Spending Review Representation 2015

Introduction

The Campaign for Science and Engineering (CaSE) is the leading independent advocate for science and engineering in the UK. CaSE believes the UK government should support a healthy and thriving science base in which all parts of this integrated system are well funded and performing optimally. In this document we set out the rationale, principles and priorities for public investment in the UK's world-leading capability in science and engineering.

CaSE works to raise the political profile of science and engineering, and ensure that the UK has world-leading research and education, skilled scientists and engineers, and successful innovative business. It is funded by around 800 individual members and 100 organisations including businesses, universities, learned and professional organisations, and research charities. Collectively our members employ 350,000 people in the UK, and our industry and charity members invest around £19.3bn a year in R&D globally[1].

The UK science base is an integrated ecosystem which encompasses all disciplines of science, engineering, innovation and technology, and a wide range of sectors including higher education, industry, Small and Medium Enterprises (SMEs) and investors. The extraordinary and well-documented success of the UK science base is founded on historic strength, past investment and valued principles for allocation of funding.

Summary

To deliver on its commitment of repairing Britain's finances and move to a higher-wage, more productive economy, the Government must nurture its means: science and innovation.

The UK cannot compete on cheap labour, capital reserves, or natural resources. We must instead play to our advantages in science and engineering. Government priorities set out in this Spending Review depend on science and innovation. In an increasingly competitive global economy, they will be the drivers of future innovation, productivity gains, and high-value job creation. A strong science base will also be vital for preparing the nation for future challenges, from climate change, food security and future cities, to antimicrobial resistance, national security and meeting the needs of an ageing population.

The Conservative Manifesto speaks proudly of the relative protection for investment in science in the last Parliament. And rightly so. However, in the current climate, anything short of a real terms increase to investment in research and development (R&D) by the end of this Parliament would be short-sighted and damaging; scientifically, politically and economically.

To compete as a scientific, technological, and economic world-leader, and reap the benefits of global investment, the Government must set an ambitious upward trajectory for investment in R&D over the long term, at a rate that exceeds predicted growth by the end of the Parliament.

[1] Figures taken from latest available years of data

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Government priorities depend on science and engineering

Increasing Productivity

In this Spending Review, the Chancellor has made clear his intent to prioritise spend in areas that drive productivity and growth. As stated in the Government's productivity plan, investment is an essential part of raising productivity and there is clear and robust evidence of a link between R&D spending and national productivity[2].

R&D and human capital are universal drivers of productivity[3]. Government investment in R&D 'crowds-in' further private sector investment[4] as well as other productivity boosting effects such as contributing to raising the level of the skills base in the UK, boosting human capital.

- Every £1 of public investment in R&D raises private sector output by 20p each year in perpetuity[5].
- £1 of public investment gives rise to an increase in private funding of between £1.13 and £1.60[6], and firms that persistently invest in R&D have 13% higher productivity than those with no R&D spending[7].The productivity-boosting effect of public sector R&D investment is greater the higher private sector R&D investment is.
- Evaluation studies have specifically shown that firms in receipt of innovation grants from UK government are 41% more likely than other similar firms to introduce new products to market, with product innovation linked to raising a firm's labour productivity[8]. This effect is boosted by collaboration with the research base.
- The outcomes of R&D also contribute to productivity of the UK workforce by developing treatments and technologies that enable people to live longer, healthier lives.

The Chancellor has outlined his aim of prioritising investment in areas that drive productivity. To meet this aim, the Government should increase its own investment in R&D and enact further measures to support and encourage private sector investment.

Creating High-value jobs

Britain's competitive edge is in high value products, processes and services based around information and knowledge content[9]. Innovative activity such as improving production processes and creating new products and services is vital for creation of high-value jobs[10]. A wide range of

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2 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/443898/Productivity_Plan_web.pdf

3 "On the Robustness of R&D" , Kul, Khan and Theodorodis, Journal of Productivity Analysis, vol. 42 (2014), 137-155

4 'The Economic Significance of the UK Science Base: a report for the Campaign for Science and Engineering', Haskel, Hughes and Bascavusoglu-Moreau, April 2014

5 Ibid

6 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/438763/bis-15-340-relationship-between-public-and-private-investment-in-R-D.pdf

7 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293635/bis-14-p188-innovation-report-2014-revised.pdf

8 Estimating The Effect Of UK Direct Public Support For Innovation, BIS analysis paper 2014

9 The way we'll work: labour market trends and preparing for the hourglass, University Alliance 2012

10 Estimating The Effect Of UK Direct Public Support For Innovation, BIS analysis paper 2014

industries, from manufacturing to digital technology, rely on science and engineering to innovate, grow, and create high-value jobs[11]. Investment and support for science and engineering is essential for the future of the UK as a high-tech and knowledge-based economy.

- Science, research engineering and technology professionals and associate professional are projected to grow as a proportion of the workforce[12]. Currently, 20% of the workforce is employed in science and engineering roles, a total of 5.8 million people in 2011.
- Innovative firms are more likely to employ staff with STEM skills. Growth of innovative UK firms starts with the hiring of more STEM graduates followed by increased R&D spending, resulting in new products to market and higher sales growth[13].
- There are estimates that the UK has an annual shortfall in domestic supply of around 40,000 new STEM skilled workers[14] and we need to double the number of graduates and technicians in the engineering discipline alone by 2020 to meet demand[15]. Failure to meet this could cost the UK £27 billion a year[16].
- Evidence points to the benefits of increasing the level and depth of STEM skills in the workforce[17][18]. Enabling more people access to STEM careers will benefit families and communities across the UK, in part due to high demand for workers and because, on average, those working in STEM occupations earn 20% more than those working in other fields[19].

The science base is as strong as the people in it, not just the institutions and equipment they use. There is fierce global competition for talented people and an active transfer market of scientists and engineers across the world. The UK must be able to train, attract and retain talented people into its research companies, charities and universities.

Government can support demand for STEM skills through prioritising science and innovation investment and policy which lead to high-value job creation. Government can also contribute to the supply of STEM skills through adequate support for high quality STEM higher education, further education and apprenticeships. Measures to achieve this are discussed later.

Driving sustainable growth across the UK

The Prime Minister said in 2014, "We are on the brink of a new industrial revolution. I want the UK to lead it[20]." That will not be possible without policies and investment that support research and innovation. The Prime Minister recognises the value to the UK of leading the world in research and innovation, in the creation and development of new ideas, new technologies, and new markets. To realise his aim, increased and sustained investment is needed.

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[11] The Science Council, The current and future UK science workforce, 2011
[12] Working Futures 2012-2022, UKCES 2014
[13] Department for Business Innovation and Skills, Highly Innovative firms and growth, 2014
[14] The STEM human capital crunch, The Social Market Foundation, 2013
[15] The state of Engineering, Engineering UK, 2013
[16] Royal Academy of Engineering, Engineering for Growth, 2014
[17] The demand for STEM graduates and postgraduates, CIHE, 2009
[18] The supply and demand for high level STEM skills, UKCES, 2013
[19] The labour market value of STEM qualifications and occupations, Department of Quantitative Social Science, Institute of Education, July 2011.
[20] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/409774/14-1230-internet-of-things-review.pdf

Lord Krebs, former Chair of the House of Lords Science and Technology Committee, has voiced his concerns saying "that unless investment in science in the UK keeps pace with that elsewhere in the world, the UK could lose its competitive edge in science and innovation, with consequential impacts on the economy"[21].

There is strong evidence to support advice that government can drive economic growth by investing in science and engineering research[222324]. The higher education sector, where a large proportion of publically-funded basic research is performed, generated over £73 billion of output and contributed 2.8% of UK GDP in 2011/12[25].

The public are supportive of scientific research and value scientists and engineers. The UK public overwhelmingly see science as beneficial. Research by Ipsos MORI and commissioned by the Department for Business Innovation and Skills (BIS), found that over 80% of those asked agree that science will make people's lives easier, and around 90% believe that scientists and engineers make a valuable contribution to society[26]. The same survey found that two-thirds (65%) see investment in science as a priority for the Government and 81% think that the UK needs to develop science and technology in order to enhance its international competitiveness.

Public spending on science and engineering is an investment bringing significant returns[27] that can boost economic growth and bring significant benefits to society[28]. However, the UK is missing out on these benefits due to structural underinvestment in R&D with knock on effects to our skills base and attractiveness as a place for industry to invest[29].

Lead healthier and happier lives

Science and engineering produces more effective medicines and cleaner energy, generates new technologies and informs government policy. Science and engineering can enable technological improvements and economic growth alongside environmental and social improvements, leading to healthier and happier lives for all[30].

