

## Comprehensive Spending Review phase two: policy submission from the Royal Society

### Executive summary

- Research discoveries are critical to innovation and development of new products, services and technologies. They drive inward investment, productivity and economic growth and ultimately improve people's lives.
- We welcome the Government's decision at the Budget to index-link the R&D budget in line with inflation, which is crucial for both private sector investor confidence and the financial sustainability of research.
- However, we need to go further if the UK is to successfully adapt to the technological and demographic trends reshaping the economy. This includes supporting skills from school through to the scientific workforce; sustaining world class research infrastructure and capability (including AI and quantum computing); supporting fundamental scientific research; sustaining strategic international scientific collaboration; and addressing key national risks – from national security through to climate change, biodiversity loss and future pandemics.
- The Spending Review is an opportunity to set out an ambitious long-term commitment to invest in UK science capability and the R&D that helps to secure sustainable growth and improves the lives of current and future generations.
- The Government should be ambitious for science and aim to make the UK the best place to carry out scientific research and to start and scale innovative companies. This requires the Government and the research sector to address challenges, such as the sustainability of higher education and research funding, as well as implementing the key recommendations from the Nurse, Grant and Tickell reviews to future-proof a competitive, dynamic and vibrant science and innovation ecosystem across all parts of the UK.
- The Government can take bold steps to market the UK as a destination of choice to global investors, innovators, scientists and entrepreneurs. Making the UK home to cutting-edge discoveries and innovation would help to improve people's lives as they benefit from new technologies and products, as well as creating high-value jobs and domestic supply chains. More action is needed to encourage global companies to base their R&D activities here and to attract overseas investment. This not only includes policy and investment certainty, but also removing barriers to attracting the world's top scientific talent – including addressing prohibitive upfront visa costs.
- Education and skills are fundamental to achieving the Government's Plan for Change. The Government has a once-in-a-generation opportunity to reform the education system so that every young person has the foundational knowledge and skills for an increasingly data driven changing world of work.
- There is a crisis in science education – including a decline in practical science, challenges with recruitment and retention of specialist science teachers at both primary and secondary level, and deep spending cuts to teachers' continuing professional development. Young people, particularly in the most disadvantaged areas, are paying the price to the detriment of their life chances and to the UK's international competitiveness.

- Artificial intelligence (AI) and other emerging technologies have the power to transform how we live and work. In today's global knowledge race, it will be important for our economy and national security to build, attract and maintain significant computing and AI capabilities in the UK (including quantum computing), as well as skilled people and software. There are significant opportunities from improving access to data for scientific and multidisciplinary research. The UK should lead on new technologies that retain public trust and protect privacy so that the benefits of AI for public services and the economy can be maximised.
- To secure truly sustainable growth, we must take urgent steps to protect the environment and halt climate change and biodiversity loss. Protecting the world's biodiversity makes clear economic sense, with an estimated £10 trillion benefit by taking early action. The Government should ensure that policies to reduce greenhouse gas emissions and adapt to climate change also help to prevent and reverse biodiversity loss. If the Government is to meet its goal for the UK to be a clean energy superpower, then immediate work must start on low-cost energy storage to strengthen the UK's energy security and resilience.

## Summary of key recommendations

### AREA FOR ACTION 1

KICKSTART SUSTAINED ECONOMIC GROWTH  
SUPPORTED BY STABLE, LONG-TERM INVESTMENT  
AND COMMITMENT TO SCIENCE AND INNOVATION

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#### KEY RECOMMENDATIONS

The Government should:

- Provide the certainty of a minimum of sustained real terms funding for research over a ten-year time horizon with a regular review cycle;
- Commit to invest at least £22 billion in R&D by 2026/27 to maintain confidence for investors and researchers, ensuring a healthy balance between discovery and applied research;
- Set an ambition to lead the G7 in R&D intensity;
- Universities and research institutions are vital engines for growth and innovation and must be put on a sustainable financial footing. The Government should implement the key recommendations from the Nurse, Grant and Tickell reviews to future-proof a competitive, dynamic and vibrant science and innovation ecosystem across all parts of the UK; and
- Protect and grow departmental R&D budgets to improve public services and safeguard the UK's resilience to pandemics and other systemic emergencies.

### AREA FOR ACTION 2

SHOW THE UK IS OPEN FOR BUSINESS TO GLOBAL  
INVESTORS AND RESEARCHERS

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#### KEY RECOMMENDATIONS

The Government should:

- Develop a single, cross-government highly visible international science strategy to increase foreign direct investment into UK science; and
- Reduce upfront visa fees to restore the UK's international competitiveness in attracting research and innovation talent.

### AREA FOR ACTION 3

BREAK DOWN BARRIERS TO OPPORTUNITY AND UNLOCK THE SKILLS OF THE FUTURE, INCLUDING THROUGH REFORM OF OUR EDUCATION SYSTEM

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#### KEY RECOMMENDATIONS

The Government's Curriculum and Assessment Review should be ambitious and consider substantial reform of the secondary and post-16 education system to offer a more expansive range of study, including:

- continuation and reform of mathematical and data education to 18 as a key engine for future growth (as set out in the Royal Society's report *A new approach to mathematical and data education*); and
- the creation of a more equitable single route through the sciences for all students up to age 16, with more time spent on hands-on practical science in schools.

The Government should also:

- Substantially increase the current very minimal education research budget. Monitoring and evaluating the impact of education policy reforms, including from the Curriculum and Assessment Review, will ensure that these are truly effective and deliver tangible improvements for children and young people;
- Immediately reverse the previous government's cuts to professional development to retain science, maths and computing teachers; and
- Set out a long-term sustainable funding solution for professional development for teachers and ensure that there is sufficient funding to facilitate teachers upskilling to help fill positions in shortage areas such as Physics.

