Comprehensive Spending Review

Representation from the Royal Society of Chemistry

September 2021

With around 45,000 members in more than 100 countries and a knowledge business that spans the globe, the Royal Society of Chemistry is the UK's professional body for chemical scientists, supporting and representing our members and bringing together chemical scientists from all over the world. Our members include those working in large multinational companies and small to medium enterprises, researchers and students in universities, teachers, and regulators.

Introduction

Throughout the pandemic we have all looked to science to provide the answers, and science has delivered time and time again. The sector has shown the importance of investing in long-term research funding, science education, infrastructure, and innovation, to help create a resilient UK. The chemical sciences can be found at the forefront of delivering the Covid recovery, from working on vaccines and testing, to innovating new technologies supporting net zero and leading the charge on sustainability

Chemistry using professionals are highly skilled and make a significant contribution to the UK economy, generating an average of £83bn per year between 2013-19 in economic output and returning £3.2bn (2019) to HM treasury[1]. We estimate there are around 275,000 chemistry using professionals in the UK working in diverse areas including R&D, education, manufacturing, and energy supply. They support around 475,000 additional jobs in the economy. As the nation faces the fiscal realities of the pandemic the chemical sciences have an important role to play in a green economic recovery. This submission proposes specific and targeted timely investments to enable that and support the Government's ambition of securing the UK's position as a "Science Superpower".

The sector has been encouraged by commitments made by this Government to increase spending on R&D to £22 billion per year by 2024/25. This Comprehensive Spending Review must set out how the UK Government can continue to support and develop R&D and the chemical sciences sector more broadly at this crucial moment – through providing long term certainty on research funding, supporting excellent chemistry education, enabling chemistry deep-tech SMEs to solve a range of problems and investing to improve our environment. The chemical sciences and chemistry skills are vital to many different areas of our economy and

[1] Chemistry's Contribution: Workforce trends and economic impact – Royal Society of Chemistry, Sept. 2020 https://www.rsc.org/contentassets/8122a7694dd14a4f9779cec4e9dbb0a6/workforce-full-report

society. A future talent pipeline of skilled chemists will be needed to achieve net zero ambitions and tackle other challenges, for example in health.

This submission develops these areas further and suggests several specific policy actions we would ask HM treasury to include in the upcoming Comprehensive Spending Review.

We call on the government to:

1. Invest in UK research and innovation
    - 1.1. Fuel the UK's economic recovery by setting out a clear, multi-year pathway to investing £22bn in R&D by 2024/25 and raising the UK's total R&D spend to 2.4% of GDP by 2027
    - 1.2. Reverse the real-terms decline in QR (quality related) research funding and ensure future allocations retain their real-terms value by keeping pace with inflation
    - 1.3. Set out a clear approach on funding for Horizon Europe
    - 1.4. Utilise the UK's position as a global science leader to level up opportunity across the country
    - 1.5. Support the innovation eco-system and SMEs beyond research funding and into delivery
    - 1.6. Invest in a major R&D programme in digital chemistry and materials innovation
2. Invest in a brilliant science education
    - 2.1. Support subject-specific professional development for science teachers
    - 2.2. Support early career science teachers whose training was disrupted by Covid-19
    - 2.3. Protect the long-term ability of university chemistry departments to develop the chemistry talent pipeline needed for economic growth and net zero
3. Invest in protecting our environment
    - 3.1. Protect our environment and prevent future waste
    - 3.2. Invest in the UK Chemicals Strategy and in global chemicals policy agendas through world class science and regulatory leadership

1. Invest in UK research and innovation

1.1 Fuel the UK's economic recovery by setting out a clear, multi-year pathway to investing £22bn in R&D by 2024/25 and raising the UK's total R&D spend to 2.4% of GDP by 2027

When it comes to economic growth, the UK is lagging behind its biggest economic competitors.[2] Since the mid-1980s the UK's investment in R&D has fallen behind[3] and we risk

[2] OECD (2021), Gross domestic product (GDP) (indicator). doi: 10.1787/dc2f7aec-en (Accessed 14 Sept 2021)
[3] OECD (2021), Gross domestic spending on R&D (indicator). doi: 10.1787/d8b068b4-en (Accessed 14 Sept 2021)

losing our competitive advantage. The European Innovation Scoreboard 2021[4] shows the UK, having already lost its status as an innovation leader, slipping further down the ranks.

