries, have been involved. There are 69 participants from the UK including Rolls-Royce, which has a leading role in the Sustainable and Green Engines (SAGE) integrated technology demonstrator[109].

106 **Clean Sky**, Clean Sky, 2016
107 **Mission & Objectives**, Clean Sky
108 **About Clean Sky 2**, Clean Sky, 2016
109 **Sustainable Green Engine,** Rolls-Royce

105 Partnerships with Industry and Member States, European Commission, 2016

European Investment Fund

The European Investment Fund (EIF) is a specialist provider of risk finance to benefit SMEs. Working through banks, guarantee and leasing companies, micro-credit providers and private equity funds, the EIF is the source of 25% of all venture capital funding in Europe and plays a role in attracting further private investment. From 2011 to 2015, the EIF supported 144 venture capital and private equity funds in the UK, including Amadeus Capital Partners, and had a total of €2.3 billion in commitments in the UK, leveraging a further €13.8 billion of additional funds[110]. It will be crucial for the UK to maintain access to the support it provides for start-up companies across the engineering and technology sectors.

Equity investment

Early indications suggest that uncertainty around the referendum has had an impact on the UK equity investment scene, although it is hard to prove causation. According to Beauhurst, which looks at equity investment into private UK-based fast-growth businesses, total deal number has decreased by 22% and investment value fallen by 11% in the first six months of 2016 compared to the last half of 2015[111]. While deals larger than £10 million were the only investment bracket to see an increase in numbers, deals worth less than £250,000 declined most sharply at 29%, which is particularly concerning to the UK's start-ups[112]. By their very nature, start-ups are particularly vulnerable to reductions in access to finance and often have little resilience to external changes.

"New technology SMEs don't have the financial resources of large companies or universities, yet are trying to generate jobs in UK manufacturing. It will be critical that the UK government considerably improves its understanding of innovation support for engineering and manufacturing, especially young engineering companies."

Professor Marcus Newborough FREng, Development Director, ITM Power

Future funding

The risk of losing access to EU sources of funding is likely to impact variably on different disciplines, universities and businesses. 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[113].

Likewise, the Common Agricultural Policy (CAP) provides 55% of UK total income from farming under the two main pillars of the basic payment scheme (also known as direct payments) and funding for the wider rural economy, which can also be used to invest in technological solutions in the agri-tech sector.

110 ***EIF in United Kingdom***, European Investment Fund, 2016, p1
111 **The Deal H1 2016**, Beauhurst, 2016
112 **The Deal H1 2016**, Beauhurst, 2016
113 **Written evidence submitted by the Institute of Acoustics (LEA0073)**, Institute of Acoustics, 2016

For the UK to mitigate these risks, government must ensure that it has a comprehensive understanding of which areas have a high dependency on EU funding sources and why. Government would then be better equipped to assess priorities for deploying replacement funds.

As an EU member state, the UK has been able to shape the EU research and innovation agenda to maximise alignment with the UK's outlook and priorities. After it leaves the EU, even if it retains the ability to participate in European research and innovation funding programmes, it is far less likely to be able to exert this kind of influence.

It is possible for non-EU member states to access European research and innovation programmes on the same terms as member states through Associated Country status (see section below). They contribute to budgets according to a formula related to their GDP but do not have a formal role in voting on its direction, although they can influence during the consultative phase.

The strength of the UK's research base and innovation performance means that some EU members or those with Associated Country status may consider that EU research and innovation support programmes will be weaker if the UK is no longer a participant, and UK experts are generally held in high esteem across the European research community[114]. The current categories of relationship held by non-EU countries that participate in Horizon2020, as described, should be seen as reference points rather than templates for the future relationship between the UK and EU research and innovation programmes. The government should be seeking the closest possible association with European research and innovation programmes that reflects and will enhance the UK's considerable strengths in these areas[115].

If the UK is unable to secure continued access to EU research and innovation programmes, it is imperative to create suitable replacements. Any such programmes would need to replicate the successful aspects of EU programmes, with support targeted at collaboration and partnership at many different levels, including researchers, universities, corporations and SMEs. At a time when there is growing public support for collaboration with developing countries through the Newton and Global Challenges Research Funds, it is important that funding sources are also available to support collaboration with other countries and on topics that do not necessarily align with international development goals.

While there are important benefits to being part of the EU's research and innovation programmes, it is also recognised that the programmes have certain limitations. One of these is the complex and burdensome administration and monitoring procedures[116]. Any new relationship with the EU research and innovation programmes should seek to minimise the administrative burden incurred, especially if the UK is to have more limited access to or influence over the funding available.

Associated Country status

Fourteen countries hold Associated Country status in relation to Horizon 2020, with Switzerland holding partial association[117]. Associated Country status allows legal entities from these countries to participate in Horizon 2020 under the same conditions as legal entities from EU member states. Associated Countries contribute financially to the framework programmes proportionally to their GDP. Unlike EU member states, Associated Countries do not have a formal role in negotiations and shaping the research and innovation programmes, although they do have observer status on the ERA's strategic policy committees.

Association to Horizon 2020 is governed by Article 7 of the Horizon 2020 regulation. Association is open to acceding, candidate and potential candidate countries; EFTA members; or countries and territories covered by the European Neighbourhood Policy (ENP), if they fulfil a set number of criteria[118]. Association takes place through conclusion of an International Agreement and the terms of association differ slightly by country.

EFTA allows free trade between its four member countries: Iceland, Liechtenstein, Norway and Switzerland. EFTA also manages the EEA membership of three of the four EFTA member countries, which gives Iceland, Liechtenstein and Norway access to the EU Internal Market. EFTA-EEA members therefore have to abide by the four freedoms of the EU, including freedom of movement. Switzerland is the exception and is not a member of the EEA, having agreed its own bilateral arrangements with the EU.

Associated Country status is offered through the ENP on condition of demonstrating domestic reform on specific issues, such as commitment to democracy, the rule of law and respect of human rights. Israel, Tunisia and Georgia are examples of countries that have Associated Country status through ENP agreements.

For the UK to seek Associated Country status, the most likely mechanisms to do so would be through continued access to the EEA, or by negotiating bilateral treaties with the EU that include Associated Country status, such as that negotiated by Switzerland. However, following the current precedent, in both cases it is likely that the UK would be requested to continue to honour the free movement of people. Switzerland's recent refusal to ratify a protocol on the free movement of persons related to Croatia has resulted in restrictions to its Horizon 2020 participation. If Switzerland does not ratify the protocol by February 2017, its agreement will be terminated and it will be treated as a non-associated country[119].