- Global research efforts have led to cancer treatments and interventions delivering health gains equivalent to £124 billion for UK patients between 1991 and 2010 through prevention, early identification, and improved survival[31]. Due to research what once would have been terminal cancers are treatable.
- One million more properties were protected in the floods of 2013-14 compared to similar floods in 2007 as a result of government-funded research. This saved £2.6 billion

[21] Lords Committee calls on the Chancellor to increase science budget, June 2013
[22] Estimating the economic benefits of cancer-related research in the UK, Glover et al, 2014
[23] The Economic Significance of the UK Science Base, Haskel et al, 2014
[24] Rates of return to investment in science and innovation, Frontier economics for BIS, 2014
[25] The impact of universities on the UK economy, Universities UK, 2015
[26] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/348830/bis-14-p111-public-attitudes-to-science-2014-main.pdf
[27] A recent report for CaSE, The Economic Significance of the UK Science Base, found that for every £1 spent by the government on R&D, private sector R&D output rises by 20pence per year in perpetuity, showing that public investment in R&D is an investment that generates economic growth attracting private sector investment from home and overseas.
[28] The Economic Significance of the UK Science Base, Haskel et al, 2014
[29] Insights from International Benchmarking, BIS analysis paper, 2014
[30] Research Councils UK, Impact report, 2014
[31] Glover, Buxton, Guthrie, Hanney, Pollitt and Grant, Estimating the returns to UK publicly funded cancer-related research in terms of the net value of improved health outcomes. 2014

of lost working days in London alone and £2 billion in fewer and less expensive insurance pay-outs[32].

- R&D has improved aircraft fuel efficiency by 30% since 1990, saving over 400 million tonnes of CO_2 per year, and is expected to improve efficiency by a further 38% between 2010 and 2050[33].

Nurture the UK's means: Principles for high performance

The UK science base is an integrated ecosystem which encompasses all disciplines of science, engineering, innovation and technology, and a wide range of sectors including higher education, industry, Small and Medium Enterprises (SMEs) and investors. The extraordinary and well-documented success of the UK science base is founded on historic strength, past investment and valued principles for allocation of funding.

Funding decisions – uphold Haldane Principle

The UK Research Base is the most efficient in the world. As is widely cited, we produce 15.9% of the most highly cited academic articles with only 3.2% of global expenditure on R&D and 4.1% of global researchers[34].

The pre-eminence of the UK across science and engineering disciplines is founded on long-held principles of allocation of funding for research on the basis of excellence as judged by expert peers. The Haldane principle refers to the benefit of research being conducted independently from Government. It has developed to state that the research community should determine which projects receive state support via the Research Councils; whilst Government guides priority-setting according to a range of criteria. The former Science Minister, David Willetts, stated in 2010 that holding to this principle "has been crucial to the international success of British science"[35]. The Haldane principle must continue to be upheld by the current Government, as stated by the Science Minister, Jo Johnson MP, in his oral evidence to the House of Commons Science and Technology Committee[36].

Excellence and agility – maintain the dual support system

The UK is a world-leader in creative academic discovery leading to innovation. The Funding Councils[37] are at the heart of the UK research base. Government investment through the Councils in world-leading science, facilities, and people creates the foundations on which the rest of the ecosystem builds.

Discovery imparts a national competitive advantage in being ahead of the curve. Artificially narrowing the field of enquiry for short term impact puts discovery and innovation at risk. The breadth of the UK's strength across disciplines must therefore be protected, enabling discovery to emerge in unpredicted places. The range of our excellence stimulates new ideas at the boundaries

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[32] Natural Environment Research Council, Impact Report, 2014

[33] Sustainable Aviation, Sustainable Aviation CO_2 road-map, 2012

[34] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263729/bis-13-1297-international-comparative-performance-of-the-UK-research-base-2013.pdf

[35] Written Ministerial Statement, Hansard, 20 December 2010

[36] http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/science-and-technology-committee/the-science-budget/oral/18733.html

[37] These include the Research Councils, and the Quality-Related funding streams of the Higher Education Funding Councils of England, Wales, Scotland and Northern Ireland.

and enables researchers to quickly capitalise on their advantage by easily recruiting experts in diverse fields.

Further, to address many of the biggest challenges facing society and to capitalise fully on new technologies, collaboration across scientific disciplines is increasingly important. It is, therefore, vital that all seven UK Research Councils are well-supported, as a lack of funding in one area would impact on progress across other areas. Further, the dual support system for allocating research investment is an efficient and effective means of supporting excellence and agility and should be maintained.

Block funding through the Higher Education Funding Councils primarily based on measures of prior research quality is vital. This unhypothecated Quality Related research funding (QR) provides essential flexibility to universities and research institutes. It enables them to take risks, explore new avenues of research, and to meet the on-going costs of research, for instance in collaboration with industry, small companies or charities. Indeed, elements of QR such as the Charity Research Support Fund enables public donations to be spent directly on research[38], helping to ensure this substantial charity investment is made in the UK and not elsewhere.

Research Councils, along with charities, the EU, industry, and government departments provide competitive funding for specific research projects and programmes. Together this model supports the most productive and efficient publicly funded research system in the G8[39]. Further, economic studies have shown that every pound invested in these funding streams yields direct benefits in industry output: every £1 invested in R&D by the Government raises private sector output by 20p each year in perpetuity[40].

The dual support system is an efficient and effective mechanism for funding research that supports agility, multidiscipline collaboration, and excellence wherever it exists to maintain the UK's productive and innovative research base. The Government should maintain the dual support system of funding research and in this proven channel over this term of Parliament increase investment in real terms

Stability and strategic planning –ring fence the science budget

Science and engineering research is a long-term enterprise, and requires sustained support over a period of many years. Along with the absolute levels of investment, the ringfence gives confidence that the UK is a 'safe bet' for individuals and companies looking to invest their time, talent and resources.

Recognising the importance of funding the science base, a subset of the government's total spend on science has been ringfenced in the last two terms of Parliament. The ringfence has provided relative protection from departmental budget cuts and a degree of stability and predictability over the period for the elements of the government spend on science contained within it. This stability enables funders to make medium-term plans and commitments with a greater degree of confidence, provides a stable funding environment that promotes effective collaboration and partnerships that often require long lead-times, and protects a proportion of the government's overall spending on research from being used by departments to cover shorter-term departmental needs.

[38] http://www.amrc.org.uk/sites/default/files/doc_lib/AMRC-challenge-for-government-in-2015.pdf
[39] International Comparative Performance of the UK Research Base, Elsevier for BIS, 2013
[40] http://sciencecampaign.org.uk/UKScienceBase.pdf

In the last term of Parliament, continuing to protect investment through the ring-fence was a forward thinking decision in a difficult funding environment. Now, as the economy improves, this Government should continue to ring-fence investment in science. Additions to the scope of the ring-fence would be welcome, such as capital and innovation budgets. Any additions must be fully funded to maintain the spending power of the science budget in real-terms.

We recognise the Government's commitment to protect science at a time which has seen significant cuts to a number of Government departments. As described in Annex A, on its own, ring-fencing the science budget will not be sufficient to foster the healthy and productive science base that the UK needs and that the Conservative Government have stated they want to build.

We are in the sixth year of a flat-cash settlement for the science budget at £4.6bn. The cumulative erosion of the ring-fenced science budget will be over £1.1bn from the beginning of 2010 spending review period up to 2015/16. Inflation will continue to affect the research budget every year that flat-cash is maintained, reducing the capacity and strength of our research base and missing out on the substantial growth opportunities and productivity raising potential that the growing evidence affirms investing in science brings[41]. To be most effective, commitment to the ring-fence must come with a commitment to increasing total investment in science and innovation.

Transparency in decision making

This Government has stated that "openness and transparency can save money, strengthen people's trust in government and encourage greater public participation in decision-making"[42]. High-level strategic decisions, whether by the Research Councils or the government, should be made in a transparent and accountable way to give confidence and direction to researchers, investors, and tax-payers.

After initial major cuts to science capital in the 2010 spending review, the last Government then prioritised additional investment in science capital bringing a welcome boost to the overall budget. However, the ad-hoc nature of these capital announcements has created concern that investment has been determined by political opportunism rather than based on scientific merit in areas that align with politically-agreed, long-term strategic considerations.

Distributing research funding on the basis of specific near-term policy objectives can lead to inefficient use of funds and risks unintentionally diverting funds away from areas of national importance. Therefore, in line with the wider government drive towards transparency and open policymaking, as well as to facilitate good stewardship of public funds, the Government should return to more stable and transparent mechanisms of allocating research investment that are in line with the principles discussed above (the Haldane Principle) and the Government's strategic science and innovation priorities.