### AREA FOR ACTION 4

GROW THE UK'S AI, DATA AND SUPERCOMPUTING CAPABILITIES (INFRASTRUCTURE, PEOPLE AND SOFTWARE) AND PROVIDE GLOBAL LEADERSHIP TO SAFELY HARNESS THE BENEFITS OF AI FOR SOCIETY

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#### KEY RECOMMENDATIONS

We welcome the Government's commitment in the AI Opportunities Action Plan to increase public compute capacity by twentyfold by 2030. The Government should:

- Explore how funders, industry partners, and research institutions with computing facilities could be incentivised to actively share essential AI infrastructures such as high-performance computing power and data resources; and
- Ensure that investment in AI infrastructure is informed by environmentally sustainable computational science best practices, including the measurement and reporting of environmental.

Access to high quality data and interoperable data infrastructures will be critical for supporting the AI industry and the use of AI in scientific research. This could involve advancing access to sensitive data through privacy enhancing technologies and trusted research environments. To progress this, the Government should:

- Provide clear and easy to comply with data protection guidance for scientific researchers; and
- Publish a national technology strategy to promote responsible use of technology in data governance, such as Privacy Enhancing Technologies (PETs).

## AREA FOR ACTION 5

### TAKING URGENT STEPS TO PROTECT OUR ENVIRONMENT, MOVE TO CLEAN ENERGY AND SLOW CLIMATE CHANGE AND BIODIVERSITY LOSS

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#### KEY RECOMMENDATIONS

To secure truly sustainable growth, we must take urgent steps to protect our environment and halt climate change and biodiversity loss. The UK is well placed to demonstrate global leadership, protecting our planet for current and future generations.

The Government should:

- Urgently produce evidence-based net zero technology roadmaps to decarbonise the energy system by 2050;
- Prioritise the construction of long term, large-scale energy storage facilities to match the expansion of renewable generation, ensuring the UK has year-round security of energy supply; and
- Ensure policies to reduce greenhouse gas emissions and adapt to climate change to help to prevent and reverse biodiversity loss.

# Full submission

## Introduction

Scientific research and innovation are essential building blocks for sustained economic growth and the UK's national renewal – by improving productivity, driving growth, creating high value jobs across the country and taking pressure off public services.

UK science produces enormous value for our society. We led the world in developing an effective COVID-19 vaccine, building on a strong base in biological sciences that has been cultivated over decades. It is only through decades of research that we develop the medicines that we take, the vehicles we travel in, or the internet and AI capabilities that have revolutionised the way we live. By investing in research, from university labs to routes to market, we can lead the way as a nation in turning early-stage discovery science into companies and products that can transform lives.

The science and technology sectors have strong growth potential. The sector currently employs just under 3 million people, with one of the largest employment growth rates in the last decade<sup>1</sup>. Scientific development underpins advances across our economy and is essential to delivering the government's Plan for Change and five missions, from the development of solar cells for green energy to analytics and forensic imaging to improve crime prevention.

It is also crucial for our national security in a geopolitically volatile world. We are in a global science race and investment in critical emerging technologies – such as health tech, quantum, AI and digital infrastructure – is vital for maintaining the UK's scientific and technological sovereignty and defence capabilities.

Science is a long-term enabler of opportunity. Investing in skills and scientific capabilities today lays the foundation for the UK's future prosperity and international competitiveness. There is more we must do to ensure that the UK is home to the next generation of cutting-edge scientific talent, discovery, innovation and technology – and to unlock the benefits of science to improve people's lives and the lives of future generations.

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<sup>1</sup> *Research and Development Expenditure*, Office for National Statistics, 2024.

## AREA FOR ACTION 1

### KICKSTART SUSTAINED ECONOMIC GROWTH SUPPORTED BY STABLE, LONG-TERM INVESTMENT AND COMMITMENT TO SCIENCE AND INNOVATION

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Science and innovation are a UK success story and an essential catalyst for the UK's national renewal – by improving productivity, driving growth, creating high value jobs across the country and taking pressure off our public services.

Research discoveries and the development of new products, services and technologies are at the root of innovation, which drives productivity and economic growth and, ultimately, improved living standards across the economy. There remains a strong case for government investment in R&D both as a crowding in device for private capital and as means to plug important market failures. The foundations of the science base, from education and PhD and technical training case to infrastructure and other national capabilities, necessitate sustained government investment.

#### How science benefits the economy

##### New knowledge and ideas

Scientific research produces specific bodies of knowledge and process that can be applied for economic benefit

##### Innovation and productivity

The application of bodies of knowledge and process spills over into innovation and productivity gains

##### Skilled people and jobs

Scientific research and development (R&D) has a significant impact on human capital, through education and training and the generation of new types of jobs

##### Wider economic impacts which are not directly monetised

Science generates important benefits that enable other economic activity, from improved public health to environmental protection and national security. In particular, it is crucial for our national resilience and ensuring that we can pre-empt and prevent national and global emergencies, including pandemics, climate change and ecological breakdown – the economic and social consequences of which are extremely significant.

#### Unlocking growth, jobs and regional prosperity through R&D

Public investment in science, research and innovation unlocks private R&D investment. For each £1 of public R&D spend in the UK, it is estimated that this stimulates on average between £3.09 to £4.02 of private R&D investment in the long term. However, the distribution of returns across R&D intensive enterprises is uneven. The majority of direct financial returns result from a small number of highly successful ventures.