114 **Research and Innovation: After the EU Referendum**, UK National Academies, 2016

115 **EPSRC and European funding**, EPSRC, 2016 and **FET Flagships**, European Commission, 2016

116 **Royal Academy of Engineering - Written evidence (EUM0066)**, Royal Academy of Enginering, 2016

117 **Associated Countries**, European Commission Directorate-General for Research and Innovation

118 **Regulation No 1291/30 of the European Parliament and of the Council**, *Official Journal of the European Union*, 2013, p111

119 **Swiss participation in Horizon 2020 (version June 2016)**, European Commission, 2016, p3

Non-associated third country status

Non-associated third countries have bilateral agreements that permit them to participate in aspects of the framework programmes. Access is often subject to restrictions, for example they cannot host ERC awards. Non-associated third countries are generally not eligible for direct funding and do not contribute financially to the framework programme budget, although they normally have to cover their own expenses for any involvement. Unlike EU member states, non-associated third countries do not have a formal role in negotiations and shaping the research and innovation programmes. Unlike Associated Countries, they do not normally have observer status on ERA's strategic policy committees.

If the UK was to seek non-associated third country status, it would be likely that the UK would only be permitted to participate in specific elements of the framework programmes; it would have no influence in the shaping of the research and innovation programmes; it would have to cover the funds needed to participate in any activities and collaborations; and it is unlikely it would be able to coordinate any activities.

European Research Area (ERA)

The European Research Area (ERA) covers EU member states and Horizon 2020 Associated Countries. The ERA's purpose is to move Europe to 'a single market' in research and innovation in medical, environmental, industrial, and socioeconomic research in which researchers, research and technology circulate freely, strengthening knowledge bases, competitiveness and capacity[120]. The ERA includes funding networks (ERA-NETs) to further international collaborations in specific areas. Those involving the UK research community include marine energy, carbon capture and storage, and graphene[121]. The European Research Area and Innovation Committee (ERAC) is a strategic policy advisory committee that advises the European Council, European Commission and member states in the full spectrum of research and innovation issues in the framework of the governance of the ERA. Representation on the ERAC is one way in which the UK currently exerts influence over decisions and discussions relating to research and innovation in the EU.

European Structural and Investment Funds

European Structural and Investment Funds, commonly known as 'structural funds', provide EU member states and regions with assistance to strengthen competitiveness and increase employment. Under the structural funds, there is no provision for Associated Countries.

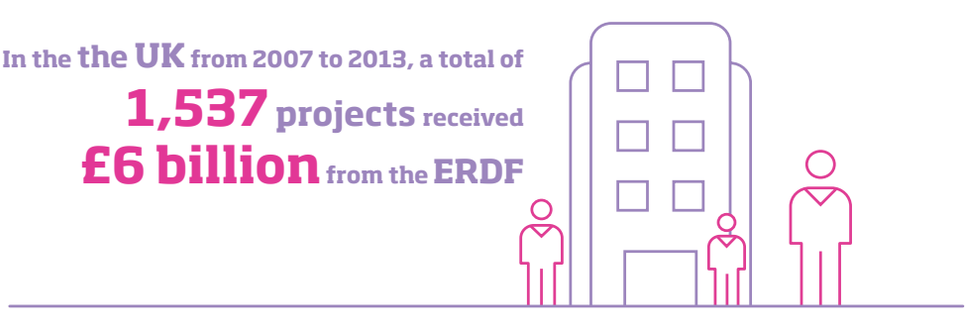
Alongside funds for agriculture, fisheries and less developed countries, the main structural funds are the European Regional Development Fund (ERDF) and the European Social Fund (ESF). Both these funds have an impact on engineering, either through the themes they support or by enhancing skills at regional level.

The ERDF aims to strengthen economic and social cohesion in the EU by correcting imbalances between regions across four thematic areas: innovation and research, digital, SMEs, and low carbon[122].

The ESF invests in people, with a focus on improving employment and education opportunities across the EU[123]. Its priority areas are employment, social inclusion, education and skills, and enhancing institutional capacity.

Structural funding works on seven-year funding rounds, with the current tranche running up to 2020 (although allocated funds can be spent until 2023). The greatest proportion is for less developed regions with GDP lower than 75% of the EU average, which applies to Cornwall and the Isles of Scilly, and West Wales and the Valleys. Most of the remainder of funding goes to 'transition regions' that have a GDP between 75% and 90% of the EU average, which include the Highlands and Islands, Merseyside and Northern Ireland. The allocation of funds to regions is made by the devolved administrations and the Department for Communities and Local Government in England.

In the UK from 2007 to 2013, a total of 1,537 projects received £6 billion from the ERDF including £34 million for the National Graphene Institute in Manchester, £14 million for superfast broadband in Cheshire, and £9 million for the National Composites Centre in Bristol[124].



120 **European Research Area Progress Report 2014**, European Commission, 2014, p2

121 **EPSRC and European funding**, Engineering and Physical Sciences Research Council (ESPSRC), 2016 and **FET Flagships**, European Commission, 2016

122 **European Regional Development Fund**, European Commission, 2016

123 **European Social Fund**, European Commission, 2016

124 **European Regional Development Fund: Written question - 20288**, House of Commons, 2016

In Wales, ERDF projects during this period are estimated to have created 36,640 new jobs and 11,900 new businesses. In Scotland, over the same period estimates are for 44,311 new jobs and 17,474 new businesses, and in the north of England, 70,546 jobs and 18,218 businesses[125].

As structural funds are 'match-funded' by government (at any level), businesses and charities, loss of access would not only result in a reduction in money from the EU itself but also potentially that from co-funders who might not be able to cover 100% of investment alone. It is essential that the industrial strategy puts in place plans to ensure that the regional development needed to underpin inclusive economic growth can be supported when the UK has left the EU.

Foreign direct investment and headquartering

With around 2,000 projects worth a total of £1 trillion, the UK received the highest level of foreign direct investment (FDI) in the EU in 2014[126]. Just over half was from non-EU countries, with the USA accounting for 24%[127]. A significant proportion of the UK's R&D investment now comes from overseas: in 2014, it represented 18% (£5.4 billion) of total UK expenditure on R&D[128]. In addition to direct investment in projects, foreign firms may choose to list on the London Stock Exchange, use the UK as their base for their regional headquarters, or build or develop technical centres of excellence (such as R&D facilities) in the UK, all of which can bring benefits to UK engineering and the wider economy.