Nurture the UK's means: increase investment in R&D

Signal intent and attract investment – set out long-term ambition

Science and engineering have been pivotal in the UK's history and across the political spectrum there is agreement that they are central to the UK's future success. To compete as a scientific, technological, and economic world-leader and reap the benefits of global investment, the

[41] Why Champion Science and Engineering?, CaSE, 2015
[42] https://www.gov.uk/government/topics/government-efficiency-transparency-and-accountability

Government must set an ambitious upward trajectory for investment in R&D over the long term, at a rate that exceeds predicted growth by the end of the Parliament.

The UK's declining public R&D investment is a lost opportunity, risking the breadth and depth of UK science excellence with implications for the absorptive capacity of firms and our ability to benefit from global investment in science and innovation[43]. In the international context, further reducing the UK's public investment in R&D would send a very damaging signal. To potential investors in charities or companies, it would signal that the UK will not be the place to access expertise or world-class facilities in future. It would signal to globally-mobile researchers and companies that the UK should not be the destination of choice to grow a career or an innovative business.

Worryingly, in a recent survey, 45% of respondents from private companies reported that cuts in public funding have affected R&D in their organisation in the last five years[44]. UK or internationally headquartered companies can choose to invest in R&D in the UK, but many also have significant investment elsewhere. We hear again and again that long term policies and funding make a real difference as to whether a company locates significant investment in a country. Yet, unlike our international peers, investment is declining and the UK does not have a long-term plan for increasing investment in R&D[45].

The UK Research Base has great capacity to yield significant returns from greater investment by this Government and thus contribute to the long-term health and productivity of the UK economy. Yet, short-termism puts at risk innovation and future growth[46]. Without political leadership, the inherent short-term nature of political cycles can present a barrier to genuinely long-term planning. Investment in science and engineering must be set out on longer time scales than the intervals between elections or spending reviews.

There is political agreement that a long-term framework and investment plan is key to supporting and building on science and engineering success in the UK. Indeed, the Chancellor has said "if Britain is to become the best place to do science and apply it: we have to give British science the funding it needs for the long-term"[47]. This Spending Review gives him, and this Government, the opportunity to do just that.

Looking at today's outputs and concluding that current levels of investment are sufficient is unrealistic. UK outputs and performance in science and innovation are linked to prior investment, sometimes 10, 20 or even 30 years prior. For this reason it is not possible to say that current excellence in the UK research base demonstrates that current investment is adequate. Structural underinvestment leaves the UK in a position where it is investing in science at a lower rate than the majority of the EU and the OECD (see Annex B). It is unlikely that the UK can sustain its position as a world-leading research nation on this basis[48]. Public investment in R&D has been falling for decades and if this persists the UK will forfeit its hard-won historical competitive advantage[49]. Action is needed.

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[43] Insights from International Benchmarking, BIS analysis paper, 2014

[44] http://www.prospect.org.uk/news/id/2015/August/28/Frontline-specialists-say-decline-publicly-funded-science-affects-whole-economy

[45] http://sciencecampaign.org.uk/?p=13867

[46] http://www.bankofengland.co.uk/publications/Documents/speeches/2015/speech797.pdf

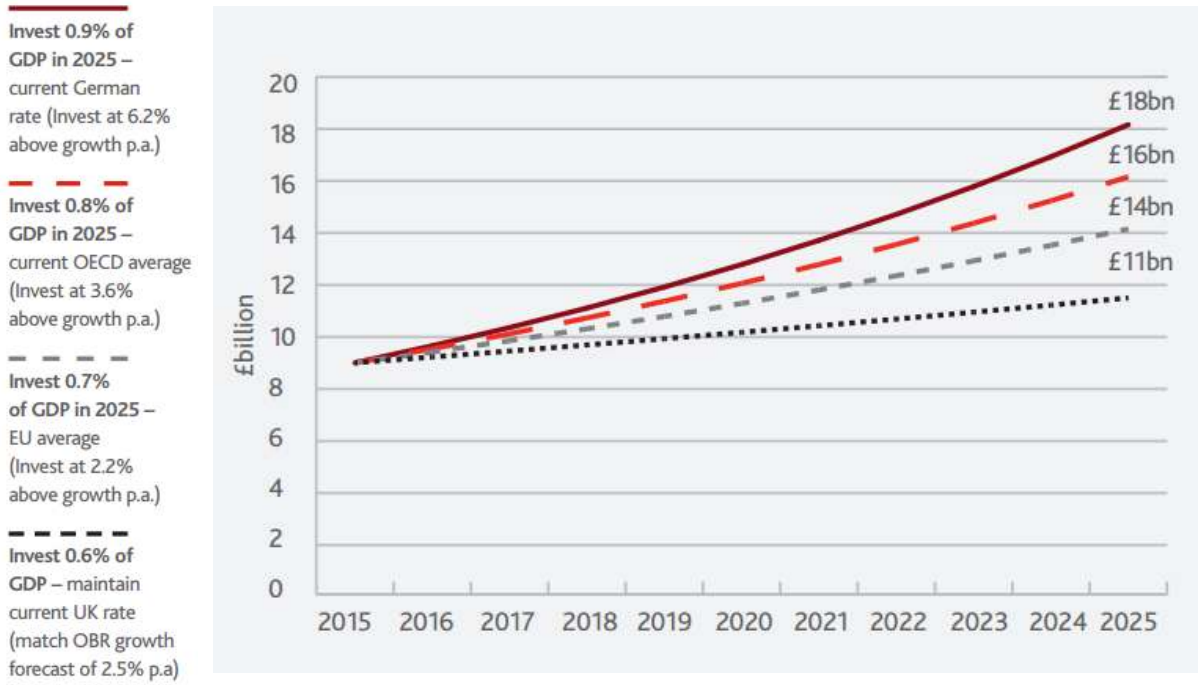
[47] Chancellor of the Exchequer's speech on science in Cambridge, 25 April 2014

[48] International Comparative Performance of the UK Research Base, Elsevier for BIS, 2013

[49] International Comparative Performance of the UK Research Base: A report prepared by Elsevier for BIS (2013)

By committing to forward looking investment in science and innovation, this Government would be investing for the future in precisely the areas it seeks to develop: high-value jobs, productivity, economic growth, along with wider aims in education, security and resilience, and health. CaSE calls on the Government to set an ambitious upward trajectory for investment in R&D over the long term, at a rate that exceeds predicted growth by the end of this Parliament.

Figure 1: 10 year plan to reach internationally competitive levels of government investment in R&D[50]



Efficient use of public investment – back capital investment with resource

This Spending Review provides the Government with the opportunity to back its Science and Innovation Strategy with essential resource funding. It is vital that resource budgets are sufficient to fully utilise research infrastructure and equipment to gain maximum scientific and economic benefit.

The 2014 Science and Innovation Strategy stated:

> *"Capital investment alone is not sufficient to ensure our research infrastructure is able to continue to deliver world class outputs. We recognise that our science base requires adequate resource funding, and will give full consideration to these requirements when we take a decision at the Spending Review next year."*

'Capital' can refer not only to the construction and maintenance of facilities facilities, but also the purchase and upkeep of vital equipment such as DNA sequencing machines or electron microscopes. 'Resource' can refer to the people who use them to test their ideas or the energy to run and service them.

In science and engineering capital investment underpins progress – the pace of technological change means that equipment has to be regularly renewed. Recognising this, the Conservative Party manifesto committed to honouring the Government's long-term capital commitment to investing

[50] Science and Engineering Investment, Policy Briefing 2014, CaSE

£1.1bn per year in real terms up to 2020/21[51]. This is welcome medium-term stability and recognises the enormous long-term growth potential that comes from investing in scientific infrastructure.

For this investment to be used efficiently, resource and capital investment must be tied. As clearly set out in the House of Lords Science and Technology Committee report on Scientific Infrastructure, value for money can only be gained from capital investment if it is matched by resource and vice versa[52]. Thus, the UK can create world-leading facilities that run internationally competitive research programmes; rather than paying for equipment that stands unused because of lack of funds. Government should aim to provide the underpinning investment in scientific infrastructure. This attracts external research investment, for example from medical research charities or research-intensive companies, where the terms of the third party direct them to invest in research but not in underpinning infrastructure[53].

Without a complementary commitment to resource, there is a real danger that prior public investment will be wasted rather than contributing towards growth and productivity, with the further effect of diminishing the UK's research capabilities in areas of national importance and strategic advantage.