Covid-19 has led to this Government making unprecedented economic decisions, disrupting its ability to lay out multiyear funding commitments. It has also led to unprecedented scientific achievements.[5] In its Innovation Strategy and R&D People and Culture Strategy, the Government rightly identifies the vital role scientific R&D will have in fuelling the UK's economic recovery.

Clarity on longer term R&D investment plans gives confidence to private and public sector partners, including international investors, making their own long-term R&D investment decisions. Funding streams that visibly enable the drivers of science – curiosity, collaboration (between sectors, nations, and disciplines), and leadership - can help to attract private investment that will enable economic recovery.[6] Analysis for BEIS shows that each £1 of publicly funded R&D stimulates between £1.96 and £2.34 of private R&D in total.[7]

That is why we are supporting calls from across the sector for the Government to produce a clear, multi-year roadmap to investing £22 billion in R&D by 2024/25 and to delivering the ambition of spending 2.4% of GDP on R&D by 2027.

There has been concern across the sector that the language around the £22 billion commitment has changed in recent times and that the 2024/25 deadline is less prominent – a further commitment to this date would reassure researchers, innovators, and investors of this Government's ambition on the status of the UK as a science superpower.

How brilliant chemistry research tackled the pandemic:

Case-study: Investigating aerosols to inform public health response to Covid-19

Over the past two decades, the Bristol Aerosol Research Centre[8] has developed a range of analytical tools in aerosol science to help understand the chemical and physical processes that describe individual aerosol particles, such as how quickly they evaporate. This work has been funded largely through UK Research Councils as well as some centralised support from University of Bristol School of Chemistry. During the pandemic, the team was ideally positioned to rapidly develop a measurement strategy to help assess the risk of airborne viral transmission in clinical settings (e.g., intubating patients)[9] and in the performing arts.

[4] European Innovation Scoreboard 2021, European Commission, June 2021
[5] International comparative performance of the UK research base – 2016, Elsevier and Department for Business, Energy and Industrial Strategy (BEIS), October 2017
[6] Science Horizons, Royal Society of Chemistry, https://www.rsc.org/new-perspectives/discovery/science-horizons/
[7] The relationship between public and private R&D funding, BEIS Research Paper Number 2020/010 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/897470/relationship-between-public-private-r-and-d-funding.pdf
[8] http://www.bristol.ac.uk/chemistry/research/barc/
[9] Brown J, et al., *A quantitative evaluation of aerosol generation during tracheal intubation and extubation*, Anaesthesia. 2020; https://doi.org/10.1111/anae.15292

The Arts and Entertainment sector, which contributed £7.9billion to GVA in 2019,[10] saw a 60% decline in output in 2020 because of the pandemic. To help understand the transmission risk from professional musicians, the team measured aerosol emissions as part of the DCMS and PHE-funded PERFORM[11] study. Their analysis confirmed that singing produced similar aerosol concentrations to talking at the same volume and contributed to evidence[12] used by SAGE in recommending the return of musical performances in August 2020.

Case-study: Understanding the structure of SARS-CoV-2 spike protein helped the development of COVID-19 antibody tests and vaccines.

