House of Commons

Science and Technology Committee

Industrial Strategy: science and STEM skills

Thirteenth Report of Session 2016–17

Report, together with formal minutes relating to the report

Ordered by the House of Commons be printed 29 March 2017

HC 991
Published on 12 April 2017
by authority of the House of Commons

Science and Technology Committee

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Contacts

All correspondence should be addressed to the Clerk of the Science and Technology Committee, House of Commons, London SW1A 0AA. The telephone number for general inquiries is: 020 7219 2793; the Committee's e-mail address is: scitechcom@parliament.uk.

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Summary

In January 2017 the Government published its Industrial Strategy Green Paper. Two of the 10 'strategic pillars' it listed covered 'science, research and innovation' and 'developing skills'—themes addressed in several of our inquiries over recent months. Our short report is intended to bring that work together, to feed into the Government's consultation exercise on its Green Paper.

The welcome additional £2 billion a year of funding recently promised by the Government represents a valuable contribution to maintaining the country's world-leading science status. It will help maintain the UK as an attractive location for science and research. The Government should, nevertheless, aim to increase R&D investment—in private and public sectors together—to the 3% of GDP target which we previously advocated. It must also be ready to ensure that its science funding makes up any net shortfall in research funding available through international collaborative research as a result of Brexit.

The broad innovation thrust of the Green Paper has been largely welcomed, including the Industrial Strategy Challenge Fund and the Government's approach of allowing sectors to take the lead in making the case for 'sector deals'. A responsive UKRI, and a multi-disciplinary approach to its strategies and science funding, will make it easier to adjust research priorities to be tuned to our post-Brexit opportunities. We welcome the Government's decision to survey the practices of universities' technology transfer offices.

On the STEM skills gap, encouraging students from an early age to have an understanding of science needs to be a priority. The school curriculum must be kept relevant for students' STEM skills needs as they enter a continually evolving workplace. Continuing reforms will need to be evidence-based, however, to reflect not just what employers need but also the evidence on what initiatives are most effective in increasing and sustaining young people's interest in science and what really influences their study subject choices. Degree-level programmes are not suited to everyone, nor is it always the most appropriate way to develop STEM skills, so the announcement of the new T' level is a welcome development.

While increasing the STEM skills of our children and students will help meet the needs of the workplace in future, it is also important to make use of existing STEM skills wherever they can be found, including from overseas. We reiterate our earlier call for the Government to give a firm commitment to EU researchers working and studying in the UK that they will continue to have a secure position here post-Brexit.

There is a weakness in the industrial strategy in that it could give more room for discussing or even acknowledging its links with Brexit. The industrial strategy must be configured to shape our Exit negotiations, but equally those negotiations will affect what can be achieved through the industrial strategy as well as how the different measures envisaged should be prioritised and re-prioritised. A regulatory regime that is well-crafted and relevant to our post-Brexit international research and trading relationships will be vital for a successful industrial strategy. While the possible post-Brexit scenarios

are perhaps inevitably too difficult to map out at this stage, the Government must address the links between the industrial strategy and Brexit as the exit negotiations get under way and as the strategy evolves in what we hope will be dynamic document.

1 Background

1. In January 2017 the Government published its Industrial Strategy Green Paper. It stated that the objective of the industrial strategy is "to improve living standards and economic growth by increasing productivity and driving growth across the whole country".[1] It listed 10 'strategic pillars' for the strategy, the first two of which are directly relevant to our interest in science, research and skills:

> (1) Investing in science, research and innovation—we must become a more innovative economy and do more to commercialise our world leading science base to drive growth across the UK.
>
> (2) Developing skills—we must help people and businesses to thrive by: ensuring everyone has the basic skills needed in a modern economy; building a new system of technical education to benefit the half of young people who do not go to university; boosting STEM (science, technology, engineering and maths) skills, digital skills and numeracy; and by raising skill levels in lagging areas.[2]

According to the Government, the industrial strategy "will launch a major upgrade in the role of science and innovation in our economy for the years ahead."[3]

2. The Business, Energy and Industrial Strategy Committee (BEIS Committee) recently reported on the industrial strategy initiative after the publication of the Green Paper.[4] Several of our own inquiries have also addressed many of the science and skills issues involved:

- In our November 2015 report on the *Science budget*, we called for an increased Government science budget and a 'roadmap' to increase spending on R&D across all sectors to 3% of GDP.[5]
- We have been monitoring the Government's proposed changes to the research and innovation landscape contained within the Higher Education and Research Bill, including the creation of a new body known as UK Research & Innovation (UKRI). We reported on developments in December 2016 after the UKRI Interim Chair was appointed,[6] and in March 2017 we took evidence from Sir Mark Walport[7] as the then newly appointed CEO-Designate of UKRI.[8]

1 HM Government, *Building our Industrial Strategy: Green Paper* (January 2017), p9
2 *Building our Industrial Strategy: Green Paper*, p11
3 *Building our Industrial Strategy: Green Paper*, p29
4 Business, Energy and Industrial Strategy Committee, Second Report of Session 2016–17, *Industrial Strategy: First Review*, HC 616
5 Science and Technology Committee, First Report of Session 2015–16, The science budget, HC 340, para 37
6 Science and Technology Committee, Eighth Report of Session 2016–17, *Setting up UK Research & Innovation*, HC 671
7 Oral evidence taken on 15 March 2017, HC 1047
8 On 2 February 2017, BEIS announced Sir Mark Walport's appointment as CEO-designate of UKRI.

- In March 2017 our report on *Managing intellectual property and technology transfer* highlighted areas where the Government could assist in the technology transfer process, and how businesses and universities could do more to commercialise the results of their research work.[9]

- We examined the risks and opportunities of Brexit for science and research in two reports—on *EU regulation of life sciences*[10] (before the June 2016 Referendum) and *Leaving the EU*[11] (after the Referendum). We identified the factors which will support the UK's science and innovation landscape post-Brexit, including access to funding, research collaboration, and access to researchers and scientists with the necessary skills.

- In June 2016 we reported on the *Digital skills crisis*.[12] We have more recently been examining methods for *Closing the STEM skills gap*,[13] including taking evidence[14] at the 'Big Bang Fair' in Birmingham in March 2017.[15]

3. We decided to take further oral evidence in February 2017, focusing on how the Green Paper has dealt with the issues from these various inquiries and reports. Our witnesses included representatives from the Royal Society, Nesta and the Science Policy Research Unit at the University of Sussex, as well as others who had previously given evidence during one or more of our earlier inquiries—the Bio-Industry Association,[16] the Royal Academy of Engineering[17] and Universities UK.[18] We are grateful to them all for their input. We have accordingly produced this short report to bring that work together and thereby feed into the Government's consultation exercise on its Green Paper. In Chapter 2 we examine the Green Paper's coverage of science, research and innovation issues, and in Chapter 3 we cover the STEM skills agenda.

9 Science and Technology Committee, Tenth Report of Session 2016–17, *Managing intellectual property and technology transfer*, HC 755
10 Science and Technology Committee, First Report of Session 2016–17, *EU regulation of the life sciences*, HC 158
11 Science and Technology Committee, Seventh Report of Session 2016–17, *Leaving the EU: implications and opportunities for science and research*, HC 502
12 Science and Technology Committee, Second Report of Session 2016–17, *Digital skills crisis*, HC 270
13 Closing the STEM skills gap inquiry
14 Oral evidence taken on 16 March 2017, HC 853
15 The latest Big Bang Fair, a science and technology festival for school children organised annually by Engineering UK, was held at the NEC in Birmingham in March 2017
16 Also gave oral evidence in our *Managing intellectual property and technology transfer* inquiry and *EU regulation of the life sciences* inquiry.
17 Also gave oral evidence in our *Managing intellectual property and technology transfer* inquiry and *Science budget* inquiry
18 Also gave oral evidence in our *Leaving the EU* inquiry and *Science budget* inquiry

2 Science, research and innovation

4. In this Chapter we draw together five themes from our earlier inquiries and reports which are relevant to the Green Paper consultation: sufficient science and innovation funding; a research funding framework that reflects the need for increasingly cross-cutting and multi-disciplinary research; support for innovation; technology transfer from publicly-funded university research; and a supportive regulatory environment. We discuss each of these below.

Science and innovation funding

5. The Green Paper noted the November 2016 announcement by the Prime Minister of an extra £2 billion a year of government expenditure for research by the end of the current Spending Review period[19] (subsequently confirmed in the 2016 Autumn Statement). An additional £4.7bn will be spent in total on research over the course of the period—one of four areas of additional expenditure to be covered by a new National Productivity Investment Fund (NPIF), which has also been used to create an Industrial Strategy Challenge Fund (ISCF) (paragraph 26).[20] The Green Paper "start[ed] a consultation on how to invest this funding" although it also then adopted almost a white paper approach in listing suggestions including: expanding Higher Education Innovation Funding (HEIF), making the Research Partnerships Investment Fund open to industry-led (rather than university-led) groups, creating new research institutions, "a new capital spending roadmap to provide the modern infrastructure to support fundamental research", and more "sector-specific funding to support business investment in R&D".[21] (We discuss the Green Paper's sector support approach further below; paragraph 21.)