Investment in innovation complements investment in science

The ecosystem of science and engineering in academia, technology transfer, innovative businesses and investors all integrate to convert creative discovery into tangible benefit. The UK's growing industrial strategy and innovation support structures build on the UK's excellent science base to derive maximum benefit for the UK.

Innovation was responsible for 63% of the UK's improvements in labour productivity between 2000-2008[54]. The UK has historically had a reputation for its world class research base. Indeed it is a major attractor for multinational R&D businesses, something we repeatedly hear from our industry members. The most direct evidence of this effect in the UK is that multinational pharmaceutical firms locate their laboratories near to universities with excellent chemistry research[55]. Across sectors, access to expertise and world class facilities are repeatedly cited as key attractors along with the international reputation of the UK's research and innovation institutions. Therefore, investing in the science base as articulated elsewhere, is also an investment in innovation.

The Industrial Strategy introduced in the last term of Parliament has attracted support from business and particularly in key sectors like automotive, aerospace, bio-tech, creative industries and energy. The key ask from industry members is for stability in the Government's approach in this area. Government and industry have, to date, invested substantial resource in this approach and it would be poor stewardship of public funds to withdraw support and change approach before the full benefit of the investment is reached. Particularly when industry tells us this approach is accelerating outputs and an attractor for investing in the UK. There could, however, be room for better read-across between the Industrial Strategy and the wider support for innovation and research across BIS.

Government investment in business-led research and innovation is primarily distributed by Innovate UK whose mission is to accelerate economic growth through business-led innovation. Importantly,

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[51] Science and Research funding allocations 2015/16, BIS, 2014
[52] Scientific Infrastructure, House of Lords Select Committee on Science and Technology, 2013
[53] http://www.amrc.org.uk/our-work/working-with-others/working-with-universities/charity-research-support-fund
[54] NESTA and BIS (2010) Annual Innovation Report
[55] The Economic Significance of the UK Science Base, Haskel et al for CaSE, 2014

businesses recognise the interconnectedness and complementarity of funding research through the Funding Councils alongside funding through Innovate UK. Indeed at a House of Commons evidence session representatives from Rolls-Royce and GlaxoSmithKline affirmed that they were in favour of more funding for Innovate UK, but not at the expense of funding through Research Councils[56]. Both are needed to ensure the UK economy and society derive maximum benefit from its current strength in science and innovation.

Innovate UK investment is spread across a wide program of activity including funding competitions, supporting knowledge transfer partnerships (KTPs) and networks, Smart awards, Catapults, and the Small Business Research Initiative (SBRI). An independent analysis in 2011[57] showed that Innovate UK provides a good return on investment. A 2013 evaluation study showed its business impact is twice as high for projects with two or more academic partners, at £9.67 GVA per pound spent, compared to projects without academic partners, at £4.22 GVA per pound[58].

More recent analysis[59] has also found that:

- collaborative grant funding for innovation leads to the additional employment of STEM graduates,
- receiving a grant stimulates around 30 per cent increase in a firm's own spending on innovation in addition to the grant funding, and
- 41 per cent more likely to introduce novel products to market.

Government investment in business-led research and innovation through Innovate UK[60] has increased from £277 million in 2010/11 to an expected £536 million in 2014/15. This represents an 80% real-terms increase which has largely been driven by investment in the network of catapult centres, which were introduced in 2011.

The Catapult network is maturing with centres at different stages of development. The businesses we speak to have voiced strong support for the value these institutions bring to the UK science and innovation offering. In particular, as they develop, the Catapult Centres are meeting the well-established demand for access to world class facilities for research, development and testing. They also provide start-ups and SMEs in different sectors with access to the expertise, networks and facilities usually only available to multi-national research companies. As a result, we hear that the centres are contributing to a growing global perception of the UK as a place to innovate, and should continue to be supported.

By design the centres do not follow a uniform model but could benefit from more coherence across the network, perhaps with an innovation support signposting function for local businesses across all sectors. All major political parties have voiced their continuing support for Catapults, including in the Conservative manifesto. It is essential that investment to date is maximised and each Catapult is able to develop to meet identified gaps in businesses' access to world-class facilities and expertise in their

[56] Business, Innovation and Skills Committee Evidence Session, Business-University Collaboration, 9 Sept 2014
[57] Evaluation of the Collaborative Research and Development Programmes. PACEC for the Technology Strategy Board, 2011
[58] Evaluation of the Collaborative Research and Development Programmes, Innovate UK, 2013
[59] Department for Business, Innovation and Skills, Estimating the effect of UK direct public support for innovation, 2014
[60] As reported in Technology Strategy Board Annual Reports and Accounts, listed as "technology grants", except figures for 2014/15, which have not been reported yet but are anticipated to be £536 million in the Technology Strategy Board Delivery Plan for 2014/15.

sector. This will lead to the Catapults contributing to the UK's growing reputation with businesses as a country that takes innovation seriously.

The growing innovation infrastructure in the UK is bearing fruit in technological advances, driving efficiencies and thus raising firm productivity, achieved through investment in R&D and aided by collaboration between firms, universities and government,. For instance, Rolls-Royce has halved the time it takes to manufacture fan discs and turbine discs used in jet engines, using methods developed at the Advanced Manufacturing Research Centre (AMRC) at Sheffield University, which now forms part of the High Value Manufacturing Catapult. They are not alone, other firms have said that collaboration with the Catapults and Innovate UK funding has enabled them to complete projects more quickly and provided a firm reason to do that work in the UK rather than abroad[61].

However, expanding the network without sufficient resource could lead to diluting the impact of the existing Catapults. The priority should therefore be to ensure that the Catapults that have been announced to date are properly supported. The public investment element of their funding must be sufficient and each centre should be properly embedded in and joined up with other structures within the research and innovation ecosystem so as to complement rather than duplicate or compete.

Other Innovate UK programmes, such as collaborative R&D and KTPs are effective in fostering closer collaboration and join up between the academic research community and businesses needing to access expertise. KTPs help companies address skills gaps in their businesses and to take advantage of specialist expertise at universities. They can also be a first point of contact between a company and a university, opening the door to further collaboration and should be continued[62].

CaSE also echoes the overarching recommendation of the recent Dowling review that government should seek to reduce complexity of public support for innovation, wherever possible and, where simplification is not possible, every effort should be made to ensure that the interface to businesses and academics seeking support for collaborative R&D is as simple as possible[63].

Collaboration and Leverage

Collaboration between universities, charities, and industry is at the heart of the UK's success in science and engineering and is a highly attractive feature for public and private researchers when deciding where to base their research. It is also increasingly recognised that future scientific and technological breakthroughs will come from the collaboration of specialists from a range of disciplines and sectors. Collaborations facilitate the sharing of cost and risk, providing a platform for innovation. It is therefore vital that government policy promotes collaboration and creates an attractive environment for private and third sector investment and innovation. The system isn't broken but more could be done to make it efficient and effective. In line with recommendations in the recent Dowling Review, CaSE believes there are further steps that Government can take promote and facilitate research collaboration between academia and industry to drive economic growth.

Academic and industry CaSE members have highlighted the UK's VAT system as a current and significant barrier to research collaboration, particularly co-location within research institutes. In a

[61] http://www.economist.com/news/britain/21652310-britains-stall-productivity-more-serious-any-rich-world-peer-closer-look
[62] Ambitious Innovation, Uncertain Outcomes, Innovation monitor 2015, EEF
[63] The Dowling Review of Business-University Research Collaborations, July 2015

recent CaSE briefing, the key issues and solutions to explore are set out in detail[64]. The primary issue is that publicly-funded research institutes are restricted to 5% commercial activity if they opt not to pay VAT or face costly tax bills to co-locate their researchers with industry colleagues. The complicated nature of the UK tax system and inflexible interpretation by HMRC is creating unnecessary cost and bureaucracy, and stifling research collaboration that the Government is seeking to grow. It is important that policies are aligned across government to ensure the efficient use of public funds within the higher education sector and that public investment is optimised to promote economic growth. CaSE echoes the recommendation in the Dowling Review[65] that the government needs to address the issue of VAT on shared facilities as a matter of urgency.

Successive governments have sought to encourage business R&D through tax-incentives such as R&D tax credits and the Patent Box. R&D tax credits do not necessarily increase the amount invested in R&D globally but contribute to creating an attractive financial environment for investment. As other nations provide them, the UK must also do so to remain competitive as a location for business to invest in R&D. To be effective, the offering must be straightforward for businesses and comparable internationally.

Evidence shows there is a complementary relationship between private and public sector R&D with public investment in research increasing rather than diminishing private sector investment[66]. It is therefore essential that investment in science and innovation is not seen as a zero-sum game in which public and private investment can substitute for each other. If Government expenditure on science and research were reduced from current levels, charity and industry would be unable to increase their investment to compensate. Instead, synergy between the public and private sectors is vital to generating economic growth. Therefore one of the most important levers for attracting private investment in R&D is investing public funds in research.