Professor Max Crispin's group[13] at the University of Southampton study the structure of large chains of sugar molecules (glycans) that surround viral proteins and how they affect viral function. Whilst their work typically has applications in HIV and cancer, the team shifted their focus at the start of the pandemic to study the structure of the SARS-CoV-2 spike protein and create a synthetic version (mimic). This mimic was used to support the development of a serological antibody test with Birmingham-based diagnostics company Binding Site,[14] which helped assess the rate of asymptomatic infection amongst frontline workers in University Hospitals Birmingham NHS Foundation Trust.[15] The team also used their understanding of the spike protein structures to help evaluate the antigens produced by vaccines against SARS-CoV-2,[16] including the Oxford/AstraZeneca vaccine.[17]

1.2 Reverse the real-terms decline in QR (quality related) research funding and ensure future allocations retain their real-terms value by keeping pace with inflation

The dual support system, which combines project-based funding (through the research councils and other sources) with quality-related (QR) research funding, is highly valued and contributes to the strength and long-term health of UK R&D. The QR funding mechanism offers an established route for Government to make long-term and low bureaucracy investments that will support its commitment to boost public R&D investment to £22bn a year by 2024/25.

QR funding is a vital complement to mission-driven funding streams: it enables institutions to train the next generation of researchers and entrepreneurs, to fund cutting-edge infrastructure and early-stage, risky or disruptive research. Crucially, QR's flexible nature

[10] Covid-19 and the arts and culture sectors, House of Commons Library briefing paper Number CBP9018, 2021, https://researchbriefings.files.parliament.uk/documents/CBP-9018/CBP-9018.pdf
[11] https://www.bristol.ac.uk/science/research/research-impact/perform-study/
[12] SWI Working Group (2020). Report: Aerosol and droplet generation from Singing, Wind Instruments (SWI) and performance activities. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/914628/S0695_Aerosol_and_Droplet_Generation_from_Singing__Wind_Instruments__SWI__and_Performance_Activities.pdf
[13] https://www.southampton.ac.uk/biosci/about/staff/mdc1n17.page
[14] https://www.bindingsite.com/en
[15] Shields A, et al SARS-CoV-2 seroprevalence and asymptomatic viral carriage in healthcare workers: a cross-sectional study, Thorax 2020;75 https://thorax.bmj.com/content/75/12/1089.abstract;
[16] Brouwer P J M, et al, Two-component spike nanoparticle vaccine protects macaques from SARS-CoV-2 infection, Cell, 2021, 184 (5), https://doi.org/10.1016/j.cell.2021.01.035
[17] Watanabe Y, et al, Native-like SARS-CoV-2 spike glycoprotein expressed by ChAdOx1 nCoV-19/AZD1222 vaccine, ACS Cent. Sci. 2021, 7 (4), https://doi.org/10.1021/acscentsci.1c00080

means universities can use it for both long-term planning and to respond quickly to emerging opportunities. This was evident during the Covid-19 pandemic, when universities were able to use QR funding to rapidly pivot their activities even before Government schemes were put in place. Despite its vital role, between 2010/11 and 2020/21 QR funding saw a real terms decline of 18.7%.[18]

To protect our national R&D capacity and capability, the Government must reverse the real-terms decline in QR and ensure that future QR allocations retain their real-terms value. We support the call from the Russell Group to double QR allocations over the next five years,[19] which could be achieved by increasing levels of QR funding by 19% per year to 2024/25.

Demonstrating the value of long-term QR research

Case-study: The Cardiff Catalysis Institute

The Cardiff Catalysis Institute is a centre of excellence for fundamental research in catalysis, a technology that in 2015 underpinned an estimated 80-90% of all products and produced a positive trade balance of £5.5bn. Substantial inward investment by Cardiff University, including from its QR allocation, has enabled it to be both strategic and responsive in capitalising on opportunities. Since its inception, the centre has secured ~£60m investment via 11 UKRI grants with more in the pipeline and published over 1000 papers in top-ranked journals. The CCI's pioneering work, successful publication track record and vibrant community of researchers and technicians have opened doors to numerous high-profile collaborations, including a world-leading alliance between the CCI and the Max Planck Society, the EPSRC-funded Catalysis Hub, and a £9m UK Research and Innovation (UKRI) Prosperity Partnership with The University of Manchester, bp and Johnson Matthey exploring the role of catalysts in reaching net zero.[20]