6. The increased budget came in the wake of our November 2015 report on the *Science budget*, in which we made a detailed case for the Government to increase its science budget, and for the private and public sectors together to invest more on research, not least because of its multiplier effect on innovation. Against a background of 'flat cash' Government spending on the science budget since 2010, we called for a "roadmap" for increasing public and private sector science R&D investment, taken together, to 3% of GDP, from a figure of only 1.7%.[22] In the subsequent 2015 Spending Review, the Government set a science budget for the Spending Review period that was stable in real terms (rather than cash terms) through the addition of a new Global Challenges Research Fund.[23]

7. The Green Paper presented the increased Government science expenditure as a response to increases in other countries:

> Our competitors have also grown their investment in research and development relative to the UK. The UK invests 1.7% of GDP in private and public funds on research and development. This is below the OECD

19 Prime Minister announcement at CBI Annual Conference, 21 November 2016
20 Autumn Statement 2016 (November 2016), para 3.29
21 Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), p15, pp29–30
22 *The science budget*, First Report of Session 2015–16, HC 340, para 37
23 HM Treasury, Spending Review and Autumn Statement 2015, Cm 9162 (November 2015), p48 and para 2.69

> average of 2.4% and substantially below the leading backers of innovation—countries like South Korea, Israel, Japan, Sweden, Finland and Denmark—which contribute over 3% of their GDP to this area.[24]
>
> The Government has protected the public science budget since 2010 […] But other countries have been increasing their investment in research and development in relation to GDP.[25]

The Green Paper anticipates the additional public funding helping "to drive up the level of private investment in science, research and innovation."[26]

8. The BEIS Committee repeated our earlier calls for the Government to set a target of research expenditure rising to 3% of GDP,[27] and the CBI has recently called for such a target to be met by 2025.[28]

9. The Green Paper does not address the potential effects of Brexit on the research funding we get from overseas. EU funding through the Horizon-2020 Framework Programme provided €1.2 billion to UK-based organisations for research project bids submitted in 2015 (16% of the total funding allocated in that period).[29] Before the Referendum, we highlighted that:

> Under current arrangements the UK benefits significantly from access to EU science research budgets. If, despite the clear attractiveness of the UK as a research location, EU research funding was withdrawn after the EU exit negotiations, new funding could come from research collaborations outside the EU and from the Treasury reallocating funds previously sent to the EU.[30]

A similar message came through in the evidence to our follow-up *Leaving the EU* inquiry.

10. Collaboration with researchers in other countries is dependent to a degree on the availability of funding for it. The Royal Society of Biology told us in April 2016, for example, that:

> Leaving the EU will not create spare capacity for collaboration elsewhere unless supporting funds are identified, ring-fenced and made available. If the UK wishes to increase global collaboration then it must increase the funding and support to make it possible, ideally encouraging collaborations both in Europe and further afield.[31]

Collaborative research also provides access to a wider pool of expertise.[32]

11. After the EU Referendum, the Government and the EU gave assurances that, while the UK remains in the EU, funding for existing Horizon-2020 research programmes

24 Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), p15 and p26
25 Building our Industrial Strategy, Industrial Strategy Green Paper, p25
26 Building our Industrial Strategy, Industrial Strategy Green Paper, p29
27 Business, Energy and Industrial Strategy Committee, Second Report of Session 2016–17, Industrial Strategy: First Review, HC 616, para 103
28 CBI, Now is the time to innovate: The road to three percent (20 March 2017)
29 European Commission (LEA 287)
30 First Report of Session 2016–17, EU regulation of the life sciences, HC 158
31 Royal Society of Biology (LEA 225); See also Seventh Report of Session 2016–17, Leaving the EU: implications and opportunities for science and research, HC 502, Annex, Table 3
32 Leaving the EU: implications and opportunities for science and research, HC 502, Annex, Table 3

involving UK researchers would continue. The Government also gave a commitment to guarantee funds for EU payments "still to be made after the UK has left the EU for which there has been a commitment while the UK is still a member". There could be cases, however, as we noted, where UK partners were simply not invited to join a new research consortium in future.[33]

12. In its Brexit White Paper, the Government stated that "as we exit the EU, we would welcome agreement to continue to collaborate with our European partners on major science, research and technology initiatives".[34] The Industrial Strategy Green Paper, published a short time before, put an emphasis on facilitating research collaboration by "maintaining and building on our strengths in R&D to continue attracting world-class people, skills and foreign investment".[35]

13. **The welcome additional £2 billion a year of funding recently promised by the Government represents a valuable contribution to sustaining the country's world-leading science status. It will help maintain the UK as an attractive location for science and research. *This should be regarded as a down-payment on a trajectory for increasing R&D investment—in private and public sectors together—to the 3% of GDP target which we and others have previously advocated. Within that context, the Government must be ready to ensure that its science funding makes up any net shortfall in research funding available through international collaborative research as a result of Brexit.***

Multi-disciplinary research

14. The Government has previously emphasised that "the challenges facing the world are complex, and increasingly require multi- or inter-disciplinary approaches".[36] It expects that the bringing together of the research councils within UKRI, as a single overarching body, will facilitate that multi-disciplinary research. Sir John Kingman, the interim chair of UKRI, told us last year that "while the research councils have worked hard on this [inter-disciplinary] agenda, the risk is that the organisational silos could cause some of the most interesting work to fall between the cracks".[37] The Government also believed that the research councils, in their current form, would not be able to collaborate in managing multi-disciplinary grants under the Global Challenges Research Fund.[38]

15. Sir Mark Walport, the newly appointed UKRI CEO, like the Government before, promised that UKRI would "deliver a system that is more agile, flexible and able to respond strategically to future challenges".[39] He told us in March 2017 that decisions about any reallocation of funding between the research councils would be made by ministers on the basis of recommendations from the UKRI board, and that after 30 years without any substantive change:

33 Leaving the EU: implications and opportunities for science and research, HC 502, paras 11–20
34 HM Government, The United Kingdom's exit from and new partnership with the European Union, Cm 9417 (February 2017), para 10.14
35 Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), p28
36 BIS, Success as a Knowledge Economy: Teaching Excellence, Social Mobility and Student Choice, Cm 9258 (May 2016)
37 Science and Technology Committee, Eighth Report of Session 2016–17, Setting up UK Research & Innovation, HC 671, para 30
38 Setting up UK Research & Innovation, HC 671, para 35
39 Sir Mark Walport, letter to partner organisations (March 2017)

> It surely makes sense to look at the strengths and disciplines, look at where there are opportunities, where there are unfilled needs and, if it is appropriate, recommend a slight change in the balance of funding between the research councils. I can assure you that there is no intention to go in flailing around changing the allocations overnight.[40]

16. In a similar vein, Professor Paul Nightingale from University of Sussex believed that "UKRI will face difficult decisions about resource allocation, including cutting areas that have stagnated".[41] Potential resource reallocation appears also to be in the mind of the Government, judging from the way that the Green Paper compared the balance of research funding in the UK with our competitors:

> We have a challenge in translating our leadership in global research into commercial outcomes—a longstanding weakness relative to other countries. […] The UK has too often pioneered discovery but not realised the commercial benefits. This may reflect in part the balance of funding. While the way we distribute funding across different stages of R&D is not out of line with other European countries, it is striking that in leading innovation nations, such as Israel and countries in Asia, a greater proportion of total R&D investment is on later-stage, experimental development.[42]

17. Professor Paul Nightingale was concerned about the implied conclusions from these comparisons:

> We need to be very careful in looking at that data and understanding what it means. The distribution between 'early-stage', 'basic' and 'applied' [research] is very influenced by industrial structure […] [and] the level of development. If you are looking at China, it is going to have more later-stage activity, in part because labour costs are so much less. We should not try to replicate China because we will not be able to compete on labour costs. The policy focus should be: […] what are the parts of those global value chains where the UK is good, and how can we upgrade to increased productivity, higher-wage jobs and more jobs within those?[43]

Universities UK had expressed similar concerns before the Green Paper was published:

> The UK's service-oriented economic base combined with a relative shortage of research and innovation funding and finance compared to our competitors means a successful industrial strategy should include some fresh thinking around how these systemic constraints can be relaxed. Simply replicating the policies and strategies adopted by countries with long track records in innovation, growth and exports—such as Switzerland, Germany or the so-called Asian Tigers—is unlikely to be a fruitful approach.[44]

40 Oral evidence taken on 15 March 2017, HC 1047, Q51
41 Paul Nightingale, Industrial strategy is a map to UK research future (January 2017)
42 Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), p26 (see also graph on p27)
43 Q31
44 Written evidence submitted to the BEIS Committee from Universities UK (ISG0160)

18. Sir Mark Walport told us that "there is general recognition that there is opportunity to expand the innovation funding. That must not be done at the expense of the research base, but when there is new funding available there is the opportunity to change the balance slightly".[45]