The economic and societal spillover benefits of science, research and development are significantly greater than rates of investment return alone, as set out above<sup>2</sup>. For example, universities and other publicly-funded R&D organisations are magnets for major industry and jobs in their surrounding region. Examples include Arm at Cambridge, Boeing at Sheffield and Strathclyde, Siemens in Lincoln and Unipart in Coventry.

To give a recent example of the economic value of societal returns, the firm Moderna made about \$20.5 billion profit from its COVID-19 vaccine. However, the direct contribution to global GDP from the development and sales of vaccines was eclipsed by the indirect effect of allowing an earlier opening of the world economy, even before the huge effect in terms of saved lives and reduced suffering is taken into account.

Science activity creates good jobs: between 2010 and 2020, the largest growth in jobs in the UK took place in the professional, scientific and technical activities sectors, a 37% increase – sectors where there are above-average gross earnings.

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2 *Science and the economy*, The Royal Society, 2024.



## The benefits of government department-sponsored R&D

### Defra's investment in flood risk management research

Flooding is a major environmental challenge in the UK, causing significant economic and social impacts. The Department for Environment, Food and Rural Affairs (Defra) has been at the forefront of funding research to improve flood risk management and resilience. This has supported various research projects and initiatives which have led to:

- **Improved flood defenses**

The funding has enabled the construction and enhancement of flood defenses, protecting thousands of homes and businesses.

- **Innovative solutions**

Research has led to the development of new technologies and approaches, such as natural flood management techniques and advanced flood forecasting systems.

- **Community resilience**

The research has helped communities better prepare for and respond to flood events, reducing the overall impact of flooding.

### Lessons learned

This case study demonstrates the critical role of departmental R&D budgets in addressing environmental challenges and protecting communities. Sustained investment in flood risk management research has not only advanced technological development but also supported economic growth and enhanced community resilience.

**Above:** Flood barriers protecting local homes and businesses at Bewdley Bridge, Worcestershire. © iStock.com / Neil Bussey.



## Protecting the UK's scientific capabilities with sustained real terms investment in R&D

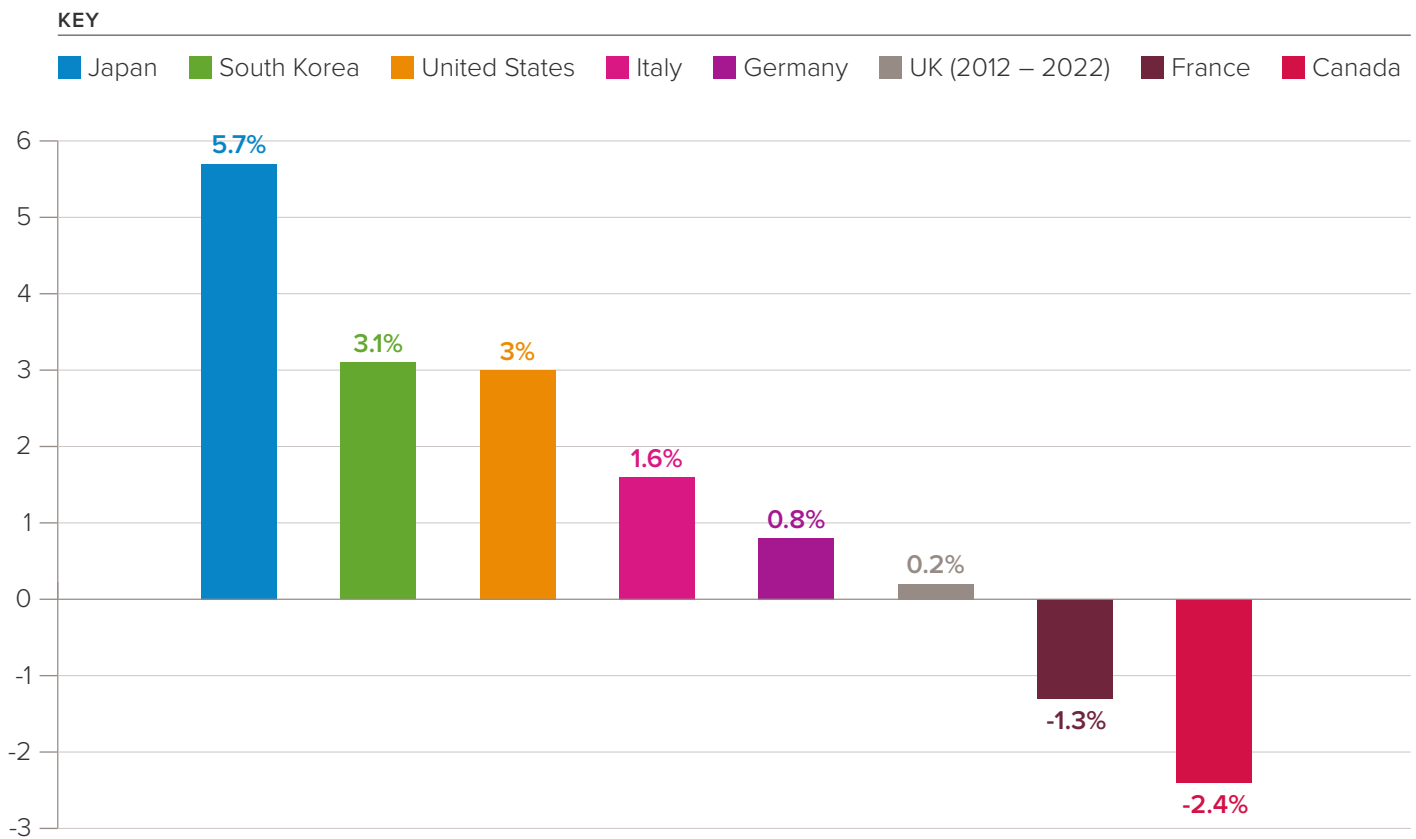
We are in a global knowledge race, particularly in the development of new technologies such as quantum and AI, which have the potential to transform our economy and society. We also live in a geopolitically volatile world. It is crucial for our future prosperity that we protect and grow the UK's scientific capabilities and technology sovereignty.