Case-study: The Centre for Natural Products Discovery (CNPD)

The Centre for Natural Products Discovery (CNPD) at the Liverpool John Moores University explores new natural products with potential applications in areas such as health and environmental sustainability. The Faculty of Science, in which the CNPD sits, used its QR allocation from the 2014 Research Excellence Framework (REF2014) to support early career researchers (ECRs). It offered mentoring, three years of protected research time and internal competitive grants to help ECRs establish their own research, collaborations and attract PhD students. This investment has been very successful for the School of Pharmacy and Biomolecular Sciences – the home of the CNDP – contributing to a 60-70% increase in research output in the REF21 exercise compared with REF 2014, with more research-active staff, more PhD completions and more publications recognised as internationally excellent (3) and world-leading (4*). The Centre's founder Professor Satyajit Sarker shares: "Around 80% of the ECRs receiving this targeted support within the CNPD have become independent researchers and are now starting to bring in their own external funding."*[21]

[18] Calculation based on value of 2010/11 QR allocation in 2021 prices compared to 2020/21 QR allocation using GDP deflators published by HM Treasury in July 2021.

[19] Underpinning our world class research base: the importance of QR funding, Russell Group, March 2021

[20] QR funding and strategic inward investment: Cardiff Catalysis Institute, Royal Society of Chemistry case study, September 2021

[21] QR funding and strategic inward investment: Centre for Natural Products Discovery, Royal Society of Chemistry case study, September 2021

1.3 Set out a clear approach on funding for Horizon Europe

The UK was an active participant in the EU's seven-year Horizon 2020 framework programme. UK researchers have collaborated with groups in 160 countries[22] and received £6.65bn in funding via the programme. UK businesses – especially SMEs – have benefitted from the funding and collaborative opportunities the EU offers, receiving £1.16bn in funding through Horizon 2020, 85% of which went to SMEs. For the chemical sciences, this amounted to more than £730m for research and innovation as a whole and £104m for chemical sciences SMEs over the Programme's lifetime.[23]

The Government must set out a clear approach to allocating funding to support the UK's welcome association to Horizon Europe for its duration, whilst protecting the domestic science budget. An explicit financial provision to cover association to Horizon Europe would allow this to happen.

Case study: Smart Separations Ltd

Dr Hugo Macedo arrived in the UK as an ERASMUS student and started his company, Smart Separations Ltd, on his kitchen table in 2013. The company was founded on the back of an InnovateUK SMART award, which enabled him to secure a £43,000 phase 1 grant from the EU's SME Instrument scheme, designed to 'boost fast company growth and market-creating innovation'. The phase 1 support gave Hugo and Smart Separations leverage to secure an additional InnovateUK Industrial Strategy Challenge Fund grant and a £1.7m phase 2 grant from the EU's SME Instrument programme. Dr Macedo noted: "The SME phase 2 was a game changer for us: it helped us scale-up that technology initially conceptualised in my kitchen, to manufacture these membranes and bring them to market." The company is growing fast, with state-of-the-art facilities in London and Portugal and a team of 25. It has developed two technology platforms: an innovative microfiltration technology based on ceramic membranes with conical pores, and, in response to the global pandemic, a fast-acting antimicrobial coating that is effective against SARS-CoV-2.[24]

1.4 Utilise the UK's position as a global science leader to level up opportunity across the country

The levelling up agenda must support opportunity across the whole of the UK and across industries, including for chemistry-using professionals. Evidence shows that using regional growth funding for research and development supports sustainable prosperity in regional economies. It enables local businesses to harness the power of research and innovation, knowledge, and infrastructure.[25]