19. **It is clear from the Green Paper and from UKRI that the Government envisages a relative shift of focus in its funding towards innovation. To some degree that reflects a changing world with increasingly multi-disciplinary challenges, but it also reflects a Government desire to reassess the relative weight given in funding different areas of research. A responsive UKRI, and a multi-disciplinary approach to its strategies and science funding, will make changing research priorities easier to implement to reflect our post-Brexit opportunities. As such, it will be a crucial participant in making the UK's industrial strategy a success, not least in terms of providing the coordinated support needed for innovation, including the Industrial Strategy Challenge Fund, as we discuss below.**

Innovation support

20. The creation of UKRI will bring Innovate UK and the bodies that fund university research together within a single organisation. The Government envisages that this will "ensure that the funding landscape is well equipped to meet tomorrow's commercial challenges".[46] Rebecca Endean from BEIS told us in October 2016 that "UKRI can play a key part in delivering any industrial strategy".[47]

21. The Green Paper subsequently emphasised that UKRI would "enable us to identify future opportunities and keep the UK at the cutting-edge of new technologies and developing solutions to global challenges".[48] The Green Paper placed particular emphasis on an approach to innovation which includes a significant focus on sectors. The BEIS Committee concluded that it is debateable whether some areas involved could be described as 'sectors' rather than particular 'products'.[49] Rupert Lewis from the Government Office for Science emphasised to us that the Green Paper addressed what he called 'enabling capabilities':

> The Council for Science and Technology advised [the Prime Minister in July 2016] on particular enabling technology areas[50]—not exclusively enabling, but largely. The Industrial Strategy Green Paper largely took that advice: New energy technology includes battery and grid storage, robotics, artificial intelligence, satellites and space, leading-edge healthcare and medicine, manufacturing processes, materials, bioscience, quantum and digital, including supercomputing and 5G. Most of them are enabling technologies.[51]

45 Oral evidence taken on 25 January 2017, HC 949, Q60
46 BIS, Success as a Knowledge Economy: Teaching Excellence, Social Mobility and Student Choice, Cm 9258 (May 2016), p75
47 Science and Technology Committee, Eighth Report of Session 2016–17, Setting up UK Research & Innovation, HC 671, Q37
48 Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), p29
49 Business, Energy and Industrial Strategy Committee, Second Report of Session 2016–17, Industrial Strategy: First Review, HC 616, para 56
50 CST, science and technology in the new government's programme, Letter to the Prime Minister (July 2016)
51 Oral evidence taken on 25 January 2017, HC 949, Q23

22. The Green Paper does, however, envisage groups coming forward to pitch to the Government for sector-specific strategies, or 'deals':

> We will work with industry and draw upon the considerable expertise of UK business to design our industrial strategy.
>
> In our own experience and in the experience of our competitors, there is advantage in addressing the opportunities in particular industries and sectors. […] Arrangements must be open to new entrants and challengers to existing incumbents, and be agile so that emerging industries and sectors can avail themselves of cross-industry institutions, not just traditional sectors. […] We propose to set an 'open door' challenge to industry to come to the Government with proposals to transform and upgrade their sector through 'Sector Deals'.[52]

23. This reflects the approach favoured by the Royal Academy of Engineering, who said last year that "prioritisation of support for specific sectors should target sectors where there is greatest potential for growth and the UK can be a market leader. […] A shared commitment by business, government and academia to investment in innovation and R&D is important and could be a condition of government support for sectors."[53] The Green Paper listed five areas of work already underway on early sector deals—on life sciences, ultra-low emission vehicles, industrial digitalisation, nuclear, and creative industries.[54]

24. The BEIS Committee, in its March 2017 report on the *Industrial Strategy*, criticised "the absence of a clear set of criteria" for sector deals,[55] and concluded:

> Sectoral policies appear to have worked well for the automotive and aerospace industries. However, with regards to other sectors this approach has had, at best, mixed results. Furthermore, this approach appears to have the greatest risk of policy being built on the vested interests of big businesses and incumbents that are best equipped to lobby. Despite Government allowing sectors to self-identify, there is a risk that a sectoral approach encourages businesses to maintain rather than break down silos, and leads to policies designed to suit preferred industries at the expense of other sectors and the wider public interest. We recommend that Government reconsider giving sectoral strategies priority and instead focus on ['strategic pillar'] horizontal policies and specific 'missions' to meet UK-wide and local public policy challenges.[56]

25. Nesta, one of our witnesses, shared such concerns, stating "data is now available and can help ensure that policy responds to reality on the ground, and the role played by younger companies, rather than lobbying by incumbents which has so often distorted industrial policy in the past." They believed that it was "pivotal that fast growing, less defined, sectors like digital and creative industries are supported in their interaction with government so that they secure the partnerships and deals they need to thrive".[57] Professor

52 Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), p10 and p100
53 Written evidence submitted to the BEIS Committee from Royal Academy of Engineering (ISG 142)
54 Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), p102–103
55 Business, Energy and Industrial Strategy Committee, Second Report of Session 2016–17, Industrial Strategy: First Review, HC 616, para 56
56 Industrial Strategy: First Review, HC 616, paras 54–55
57 Nesta, 'Government launches Industrial Strategy green paper: Nesta comments', press release, 23 January 2017

Alex Halliday from the Royal Society warned of a need to avoid "those cross-disciplinary areas that could end up being ignored because you have siloed everything into sectors".[58] Professor Paul Nightingale warned against supporting "just the incumbents, which is highlighted in the Green Paper".[59]

Industrial Strategy Challenge Fund

26. Complementing the sector approach to supporting innovation, the Green Paper also provided further information on the Government's Industrial Strategy Challenge Fund (ISCF), previously announced by the Prime Minister in November 2016.[60] It listed the criteria for the ISCF: a potentially large, or fast growing global market; UK research and business capacity to meet market needs; significant potential social and economic benefits; and where government support will make a difference.[61]

27. The Green Paper sought views on the priorities for the ISCF, but also listed eight potential technologies (with some overlap with the previous 'Eight Great Technologies') that could be favoured, including robotics and artificial intelligence, satellites and space technologies, and quantum technologies—a list that the Council for Science & Technology had recommended to the Prime Minister in October 2016.[62] The Green Paper noted UKRI's role in the ISCF initiative:

> The Industrial Strategy Challenge Fund creates a new funding stream which will enable UKRI to back technologies at all stages where the UK has the potential to take an industrial lead, from early research to commercialisation. […] Some challenges may well cut across the boundaries of existing research councils, and the creation of UKRI will enable us to take an effective overview of the development of new technologies unrestricted by traditional silos.[63]

UKRI, the Green Paper stated, would consult on the initiative "in more detail in early 2017".[64] In the meantime, Sir Mark Walport told us that:

> [The ISCF] is where emerging technology meets a very strong scientific base in universities and research institutes, where there is a nascent or an existent industrial sector that is able to provide pull, where there is a substantial market, not only UK but global.[65]

28. The President of the Royal Society believed that the 'challenge-led approach' of the ISCF "has the potential to catalyse transformational research and innovation outcomes, incentivise new and sustained partnerships between public and private research organisations and deliver economic growth".[66] Our witnesses were also generally

58 Q3
59 Q21
60 Prime Minister's speech at CBI annual conference, November 2016
61 Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), pp30–31
62 Council for Science & Technology, Letter (and Annex) to the Prime Minister on the Industrial Strategy,20 October 2016
63 Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), p30
64 Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), p29
65 Oral evidence taken on 25 January 2017, HC 949, Q29
66 Royal Society, 'Royal Society response to Industrial Strategy', press release, 23 January 2017

supportive of the ISCF approach,[67] although Paul Nightingale and Alex Halliday had reservations about the risk of money being wasted if candidates were not considered with some caution.[68] Nesta wanted the ISCF to bring innovation to different parts of the economy to those usually favoured by Government support:

> It sends a clear signal that the UK is an international hub for the development of future technologies, and gives businesses, large and small, the confidence to invest. But this funding should not go towards more of the same programmes. Instead it should stimulate innovation from the more unusual quarters of our society and economy, as well as from the usual suspects.[69]

29. The 2017 Spring Budget in March announced "an initial investment" of £270 million for 2017–18 and listed areas to benefit in "the first wave of challenges funded from the ISCF", including batteries, artificial intelligence and robotics systems, and new medicine manufacturing technologies.[70] Rebecca Endean, now an official in UKRI as well as BEIS, told us that these early allocations were made because "some of the money had to be decided on and allocated before UKRI could come into existence. We wanted to do that because the industrial strategy is such a high priority for Ministers; that we wanted to start having an impact before UKRI came into existence".[71]

30. **The broad innovation thrust of the Industrial Strategy Green Paper has been largely welcomed, including the Industrial Strategy Challenge Fund announced last November and the Government's approach of allowing sectors to take the lead in making the case for 'sector deals'. How well such initiatives translate into the improved productivity that the Green Paper seeks will depend on how extensively and imaginatively they are taken up. Their impact will only become apparent in the years ahead. *In the meantime, the Government should clarify in the next iteration of the industrial strategy the relationship between the sectors deals and ISCF, and UKRI's role in these initiatives in the period before the organisation is fully up and running.***