Towards the end of the last Parliament capital funding opportunities tended to be short-notice, and often without corresponding resource. Such uncertainty affects strategic planning for new research infrastructure or upgrading existing facilities at a national and institutional level. Short timescales can also strain the relationships that drive the success of the science base. Favours must be called in to assemble consortia across academia, industry and town planning to meet short deadlines. These relationships are critical for leverage of investment from outside of government, amplifying the value of the government investment.

The Research Partnership Investment Fund (RPIF) has proved to be a popular and effective fund enabling universities to leverage funding from private partners for capital projects. A predictable process, including sufficient lead in times for competitively awarded capital such as RPIF, will enable the UK to reap the benefits of the firm Government commitment to capital investment over the term. The sector would like to see RPIF continued but also recognise the current model would benefit from some revisions. For instance:

- the timescales on RPIF could be revised so that the bid can come earlier in the process followed by longer lead out times
- predictability would allow institutions to plan for future bids therefore a 5 year commitment with statement of frequency would be welcome

[64] http://sciencecampaign.org.uk/CaSEVATbriefing2015.pdf
[65] The Dowling Review of Business-University Research Collaborations, July 2015
[66] The Economic Significance of the UK Science Base, Haskel, Hughes and Bascavusoglu-Moreau, 2014

- reducing the current threshold levels would enable a wider pool of businesses and universities with high quality bids to engage.

The Government should revise and embed RPIF so that it becomes an increasingly effective fund that leverages private investment and engages a range of businesses with universities.

Capitalise on strengths across the UK – build capacity through strategic investment

The Research Councils have a long-held and valuable mission to support excellence wherever it exists. Excellence must remain the guiding principle of funding allocation for research projects and large capital investments in the Research Base. The strength and efficiency of the Research Base demonstrates the success of this approach.

In recent years, the Government has increasingly looked to address regional economic imbalances with investments in science and engineering research. Such geographical considerations must be in the context of delivering the highest quality of research possible.

> *"Britain's weak productivity is also driven by the fact that too much of our economic strength is concentrated in this capital city. This is unhealthy and unproductive, and we must achieve a better settlement for the future. Not by pulling London down… But what really drives this government, is building up other parts of our United Kingdom, as a balance to London's strength."*
>
> *George Osborne, Summer Budget Speech 2015*

In the same way, it would be counterproductive to balance research strength across the UK by pulling down current leading areas through disinvestment or spreading the same investment more thinly. There is already excellent research and innovation happening in universities and companies right across the UK, with some areas of particular strength. We fully support the aim of increasing scientific strength across the UK, but to do so will involve significant and sustained investment.

Regions, cities and substantial infrastructure budgets exist across Government departments to support the Government's regional development agenda. If the Government considers investment in science and innovation would support these aims, the scope of these budgets could be expanded to support investments to build science and engineering capacity.

As with any Government activity, a strong evidence base will help ensure the policy aims are achieved. The Government could invest in research to better understand how science and engineering investment can best support regional development whilst ensuring the quality of British science and innovation outputs are enhanced rather than adversely affected by regional policy interventions. The science and innovation audits commissioned by Government will certainly form part of this evidence. It would also be beneficial to involve the expertise of the Research Councils in a transparent process when deciding if, how, and where to make such investments.

Smarter Government - Prioritise R&D investment across government

Science and engineering make valuable contributions to policy-making across government. CaSE encourages strong networks for dialogue between scientists, engineers and policy-makers, and advocates transparency in the process of considering evidence in policy-making. Investment in R&D can also reduce government spending in many areas, from improved medical treatments reducing NHS costs, to social sciences research improving the evidence basis for, and thereby efficiency of, government policy.

Departmental R&D spending makes up about 40% of the Government's total expenditure on R&D[67]. Between 2009/2010 and 2011/12, half of all departments reduced R&D expenditure by 20% or more, with some cutting by as much as 50%[68]. These reductions were disproportionately large compared to departmental savings of 0-5%. This picture has not significantly improved since and is a continuation of a longer-term trend that could be damaging the Government's ability to respond to new challenges.

Departmental R&D budgets are the intelligence budgets of the Government. They allow ministers and civil servants to stay ahead of rapidly-moving policy and technology, to test ideas, and evaluate them when they have been implemented so that successes and failures can be learned. In some departments, primarily the Department of Health and the Ministry of Defence, research funded from these budgets has a direct impact on frontline staff and their ability to operate effectively.

There are many complementary relationships between research councils and Government departments as well as direct links to other institutions and individual researchers with expertise in associated fields. For instance, investment through NIHR and MRC are complementary[69] and cuts to one would impact on both. Both need to be supported. Research commissioned by departments is often conducted by the academic sector, meaning there is a symbiotic relationship between these budgets and investment in R&D through BIS. Investment in the Research Base by BIS ensures there is an academic resource able to conduct research commissioned by departments.

The tension within departments is that every pound spent on research could be seen as a pound less spent on frontline support – whether that be schools, disability support or investment in transport links. However, cutting R&D on this short-term basis could be counterproductive. Departmental spend on R&D is used by departments to invest in research to develop and evaluate new ideas and existing policies. Therefore, relatively small amounts of spend on research can lead to better frontline provision and increased cost effectiveness of public spend. For instance, the Department for Transport funded some research into how to design train carriages to facilitate the boarding of a high volume of people before new trains were built. This led to improvements in the design and function of new stock[70]. Departmental R&D is a significant component of government investment in science and needs to be considered alongside the ring-fenced science budget and capital spend.

As recognised in the 2014 Science and Innovation Strategy, departmental R&D spending is currently poorly protected from short-term budget cuts despite its importance to the everyday effectiveness of Government. This investment joined up across government is also essential to meeting some of this Government's major challenges. Solving challenges ranging from tackling antimicrobial resistance or the challenge of housing the population, to future proofing transport systems and creating high quality jobs, rely on scientists or engineers or would benefit from advances in science and engineering.

These budgets must therefore be rightly prioritised. This currently isn't the case as budget allocation and management isn't transparent or consistent across departments. Government should explore options to protect R&D budgets across government departments and ensure they are sufficient to provide effective intelligence support for policy and funding decisions. One option to strengthen

[67] http://www.ons.gov.uk/ons/dcp171778_370646.pdf
[68] http://sciencecampaign.org.uk/documents/2014/DepartmentalR&Dexpenditure2011-12.pdf
[69] http://www.mrc.ac.uk/documents/pdf/investment-and-impact-case-study-booklet/
[70] Public procurement as a tool to stimulate innovation evidence, House of Lords S+T Committee, 2011

consistency and transparency would be for Departmental Chief Scientific Advisers to have oversight of the department's R&D strategy and budget.

Amid discussions of greater devolvement of decision making to a local and regional level there needs to be training, structures and budgets to ensure that the learning and good practice from central government on using evidence in policy making can be built upon at the local level. To drive innovation, deliver quality, efficiency and value for money in public service delivery, aims set out in the Spending Review document, appropriate consideration needs to be given to the processes, structures and funding required to ensure evidence informs local and regional policy decisions.

Support the UK's future: invest in science and engineering skills

The science base is as strong as the people in it, not just the institutions and equipment they use. There is fierce global competition for talented people and an active transfer market of scientists and engineers across the world. A wide range of industries, from manufacturing to digital technology, rely on science and engineering to innovate, grow, and create high-value jobs[71].

The UK must be able to attract and retain talented people into its research companies, charities and universities. Without talented people, progress towards exciting new treatments and technologies would grind to a halt. This requires R&D funding that supports quality jobs, investment to nurture future talent and support those at the forefront of their career, and migration policy that facilitates global recruitment into UK industry and academia.

Making the UK the best place in the world to do science will involve making science and engineering jobs in the UK attractive to top talent. There is a large public sector R&D workforce whose jobs are directly impacted by cuts to public funding. In a recent survey one respondent articulated the damage cuts are having to recruiting and retaining talent as well as to outputs: "Our customers are ready and able to fund more work than we can do, but our headcount is restricted and because of poor and falling pay we are unable to recruit and retain specialists in most areas"[72]. The survey also showed that over one in five of respondents were actively looking for opportunities outside of science. Public investment in R&D includes investment in research staff at public institutions. Our science and innovation capacity will continue to be hampered if talent continues to leave to work in other sectors or in competitor nations.