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[22] Vinnova, H2020 visualisation (accessed 20/09/2021) Source: signed projects, eCORDA H2020 database, 2021-02-02.
[23] Horizon 2020 Funded Projects dashboard (Accessed 20/09/2021) Source: EC H2020 database, 2021-08-23.
[24] International collaborations create chemistry: Smart Separations Ltd., Royal Society of Chemistry case study, April 2021
[25] Research from our report "Chemistry's Contribution: Workforce trends and economic impact" shows in 2019 there were an estimated 275,000 chemistry-using professionals across the UK, with the largest share in London and the South East of England with disparities across the UK. The North West of England is an important regional hub, but the number of chemistry-using professionals in the region declined by 24% between 2013-2019. In the same period there were also substantial declines of 27% in Wales and the North East.

The Shared Prosperity Fund (UKSPF), through which the UK Government has committed to spending around £1.5bn a year from 2022, must support scientific R&D. We agree with our colleagues at the Campaign for Science and Engineering (CaSE) that there is a need for Government to set out details of the innovation element of the UKSPF and outline how institutions across the UK will be able to access the fund, supporting collaboration between small businesses and universities and driving growth in all parts of the UK, in particular areas with the greatest "untapped potential."[26]

Case study: The RobOT Project

The chemical sciences has strengths across the UK, in universities, industry and businesses. Our recently published Digital Futures report[27] examines regional strengths in digital infrastructure, with one example being Professor Andy Cooper's work in Liverpool. The RobOT project uses experiments, computational modelling, and robotics to develop better ways of discovering new materials. The ERC funding for Prof. Cooper's group has helped to build a case for major UK Government and industry investment in the city of Liverpool itself. In an £81 million partnership with Unilever and the Higher Education Funding Council for England (HEFCE), the University of Liverpool built the Materials Innovation Factory (MIF) in 2016, developing a unique materials chemistry research hub that aims to be a world leader in computer-aided material science. Prof. Cooper believes the prestigious European funding, as well as grants from the Engineering and Physical Sciences Research Council and InnovateUK, combined with the local Unilever site at Port Sunlight, built a strong case for investment in the MIF, bringing hundreds of jobs to the city. This provides a great example of how a combination of public and private investment can enable excellent research to contribute to regional economies.[28]

1.5 Support the innovation eco-system and SMEs beyond research funding and into delivery

Deep-tech SMEs founded on chemistry are continuing to demonstrate the potential for solutions to some of the world's most pressing problems – in areas including COVID response, medical developments, net zero and wider sustainability. However, the journey for deep-tech SMEs from initial discovery to impact is risky, capital intensive and often more than 15 years long. The right funding for innovation and commercialisation as part of the overall investment in research and innovation is vital, yet the needs of emerging SMEs in this sphere go beyond R&D funding.

As with research, **funding and opportunity are needed to support the whole innovation eco-system, particularly when we look at scale-up and delivery for SMEs and their products.**

RSC has commissioned the Enterprise Research Centre to carry out research on 'What works for innovation', to gather evidence on chemistry-intensive SMEs and their R&D and innovation

[26] The five-point roadmap to making the UK a 'science superpower', Campaign for Science and Engineering (CaSE) https://www.sciencecampaign.org.uk/resource/five-point-roadmap-for-uk-science.html
[27] Digital Futures: A new frontier for science exploration and innovation, Royal Society of Chemistry https://www.rsc.org/globalassets/22-new-perspectives/discovery/digital-futures/rsc-digital-futures-report---digital.pdf
[28] Case study on RobOT, International Collaborations Create Chemistry, Royal Society of Chemistry, December 2018

activities, including the key drivers and barriers to innovation. Emerging findings are indicating that chemistry deep-tech SMEs are a particularly innovative population but that they face some significant barriers. They need greater and better-targeted support across Government, funders, and the private sector in areas such as access to finance, availability of suitable premises, access to networks and to entrepreneurial, leadership and management skills.