At present, the UK has the highest number of European headquarters for multinationals[129] and the UK's membership of the EU is considered to be an important element in attracting foreign companies to headquarter in the UK[130]. Membership allows multinationals based outside the EU to access the single market. There is clearly a risk that some companies could relocate operations from the UK and transfer jobs and economic activity to an EU member state. However, the UK has the perceived advantages over many other EU states of a relatively open attitude to foreign ownership of utilities and assets, a flexible labour market, use of the English language, relative political stability, and lack of movement of capital restrictions[131]. The industrial strategy provides a key opportunity to maximise those strengths and offset risks to the UK's ability to retain and attract FDI.

A House of Commons Treasury Committee investigation into costs and benefits of the UK's EU membership concluded that any negative impacts of the EU on FDI would depend on a range of factors, including the level of access to the single market, any alterations to regulatory frameworks, and future international trade deals[132].

The government must engage proactively with companies currently making major investments in the UK through listing, headquartering or technical centres of excellence to understand the factors that would make them more likely to maintain and increase their UK investments.

125 ***UK regions and European structural and investment funds***, Sheffield Political Economy Research Unit, 2016, p7 and p11

126 ***Inward Investment Report 2014/15***, UK Trade and Investment (UKTI), 2015, p1

127 ***Brexit: impact across policy areas***, House of Commons Library,2016, p32

128 **UK Gross domestic expenditure on research and development: 2014**, ONS, 2016

129 ***The UK – number one for European headquarters***, UKTI, 2015, p1

130 ***Alternatives to membership: possible models for the United Kingdom outside the European Union***, HM Government, 2015, p23

131 **The economic and financial costs and benefits of the UK's EU membership**, House of Commons Treasury Committee 2016, p54 and ***Brexit and the UK's public finances***, IFS, 2016, p40

132 **The economic and financial costs and benefits of the UK's EU membership**, House of Commons Treasury Committee 2016, p53

Box 7. European Space Agency case study

The UK space industry is a strong and coherent industry whose aggregate turnover was valued at £11.8 billion in 2012/13[133]. Its ambitious growth strategy[134] aims to establish the UK as a leading space nation and grow the UK's share of the global market to 10% by 2030. UK government investment in the European Space Agency (ESA)[135] has resulted in the establishment of ESA facilities[136] at Harwell and has allowed the UK to lead on the development of the rover for the 2018 xoMars expedition and access to the International Space Station among other projects[137]. Involvement in ESA-funded science and technology development work has provided UK companies with relevant knowledge and networks so that they are in a better position to win orders from the European Commission for industrial projects, such as Galileo[138] and Copernicus[139]. It has also strengthened their ability to break into international markets.

ESA is separate from the European Commission, so exiting the EU should not have a direct impact on the UK's participation in ESA programmes. However, the UK's ability to procure European Commission industrial projects as a result of this relationship is less certain once it exits the EU. The Horizon 2020 R&D programme is also increasingly perceived to be a 'feeder' for industrial projects, including space projects, and the UK's possible exclusion from this programme is another factor that may limit its ability to win European Commission projects in future. The next procurement of Galileo will take place before negotiations about exiting the EU are decided so it will be necessary

133 ***The Case for Space 2015: the impact of space on the UK economy, A study for the Satellite Applications Catapult, Innovate UK, UK space and the UK Space Agency***, London Economics, 2015, p3

134 ***The Space Innovation and Growth Strategy Main Report***, Space IGS, 2010 and ***UK Space Innovation and Growth Strategy 2015 Update Report***, Space IGS, 2015

135 **UK secures £1.2 billion package of space investment**, Department for Business, Innovation and Skills, 2012

136 These include The European Centre for Space Applications and Telecommunications (ESCSAT) and the European Space Agency's Business Incubation Centre (ESA-BIC).

137 **UK space industry set to rocket with over £200 million of new investment for Europe's space programme**, UK Space Agency, 2014

138 Galileo is Europe's own global navigation satellite system, see: **What is Galileo?**, European Space Agency, 2015

139 Copernicus is the European programme for the establishment of a European capacity for Earth Observation, see **In Focus**, Copernicus, 2016

to address this in the short term as well as further down the line. While the possible relaxation of state aid rules removes barriers[140], it should be noted that the World Trade Organization has its own rules for state support[141]. The continuation of funding to ESA would demonstrate that the UK is strongly aligned with Europe's space programmes even though its relationship with the European Commission has changed. However, if the potential of this funding to bring business to UK companies reduces, it may be necessary for government to reconsider the balance of funding between domestic, European and international programmes.

In 2012/13, approximately 12% of the UK space industry's total turnover came from exports to Europe. With the possible loss of orders from Europe, global trade becomes increasingly important, and correspondingly the appropriate international trade agreements and regulatory environment. There is also a need to maintain the perception by overseas companies that the UK is a good place to locate their business and to invest. One particular concern is that large companies, which have subsidiaries in many countries, could favour their non-UK subsidiaries to deliver whole systems, and any UK subsidiary would not maintain their status as a prime.

Within the sector, the different segments have varying priorities. For example, data protection regulation will be of much greater significance to providers of space applications such as telecoms and earth observation than to space manufacturers. The specific perspectives of the different segments, as well as the priorities for the sector as a whole, will need to be taken into account by government during negotiations. The government needs to develop policies that are able to respond to rapid developments in technology and maximise the potential for economic growth, while balancing competing perspectives that reside within different governmental departments. For example, the UK's ability to compete internationally in the area of earth observation must be carefully balanced with defence and security implications.

Availability of skills, particularly in data analytics, IT and digital technologies, is a major challenge for the space industry if it is to reach its growth targets, and for this a supply of both homegrown and overseas talent will be vital. Indeed, recruiting an international workforce has broader benefits, since employees have the ethos and ability to communicate with international customers as well as the required technical skills.

140 Sir Martin Sweeting, Executive Chairman of Surrey Satellite Technology Ltd, estimated that the process of ensuring compliance with state aid rules impeded the development of a new radar satellite by approximately 18 months, and the company thus lost time in entering a competitive international market.

141 **Transatlantic trade war in the offing after Boeing claims victory following WTO ruling on Airbus's EU subsidies**, *Daily Telegraph*, 2016

Recommendations

The success of the engineering sector is vital to the continued economic prosperity of the nation. UK engineering already competes successfully in the global marketplace. It has the talent and reputation needed to grow even stronger in world markets if given the right conditions and support. The new industrial strategy should provide the perfect framework to enable UK industry and innovation to prosper and the UK engineering community is eager to partner with government to help shape the conditions needed for this to happen.

In negotiating the UK's exit from the EU and reinforcing its place as a global trading nation, it is vital that investor confidence is maintained, market arrangements are carefully considered and funding support mechanisms improved.