Technology transfer

31. Sector deals and the ISCF will not be the only prerequisites for effective innovation. It is also imperative that there is meaningful technology transfer and commercialisation of the research undertaken in our universities. The Government's July 2015 'Productivity Plan' included a commitment for universities to "continue to increase their collaboration with industry to drive research commercialisation, and increase the income they earn from working with business and others to £5 billion per annum by 2025".[72]

32. In our recent *Managing intellectual property and technology transfer* report, we highlighted areas where the Government could assist in the technology transfer process, for example through the Small Business Research Initiative (SBRI). We recommended that the Government examine the VAT rules on academic buildings that are shared with businesses, which can hinder collaborations; work with the National Centre for

67 Q2 [Prof Alex Halliday], Q12 [Prof Alex Halliday], Q20 [Prof Paul Nightingale],
68 Qq24, 27, 29, 64
69 Nesta, 'Government launches Industrial Strategy green paper: Nesta comments', press release, 23 January 2017
70 HM Treasury, Spring Budget 2017 (March 2017), para 4.24
71 Oral evidence taken on 15 March 2017, HC 1047, Q41
72 HM Treasury, Fixing the foundations: Creating a more prosperous nation, Cm 9098 (July 2015)

Universities & Business to publicise the 'Konfer' collaboration data-platform; get all Local Enterprise Partnerships to work more closely with universities and build on the strengths of the University Enterprise Zone pilots; and address university commercialisation issues in its ongoing Patient Capital Review. We also recommended that the majority of the Industrial Strategy Challenge Fund (paragraph 26) should be disbursed in the form of grants rather than loans.[73]

33. The Green Paper included some prospective initiatives which could be helpful to that technology transfer agenda, and help address the issues we highlighted in our report. It noted, for example, a review of the SBRI scheme.[74] Before the Green Paper was published, the Royal Academy of Engineering had commented that the "SBRI is far too limited in scope, only applying to departmental research spend, and is very small in comparison to the overall public procurement spend".[75]

34. On the other hand, while the Green Paper envisages the Government working with Local Enterprise Partnerships "to review their role in delivering local growth and examine how we can spread best practice and strengthen them",[76] it made no specific reference to the University Enterprise Zones pilot.[77] The future of the scheme, once its pilot funding ends in 2017, remains unclear.

35. We examined in our *Managing intellectual property and technology transfer* report how universities themselves could do more to commercialise the results of their research work, including the development of best practice. In the Green Paper, the Government acknowledged that it has "a key role to play in facilitating the exchange of ideas and collaboration between business, universities and government laboratories",[78] and announced new research on universities' "principles and practices on commercialisation of intellectual property":

> With a view to spreading best practice the Government will commission research on different institutions' principles and practices on commercialisation of intellectual property, including how they approach licensing intellectual property and take equity in spin-outs. For example, the size of equity stakes taken in spin-outs varies considerably, with little consensus over what is appropriate. […] This research will explore the approaches taken by different institutions and examine the impact these have on spin-out creation and growth. The Government will then use the findings to identify and spread best practice among universities' technology transfer offices.[79]

The Green Paper also highlighted that the Government would "place Intellectual Property Office representatives in key UK cities […] to build local capability to commercialise intellectual property".[80]

73 Science and Technology Committee, Tenth Report of Session 2016–17, Managing intellectual property and technology transfer, HC 755
74 Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), p72
75 Written evidence submitted to the BEIS Committee from Royal Academy of Engineering (ISG 142)
76 Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), p125
77 Q60
78 Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), p25
79 Building our Industrial Strategy, Industrial Strategy Green Paper, p32
80 Building our Industrial Strategy, Industrial Strategy Green Paper, p34

36. Professor Dame Ann Dowling, president of the Royal Academy of Engineering, welcomed the Government's proposed review, commenting that "by exploring the impact of different commercialisation approaches, including the varying size of equity stakes taken by institutions, I hope that the Government can provide valuable 'best practice' guidance to university technology transfer offices".[81]

37. The Government announced additional funding during the course of our intellectual property and technology transfer inquiry, including £120 million over the next four years, to "incentivise university collaboration in tech transfer".[82] This is welcome, but, as we have previously concluded, the Government's efforts have disproportionately focused on the 'supply' of commercialisable research by universities, rather than on the level of 'demand' from businesses.

38. In our Industrial strategy inquiry, our witnesses had mixed views on the focus in the Green Paper on university-sourced innovation. Professor Paul Nightingale of Sussex University emphasised that this accounted for "only 3% of the UK economy" and that the focus should be on raising productivity more generally.[83] Others, including Professor Alex Halliday and Professor Quintin McKellar, saw it nevertheless as an important front for increasing innovation.[84] Our witnesses generally took issue with the implied salience in the Green Paper of the number of patents and spin-out companies as measures of commercialisation success.[85] Professor McKellar highlighted that the UK had higher relative figures than the US for spin-outs created but lower figures for patents, but "neither is a particularly good metric".[86]

39. **There are aspects of the Green Paper which are likely to facilitate the greater 'supply' of technology transfer from university research, including the prospect of a broadened SBRI. We welcome the Government's decision to review the practices of universities' technology transfer offices, and look to it to take forward the agenda for improvement that we presented in our recent report on managing intellectual property and technology transfer. If, as we hope, the Green Paper's initiatives have a favourable impact on economic growth, that could in turn help improve the 'demand' that is needed from businesses for the outputs of university research.**

Regulatory environment

40. In our *Regulation of life sciences* report, before the EU Referendum in June 2016, we examined the pros and cons of the EU regulatory regime for collaboration, access to markets and costs.[87] We concluded that the precautionary principle had been "wilfully misused" in the formulation of EU life science policy-making, notably for genetically modified organisms (GMOs), and that a change to a more scientifically-grounded 'process-based approach' to regulation was needed. In our subsequent *Leaving the EU* report in November we heard that with Brexit "a substantial amount of work will be needed to

81 Royal Academy of Engineering, 'Industrial strategy: Academy welcomes proposals that will benefit the whole country', press release, 23 January 2017

82 Science and Technology Committee, Tenth Report of Session 2016–17, Managing intellectual property and technology transfer, HC 755

83 Q3 (see also Qq34–35)

84 Q2 [Prof McKellar]; Qq36, 39 [Prof Halliday]

85 Qq37–39, 58; Building our Industrial Strategy, Industrial Strategy Green Paper (Jan 2017), p27

86 Q37

87 First Report of Session 2016–17, EU regulation of the life sciences, HC 158

review science and technology-related legislation, regulations and projects",[88] but also that there would be the opportunity, as some witnesses put it, for the UK to "create a distinctive, attractive environment for research and innovation" and become "a global leader in scientific regulation".[89] The UK, we heard, could become "an exemplar for public dialogue and engagement with science".[90] We concluded that "the Government must seek to capitalise on the opportunities of Brexit, including in terms of setting regulations to facilitate accessing markets and research collaborations beyond the EU".[91]

41. Last September, in anticipation of the Green Paper, the Royal Society warned:

> To prevent regulation acting as a barrier to applications that have public support, it is essential that legislation regulating the research and innovation sector is designed to respond effectively to future challenges and account for fast developing technologies. […] It is critical that we identify those areas of regulation where alignment with EU rules is most important for the UK's competitiveness, and that UK experts remain fully engaged in shaping the development of standards and regulations.[92]

42. The regulatory environment, however, was not directly covered in the Green Paper. As Steve Bates from the Bio-Industry Association put it, "it only mentions 'regulation' three times in the Green Paper and they all refer to saving businesses money through reducing red tape".[93] Jen Rae of Nesta, on the other hand, pointed out that potential sector deals (paragraph 22) could also be "a conversation about regulation and about how different sectors interact with Government in different ways".[94]

43. **A regulatory regime that is well-crafted and relevant to our post-Brexit international research and trading relationships will be vital for a successful industrial strategy. *The next iteration of the industrial strategy must give a fuller indication of the relationship with the proposed post-Brexit regulatory environment, and, as we explain in Chapter 4, present a closer and more explicit alignment with the Government's Brexit strategic aims.***

88 Seventh Report of Session 2016–17, Leaving the EU: implications and opportunities for science and research, HC 502, Annex, Table 4
89 Campaign for Science and Engineering (LEA 267); UCL (LEA 258) para 52
90 Leaving the EU: implications and opportunities for science and research, HC 502, para 49
91 Leaving the EU: implications and opportunities for science and research, HC 502, Summary
92 Written evidence submitted to the BEIS Committee from Royal Society (ISG0157)
93 Q48
94 Q54

3 Closing the STEM skills gap

44. The Green Paper acknowledged that "We have a shortage of technical-level skills, and rank 16th out of 20 OECD countries for the proportion of people with technical qualifications. We have particular skills shortages in sectors that depend on STEM subjects".[95] Nearly 40% of UK employers report difficulties recruiting staff with relevant STEM skills.[96] Engineering UK has calculated that by being able to hire 182,000 skilled workers per year by 2020, the UK's GDP could increase by £27 billion.[97]

45. Professor Alex Halliday from the Royal Society highlighted the need for the Government to focus on the skills agenda in the industrial strategy:

> Technical education and the skills agenda are hugely important for the UK, an area where we have lagged behind relative to other countries and we need to up our game dramatically, both in further education […] and in broadening education. […] We need people to be able to reskill in new ways […]. We need people to get a broad education so they can move from one area to another, both because they are going to have to deal with the fact that their employment may change and from the point of view that we need experts with breadth.[98]

46. The Green Paper sought to "open a discussion on how we can create a new system of technical education, including a radically simplified set of qualifications; […] and creating prestigious new Institutes of Technology to deliver higher-level technical education in all regions".[99] The document identified particular challenges:

- significant problems with basic skills (literacy and numeracy);
- shortage of highly skilled technicians below graduate level;
- shortages in STEM with nearly half of businesses reporting a shortage of STEM graduates, unable to recruit appropriate staff;
- skills shortages in specific sectors, forcing employers to look overseas to fill vacancies.