Skills shortages

As discussed earlier, the UK has a long-standing STEM skill shortage. Too many research-intensive companies say they can't recruit graduates with the skills they need from the UK[73]. Attracting a wider range of people to study and work in science and engineering will help meet our country's own skills needs, will provide fulfilling careers for our own workforce, and well-paid jobs for the economy.

There are many different routes into STEM careers, be it through further education, higher education, apprenticeships, or a combination of these pathways.

Teaching science

There are not sufficient numbers of science, maths or computing teachers to meet the demand from schools and pupils. In England in 2013/14 there was a deficit of over 1000 teachers in STEM subjects

[71] The Science Council, The current and future UK science workforce, 2011
[72] Prospect R&D survey, June 2015
[73] https://www.gov.uk/government/publications/high-level-stem-skills-supply-and-demand

compared to recruitment targets. CaSE therefore supports the Governments drive to increase recruitment of maths and physics teachers in particular. Alongside this, measures to improve retention would be welcome to ensure trained and experienced teachers are retained in the profession.

At primary level, research shows the strong impact that teachers' knowledge and confidence in science have on students' attitudes towards science and their attainment and progression in it[74]. Currently around 5% of teachers in primary education have a science related degree[75]. If we want primary schools to deliver excellent science teaching, teachers must have access to appropriate science expertise in a school system that values science beyond attainment outcomes. The UK should champion primary science, give schools access to science expertise and adequately resource teaching[76]. This Government could support the increase in primary science expertise by investing in the professional development of existing primary teachers (at a cost of £2 million per annum)[77] to ensure that every child has access to a high-quality science education.

Informal learning - support our national assets

The Government has affirmed its commitment to supporting and enabling more young people, from a diverse range of backgrounds, to access and succeed in STEM. We support this aim. Nationwide efforts on STEM engagement are fractured across different government departments such as BIS, DfE, DCMS, and could benefit from being more joined up. A number of publicly funded institutions such as Kew Gardens, the Natural History Museum and the Science Museum Group see education and outreach as key missions. This aligns with Government aims of in increasing interest and uptake of STEM. And yet these institutions have faced funding cuts[78], that if deepened would make their outreach and education work unsustainable. By taking a government-wide view greater synergies could be achieved from government spend on STEM education and engagement with a focus on schemes and activities that have genuine reach and impact.

Further Education access to opportunities and retraining

Most English young people take some vocational courses before they are 16 and the majority follow courses which are largely or entirely vocational post-16[79]. Across science and engineering there is a need for upwards of 450,000 new STEM based technicians by 2020[80]. Around one-third of the science workforce in the UK is non-graduates working with science skills in a variety of ways and many of these will be highly skilled technicians[81].

However, there are concerns around the continuing provision of high quality, well-funded vocational STEM courses. There is considerable cost involved in providing some STEM programmes over and above other subjects. Data suggest that the current programme weightings for funding science, engineering and IT in FE colleges do not adequately reflect the cost of delivering these practical subjects[82]. Further Education has seen substantial budget cuts, particularly for adult education,

[74] http://www.wellcome.ac.uk/About-us/Publications/Reports/Education/Perspectives/index.htm
[75] http://www.psqm.org.uk/docs/PSQmconferenceSEPT2013_primary_focus-LouiseStubberfiledWellcome.pdf
[76] Evaluation of the impact of a CPD course for primary science specialists, Wellcome Trust, 2015
[77] Estimate from the Wellcome Trust. The current Primary Science Specialist course being offered by National Science Learning Centre has a cost of £3011 which includes 3 x 2 days residential at the NSLC.
[78] For instance, the Science Museum Group has seen a real terms decline of 30% in Government support since 2010 and, if this trend continues their grant in aid will have halved over a decade.
[79] Review of Vocational Education, Wolf Report, 2011
[80] The state of Engineering 2014, Engineering UK, 2013
[81] UK Science Workforce, Science Council, 2011
[82] The challenges of STEM provision for FECs, 157 Group, 2012

removing opportunities for those who are keen to retrain, upskill and get on in life, and making STEM provision unsustainable for colleges. The Government should look to address the growing Further Education STEM funding gap to ensure that STEM courses are feasible and of high quality. Not doing so would be a disservice to students and a missed opportunity for investing in much needed skills that will be essential for future economic growth.

Apprenticeships and professional standards

STEM apprenticeships can offer great employment and progression routes. In general, those taking apprenticeships experience lower funding, greater complexity and more variability in quality than university students[83]. Despite the focus on improving apprenticeships in recent years, STEM apprenticeships have become less popular since 2011 and too few young people are choosing the vocational route into a STEM career. Of the 440,400 apprenticeships started in 2013/14, 65,190 (14.8%) were in STEM. In overall numbers, there has been a decrease in people taking STEM apprenticeships, down from 70,100 in 2011/12[84].

In 2013/14, only 270 higher level engineering, science or maths apprenticeships were started. The numbers of people going on to finish and qualify with a higher apprenticeship is much lower again, with only 30 in 2013/14. The reality is this route is not yet a viable alternative for young people finishing school and looking for a route into a high quality science and engineering career. There is the opportunity to change that with the Government's commitment to creating more apprenticeships but there needs to be a gear shift in prioritising the creation of quality higher level STEM apprenticeships.

As new apprenticeships are developed in partnership with employers, the new standards should include skills which are relevant and valuable beyond just the current job, supporting progression within the sector. In science and engineering there are professional registration standards, such as Registered Science Technician and Engineering Technician, that are developed with the input of employers and the education sector and provide transferability and progression pathways. Science and engineering apprenticeships should link to professional registration standards to ensure transparency, quality and accountability.

Higher Education high cost subjects

Public investment in research generates talented graduates who leave the university system and go and work in industry. Their problem-solving skills reduce the costs and increase the economic benefits of innovation, increasing its demand and encouraging its exploitation and diffusion[85]. The funding of higher education must be sustainable and must also remain free at point of use. The provision of science and engineering undergraduate courses comes with additional costs associated with equipping laboratories and providing materials for practical work. Therefore, they cost more to deliver than many others and certainly more than the current cap on undergraduate fees of £9000. Although often invisible to the student, the Government's additional funding for high cost subjects is designed to bridge the funding difference between the student fee and the cost of provision. In the current system, without this extra funding, science and engineering subjects would not be a viable option for universities to offer undergraduates.

The Government, and wider UK, has much to gain from an increased pool of skilled scientists and engineers. Alongside the increased uptake of science and engineering it is therefore absolutely right

[83] State of the Nation, Social Mobility and Child Poverty commission, 2013
[84] Further Education data library, Skills Funding Agency and Department for Business Innovation and Skills
[85] UK innovation survey, Highly innovative firms and growth 2014

that Government meets the additional costs that come with teaching these subjects. To ensure that the Government's commitment to lifting the student number cap results in increased STEM provision, the Government must provide sufficient funding, through the combination of student fee and additional government contribution, to cover the costs associated with high quality science and engineering undergraduate provision.

Postgraduate

Students undertaking postgraduate research degrees are a core component of the UK research workforce. Their academic papers and final doctoral thesis constitute a significant contribution to human knowledge and understanding. As such the research is valuable in its own right but also a vital part of the training process for higher-skilled workers, including scientists and engineers, which the UK needs more of[86]. The economic and social benefits of PhDs and other postgraduate research programmes merit public investment and support.

The most appropriate way to support postgraduate research is by providing greater investment through the well-developed systems of the Government research funding bodies, primarily the Research Councils. This can be used to leverage private and charity funds whilst ensuring that postgraduate research is aligned with the UK's wider research priorities and industrial needs (the Nurse Review is currently looking at how this can best be achieved[87]). Greater investment delivered in this way should result in a better alignment of the number of PhD-qualified individuals with the workforce needs of industry and academia. This is an important and necessary target to raise productivity and strengthen the economy.