In general, to support investor confidence, the government will need to:

- provide stable, coherent and targeted support that will incentivise investment into the UK. State a clear direction that includes a policy framework for both tariff and non-tariff barriers
- create the conditions for the UK to continue to attract a high level of FDI by ensuring that the cost of doing business is competitive and by fostering regulatory frameworks and future international trade deals that make the UK an attractive place to do business.

During negotiations with the EU, the government should aim to:

- continue membership of the Energy Community and alignment with the Digital Single Market
- mitigate the impact of the potential loss of European Investment Bank loans for UK infrastructure projects and provide possible alternative sources of low cost finance
- maintain data protection and cybersecurity policies closely comparable to those of the EU to avoid barriers to trade.

In terms of funding, government needs to ensure that UK researchers and innovative businesses retain the ability to collaborate with partners in the EU and the rest of the world by accessing support targeted at such collaboration and partnership, particularly for SMEs. In particular, government needs to:

- seek the closest achievable association with EU research and innovation programmes and ensure that, if needed, long-term UK funding programmes are available that complement current UK funding streams by supporting international mobility and collaboration, including academic and industry partnerships
- recognise that European funding streams and collaboration frameworks provide crucial sources of innovation support for UK businesses, of all sizes, that will need to be replaced if no longer available
- consider the impact on funding streams for regional development and the devolved nations and identify a future system that will deliver effective, targeted regional development and support.

Theme three: Standards and legislation

A key issue is the degree to which leaving the EU will affect regulations, Directives and standards in the UK.

The success of the European single market as the biggest tariff-free trading market in the world is based in large part on the 'new approach' to legislation and standards. This approach aims to harmonise the essential requirements laid down in Directives with industry-led voluntary standards, leading to a single, common set of requirements for goods and services traded in the single market. UK engineering has invested heavily in this approach and gained significant commercial advantage as a result.

As the negotiations progress, it will be essential to identify and protect those regulations and standards where alignment with the EU is critical for the UK's prosperity. In addition, the UK must maintain influence in shaping the development of legislation and standards by supporting UK national standards bodies in continuing to be members of the European Standardization Organizations such as the European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC) and the European Telecommunications Standards Institute (ETSI), and maintaining other formal relationships as far as possible.

Regulations

Once passed, EU Regulations are automatically binding, applying to member states and all other non-state actors without the need for individual countries to take any further steps to adopt them. They may stipulate necessary technical obligations, such as common safeguards on goods imported from outside the EU.

Regulation is not just red tape: it can provide a controlled framework in which products and services in key sectors are brought to market. Movement away from common rules could increase the time and cost to UK engineering business, research and innovation, and the anticipated benefits of removing the need to comply with EU Regulations need to be balanced against the costs that will be incurred in making and adapting to the change.

Most EU Regulations also automatically apply to EEA countries as well. Therefore, if the UK were to leave the EU and not become part of the EEA, the enforcement of EU Regulations would lose their justification in UK law, which could cause significant complications in such areas as environmental protection and other regulated areas such as energy and transport.

Owing to their prevalence across economic sectors, numerous EU Regulations affect the engineering community. UK engineering companies exporting to the EU would have to continue to adhere to EU Regulations on, for example, component safety and energy efficiency.

Where regulations cover non-reserved areas (in relation to the devolved nations), the removal of the overall framework of EU Regulations could allow the devolved administrations to implement their own legislation in areas now dominated by EU legislation, creating the potential for greater fragmentation of policies across the UK on areas such as transport, water and the environment. This could potentially lead to the elimination of common EU rules that have been implemented in order to safeguard rights and freedoms of trade and movement[142].

The government has recently announced its intention to introduce a 'Great Repeal Bill' to Parliament. If passed, this will remove the European Communities Act 1972 from the statute book and enshrine all existing EU law into UK law. This is a necessary step in the process of leaving the EU but the process will be complex and must be managed carefully both in the lead up to exiting the EU and afterwards in terms of tracking how UK law diverges from EU law.

Directives

Directives are EU legislation that set goals (essential requirements) for member states to achieve but do not dictate the method to achieve this which may or may not involve modifying existing law or passing new laws.

The House of Commons Library estimates that there have been 4,514 Acts and Statutory Instruments implementing EU Directives between 1993 and 2014[143]. A large number of these, such as the Registration, Evaluation, Authorisation & Restriction of Chemicals (REACH) Regulations and the Environmental Permitting Regulations, have a significant effect on the UK engineering community.

Some Directives are transposed via national primary legislation. For example, the EU Directive on the geological storage of carbon dioxide was enacted by the Energy Act 2008. Whatever the future relationship with the EU, such UK legislation will remain in place until Parliament repeals or modifies it.

Many Directives are transposed through secondary legislation, for example, the EU Landfill Directive was transposed through the Landfill (England and Wales) Regulations 2002. On leaving the EU, the European Communities Act 1972 would be repealed, removing the basis of such Statutory Instruments. Therefore, to ensure applicability of Directives, saving provisions would need to be put in place[144] through the Great Repeal Bill noted above.

If the UK stays within the EEA, the application of some environmental Directives will depend on the political will to continue commitments. Although the EEA agreement does contain many EU environmental provisions, nature conservation measures such as the Habitats Directive and the Birds Directive are excluded. Therefore, the UK would have the choice to repeal or modify the relevant enabling regulation as it sees fit.

142 **The potential policy and environmental consequences for the UK of a departure from the European Union**, Institute for European Environmental Policy (IEEP), p23

143 ***EU obligations: UK implementing legislation since 1993***, House of Commons Library, 2015, p3

144 See, for example: **Impact of Brexit on infrastructure, mining and commodities**, Norton Rose Fulbright, 2016, p3

"Directives like the Renewable Energy Directive and the Pressure Systems Directive are important. The UK must not try to cut corners and become the 'Dirty man of Europe'."

Professor Ian Arbon, Senior Partner, Engineered Solutions

On the UK leaving the EU, as the legislative framework for EU Directives has largely been transposed into a significant number of UK laws (both legislation and common law), the risk of unintended consequences would mean it would be a significant task to start repealing significant amounts of legislation without careful review.

As there is likely to be a wide range of opinions on the appropriateness of maintaining each directive, this review should involve professional institutions and other stakeholders with detailed knowledge of their applicability. For example, from a public health perspective, it would be politically difficult for government to loosen the Drinking Water Directive. However, other areas, such as the Water Framework Directive, could be revised, removing, for example, the 'one-out-all-out' principle for water quality, where if part of a water body fails on one criterion, it would lose good status.

Standards

Manufactured goods accounted for £224 billion (or 44% of total) UK exports in 2014[145]. The largest market for these exports is the EU[146], which is dependent on the exported goods being compliant with European standards.