47. In addressing these challenges, the Green Paper included Government commitments to improve basic skills through its 'Skills Plan', to create a new system of technical education, to identify specific skills gaps and address STEM shortages, to provide quality careers information and advice, and to test new approaches to life-long learning. Jen Rae from Nesta told us:

> We are long overdue a shake-up in vocational and technical skills delivery.[100]

95 Building our Industrial Strategy - Green Paper (January 2017), p16
96 CBI/Pearson, The Right Combination: CBI/Pearson Education and Skills Survey 2016 (July 2016)
97 Engineering UK, Engineering UK 2016: Synopsis, recommendations and calls for action (2016)
98 Q2
99 Building our Industrial Strategy - Green Paper (January 2017), p16
100 Q67

> The skills section [of the Green Paper] […] is a welcome look at technical skills, but there is an opportunity here to be much more ambitious about skills provision and looking at the future of the workforce, not just in the next five years but also over a much longer term.[101]

48. The 2017 Spring Budget announced a £500 million investment in technical education, creating a so-called T' level for 16–19 year olds to be introduced from autumn 2019. Students will be able to choose from 15 different course 'routes'. Formal training hours for 16–19 year olds will increase by 50% and students will be able to undertake industry work-placements. Maintenance loans will also be provided for students doing higher-level technical courses at National Colleges and Institutes of Technology. The Budget also announced a commitment of up to £300 million "to further develop the UK's research talent", including creating 1,000 PhDs across STEM areas.[102] Professor Dame Ann Dowling found the investment in new Institutes of Technology "very welcome news".[103]

49. The BEIS Committee complained, however, that in the Green Paper "a 'new commitment' to 'explore and further encourage the uptake of STEM subjects' is vague and suggests little by way of a change in direction".[104] The Committee was "disappointed that the Green Paper fails to outline any detailed proposals for discussion in relation to encouraging the uptake of STEM subjects, and improving the skills of those already of working age".[105] In our own inquiry, Paul Jackson, the chief executive of Engineering UK, observed that the Government's Digital Strategy was published a short time before the Green paper and the two "were not linked together".[106] The BEIS Committee also cast doubt on the feasibility of schools being able to introduce the new skills initiatives envisaged in the Green Paper because they would be "highly constrained by the fact that mainstream schools in England are expected to make £3 billion of efficiency savings by 2019–20 at a time of rising pupil numbers".[107]

50. Many in industry and academia have nevertheless welcomed the proposals outlined in the Green Paper. The president of the Royal Society welcomed the focus on skills:

> In order to thrive in the global economy the UK will need to be smarter. Quality technical education, alongside traditional academic routes, is essential to ensure that people have the skills required for high-wage jobs and employers can get the highly skilled staff they need. To ensure that the skills pipeline is working, we also need to look at our schools. The Government should also ensure that all young people are learning science and maths skills as part of broader education to age 18.[108]

101 Q43
102 HM Treasury, Spring Budget 2017 (March 2017),
103 Royal Academy of Engineering, 'Industrial strategy: Academy welcomes proposals that will benefit the whole country', press release, 23 January 2017
104 Business, Energy and Industrial Strategy Committee, Second Report of Session 2016–17, Industrial Strategy: First Review, HC 616, para 113
105 Industrial Strategy: First Review, HC 616, para 115
106 Oral evidence taken on 16 March 2017, HC 853, Q28
107 Industrial Strategy: First Review, HC 616, para 112
108 Royal Society, 'Royal Society response to Industrial Strategy', press release, 23 January 2017

Professor Dame Ann Dowling commented that "we will only be able to make the most of [the] opportunities if there is also investment in the skills that employers need. The Government's industrial strategy will be critical in delivering that step change in our skills base."[109]

51. However, some have cautioned that the Green Paper's approach and focus might be too narrow. Professor Quintin McKellar from Universities UK told us:

> We very much support the ambition with regard to technical education but would suggest that that should be at both degree and sub-degree level. We support the ambition for lifelong learning, particularly part-time and short courses and how they might contribute to retraining and upskilling individuals in society.[110]

> Setting up a few more free schools that focus on STEM is not going to cut the mustard, I am afraid. You need a much longer-term, much deeper level of investment. […] What we need now are people who have a range of skills and a range of backgrounds, not simply focused on one specific area. The Green Paper emphasises too much sub-degree-level technical skills.[111]

52. We have not been able to examine the raft of skills-related initiatives announced in the Green Paper. However, our previous inquiries on *Digital skills* and *Leaving the EU*, and our current parallel inquiry on the *STEM skills gap*,[112] have highlighted a number of measures where STEM capacities could be improved and be fed into the next iteration of the industrial strategy initiative, as we discuss below.

STEM in education

53. In our *Digital Skills Crisis* report last year, we emphasised the need for interest in computer science and STEM more broadly to be captured at primary school level and then maintained until potentially career-defining choices are made in selecting subjects at GCSE and A' level".[113] We took evidence in March 2017 at the Big Bang UK Young Scientists and Engineers Fair in Birmingham and were greatly encouraged to see the enthusiasm of so many children and young people for science and technology.

54. Nevertheless, there remains a STEM skills problem. Research in 2014 found that a high proportion of children and young people enjoy science, and believe that it is important for the future, but only a small proportion of students wanted to become a scientist.[114] Our recent report on *Science communication and engagement* highlighted that young people's 'science capital'[115]—their exposure to science influences—correlates with the likelihood of them pursuing a career in STEM and is less prevalent in disadvantaged

109 Royal Academy of Engineering, 'Industrial strategy: Academy welcomes proposals that will benefit the whole country', press release, 23 January 2017
110 Q2
111 Q40
112 Closing the STEM skills gap inquiry
113 Science and Technology Committee, Second Report of Session 2016–17, Digital Skills Crisis, HC270
114 King's College London, ASPIRES Young people's science and career aspirations, age 10–14 (November 2014)
115 King's College and the Science Museum, Science Capital: Enterprising Science

groups.[116] Parents and teachers are the biggest influencers on children's study choices, but half of parents feel ill-informed about the benefits of STEM subjects and associated potential career paths.[117] Paul Jackson from Engineering UK told us that:

> The gap we are seeing is in areas such as engineering, digital and physical science. […] We are seeing a gap of upwards of 20,000 graduate-type skills, so level 4 and above […] and a similar number at level 3. […] Education is not changing positively in encouraging people to study science and maths through to 18.[118]

55. Philip Pratley from Leonardo told us:

> Who are the key influencers who stop them, who will be discouraging them? […] Teachers can be a most tremendous influence and we are seeing an increasing awareness among staff of the career potential that engineering and STEM provides. It is often parents and we work with schools to provide materials for families days and careers evenings that give the parents the confidence of knowing that engineering is a credible and genuine career with huge opportunity rather than perhaps the more stereotypical view they had before.[119]

56. Research by 'Your Life', a campaign to increase the numbers of young people studying maths and physics post-16, found that young people are put off maths and science "in their droves" while at secondary school.[120] Allan Cook from the Royal Academy of Engineering urged the Government to focus in the industrial strategy on younger children—"from an engineering point of view, we have to get the message across much earlier than 11, 12 and 13-year-olds; their decisions and their mind-set have already been formed long before then".[121] Similarly, Philip Pratley from Leonardo told us "when we speak to the teachers of 11 and 12 year olds—years 7 and 8—[…] those teachers will say 'If I have lost that child before he or she is 11, especially before she is 11, I have lost them.'"[122]

Education reform

57. This disappointing picture comes after many years during which the treatment of STEM in the education system has been regularly changed and reformed. Standardised testing ('Sats') was introduced with the National Curriculum for schools in England and Wales in 1988, including pupil assessments for English, mathematics and science from key stages 1–4 (5–16 year olds).[123] Standardised testing in science was scrapped in 2009,[124] which was supported by some who thought that testing did not best measure a child's scientific ability and risked putting them off science,[125] as well as limiting teachers'