In an increasingly competitive global environment for R&D talent and investment, Government spending on R&D must keep pace with other nations. China is increasing its R&D spend by 7% every year until 2026, while the USA has committed an additional \$250 billion to core science and technology budgets.

Without political ambition and commitment, the UK is at risk of falling behind in this global race. The UK's productivity and levels of R&D investment, as a proportion of GDP, lag behind our international counterparts. The UK is 11th in the OECD for R&D investment as a % of GDP (2.9% in 2021)<sup>3</sup>, behind Belgium, Austria and Finland. The compound annual growth rate for UK Government investment in R&D over the past decade falls below inflation and is outperformed by our international counterparts, while productivity growth also remains sluggish<sup>4</sup>.

FIGURE 1

Compound Annual Growth Rate (CAGR) of R&D Budget Allocations in G7+1 Nations 2013 – 2023<sup>5</sup>.



<sup>3</sup> Gross domestic spending on R&D (indicator), OECD, 2024. doi: 10.1787/d8b068b4-en (accessed 17 May 2024).

<sup>4</sup> Productivity flash estimate and overview, UK, Office for National Statistics.

<sup>5</sup> Adjusted for Inflation and Purchase Power Parities.

The UK's research sector is also under financial strain. For example, in universities, which account for over 75% of publicly-funded research spending, the full economic costs of research are far out-stripping the income received to fund it; with the research deficit reaching £5bn in 2021 – 22<sup>6</sup>. We recognise the wider financial pressures facing both the higher education sector and research institutes. The sustainability of research should be considered as part of the Spending Review process.

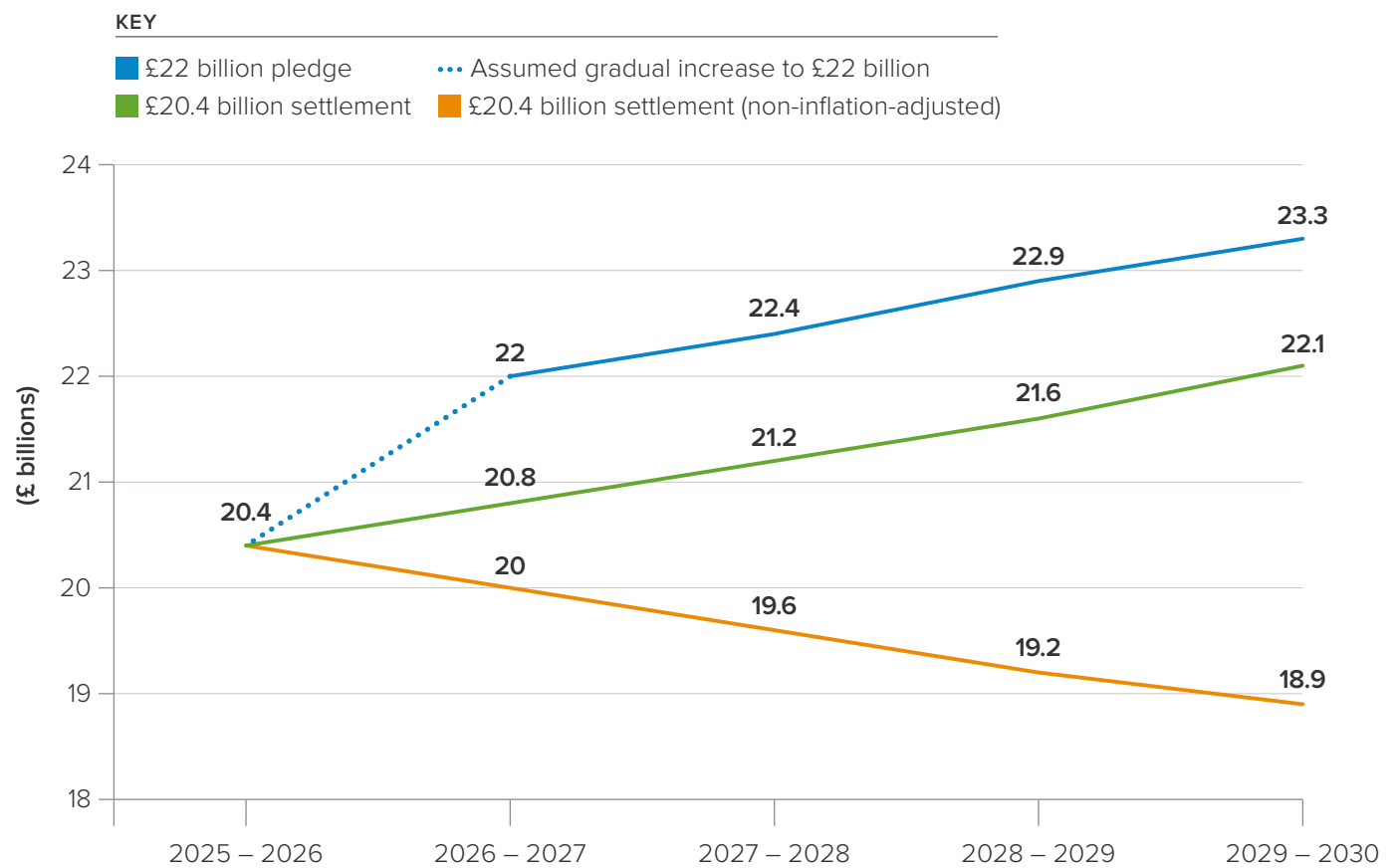
It is vital for the health of the UK's science and research ecosystem that public-funding of R&D is maintained at sustainable and sufficient levels. As the graph below demonstrates, 'flat cash' funding for science over the course of this Spending Review period would be equivalent to a £3.2bn real terms funding cut and a £4.4bn funding gap when compared to the previous Conservative Government's commitment.