Standards are voluntary tools of the market agreed through consensus by the relevant standards bodies in consultation with industry and other stakeholders. They are a common means of ensuring compliance with legal requirements (although not necessarily the only means of compliance). Standards apply to both goods and services.

Technical standards are also used in engineering training and higher education as the basis for units and curriculum. They provide a framework to structure learning and technical content on which to base learning outcomes and assessment.

Through the application of standards, the EU has developed commonality of technical requirements across manufacturing, infrastructure and environmental sectors. This gives access to the single market across 33 countries through the European Standardization Organizations (ESOs) – CEN[147], the CENELEC[148] and ETSI[149]. The UK is represented in these organisations by the British Standards Institution (BSI)[150].

Standards have multiple market benefits for the consumer. They contribute to GDP growth, increase productivity[151], provide confidence and a common trading language, lower production costs, reduce barriers to trade, and encourage economies of scale[152]. Standards can act as a catalyst for innovation, enabling compatibility and interoperability that in turn help develop networks of users, avoid lock-in of old technologies, increase variety of system products and boost efficiency in the supply chain.

When CEN or CENELEC adopts a European standard, all their national member standards bodies across 33 (EU and EFTA) countries must do two things: adopt that standard identically and withdraw any national standard that conflicts with it. This means that across the 33 member countries, there is a single standard. This is known as the 'single standard model' and the UK's continued membership of the ESOs would commit the UK to maintain this arrangement.

"It's crucial to our business that the UK adheres to common standards going forwards."

Dr Chris Elliott FREng, Director Leman Micro Devices SA

The UK could develop its own standards but doing so would entail a high risk of divergence from European practice, bringing complexity and added costs for the UK and potentially damaging the country's reputation as a global trading, research and innovation partner. Indeed, non-EU countries are increasingly using CEN standards as the basis for their own[153], which means that it would be difficult for independently developed British standards to influence world markets. Some sectors, such as defence and oil and gas, are less reliant on European standards as they work towards international standards. However, membership of the ESOs will only assist in these global relationships.

Membership of CEN and CENELEC is not dependent on membership of the EU. However, those countries that are members from outside the EU do fulfil other criteria, either membership of EFTA or being prospective EU members.

Given the UK's level of current engagement and expertise, the UK's continued membership of CEN and CENELEC would be desirable for all parties. Nevertheless, this is not a foregone conclusion and could require a change in CEN and CENELEC statutes depending on the outcome of the negotiations between the UK government and the EU.

Outside the standards organisations, the UK could still adhere to European standards and trade as now, but it would have lost the ability to protect UK interests through participation in setting standards. Continued membership of these organisationsplays a critical role in the economic prosperity of the UK.

145 ***Manufacturing: Statistics and policy***, House of Commons Library, 2015, p12
146 **The Pink Book 2015**, ONS, 2015, p9.3 and p9.8
147 **Who we are**, CEN, 2016
148 **Who we are**, CENELEC, 2016
149 **About ETSI**, ETSI, 2016
150 **About BSI**, BSI, 2016

151 **The Economic Contribution of Standards to the UK Economy**, Centre for Economics and Business Research, 2015, p90
152 **The Economics of Standardization**, GMP Swann, 2000, p8
153 For example, Eurocodes provide a common approach for the design of buildings and other civil engineering works and construction products. See: **The EN Eurocodes**, Eurocodes

Metrology

Closely related to the issue of standards is are the commonly agreed basis for measurements. Many of the written standards produced by BSI and the ESOs are based on standardised measurement and characterisation techniques that depend strongly on the National Measurement Systems work led by the National Physical Laboratory (NPL), working closely with the national measurement institutes (NMIs) in other European countries. 'Metrological' or Physical Measurement Standards are agreed at the international level under the International Committee of Measurement Standards (CIPM). NPL represents the UK position in the setting and dissemination of global Physical Measurement Standards through EURAMET, the European measurement organisation and also directly into the CIPM.

At present, a large part of new measurement techniques development is done in collaboration with NMIs in other countries in Europe through programmes jointly funded by the EU and national governments. The UK, through NPL, has led the development of these programmes and has been a driving force in close collaboration with European partners. As with the ESOs, it is important that the UK maintains its influence in this area.

Eurocodes

There are 10 Eurocodes with a total of 58 parts aimed at harmonising infrastructure and building design that were developed by CEN with the support of the European Commission and came into force in 2010. While they were a European Commission initiative, as they were drawn up and continue to be monitored by CEN, they apply across both EU and non-EU CEN parties[154]. Eurocodes introduced common technical rules, for example, around fire resistance, building stability and construction products. They replaced existing individual member states' codes, although there are many similarities between Eurocode rules and methodologies and the preceding British standards[155].

In common with other CEN standards, as they can, and do, apply to countries outside of the EU/EEA, their continued adoption in the UK would be the best approach.

It would take considerable time and expense for the UK to develop its own replacement codes. As with other CEN standards, continuing use of Eurocodes would allow the significant number of UK built environment companies operating in the EU to adhere to one common set of rules rather than face the expense of complying with two.

CEN has recently embarked on the development of the second generation of EN Eurocodes, for which it has received its largest ever single standardisation grant from the European Commission. This process is currently under the leadership of a UK chair and UK secretariat. It would be damaging to the UK interest to lose such influence over a suite of standards used by engineers around the world, both within the EU and in many countries outside it.

Quality assurance and product safety (accreditation services)

EU regulatory approved products bear the CE mark, which must come from a notified body and these bodies are currently accredited via a national competent authority. Once the UK leaves the EU, alternative arrangements will have to be put in place to maintain this status. This should be possible given that there are notified bodies operating in non-EU countries such as Norway and Turkey via Mutual Recognition Agreements[156].

As with standards, it is expected that quality assurance procedures, such as CE marking for medical devices, will need to be maintained in the UK in line with current EU good manufacturing practices to ensure that products can be sold in the EEA. Product safety is governed by the General Product Safety Directive, transposed into UK law through secondary legislation in 2005 so will remain in place on leaving the UK until, and if, Parliament decides otherwise. However, as adherence to the directive is essential to sell goods into the EU, it has to remain in place for access to the EU market and it is unlikely that lower standards for UK consumers would be politically acceptable.

Even if the UK is not part of the EEA, UK manufacturers could continue exporting medical devices to the EEA if similarity is maintained in the UK/EU regulatory frameworks through Mutual Recognition Agreements.