116 Dewitt, J. and Archer, L, Who aspires to a science career? A comparison of survey responses from primary and secondary school students. International Journal of Science Education (2015), 37(13) 2170–2192
117 Accenture, Accenture Finds More Than Half of 12-Year-Old Girls in the UK and Ireland Believe STEM Subjects are TOO Difficult to Learn (September 2015)
118 Oral evidence taken on 16 March 2017, HC 853, Q2
119 Oral evidence taken on 16 March 2017, HC 853, Q20
120 AT Kearney for Your Life campaign, Tough Choices, (2016)
121 Q66
122 Oral evidence taken on 16 March 2017, HC 853, Q25
123 STEM learning, National Curriculum
124 Guardian, Science Sats to be scrapped but maths and English tests expected to continue, 6 May 2009
125 Science Community Representing Education (SCORE), Government abolishes Key Stage 2 Science Sats, press release, 2009

flexibility in the classroom. Others argued that the removal of testing provided little incentive to stimulate an interest in science at primary level.[126] Following recent reform of the national curriculum, assessments in science will be reintroduced at Key Stage 2 (11 years)—a number of schools will be selected (representing the population as a whole) for sample testing.[127]

58. In the early 1990s, a combined GCSE science (or 'Double Science') was offered in place of separate physics, chemistry or biology courses.[128] Then in 2006, 'Triple science' or single award GCSEs in biology, physics or chemistry were re-introduced.[129] It was hoped at that time that these reforms would help address the STEM skills gap. A recent King's College London ASPIRES survey has shown, however, that socially disadvantaged students are less likely to study Triple Science: Schools rather than students decide the availability of Key Stage 4 science options, and many students think that Triple Science is only for 'clever' children.[130] More positively, with the introduction of the English Baccalaureate, 29% of students opted for Triple Science in 2011 compared to 16% the year before.[131]

59. The Royal Society highlighted in 2011 that many children lost interest in mathematics and science during their secondary school years and that too few students chose to study STEM at A' level to make degree programmes in STEM subjects viable.[132] Mark Page from Your Life told us that "what we see in the research is that those who are streamed into Double Science feel that that is it, and there is no possibility to carry on".[133]

60. Over a number of years, however, there have been considerable efforts by Government, industry and education sectors to develop a range of diverse and innovative initiatives to raise awareness and stimulate interest in STEM among children and young people. Initiatives include website, education and career resources aimed at teachers and parents, as well as sciences fairs and festivals. In our inquiry on *Science communication and engagement*, we received many encouraging submissions from national and local science museums, nature clubs and festivals, which have helped to complement formal STEM learning in schools. In recent years, events such as the Cheltenham Science Festival, the Big Bang Fair, British Science Week, the opening of the At-Bristol Science Centre and the Life Science Centre in Newcastle upon Tyne, amongst others, have not only increased public engagement in science but have also played a vital role in building our 'science capital'. In our *Skills gap* inquiry, similarly, we have received information on a large number of initiatives aimed at increasing interest and skills (Box 1). The Government has contributed to other initiatives, including STEM Ambassadors, the Inspiring Science Fund and contributing to CREST awards.[134] However, according to the Royal Academy of Engineering, despite there being over 600 organisations running such STEM initiatives, they have not *overall* had the desired impact of increasing uptake of STEM subjects among young people.[135]

126 Oral evidence taken on 16 March 2017, HC 853, Qq73, 74
127 Standards & Testing Agency, Science Sampling Arrangements (April 2016)
128 Science, UK Education Reform: Too much of a Good Thing? (September 2008)
129 Fairbrother R., Dillion J., Triple Science back on the agenda, King's College London (2008)
130 Archer L., Moote J., et al, Stratifying science: a Bourdieusian analysis of student views and experiences of school selective practices in relation to 'Triple Science' at KS4 in England, Research Papers in Education (August 2016)
131 Department for Education, More students study core subjects, thanks to EBacc, (August 2011)
132 Royal Society, Preparing for the transfer from school and college science and mathematics education to UK higher STEM education (February 2011)
133 Oral evidence taken on 16 March 2017, HC 853, Q59
134 BEIS (GAP057), paras 1.32–1.39
135 Royal Academy of Engineering, The UK STEM Education Landscape (May 2016)

Box 1: Initiatives from submissions to our STEM skills inquiry

Arkwright Scholarships Trust	UK wide scholarship scheme to nurture sixth form STEM students to take up engineering careers[1]
Aston University	STEM outreach, delivery of degree apprenticeships, industry work placements, establishment of its Engineering Academy[2]
BP	BP Education Service provides teaching resources. Schools Link, an employee volunteering programme in schools[3]
British Science Association	CREST Awards—rewards 32,000 11–19 year old students for achievements in STEM project work[4]
Carillion	SNOWE network provides guidance to female engineers, includes buddying system[5]
EDF Energy	Web based resources through 'The Pod' for pupils4–14 year olds on science, sustainability and the environment[6]
Edge Foundation	Career Footsteps and Business in Classroom programmes to improve young people's understanding of STEM career options[7]
EEF	Provides 50 technical training courses, trains 300 apprentices per year in engineering and manufacturing skills[8]
Enterprising Science	Collaborative research and development programme for science education; partnership with BP, Science Museum and King's College London[9]
Field Studies Council	Education charity with an estimated 154,000 visitors every year to its field centres focuses on courses in biology, geography and geology.[10]
Harris Academy Greenwich	STEM club for children ages 7 – 13[11]
Institute for Research in Schools	Programme that encourages science and engineering students to master skills in handling data; provides teachers training on current research and development[12]
London Borough of Haringey	Haringey STEM Commission creates post-16 opportunities to support young people into STEM based career pathways[13]
Natural History Museum	Angela Marmot Centre dedicated to supporting amateur and professional naturalists, which has also launched Identification for the Future project[14]
National Physical Laboratory	STEM outreach in schools and post-graduate Institute for Measurement and Science[15]
National STEM Learning Centre and Network	Project ENTHUSE provides bursaries for CPD training for teachers in STEM subjects[16]
Nuffield Research Placements	Research Placements for Year 12 students[17]

Q-Step	Integrated teaching approaches, degree programmes and modules and STEM work placements[18]
Royal Academy of Engineering	Engineering Talent project aimed at changing the perception of engineering at young people will be launched in September 2017
Royal Geographical Society	Professional development for teachers (provision of teaching materials)[19]
Science Industry Partnership	Development of six programmes on careers, traineeships, SMART apprenticeships, industry degree scheme, modular masters in formulation science and technology and workforce development[20]
Shortcut Project	Development of research skills[21]
University of Leicester/National Space Centre	National Space Centre attracts 3000,000 visitors every year; National Space Academy using space as the context to teach GCSE, A 'level, BTEC and apprenticeship to complement University's undergraduate/post graduate courses [22]
Women in Manufacturing and Engineering	Business initiative working with Green Port Hull and Jobcentre Plus to get women and girls into manufacturing and engineering[23]
Your Life	Three-year campaign to increase numbers young people studying maths and physics post 16[24]

1 Arkwright Scholarships Trust (GAP043)
2 Aston University (GAP032)
3 BP (GAP044)
4 British Science Association (GAP085)
5 Carillion (GAP053)
6 EDF Energy (GAP039)
7 Edge Foundation (GAP026)
8 EEF (GAP035)
9 BP (GAP044)
10 Field Studies Council (GAP019)
11 Harris Academy Greenwich (GAP012)
12 Institute for Research in Schools (GAP016)
13 London Borough of Haringey (GAP038)
14 Natural History Museum (GAP049)
15 National Physical Laboratory (GAP034)
16 BP (GAP044)
17 Nuffield Foundation (GAP0005)
18 Nuffield Foundation (GAP0005)
19 Nuffield Foundation (GAP0005)
20 Science Industry Partnership (GAP018)
21 East Midland Zoological Society (GA007)
22 University of Leicester/National Space Centre (GAP023)
23 Women in Manufacturing and Engineering (GAP014)
24 Your Life (GAP027)

61. **Encouraging students from an early age to have an understanding of science needs to be a priority if the UK is to stay at the forefront of research and innovation.** ***While there have been extensive reforms in the national curriculum, which will be difficult for teachers and students alike to absorb, it must be kept relevant for students' STEM skills needs as they enter a continually evolving workplace. Continuing reforms will need to be evidence-based, however, to reflect not just what employers need but also the evidence on what initiatives—many at a local scale—are most effective in increasing and sustaining young people's interest in science and what really influences their study subject choices. We recommend therefore that the Government review the initiatives that have been submitted to our STEM skills gap inquiry (Box 1), and work with the learned societies, national academies and professional bodies to identify best practice and opportunities for scaling up their wider use and Government support.***

62. **Degree-level programmes are not suited to everyone, nor is it always the most appropriate way to develop STEM skills. There have been too few clear and well recognised routes into skilled and highly paid roles in STEM-related areas as alternatives to university degree courses. The announcement of the new T' level is therefore a welcome development.**

Higher Education and apprenticeships

63. The Government is taking forward the results of its earlier reviews of the employability of computer science graduates (Shadbolt review)[136] and of the STEM and other skills requirements of employers (Wakeham review).[137] The Government is also aiming to create 3 million new apprenticeships by 2020; part of the Chancellor's *Fixing the Foundations* productivity plan.[138] BEIS told us that there are currently apprenticeships in sectors such as construction, advanced engineering, engineering environmental technologies, energy and utilities and space engineering. The Government had made a 40% increase in funding for Level 2 apprenticeship pathways and an 80% increase for those at level 3 and above, to reflect the disproportionate amount that employers are likely to be paying to providers for training on top of existing Government funding.[139]