Annex A – Analysis of public R&D investment

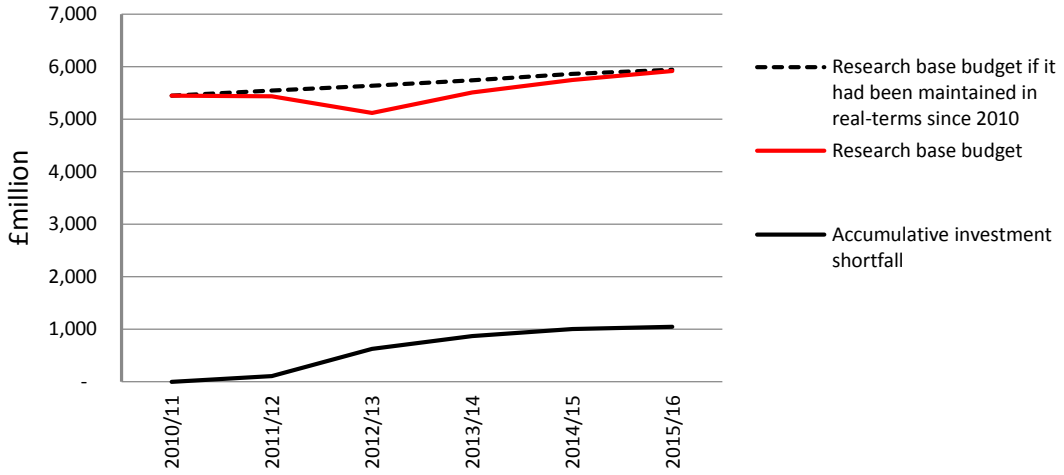
A £1 billion shortfall in investment has accumulated from 2010-2015

The total research base budget, which includes resource and capital investment, has increased in cash terms from £5.5 billion in 2010/11 to a planned £5.9 billion in 2015/16. This represents an in-line with inflation increase overall (Figure 2). However, the annual funding shortfalls resulting from the 2010 flat-cash settlement for the resource 'Science Budget' have accumulated to a £1 billion loss to the UK research base over the lifetime of the last Parliament.

[86] UKCES, The supply and demand for high-level STEM skills, 2013: https://www.gov.uk/government/publications/high-level-stem-skills-supply-and-demand

[87] BIS, Nurse review of Research Councils, 2015: https://www.gov.uk/government/consultations/nurse-review-of-research-councils-call-for-evidence

Figure 2: Research base investment 2010/11 to 2015/16 (cash-terms)



Total investment dropped in 2012/13 and then gradually increased driven by *ad hoc* capital investments. However, these later investments have not been enough to recoup the money lost from the earlier drop in funding. This means an above-inflation increase in investment in the next Parliament will be necessary to make up for money lost to the research base.

CaSE recognises the Government's commitment to reduce public spending and national debt and supports efforts to improve efficiency in how the Funding Councils and the wider research base operate as it will lead to more investment directly in science and innovation. The research community is on track to meet the target of £428 million in efficiency savings to be achieved between 2010 and 2015, set by the Wakeham report[88,89]. The £1 billion shortfall revealed by CaSE's analysis has therefore not been absorbed through efficiency savings alone. It has instead squeezed the research base and its ability to perform optimally. Furthermore, Universities UK members have raised concerns that the long-term sustainability of research could be brought into question should the Wakeham recommendations be rolled forward into future years with similar expectations of savings[3].

Real-terms reductions in investment can't be fully compensated for through efficiency savings. They will instead come at the expense of scientific excellence and the volume of research performed in the UK. In-year cuts or unexpected drops in investment can also have a disproportionate impact on research; they may result in the cancellation of funds that have already been factored into a multi-year research project for example, or result in the shutdown of facilities required by many users, including from academia and industry. Short-term savings in government spending will therefore have a counter-productive effect by choking off the innovation needed for economic growth.

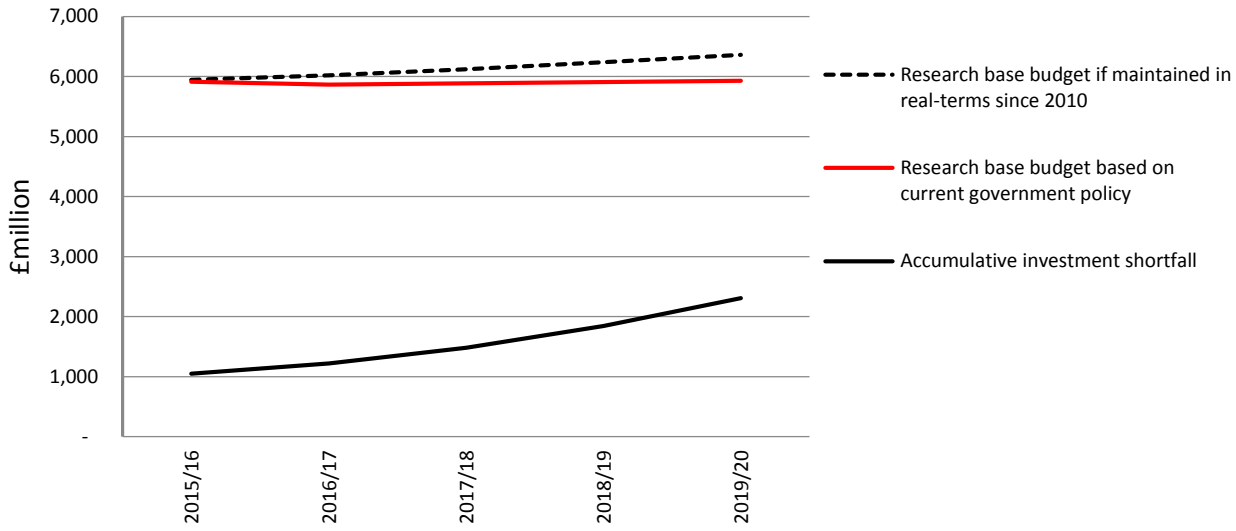
Increased investment is needed to reverse the shortfall

In the 2013 Spending Review, the government announced that it would increase science capital investment to £1.1 billion in 2015/16, and maintain this in line with inflation each year up to 2020/21. This was reaffirmed in the Science and Innovation Strategy published in December 2014[90] and the Conservative Manifesto. The Government has not made any commitments regarding the resource 'Science Budget' from 2016/17 onwards. If the current flat-cash ring-fence is maintained

[88] http://www.rcuk.ac.uk/RCUK-prod/assets/documents/reviews/fec/fECReviewReport.pdf
[89] http://www.universitiesuk.ac.uk/highereducation/Documents/2015/EfficiencyEffectivenessValueForMoney.pdf
[90] https://www.gov.uk/government/publications/our-plan-for-growth-science-and-innovation

over the next Parliament, the accumulated shortfall for the research base will continue to increase (Figure 3) meaning that the Research Base's capacity will continue to reduce.

Figure 3: Predicted research base investment 2015/16 to 2019/20 (cash-terms)



There is a growing disparity between resource and capital investment

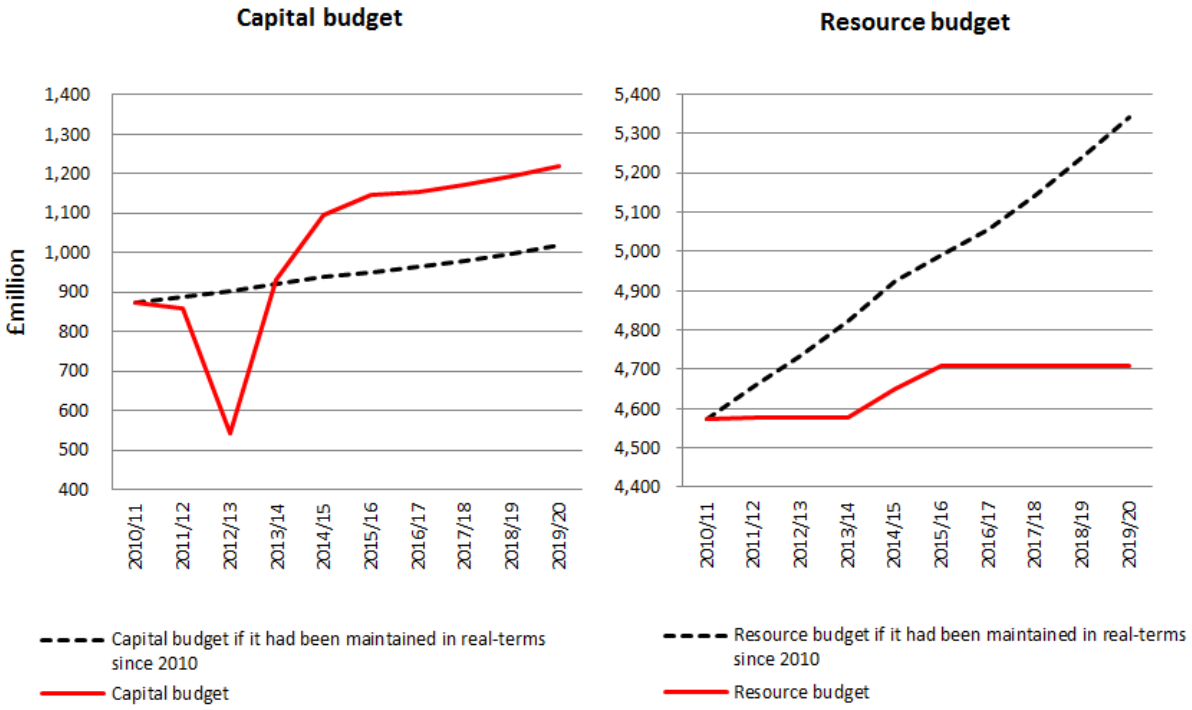
The 40% cash-terms cut to capital announced in the 2010 Spending Review never materialised due to *ad hoc* capital spending announcements since then (Figure 4, capital). Overall, capital investment has almost increased in line with inflation; by the end of 2015/16 the accumulative capital investment shortfall will be £41 million.