State aid

EU state aid rules aim to ensure equality in competition by restricting government financial support or material backing to companies. The European Commission must give prior approval: if state aid is given without clearance, it will be deemed to be unlawful. Member states can complain post-facto to the Commission. A recent UK example is Hinkley Point C, which despite clearance by the Commission, faces legal action by Austria and Luxembourg[157].

State aid rules apply to EEA member states in broadly the same way as they do in the EU. Switzerland has a series of sectoral bilateral agreements with the EU that include limits on state aid, but there are no blanket restrictions[158].

If the UK leaves the EU and does not join the EEA, EU state aid rules will cease to apply. The potential removal or diminishing applicability of state aid rules could allow development of an invigorated domestic industrial strategy with more emphasis on hi-tech innovation in engineering and manufacturing and the forging of new trade partnerships. The UK could use the opportunity to develop its own policies on supporting strategically or economically important technologies or sectors. This could enable the UK government to provide support to large-scale infrastructure, such as energy generation, either through direct capital funding or tax incentives.

However, even outside the EEA, the UK would remain bound by World Trade Organization (WTO) rules relating to subsidies,

154 See, for example: ***Adoption of Eurocodes in the Balkan Region***, JRC Scientific and Policy Reports, 2014

155 **Eurocodes: Frequently Asked Questions**, Standards for Highways

156 **Mutual Recognition Agreements**, EFTA

157 **Luxembourg joins Hinkley C nuclear challenge**, The Ecologist, 2015

158 **Brexit: implications for state aid rules**, Oxera, 2016

which are based on similar, albeit narrower principles. These include its Agreement on Subsidies and Countervailing Measures, which governs government provision of financial support, for example, around subsides for renewable energy[159].

Under WTO regulations, there is no notification and approval process, and effectively, states enforce the rules. While being governed by such a system has the potential advantage for the UK that there would be fewer restrictions on the application of state aid, it would also mean a weakening of its ability to stop other nations engaging in practices detrimental to UK businesses.

As any changes to state aid following the UK's exit from the EU are likely to have far-reaching consequences to a wide range of UK businesses, it is important not only to the economy but in critical sectors such as energy generation and industrial manufacturing, that alteration to the rules should be examined in the context of their potential to support the industrial strategy.

Influence

The UK has long been one of the EU member states most dedicated to tackling climate change[160]. However, as with the UK's position on the EU single market, it has traditionally been less keen on using prescriptive regulations to achieve it[161]. Instead, the UK has preferred market-based approaches, such as the EU Emissions Trading System (EU-ETS), to setting specific sectoral targets for areas such as energy efficiency. The influence of the UK in the EU can also be seen in regulation of the telecoms sector where a generally liberal approach has been adopted[162].

The continued strength of UK influence depends on the nature of the future relationship with the EU. Even if it joins the EEA, the UK will have less influence on policy formation, potentially resulting in the EU adopting a more interventionist and regulation-orientated approach. In the future, if the UK is obliged to comply with EU Regulations because of single market rules, this could potentially lead to a less liberalised market in the UK.

While the policy direction in the future may be significantly different to today's, it is important to remember that it is not created in isolation. EU policy will continue to develop through technical, academic and policy expertise, and may still influence UK strategies and policy when outside the EU. This highlights the critical importance of ensuring that UK experts continue to engage to the greatest possible degree in the expert groups[163] that influence decision-making, both before and after the UK leaves the EU. The quality of the experts fielded will also have a direct impact on the UK's ability to exert influence.

Procurement

Outside the EU, the participation of UK businesses in the tender processes for public sector development and projects in EU/EEA member states will be determined by the nature of the relationship that emerges between the UK and the EU. If the UK retains EEA membership, the position will effectively remain as it is now.

Irrespective of the nature of the future relationship with the EU, it is likely that the UK's public sector will continue to be governed by some form of public procurement regulation on the grounds that international trade rules are generally based on reciprocity[164]. These include the WTO's non-obligatory multilateral agreements (the Government Procurement Agreement (or GPA) rules, narrower in scope than EU procurement Directives, which are themselves compliant with GPA rules). Notably, China is currently negotiating accession to this agreement and the public procurement markets that this would enable them to access.

As it remains desirable for the UK to ensure that UK companies retain access to the public procurement markets of EU members and other major trade partners, compliance with some form of public procurement rules will be necessary.

Moreover, as the UK has a long history of best value for taxpayers' money and competitive tendering in the public sector, on balance, this is likely to actually be more advantageous than disadvantageous to UK business.

Data

All aspects of the engineering sector are data driven and increasingly depend on the transnational free flow of information. The new EU Cybersecurity Directive and GDPR are expected to be incorporated into UK legislation before negotiations to leave the EU are complete. As with all transposed legislation, there are likely to be calls for re-examination to see whether it is the best fit for the UK. However, it is important that any changes in the UK's relationship with the EU do not impede the flow of data[165].

The EU-US Privacy Shield, a framework for transatlantic exchanges of personal data for commercial purposes, imposes obligations on US companies to protect EU/EEA citizens' personal data[166]. It requires the USA to monitor, enforce more robustly and cooperate with European Data Protection Authorities and for the EU to provide transparency about transfers of personal data to the USA and stronger protection of personal data.

159 **Brexit - the implications for the renewables market**, Simmons & Simmons, 2016

160 ***The potential policy and environmental consequences for the UK of a departure from the European Union***, IEEP, 2016, p.61

161 ***Review of the Balance of Competences between the United Kingdom and the European Union: Appendix to the Environment and Climate Change Report***, HM Government, 2016, p9

162 **Brexit: Impact on telecommunications**, DLA Piper, 2016

163 **http://ec.europa.eu/transparency/regexpert/index.cfm?do=faq.faq&aide=2**

164 ***Public Procurement in International Trade***, European Parliament, 2012, p7

165 **Use the UK's tech excellence to power Britain back to growth**, techUK, 2016

166 **EU - US Privacy Shield**, European Commission, 2016, p1

If the UK leaves the EU and does not join the EEA, it would need to be classified as a 'safe third party country' by the European Commission, so as to permit EU personal data to be transmitted to the UK. If the UK adopts (and maintains after leaving) the EU's GDPR and the NIS Directive, this would be expected to result in safe classification. However, if the UK does not apply them, the government would need to establish its own framework, similar to the Privacy Shield.

Given the UK's input into producing the EU Regulations and Directives, it would seem unnecessary to further develop a bespoke framework.

Professional qualifications

Regulated professional titles are covered by the Professional Qualifications Directive[167], which sets out conditions for recognition of qualifications and access to a regulated profession by EU and EEA member states. The directive is transposed into UK law by the European Union (Recognition of Professional Qualifications) Regulations 2015.