64. However, the National Audit Office found that the majority of the growth in apprenticeship starts was in Level 2 apprenticeships, with only 2% of starts at the more stringent Levels 4 – 7.[140] Paul Jackson from Engineering UK told us:

> It is difficult for [companies] to be able to use the levy money on three- and four-year apprenticeships as effectively as they would like. They can probably draw down only 25% to 50% of the levy funding and many of them would like to be able to reach into education and use that as part of the funding for the work that bridges the gap between employers and companies.[141]

136 Department for Business, Innovation and Skills, Shadbolt Review of Computer Sciences Degree Accreditation and Graduate Employability (April 2016)

137 Department for Business, Innovation and Skills and Higher Education Funding Council for England, Terms of reference for the Wakeham Review of STEM Degree Provision and Graduate Employability (February 2015); Higher Education Funding Council for England (GAP0068)

138 HM Treasury, Fixing the Foundations: creating a more prosperous nation (July 2015)

139 Department for Business, Energy & Industrial Strategy (GAP0057)

140 National Audit Office, Delivering value through the apprenticeships programme, HC 624, Session 2016–17

141 Oral evidence taken on 16 March 2017, HC 853, Q11

In a similar vein, Steve Bates from the Bio-Industry Association believed that larger businesses might not benefit as much from the apprenticeship levy if there is a "drive […] to the lower-end of apprenticeships", and suggested that levy-paying companies be able to share their funds to collaborate on providing apprenticeships in SMEs within their supply-chains.[142]

65. Allan Cook from the Royal Academy of Engineering believed that, unless the management of the apprenticeship levy was transferred from the Department for Education—"the wrong place"—to BEIS, it would not get "the right level of attention it needs".[143]

66. **The Green Paper provides no new information on how the apprenticeships programme will be implemented, beyond previous announcements, nor how it will be further developed to fill emerging STEM skills gaps. *The next iteration of the industrial strategy initiative should address this.***

Access to existing STEM skills

67. While increasing the STEM skills of our children and students will help meet the needs of the workplace in future, it is also important to make use of existing STEM skills wherever they can be found, including from overseas. Between 2004 and 2014, there was an 18% increase in the number of STEM graduates in the UK, driven by an increase in non-UK EU resident STEM graduates of 72% and in non-EU STEM graduates of 51%[144]. The science minister, Jo Johnson MP, confirmed soon after the June 2016 Referendum that EU students currently studying in the UK or beginning their studies in autumn 2016 would remain eligible for student finance throughout the duration of their courses, and it was subsequently announced that this would also apply to those starting courses in autumn 2017.[145]

68. We highlighted after the Referendum that researcher mobility is a crucial component of the UK's successful research and science sector. We recommended in our *Leaving the EU* report that the issue should be treated separately from discussions about immigration control more broadly, and that the Government should make an immediate commitment to exempt EU researchers currently working in the UK from Brexit negotiations on any reciprocal immigration controls for workers already in post.[146] The Government felt unable to give that assurance in its response to our report, although they did say that this would be priority in its Brexit negotiations:

> [The Government] is committed to building on the UK's world-leading science base and making the UK the go-to nation for scientists, innovators and investors in technology. […] Providing reassurance to these individuals and UK researchers working in Europe will be important for the

142 Q68
143 Q68
144 Gatsby Foundation, Key indicators in STEM education (December 2014)
145 Department for Education, 'Funding support for EU students', press release, 11 October 2016
146 Leaving the EU: implications and opportunities for science and research, HC 502

> Government going forwards. Securing the status and providing certainty to EU nationals already in the UK—and to UK nationals in the EU—is one of this Government's top priorities for the forthcoming negotiations."[147]

69. ***In agreeing this report on the day that the Prime Minister triggers Article 50 of the Lisbon Treaty, we reiterate our earlier call for the Government to give a firm commitment to EU researchers working and studying in the UK that they will continue to have a secure position in the UK post-Brexit.***

147 Science & Technology Committee, Sixth Special Report of Session 2016–17, Leaving the EU: implications and opportunities for science and research: Government Response to the Committee's Seventh Report, HC 1015

4 Conclusions

70. Last autumn, the Council for Science & Technology wrote to the Prime Minister on the then still under development Industrial Strategy, to highlight the "compelling case" for science and skills in the initiative.[148] The Green Paper subsequently presented science and skills as the first two in its list of 10 'strategic pillars' to increase the country's productivity. This, and the raft of helpful initiatives involved under these headings, presents a picture of the Government taking seriously these essential productivity building blocks. The president of the Royal Society believed that "by placing science and innovation at the heart of our industrial strategy, the Government is clearly focused on capitalising on the UK's strengths."[149] Our witnesses were also generally supportive of the Green Paper's approach.[150]

71. The Green Paper takes insufficient account, however, of Brexit. The Royal Academy of Engineering stated last year that:

> Following the result of the EU referendum, an industrial strategy becomes all the more important in providing a vision and roadmap for how the UK can strengthen and grow as a technologically advanced, globally engaged and competitive economy.
>
> An industrial strategy will take many years to deliver. […] Measurable change may take 10 years to realise, although it is possible to employ softer measures or monitor incremental gains in the short term. An early benchmarking exercise will be needed at the outset.[151]

Similarly, the Bio-Industry Association said that "industrial strategy needs to be joined-up with Brexit risks and opportunities and should bolster areas of adverse impact, as well as assist in the exploitation of areas of opportunity."[152]

72. Once the Green Paper was published, Allan Cook from the Royal Academy of Engineering emphasised that "the industrial strategy is a big challenge, and adding to it the complexity of Brexit makes it an even bigger challenge".[153] Steve Bates from the Bio-Industry Association observed that "the three things that the industrial strategy does not touch on that are vital for our sector in the context of Brexit are regulation, immigration and funding".[154] Professor Paul Nightingale emphasised "huge uncertainty around Brexit" and highlighted the importance of non-tariff barriers for some sectors in particular.[155] Professor Quintin McKellar believed that the industrial strategy "could be supportive of us leaving the European Union and helping maintain that productivity as we leave".[156] Professor Alex Halliday was most worried about the uncertainty surrounding the regulatory environment.[157]

148 Council for Science & Technology, Letter (and Annex) to the Prime Minister on the Industrial Strategy, 20 October 2016
149 Royal Society, 'Royal Society response to Industrial Strategy', press release, 23 January 2017
150 Q2 [Prof Quintin McKellar, Prof Paul Nightingale, Prof Alex Halliday], Q43 [Allan Cook, Jen Rae, Steve Bates]
151 Written evidence submitted to the BEIS Committee from Royal Academy of Engineering (ISG 142)
152 Written evidence submitted to the BEIS Committee from BioIndustry Association (ISG 78)
153 Q47
154 Q47
155 Qq6–7
156 Q6
157 Q8

73. The BEIS Committee criticised a lack of clarity about "the relationship between the industrial strategy and [the Government's] negotiating priorities for leaving the European Union". It found it "unfortunate" that the recent Brexit White Paper "reinforces a lack of coordination between the Government's major challenge and its principal plank of business policy".[158]

74. **There is a weakness in the industrial strategy in that it could give more room for discussing or even acknowledging its links with Brexit. The industrial strategy must be configured to shape our Exit negotiations, but equally those negotiations will affect what can be achieved through the industrial strategy as well as how the different measures envisaged should be prioritised and re-prioritised.**

75. **The complicating factor of Brexit, which could in time render the industrial strategy over-ambitious or under-ambitious depending on the terms of the Exit and how well our new research and trading relationships with others turn out, makes it difficult to set a yardstick for judging the eventual success of the strategy—the possible scenarios are perhaps inevitably too difficult to map out at this stage. *This is, nevertheless, an area that the Government must address as the Brexit negotiations get under way and the industrial strategy evolves in what we hope will be dynamic document.***

76. In the meantime, some of our witnesses provided their own preferences on success metrics for the Industrial Strategy. Professor Quintin McKellar believed that "increased productivity across the country" should be the metric for measuring the delivery of the Industrial Strategy. Allan Cook similarly highlighted "productivity and economic growth".[159] Steve Bates favoured monitoring the number of UK companies that grow "to global scale".[160] Professor Alex Halliday emphasised the importance of 'place'—the impacts beyond the traditionally favoured regions.[161]

77. With UKRI set to play such a pivotal role in delivering key aspects of the research and innovation strand of the industrial strategy, our call in our *Leaving the EU* report last year for the Government to set out "measurable benefits" to be delivered by the organisation remain critically important. We were pleased to see in the Government's response an acknowledgement that it would be "appropriate to develop specific metrics to monitor the success of UKRI in concert with ministers and the CEO of UKRI, once the CEO and UKRI board are in post." The response helpfully listed areas which might provide metrics, and emphasised that UKRI's forthcoming Research and Innovation Strategy "will identify qualitative and quantitative objectives for which UKRI will be accountable. We intend to continue to monitor the operation of UKRI as well as its part in delivering a measurable success for the industrial strategy.