From 2016/17 onwards, capital investment will be above what it would be if 2010/11 spending had been maintained in line with inflation. Under current government policy and inflation forecasts, total capital investment is predicted to be £800 million higher than if investment only rose with inflation from 2010/11 to 2019/20. In the current economic climate, this is a forward looking commitment. It is essential, and much needed, investment in our scientific infrastructure if the UK is to grow as a knowledge economy.

The resource 'Science Budget' had a £130 million cash increase over the last Parliament (the Newton Fund introduced in 2014/15[91] contributed significantly to this) and its value has therefore been eroded by inflation. By the end of 2015/16 there is expected to be a resource investment accumulative shortfall of £1 billion (Figure 4, resource).

[91] http://www.rcuk.ac.uk/media/news/140410/

Figure 4: Investment 2010/11 to 2019/20 (cash-terms)



There will be shortfalls in each year of the next Parliament if the Government chooses to continue the policy of capital investment rising with inflation from a baseline of £1.1 billion in 2015/16 and assuming a continued flat-cash ring-fence. The overall loss to the UK research base will reach £2.3 billion by the end of the next Parliament. Looking solely at resource, if the current flat-cash ring-fence is maintained and a new baseline is taken from 2015/16 (to account for the slight cash increase in the last term of Parliament) the shortfall in investment in the Research Base will rise to over £3.1 billion by the 2020 general election. This acceleration is due to the acceleration in inflation currently forecast for the end of this decade. This shortfall will be entirely in resource budget, with an ever-widening disparity between capital and resource investment.

It is hard to imagine how UK research can continue to perform with such a large loss of investment. Above inflation increases will be necessary to return the spending power of the budget to 2010 levels, which were already low historically and internationally.

Annex B – Analysis of international competitiveness

The UK remains 12th among the 28 member states for total GERD[92] as a proportion of GDP. The EU average GERD for 2013 was 2% and Germany and other Northern European countries were close to or above 3%[93]. The OECD GERD average was 2.4%. China spent 2% in 2013 and both Israel and Korea spent around 4.2%. 2013 data isn't available for the United States but in 2012 they spent 2.8% of their GDP on R&D.[94]

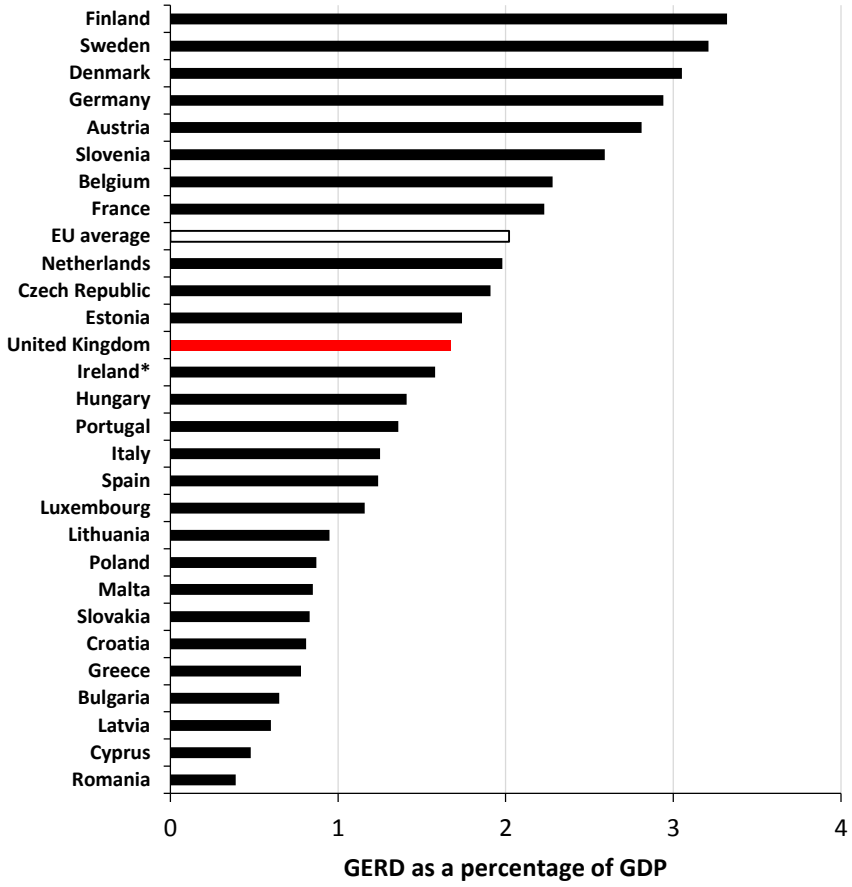
[92] Gross Domestic Expenditure on R&D (GERD) is the total spending on R&D of five sectors: government, industry, higher education, non-profit, and overseas funders. GERD is the preferred measure of R&D activity for international comparisons and allows the monitoring of investment trends over time.

[93] http://ec.europa.eu/eurostat/data/database

[94] Main Science and Technology Indicators (MSTI database) http://stats.oecd.org/index.aspx?r=906522

Committing to matching predicted growth[95] would counteract the negative impact of inflation that has led to the significant real terms cut of over this term of Parliament[96]. This commitment would also halt the downward trend of the UK's rate of total investment in science and maintain spend at 0.6% of GDP, around £11bn in 2025. A commitment to match growth would certainly bring benefits and curb the damaging downward trend, but would not bring us any nearer to parity with other nations which are investing at a higher rate with ambitious targets for investment.

Figure 5: EU countries GERD as a percentage of GDP, 2013



UK GERD in 2013 was 1.67% of GDP, this is an increase on the 1.62% level for 2012 but there has been a general downward trend since 2009, when it was 1.71%.The government expenditure on R&D (GovERD) was 0.49% of GDP, this is an increase from 0.46% in 2012 but there has been a downward trend since 2009 when it was 0.56%. In 2013, the Government would have to have invested 0.87% GDP or £15 billion to match Germany's investment. This would have been £6.6 billion more than the £8.4 billion actually invested by the UK Government.

International league tables for GovERD are not yet complete and currently contain underestimated values for UK GERD in 2013 so accurate international comparisons are difficult at this time. However, as a rough comparator, the OECD average in 2012 was 0.7% of GDP and the EU average was 0.64%. Germany's was 0.84% and America's 0.86%.

[95] The OBR growth forecast growth of around 2.5% per year
[96] Budget briefing, CaSE, 2014

A target of spending 3% of GDP on R&D was officially adopted by the European Council in 2002[97]. This target includes public and private investment and is often quoted as what the UK should be aiming for. However, the target has not been achieved, in 2002 the European average was 1.9%, in 2013 it was 2%.

Most countries, including the UK, have an approximate ratio of 1/3 public, 2/3 private investment[98]. If the UK were to invest 3% of GDP in R&D, one would expect a third of that to be from the Government, equalling approximately £8.8 billion per year more than is currently invested. For perspective, the Francis Crick institute being constructed at St Pancras will be Europe's largest research institute and has cost approximately £700 million in total.

Economic analysis on which the Council made its decision stated that the policy would "have a significant impact on long-term economic growth and Employment in Europe, to the order of 0.5% of supplementary output and 400,000 jobs per year after 2010"[99]. In economic terms, investment in R&D raises productivity; this boosts the economy and does not necessarily increase the number of jobs but creates higher-value jobs (because they are more technical and productive). Raising productivity and creating higher-value jobs are both stated aims of this Government.

An economic analysis paper published in 2008 on the optimal level of national R&D investment concludes that between 2.3% and 2.6% of GDP "maximizes the long-run impact on productivity growth and is the key to sustained productivity and technology improvements that are becoming more and more necessary to modern economic growth"[100]. A more recent 2014 BIS analysis suggested the UK should aim for 2.9%, the average of our competitors, commenting that "they do not appear to get poor returns on their investment"[101]. The UK has a long way to go before it is close to these figures.

For further information, contact:

Naomi Weir, Acting Director, CaSE

naomi@sciencecampaign.org.uk

02076794995

Declaration of interests:

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