In the UK there are no statutory requirements for an engineer to hold a professional qualification in order to practise. However, if an applicant for membership from an EU member state can provide formal proof of a relevant professional qualification in their home state and payment of the appropriate fee, the directive requires a professional institution to recognise that qualification in the process of granting membership.

Some EU member states have strict rules around access to professional employment which may be restricted to those who hold the relevant national professional qualification. For example, to work as a civil engineer in some member states, UK civil engineers first must be enrolled on a state register. At present, the directive means this process is relatively straightforward and similar to the process for EU engineers joining UK institutions.

Recommendations

The issues relating to standards and legislation will be central to the trade negotiations that will determine the UK's future relationship with the EU and other countries. These negotiations will include tariff arrangements but non-tariff issues will be equally, if not more important. The UK has always played a leading role in shaping the standards and legislation behind the EU's single market and UK engineering has invested heavily in the setting of industry standards that define our products and services. It is vital that this level of influence is maintained and built upon.

The fact that the UK is already harmonised with the rest of the EU with regard to standards and legislation will help with non-tariff aspects of negotiations concerning the UK's relationship with the single market. This will also form the basis of any trade negotiations with countries outside the EU.

In terms of trade negotiations, the government should aim to:

- eliminate as far as possible barriers or dual regulatory burdens that would increase costs for UK business and make the UK a less attractive trading partner.

Upon leaving the EU, the UK will be in a position to decide how closely its standards and legislation align with the EU. A certain amount of divergence is likely but any significant divergence relating to the trade of goods or services might force global businesses to decide between complying with the UK rules for access to a market of 65 million customers or the EU rules for access to a market of 680 million customers.

The issue of Regulations, Directives and other EU law applicable to the UK will initially be dealt with by what the Prime Minister has called the 'Great Repeal Bill'. The details of the Bill are still to be determined but consideration will need to be given to:

- avoiding, as far as possible, divergence from EU legislation that would discourage trade and investment, lose consumer safeguards and raise costs for the consumer
- identifying those areas where the loss of or divergence from EU legislation might cause legal complications either at a national or devolved level
- a review of public procurement and state aid rules as part of the industrial strategy to remove complexity and enable a much more productive partnership between government, academia and industry
- ensuring that environmental protection and health and safety standards are maintained at the highest international standard
- a review of the status of UK accreditation services, in areas such as noise emissions, transport and safety equipment, where business could be at risk upon leaving the EU.

It will be important to retain as much influence as possible on setting standards and legislation. In particular, it is important for government to:

- support UK national standards bodies in continuing to exert influence on setting standards through membership of ESOs and maintain the UK's commitment to the 'single standard model'
- maintain and encourage the participation of UK people and organisations on expert groups that advise on EU policy and legislation.

167 **Recognition of professional qualifications in practice**, European Commission, 2016

Appendix 1 – Methodology

Approach to data collection

The project has deployed a range of approaches to gather evidence and opinion on the impact of the leave vote on engineering. The Engineering the Future alliance, through the professional engineering bodies that constitute its membership, has access to 450,000 engineers in business, academia and the public sector. The primary aim of the research was to generate information and advice that would enable government and negotiators to get the best result for engineering and the UK as a whole.

As a result, we focused on qualitative data collection to identify the nature, extent, and dependencies of the opportunities and risks. Some quantitative methods have helped test overall views on potential impact.

Naturally, following the referendum, many organisations across the science, technology, and engineering landscape were undertaking similar work, and this piece of work has been informed by those being conducted by other organisations. In particular, we took account of:

- the work of the four national academies (of which the Royal Academy of Engineering is one) in developing robust guidance on the impact on research
- a complementary strand of work being undertaken in a similar fashion that was focused on the construction industry
- the work being done by employer bodies to help companies maximise the benefits and mitigate risks.

Initial workstreams

In the initial stages, the Royal Academy of Engineering and professional engineeering bodies directly contacted their Fellows and members to identify key issues, opportunities and areas of concern. From this, the project team identified a number of areas in which the impact of the referendum was thought to be significant:

- education – particularly higher education
- research and innovation
- skills and the workplace
- standards and regulations
- economy, the nations and regions
- infrastructure, particularly technology, energy and climate change.

Desk research

Members of the project team undertook extensive desk research, and also used data analysis tools, such as the Higher Education Information Database for Institutions (HEIDI), to:

- establish the baseline knowledge in the six initial workstreams
- check and verify statements made by participants in the various events
- give context and additional information.

Consulting the community

Extensive consultation was undertaken during the course of the project. This included:

- inviting the engineering community at large to communicate through a website and dedicated email address. Over 100 people contributed through this medium
- testing of the initial workstreams with an online webinar, hosted through IET.TV, which reached around 300 participants
- running six events that looked at either specific topics (higher education and research; the industrial landscape; and energy and climate change), or the impact of leaving the EU on the devolved nations (Scotland, Wales, and Northern Ireland). In total, about 200 invitees attended
- conducting around 15 interviews with key industrialists
- conducting an online survey to gather further information from corporates and companies - responses were received from over 400 respondents.

The project team

The study was carried out by the following people:

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Paul Davies, Head of Policy, Institution of Engineering and Technology

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Claire Donovan, Head of Engineering the Future, Royal Academy of Engineering

Maya Desai, Policy Advisor, Engineering the Future, Royal Academy of Engineering

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Dr Anna Bonne, Head of Sector – Transport, The Institution of Engineering and Technology

Juniour Blake, External Relations Manager, Royal Academy of Engineering

Niroshan Anton, Education Policy Intern, Royal Academy of Engineering

Engineering the Future

The following institutions and organisations make up the Engineering the Future alliance:

BCS – The Chartered Institute for IT

British Institute of Non-Destructive Testing

Chartered Institution of Building Services Engineers

Chartered Institution of Highways & Transportation

Chartered Institute of Plumbing and Heating Engineering

Chartered Institution of Water and Environmental Management

Energy Institute

Engineering Council

EngineeringUK

Institution of Agricultural Engineers

Institution of Civil Engineers

Institution of Chemical Engineers

Institute of Cast Metals Engineers

The Institution of Diesel and Gas Turbine Engineers

Institution of Engineering Designers

Institution of Engineering and Technology

Institution of Fire Engineers

Institution of Gas Engineers and Managers

Institute of Highway Engineers

Institute of Healthcare Engineering & Estate Management

Institution of Lighting Professionals

Institute of Marine Engineering, Science and Technology

Institution of Mechanical Engineers

Institute of Measurement and Control

Institution of Royal Engineers

Institute of Acoustics

Institute of Materials, Minerals and Mining

Institute of Physics

Institute of Physics & Engineering in Medicine

Institution of Railway Signal Engineers

Institution of Structural Engineers

Institute of Water

Nuclear Institute

Royal Academy of Engineering

Royal Aeronautical Society

Royal Institution of Naval Architects

The Welding Institute

Society of Operations Engineers

Society of Environmental Engineers

Appendix 2 – Acknowledgements

The Academy would like to thank individuals from the following organisations for their help in the preparation of this study.