158 Business, Energy and Industrial Strategy Committee, Second Report of Session 2016–17, Industrial Strategy: First Review, HC 616, paras 77 and 79

159 Q46

160 Q46

161 Q4

Conclusions and recommendations

Science, research and innovation

1. The welcome additional £2 billion a year of funding recently promised by the Government represents a valuable contribution to sustaining the country's world-leading science status. It will help maintain the UK as an attractive location for science and research. *This should be regarded as a down-payment on a trajectory for increasing R&D investment—in private and public sectors together—to the 3% of GDP target which we and others have previously advocated. Within that context, the Government must be ready to ensure that its science funding makes up any net shortfall in research funding available through international collaborative research as a result of Brexit.* (Paragraph 13)

2. It is clear from the Green Paper and from UKRI that the Government envisages a relative shift of focus in its funding towards innovation. To some degree that reflects a changing world with increasingly multi-disciplinary challenges, but it also reflects a Government desire to reassess the relative weight given in funding different areas of research. A responsive UKRI, and a multi-disciplinary approach to its strategies and science funding, will make changing research priorities easier to implement to reflect our post-Brexit opportunities. As such, it will be a crucial participant in making the UK's industrial strategy a success, not least in terms of providing the coordinated support needed for innovation, including the Industrial Strategy Challenge Fund. (Paragraph 19)

3. The broad innovation thrust of the Industrial Strategy Green Paper has been largely welcomed, including the Industrial Strategy Challenge Fund announced last November and the Government's approach of allowing sectors to take the lead in making the case for 'sector deals'. How well such initiatives translate into the improved productivity that the Green Paper seeks will depend on how extensively and imaginatively they are taken up. Their impact will only become apparent in the years ahead. *In the meantime, the Government should clarify in the next iteration of the industrial strategy the relationship between the sectors deals and ISCF, and UKRI's role in these initiatives in the period before the organisation is fully up and running.* (Paragraph 30)

4. There are aspects of the Green Paper which are likely to facilitate the greater 'supply' of technology transfer from university research, including the prospect of a broadened SBRI. We welcome the Government's decision to review the practices of universities' technology transfer offices, and look to it to take forward the agenda for improvement that we presented in our recent report on managing intellectual property and technology transfer. If, as we hope, the Green Paper's initiatives have a favourable impact on economic growth, that could in turn help improve the 'demand' that is needed from businesses for the outputs of university research. (Paragraph 39)

5. A regulatory regime that is well-crafted and relevant to our post-Brexit international research and trading relationships will be vital for a successful industrial strategy. *The*

next iteration of the industrial strategy must give a fuller indication of the relationship with the proposed post-Brexit regulatory environment, and present a closer and more explicit alignment with the Government's Brexit strategic aims. (Paragraph 43)

Closing the STEM skills gap

6. Encouraging students from an early age to have an understanding of science needs to be a priority if the UK is to stay at the forefront of research and innovation. *While there have been extensive reforms in the national curriculum, which will be difficult for teachers and students alike to absorb, it must be kept relevant for students' STEM skills needs as they enter a continually evolving workplace. Continuing reforms will need to be evidence-based, however, to reflect not just what employers need but also the evidence on what initiatives—many at a local scale—are most effective in increasing and sustaining young people's interest in science and what really influences their study subject choices. We recommend therefore that the Government review the initiatives that have been submitted to our STEM skills gap inquiry, and work with the learned societies, national academies and professional bodies to identify best practice and opportunities for scaling up their wider use and Government support.* (Paragraph 61)

7. Degree-level programmes are not suited to everyone, nor is it always the most appropriate way to develop STEM skills. There have been too few clear and well recognised routes into skilled and highly paid roles in STEM-related areas as alternatives to university degree courses. The announcement of the new T' level is therefore a welcome development. (Paragraph 62)

8. The Green Paper provides no new information on how the apprenticeships programme will be implemented, beyond previous announcements, nor how it will be further developed to fill emerging STEM skills gaps. *The next iteration of the industrial strategy initiative should address this.* (Paragraph 66)

9. *In agreeing this report on the day that the Prime Minister triggers Article 50 of the Lisbon Treaty, we reiterate our earlier call for the Government to give a firm commitment to EU researchers working and studying in the UK that they will continue to have a secure position in the UK post-Brexit.* (Paragraph 69)

Conclusions

10. There is a weakness in the industrial strategy in that it could give more room for discussing or even acknowledging its links with Brexit. The industrial strategy must be configured to shape our Exit negotiations, but equally those negotiations will affect what can be achieved through the industrial strategy as well as how the different measures envisaged should be prioritised and re-prioritised. (Paragraph 74)

11. The complicating factor of Brexit, which could in time render the industrial strategy over-ambitious or under-ambitious depending on the terms of the Exit and how well our new research and trading relationships with others turn out, makes it difficult to set a yardstick for judging the eventual success of the strategy—the possible scenarios are perhaps inevitably too difficult to map out at this stage. *This*

is, nevertheless, an area that the Government must address as the Brexit negotiations get under way and the industrial strategy evolves in what we hope will be dynamic document. (Paragraph 75)

Formal Minutes

Wednesday 29 March 2017

Members present:

Stephen Metcalfe, in the Chair

Victoria Borwick	Gareth Snell
Chris Green	Graham Stringer
Carol Monaghan	Derek Thomas

Draft Report *(Industrial Strategy: science and STEM skills)*, proposed by the Chair, brought up and read.

Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 77 read and agreed to.

Summary agreed to.

Resolved, That the Report be the Thirteenth Report of the Committee to the House.

Ordered, That the Chair make the Report to the House.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

[Adjourned till Wednesday 19 April at 9.00 am

Witnesses

The following witnesses gave evidence. Transcripts can be viewed on the inquiry publications page of the Committee's website.

Wednesday 22 February 2017	*Question number*
Professor Alex Halliday, Vice President, The Royal Society, **Professor Quintin McKellar CBE**, Vice-Chancellor, University of Hertfordshire, and Chair, Innovation and Growth Policy Network, Universities UK, and **Professor Paul Nightingale**, Deputy Director, Science Policy Research Unit (SPRU), University of Sussex	Q1–41
Steve Bates OBE, Chief Executive, BioIndustry Association, **Jen Rae**, Head of Policy, Nesta, and **Allan E Cook CBE**, Vice President, Royal Academy of Engineering	Q42–70

List of Reports from the Committee during the current Parliament

All publications from the Committee are available on the publications page of the Committee's website.

The reference number of the Government's response to each Report is printed in brackets after the HC printing number.

Session 2016–2017

First Report	EU regulation of the life sciences	HC 158
Second Report	Digital skills crisis	HC 270 (HC 936)
Third Report	Satellites and space	HC 160 (HC 830)
Fourth Report	Forensic Science Strategy	HC 501 (HC 845)
Fifth Report	Robotics and artificial intelligence	HC 145 (HC 896)
Sixth Report	Evidence Check: Smart metering of electricity and gas	HC 161 (HC 846)
Seventh Report	Leaving the EU: implications and opportunities for science and research	HC 502 (HC 1015)
Eighth Report	Setting up UK Research & Innovation	HC 671 (HC 1063)
Ninth Report	Future programme: 'My Science Inquiry'	HC 859
Tenth Report	Managing intellectual property and technology transfer	HC 755
Eleventh Report	Science communication and engagement	HC 162
Twelfth Report	Science in emergencies: chemical, biological, radiological or nuclear incidents	HC 163
First Special Report	Satellites and space: Government Response to the Committee's Third Report of Session 2016–17	HC 830
Second Special Report	Forensic Science Strategy: Government Response to the Committee's Fourth Report of Session 2016–17	HC 845
Third Special Report	Evidence Check: Smart metering of electricity and gas: Government Response to the Committee's Sixth Report of Session 2016–17	HC 846
Fourth Special Report	Digital skills crisis: Government Response to the Committee's Second Report of Session 2016–17	HC 936
Fifth Special Report	Robotics and artificial intelligence: Government Response to the Committee's Fifth Report of Session 2016–17	HC 896
Sixth Special Report	Leaving the EU: implications and opportunities for science and research: Government Response to the Committee's Seventh Report	HC 1015

Seventh Special Report	Setting up UK Research & Innovation: Government Response to the Committee's Eighth Report	HC 1063

Session 2015–2016

First Report	The science budget	HC 340 (HC 729)
Second Report	Science in emergencies: UK lessons from Ebola	HC 469 (Cm 9236)
Third Report	Investigatory Powers Bill: technology issues	HC 573 (Cm 9219)
Fourth Report	The big data dilemma	HC 468 (HC 992)
First Special Report	Royal Botanic Gardens, Kew: Government Response to the Committee's Seventh Report of Session 2014–15	HC 454
Second Special Report	Current and future uses of biometric data and technologies: Government Response to the Committee's Sixth Report of Session 2014–15	HC 455
Third Special Report	Advanced genetic techniques for crop improvement: regulation, risk and precaution: Government Response to the Committee's Fifth Report of Session 2014–15	HC 519
Fourth Special Report	The science budget: Government Response to the Committee's First Report of Session 2015–16	HC 729
Fifth Special Report	The big data dilemma: Government Response to the Committee's Fourth Report of Session 2015–16	HC 992