It is also important to note that even if R&D funding is index-linked, inflationary cost increases in the R&D sector are likely to be higher than the headline rate of inflation. This is because laboratories are highly energy intensive,<sup>[1]</sup> so are particularly vulnerable to fluctuations in electricity costs, while the costs of specialised scientific equipment are also vulnerable to disruptions in global supply chains.

A 'flat cash' settlement for R&D would be a retrograde step, risking a significant adverse effect on the UK's science capabilities, investor confidence and the loss of billions of pounds of potential private sector co-investment.

**FIGURE 2**

Impact of Inflation on UK Government R&D Budget Pledges (2024 – 2030)<sup>7</sup>.



<sup>6</sup> Research financial sustainability: issues paper, UKRI, November 2023.

<sup>7</sup> The figures for the three scenarios are underpinned by the latest GDP deflators from the Office for National Statistics (ONS) and the Office for Budget Responsibility (OBR). Additionally, a green dotted line has been included to represent an assumed gradual increase in the R&D budget from £20 billion to £22 billion between 2024 – 25 and 2026 – 27.

## Driving private sector investment in innovation with decisive, long-term thinking

There are clear steps that the government can take to re-establish global leadership in science, unlock greater private investment in R&D and improve people's living standards through economic growth and productivity gains.

This includes providing the certainty of sustained real terms funding for research over a ten-year time horizon. Science is a long-term endeavour: the rapid development of the mRNA Covid-19 vaccines, which saved countless lives and billions of pounds, were from advances which were decades in the making. The most advanced scientific nations make a clear, long-term commitment to their science and research priorities. Certainty matters: it provides space for researchers to pursue bold ideas and innovations and a predictable environment for investors.

This government has an opportunity to end the political short-termism and stop-start investment in science and to rebuild the UK's reputation as a reliable investment partner. The Government's commitment to ten-year funding for key R&D activities is a welcome first step. We welcome the opportunity to work with the government to make these commitments, which require careful implementation, a reality. It is crucial that ten-year funding frameworks are allocated using transparent, objective criteria, with the flexibility and agility to respond to changing market conditions such as shifting priorities and inflationary costs.

## KEY RECOMMENDATIONS

The Government should:

- Provide the certainty of a minimum of sustained real terms funding for research over a ten-year time horizon with a regular review cycle
- Commit to invest at least £22bn in R&D by 2026/27 to maintain confidence for investors and researchers, ensuring a healthy balance between discovery and applied research
- Re-establish global leadership positions in science and innovation and set an ambition to lead the G7 in R&D intensity
- Universities and research institutions are vital engines for growth and innovation and must be put on a sustainable financial footing. The Government should implement the key recommendations from the Nurse, Grant and Tickell reviews to future-proof a competitive, dynamic and vibrant science and innovation ecosystem across all parts of the UK
- Protect departmental R&D budgets to improve public services and safeguard the UK's resilience in preparing for and managing pandemics and other national and global emergencies

## AREA FOR ACTION 2

### SHOW THE UK IS OPEN FOR BUSINESS TO GLOBAL INVESTORS AND RESEARCHERS

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This Government can take bold steps to market the UK as a destination of choice to global investors, innovators and entrepreneurs. Making the UK home to cutting-edge discoveries and innovation would help to improve people's lives by benefitting from new technologies and products, as well as creating more high-value jobs and supply chains.

Getting the most from UK science means thinking globally. International collaboration extends the impact and reach of scientific discoveries and innovations. This in turn translates into advances in economic performance, the health and security of people and the planet, and our resilience to national and global-scale shocks. In 2022, more than half of the UK's research output (61.5%) was the result of international collaboration<sup>8</sup>, compared with 26% in 1998.

Following re-association with Horizon Europe, we should maximise the UK's participation in Horizon and future EU Framework Programmes to drive the growth and global influence of our research and innovation. Alongside this, we need a long-term international science strategy which supports global scientific collaboration and leverages greater foreign direct investment to support the growth of UK science, research and innovation.

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Overseas funding into UK R&D activities fell by nearly a quarter (-21%) to £6 billion between 2021 and 2022.

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#### Marketing the UK science sector as a destination of choice for global investment

Overseas funding and foreign direct investment are crucial levers for growth in a challenged fiscal environment. There are positive spillover effects from this, as companies that base their R&D investments in the UK, typically have a more 'sticky' investment profile which generates further job creation. It is concerning that overseas funding into UK R&D has fallen by nearly a quarter year-on-year (21% from 2021 – 22) to the lowest point in the last 5 years (inflation-adjusted)<sup>9</sup>.