Aerospace Technology Institute	Household Sprayers	Qinetiq
Agricultural Technology Co	Howden Compressors	Rolls-Royce
Airbus	Imperial College London	Royal Aeronautical Society
Amadeus Capital Partners	Ineos	Royal Institution of Naval Architects
Analytics Engines	Institute of Acoustics	Rural Partners
Anglia Ruskin University	Institute of Cast Metals Engineers	Schlumberger
Anglo-American	Institute of Healthcare Engineering and Estate Management	Scitus Management
ARM	Institute of Highway Engineers	Scottish Council for Development and Industry
Arup	Institute of Marine Engineering, Science & Technology	Scottish Government
Assent Engineering	Institute of Materials, Minerals and Mining	Shoreham Services Engineering Consultancy
Atkins	Institute of Measurement and Control	Siemens
ATL Agricultural Technology	Institute of Physics	Silsoe Spray Applications Unit
Autoguide Equipment	Institute of Physics and Engineering in Medicine	Skanksa
BAE Systems	Institute of Refrigeration	Society for the Environment
Barry Linton Associates	Institute of Water	Society of Environmental Engineers
BCS, The Chartered Institute for IT	Institution of Agricultural Engineers	Southampton Solent University
Bechtel	Institution of Chemical Engineers	Spaldings
Birmingham City University	Institution of Civil Engineers	Spectrum CBM
Bloomberg New Energy Finance	Institution of Engineering and Technology	St. Kitts & Nevis International Ship Registry
Bombardier	Institution of Engineering Designers	Storrington Industries
Bosch	Institution of Fire Engineers	Subsea 7
BP	Institution of Gas Engineers and Managers	Surrey Satellite Technology Ltd
Breathing Buildings	Institution of Lighting Professionals	Syngenta
British Institute of Non-Destructive Testing	Institution of Mechanical Engineers	Tata Steel
British Standards Institution	Institution of Railway Signal Engineers	Tatepa
Brookes Bell Group	Institution of Royal Engineers	TeamSurv
Business West (Chamber of Commerce)	Institution of Structural Engineers	Tectre
Calrec Audio Limited	International Irrigation	Teesside University
Cambridge Global Capital	ITM Power	Teledyne Marine
Carbon Capture & Storage Association	Jaguar Land Rover	Telefonica
Catalyst Inc	JJ Churchill	Thales
Chartered Institute of Plumbing and Heating Engineering	Kernel Capital	The Anaerobic Digestion and Bioresources Association
Chartered Institution of Building Services Engineers	Land and Water Bolivia	The Bartlett School of Environment

Chartered Institution of Highways & Transportation	Leman Micro Devices SA	The Business Innovation Group
Chartered Institution of Water and Environmental Management	Lite-Trac systems	The Carbon Capture and Storage Association
Citizens Advice	Lloyds' Register	
CIWEM	Lloyds' Register Foundation	The Society of Operations Engineers
Claremont Technology	London South Bank University	The Welding Institute
Colbarn Engineers	Longtarget	Trantor International
Committee on Climate Change	LR Group	Trig Avionics
Confederation of British Industry	Mabel Engineering Services	TriTone Partnership
Consocius Consulting	Manchester University	UCL Energy Institute
Constructing Excellence in Wales	Marine and Steam Limited	UK Atomic Energy Authority
Contract Design (Northen)	Marine Learning Alliance	UK Space Agency
Cornell University	Mark Harris Consultancy	Ulster University
Cranfield University	Martec	Ultra Electronics
Department for Business, Energy and Industrial Strategy	Matrix 4 Capital	University College London
Department for International Trade	Meggitt	University of Bath
Department for the Economy	Midas Systems	University of Cambridge
Digital Engineering Group	Ministry of Defence	University of Cardiff
Durham University	MooD International	University of East Anglia
Easun Reyrolle	National Grid	University of Edinburgh
EEF	National Oceanography Centre	University of Exeter
Electricity North West	Natural Resource Wales	University of Glasgow
Emerson	Nestle	University of Leeds
Energy Institute	Nestoil Limited	University of Leicester
Engineered Solutions	Network Rail	University of Oxford
Engineering Council	Newcastle University	University of Strathclyde
Engineering Industries Association	Newmac	University of Warwick
EngineeringUK	NHS	VLE Support
engineersHRW	NIRAS Consulting	Warsash Maritime Academy
Esprit Associated	Northern Ireland Civil Service	WDR & RT Taggart
First Utility	Nuclear Industry Association	Weir Group
FirstGroup	Nuclear Institute	Welsh Government
Five AI	Ofcom	Welsh Local Government Association
Forte Maritime	ORE Catapult	Wesley Clover International
General Dynamics	Orwell Offshore	Wessex Grain
GGP Consult	P&O	Wilhelmsen
Green Alliance	PA Consulting Group	WJ Groundwater
Griffin Turbine and Generator Services	PERITUS International	Wood Group
Griffith Elder and Company	Petromall	Woodlands Farm (Chedworth)
Harper Adams University	Pitchell Consulting	WRc
Hayford Consulting	Progressive Energy	Writtle University College
Hebrides Marine Services	Project Design Engineers	WSP Parsons Brinckerhoff
Heriot-Watt University	Proway	Yazaki

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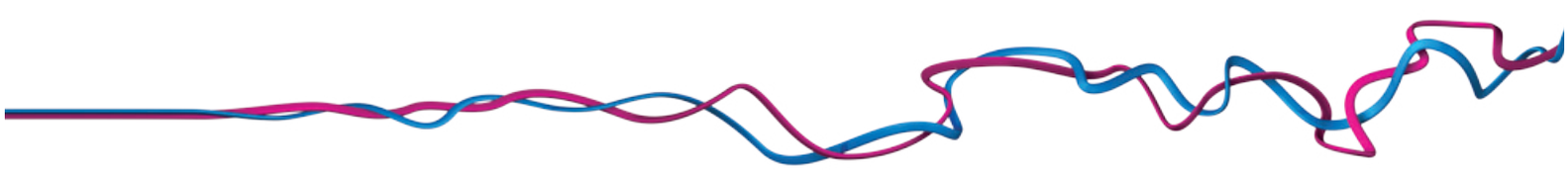

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