The UK government can and should play a more active role in attracting foreign direct and overseas funding into UK science and marketing the UK as a destination of choice for global innovators and entrepreneurs.

More action is needed to encourage global companies to base their R&D activities here and to attract overseas investment. As set out above, this not only includes policy and investment certainty, but also removing barriers to attracting the world's top scientific talent. International researchers and students bring valuable knowledge and investment to the UK. We welcome recognition of this from the Government, but there is more we must do to strengthen the UK's international competitiveness.

This includes exploring ways to reduce upfront visa costs for scientific researchers, which are some of the highest in the world. Recent analysis commissioned by the Royal Society shows that visa costs have increased by 58% in three years, with UK visa costs on average 17 times higher than our international counterparts<sup>10</sup>. In its forthcoming Immigration White Paper, the Government should set out options to reduce the cost burden on applicants, employers and research and innovation funders and bring costs in line with the UK's international competitors. As the UK's premier route for attracting research and innovation talent, the Global Talent Visa should be the starting point for lifting the costs barrier. Without action, the UK's position as a destination of choice for innovation is at risk.

#### KEY RECOMMENDATIONS

The Government should:

- Develop a single, cross-government highly visible international science strategy to increase foreign direct investment into UK science
- Reduce upfront visa fees to restore the UK's international competitiveness in attracting top scientific talent

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<sup>8</sup> *International comparison of the UK research base*, 2019.

<sup>9</sup> *Research and Development Expenditure*, Office for National Statistics, 2024.

<sup>10</sup> *Summary of visa costs analysis*, The Royal Society, 2024.

## AREA FOR ACTION 3

### BREAK DOWN BARRIERS TO OPPORTUNITY AND UNLOCK THE SKILLS OF THE FUTURE, INCLUDING THROUGH REFORM OF OUR EDUCATION SYSTEM

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The problem-solvers of tomorrow will need a foundation in science, digital and data skills alongside knowledge of the humanities and creative arts. The Government's reviews of the curriculum and of post-16 education provide an important opportunity to reform our education system and introduce a broader range of study across the sciences and humanities. These must be sufficiently ambitious in scope to produce truly transformative and sustainable change.

Currently students are presented with an 'illusion of choice', where many are forced to abandon studying for a wide range of skills post-16. Developing a single route through the sciences at GCSE would focus on studying key concepts in depth across all three science subjects but would also enable a reduction in the breadth of content, supporting the aims of the Curriculum and Assessment Review to allow for greater breadth of subject choice.

#### **Mathematics and data education for a data driven world**

Our education system needs to urgently adapt to our increasingly data and technology-rich world. If we are to compete with our international counterparts, we must reduce the educational inequalities in STEM and raise levels of maths and data education to equip our young people with the skills for the changing world of work.

In maths, there are wide gaps between the lowest and highest achievers, with a long tail of underachievement linked to economic disadvantage. A third of pupils effectively fail maths at 16 every year, and few improve when they retake exams. Only 11% of UK students achieve the PISA higher level 5 (e.g. modelling complex situations) compared to 41% in Singapore. Socio-economic status is strongly correlated with mathematical performance and the gap between bottom and top quintiles has not improved in 10 years<sup>11</sup>.

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Almost half of all working adults in England have the numeracy expected of an 11-year old.

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The Government has a once-in-a-generation opportunity to take a new approach. Every child should leave school with the skills and confidence in maths and data to thrive in work and life, so that they can compete for skilled jobs, start new high-growth companies, or plan well for old age.

As part of the Department for Education's Curriculum and Assessment Review, a new approach to maths and data education should be planned and tested over 2 – 3 years, then implemented over the long term (10 – 15 years) and supported by a task force to lead implementation.

As set out in the Royal Society's recent *Mathematical futures* report<sup>12</sup>, a new curriculum for mathematical and data education, beginning in early years, must integrate data, statistics and use of digital and computing tools into mathematics so that young people are better prepared for the workplace in a growing economy.

Qualifications and assessment also need to change to demonstrate to employers what young people can do with the skills and knowledge they have. In addition, teachers need to be better supported and trained to embed mathematical skills across a range of subject areas.

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<sup>11</sup> *Mathematical Futures: A new approach to mathematical and data education*, The Royal Society, 2024.

<sup>12</sup> *Ibid.*



### Tomorrow's climate scientists – bringing science to life in schools

Hands-on practical science in schools has been declining significantly over time, with only a quarter (26%) of year 10 pupils given access to practical science in school at least fortnightly (Science Education Tracker, The Royal Society, 2024). The Royal Society's Partnership Grant scheme, funded by the Department for Science, Innovation and Technology, provides funding for young people and their teachers to carry out a practical scientific research project, in partnership with a qualified STEM researcher from academia or industry.

The *Tomorrow's climate scientists* programme empowers students to have a voice in the direction of scientific research around climate change and biodiversity by working with their STEM partner. It also supports students to develop green skills as the UK moves towards a net zero future.

Young people develop key practical skills, gain first-hand knowledge of career opportunities and experience the excitement that comes from carrying out their own investigations, often addressing local challenges.

As they problem solve, they develop a can-do attitude and the creativity and imagination that is highly valued by employers. They learn the value of teamwork and collaboration and that everyone, irrespective of background, can benefit from and contribute to scientific progress.

“Crucially important skills have been honed and developed which are industry-relevant and will facilitate positive destinations for all of the students such as university applications, lab apprenticeships and other STEM employment opportunities. All of the students loved the STEM partner input, and guest lectures, and similarly they enjoyed using the nanopore technology and practicing their lab skills.”  
Berkshire College of Agriculture

More information on the impact of the Partnership Grants programme can be found [here](#).

**Above:** Researching a recultivated field. © iStock.com / agnormark.

### Retaining and investing in STEM teachers

The Government's plan to recruit 6,500 new teachers is welcome, especially given low levels of STEM teacher recruitment. In 2023/24 DfE only reached 17% of its target for recruitment of physics teachers and 36% for computing<sup>13</sup>. Schools and colleges in disadvantaged areas report greater difficulties in filling teaching posts and problems are particularly pronounced in maths, computing and sciences, with schools struggling to recruit teachers with a relevant degree to the subject they are teaching<sup>14</sup>.

It is crucial that the Government also invests in retaining teachers once they are qualified and working in the profession. Current estimates indicate that some 40,000 teachers leave the teaching profession in England each year. Evidence shows that access to subject-related professional development is associated with lower attrition rates of teaching staff. A 2021 EPI report commissioned by Wellcome suggests that if schools increased spending on professional development by £500 per teacher per year, up to 12,000 teachers could be prevented from leaving teaching every year<sup>15</sup>.

The Government should prioritise funding for continuing professional development (CPD) for teachers, including the restoration of funding for science CPD following cuts made during the previous Parliament. For example, funding for teacher training that has taken place at the National STEM Learning Centre has been cut by 47%, approximately £4m. We are equally concerned that the National Centre for Computing Education, which provides specialist training for computer science teachers, is facing funding cuts of nearly 40% in four years, while funding for regionally-based training for science teachers has been cut by 73% in three years with no funding committed beyond March 2025.

While there would be costs associated with reversing the cuts to continuing professional development for teachers, these could be offset by savings in recruitment costs from the reduction in churn of teachers leaving the profession.

### Investing in research and evidence-based approaches to education

Educational research can provide the best evidence on how to break down barriers to opportunity in the education system. However, current spend on educational research in proportion to the total education spend is tiny in comparison with other public sectors<sup>16</sup>. For example, in 2021/22, health research funding equated to approximately 1.7% of public investment in health, compared to just 0.05% for education research, relative to public investment in education.

Investment in more longitudinal research would allow meaningful evaluation of the effectiveness of education policies. This would ensure value for money in future education policy interventions and support long-term research in emerging areas, such as the role of AI in education.

### Cross-government and industry-academia collaboration on education and skills

There is a valuable opportunity for the Government to join up policy across the Departments for Education, Business and Trade and Science, Innovation and Technology, to ensure that new policy interventions on education and skills are designed and targeted to the changing needs of the UK labour market. The creation of Skills England is a positive step in this direction and, as part of its remit, should consider how to better join up primary, secondary, and further and higher education with industry. This could include working with the recently established Industrial Strategy Council.

Greater cross-government and industry join-up would help to ensure that our education system and a newly designed curriculum is oriented towards future skills needs and that all young people leave school with the skills to thrive in the workplace and improve life outcomes.

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<sup>13</sup> *Teacher Labour Market Annual Report*, National Foundation for Education Research, 2024.

<sup>14</sup> *Teaching and Leadership: Supply and Quality*, Education Policy Institute, 2021.

<sup>15</sup> *The effects of high quality professional development on teachers and students*, Education Policy Institute, 2021.

<sup>16</sup> *Investing in a 21st century education system* – The Royal Society, The British Academy, May 2024.

## KEY RECOMMENDATIONS

The Government's Curriculum and Assessment Review should be ambitious and consider substantial reform of the secondary and post-16 education system to offer a more expansive range of study, including:

- continuation and reform of mathematical and data education to 18 as a key engine for future growth (as set out in the Royal Society's report *A new approach to mathematical and data education*)
- the creation of a more equitable single route through the sciences for all students up to age 16, with more time spent on hands-on practical science in schools.

The Government should also:

- Substantially increase the current very minimal education research budget to take the guesswork out of educational policy by significantly improving the evidence base. Monitoring and evaluating the impact of education policy reforms, including from the Curriculum and Assessment Review, will ensure that these are truly effective and deliver tangible improvements for children and young people
- Immediately reverse the previous government's cuts to professional development to retain science, maths and computing teachers
- Set out a long-term sustainable funding solution for professional development for teachers and ensure that there is sufficient funding to facilitate teachers upskilling to help fill positions in shortage areas such as Physics



## AREA FOR ACTION 4

### GROW THE UK'S AI, DATA AND SUPERCOMPUTING CAPABILITIES (INFRASTRUCTURE, PEOPLE AND SOFTWARE) AND PROVIDE GLOBAL LEADERSHIP TO SAFELY HARNESS THE BENEFITS OF AI FOR SOCIETY

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Artificial intelligence (AI) has the power to transform how we live and work. A review commissioned for the Royal Society suggests the valuation of the global AI market (as of 2022) is approximately £106.99 billion<sup>17</sup>. Sectors more exposed to AI (meaning that AI can readily be used for some tasks) are seeing an almost fivefold increase in the rate of productivity growth globally<sup>18</sup>.

Research is fundamental to developing applications for AI that benefit society, as well as to understanding and managing its potential risks. AI also offers significant opportunities for use in scientific research, such as speeding up drug discovery, but the current 'black box' nature of the technology also poses challenges due to the lack of transparency of the data and inputs used.

#### **Strengthening the UK's supercomputing capabilities: leading a CERN for AI?**

In today's global knowledge race, it will be important for our economy and society to build, attract and maintain significant computing and AI capabilities in the UK. Access to high performance computing power has been critical for major scientific breakthroughs, such as protein folding with AlphaFold. Scientists require access to essential data and AI infrastructure to adopt more complex techniques, process higher volumes and types of data, and ensure quality in AI-based research.

We welcome the Government's commitment in the AI Opportunities Action Plan to increase public compute capacity by twentyfold by 2030. Funders, industry partners, and research institutions with computing facilities should be incentivised to actively share essential AI infrastructures such as high-performance computing power and data resources. This could include sponsored access to supercomputing and the establishment of regional hubs – akin to a CERN for AI.

#### **Supporting sustainable growth in data and computing infrastructure**

The resource-intensive nature of AI raises ethical questions. We welcome the Government's commitment to establish an AI Energy Council to understand the energy demands and challenges which will fuel the development of AI technology and infrastructure. The growth of AI infrastructure, such as data centres, should be environmentally sustainable. The Government should ensure that investment in AI infrastructure is informed by environmentally sustainable computational science best practices, including the measurement and reporting of environmental impacts.

#### **Harnessing new technologies to protect privacy and public trust**

One of the biggest barriers to AI adoption is trust<sup>19</sup>. Access to high quality data and interoperable data infrastructures will be critical for supporting the AI industry. This will involve advancing access to sensitive data through privacy enhancing technologies; incentivising the adoption of open science principles and practices; and investing in data curation and AI literacy across scientific disciplines.

#### **Improving access to data for scientific research**

There are significant opportunities from improving access to data for scientific and multidisciplinary research. Collaborative analysis and other privacy enhancing techniques have a role to play in positioning the UK internationally as a trusted data partner. The Government should accelerate the development of privacy enhancing technologies and other data-use techniques by establishing collaborative test environments (such as an international privacy enhancing technologies sandbox). The facilitation of greater researcher access to data and the responsible adoption of these technologies will ensure the UK can realise the benefits of AI for improving public services and delivering on the Government's Plan for Change.

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<sup>17</sup> *Science in the age of AI*, The Royal Society, 2024.

<sup>18</sup> *Global AI Jobs Barometer*, PriceWaterhouseCoopers, 2024.

<sup>19</sup> *The UK Productivity Gap: How AI can untap workplace potential*, Workday 2024.

## KEY RECOMMENDATIONS

- Funders, industry partners, and research institutions with computing facilities should be incentivised to actively share essential AI infrastructures such as high-performance computing power and data resources
- The Government should ensure that investment in AI infrastructure is informed by environmentally sustainable computational science best practices, including the measurement and reporting of environmental impacts.
- Access to high quality data and interoperable data infrastructures will be critical for supporting the AI industry. The Government should:
  - Provide scenario-specific data protection guidance on scientific research exemptions
  - Publish a national privacy enhancing technologies (PETs) strategy to promote the responsible use of PETs in data governance

## AREA FOR ACTION 5

### TAKING URGENT STEPS TO PROTECT OUR ENVIRONMENT, MOVE TO CLEAN ENERGY AND SLOW CLIMATE CHANGE AND BIODIVERSITY LOSS

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There is a need for rapid and determined action on climate change and biodiversity loss and the UK is well placed to demonstrate global leadership.

#### Supporting the UK to become a clean energy superpower

To fulfil our net zero commitments, the Government should develop evidence-based technology roadmaps that are informed and continuously updated by bringing together scientists, economists, social and behavioural scientists and industry. These should send signals to internationally mobile investment through recommending the technologies to deploy, develop or research.

While the Government's 'Clean Power 2030 Action Plan' is a welcome step, it does not sufficiently prioritise the construction of long duration energy storage at the scale and pace needed for the UK to meet its ambition to make Britain energy secure with clean power by 2030. As we transition to increased levels of renewable energy supply, large-scale, long term electricity storage will be essential to mitigate variations in wind and sunshine, such as using salt caverns to store the up to 100 Terawatt-hours of electricity needed by 2050<sup>20</sup>.

#### Treating biodiversity loss with the same urgency as climate change

Biodiversity matters. Nature can be harnessed to mitigate and adapt to climate change and provide buffers against extreme events such as floods and wildfires. Biodiversity management and conservation contributes resilience in the face of health and economic threats that emerging pandemics present. Diversity in livestock, crops and aquaculture is integral to the challenges of sustainably feeding the world.

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£10 trillion – the benefit from taking early action to prevent further biodiversity loss

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Today, the Earth is losing biodiversity at rates not before seen in the modern era. Urgent action is needed if we are to prevent further biodiversity loss. In the UK, only 14% of priority habitats, 7% of woodland and 25% of peatlands are assessed to be in good condition. Protecting the biodiversity of our planet also makes clear economic sense and will benefit countries around the world, with an estimated £10 trillion benefit to taking early action.

#### KEY RECOMMENDATIONS

The Government should:

- Urgently produce evidence-based net zero technology roadmaps to decarbonise the energy system by 2050;
- Prioritise the construction of long term, large-scale energy storage facilities to match the expansion of renewable generation, ensuring the UK has year-round security of energy supply; and
- Ensure policies to reduce greenhouse gas emissions and adapt to climate change help to prevent and reverse biodiversity loss. This should include:
  - Developing new approaches to accounting for the true value of biodiversity, drawing on the Dasgupta Review, as well as global monitoring to help countries meet their biodiversity targets; and
  - Consulting on mandatory reporting which requires companies to report and account for their impacts on nature and biodiversity, as is already best practice for carbon emissions.

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20 *Large scale electricity storage*, The Royal Society, 2023.