This piece of research is due to complete towards the end of October. We would like to brief Treasury officials on the emerging findings on SME needs at the earliest opportunity.

1.6 Invest in a major R&D programme in digital chemistry and materials innovation

As part of the Government's investment in R&D set out in section 1.1 of this submission it should invest in a major R&D programme in digital age molecular and materials innovation. We need to attract the brightest minds and business interests to ensure the UK leads at the next frontier in designing and making the most advanced structures and products on the market.

The UK has an opportunity now to harness its unique capability and know-how, but it cannot be complacent in the face of competition from major economies and scientifically advanced nations in a globalised market for talent and ideas.

Beginning with transformative discovery research in digital chemistry, and leveraging national capability in AI and robotics, this programme will contribute to delivering our Advanced Materials & Manufacturing, Net Zero & Life Sciences ambitions.

New molecules and materials are key to innovation in multiple economic sectors including:

- Health: Next generation therapeutics to fight everything from covid and antimicrobial resistance to cancer and dementia
- Energy and Environment: New materials for batteries to power electric vehicles, solar panels or to harness waste carbon dioxide. Recyclable and biodegradable plastics.
- Electronics & Digital: Materials for next gen data storage, processors & displays

By harnessing the latest in AI, robotics, advanced measurement and computational modelling, universities and companies globally are competing to discover new molecules and materials and translate those discoveries into new products faster, safer and at lower cost.

Straddling academia and industry, this multidisciplinary endeavour will need chemistry, materials, biology, engineering, computer science, statistics, and robotics. It will amplify the impact of public investments like the Turing Institute, AI & Automation Centres for Doctoral Training, Centres for Advanced Manufacturing, Rosalind Franklin Institute, Crick Institute, Henry Royce Institute and Faraday Institution.

With additional strategic investment in digital chemistry discovery research, automated experimental research platforms, scale-up facilities, distributed computational modelling capability and scientific data and analytics centres, the UK will be a global leader in the race to digitally accelerate molecular and materials innovation.

2. Invest in a brilliant science education

2.1 Support subject-specific professional development for science teachers

At the RSC we believe every child should have an unbroken chain of experts teaching them throughout their school education. Long standing teacher shortages in some subjects, including chemistry, make it unlikely that this aim will be met through increased recruitment alone, supporting the existing teaching workforce is a cost-effective way of improving the situation. Furthermore, regional inequalities exist in the system: schools in the most deprived areas are less likely to have science teachers with a qualification relevant to the main science discipline they teach.

These problems can be improved through subject-specific Continuing Professional Development (CPD). However, CPD opportunities for teachers are often disconnected, piecemeal and difficult to navigate. Teachers can be put off by gatekeepers in the schools and the challenges of getting release. In addition, CPD is too often low quality. Consequently, taking part in CPD is often seen by teachers as a burden rather than an opportunity. There have been some excellent funded programmes; however, the process for developing, commissioning, and renewing those programmes is bureaucratic and inhibits innovation.

Initial Teacher Training (ITT) is just the start of a teacher's journey to become an expert practitioner, and teachers must be supported to develop and expand their knowledge throughout their careers. This should include:

a) Investing in a coherent programme of subject-specific training and development for all teachers, throughout their careers. It should meet the needs of a broad range of teachers, including those teaching beyond their original area of disciplinary expertise.

b) Developing a system for quality-assuring teachers' CPD and pre-service Subject Knowledge Enhancement courses. Teachers and school leaders need an efficient way of assessing which pre-ITT and in-service CPD options will be most likely to improve student outcomes.

c) Creating a system to collect and record information about teachers' subject-specific expertise. Tracking of teachers' subject expertise by Government (including expertise gained through in-service CPD) would allow for the planning and coordination of teacher development and recruitment at a national and local level. We advocate for the formation of a digital "badging" system as a standard way for teachers' disciplinary expertise to be recognised and recorded.

To this end, **we agree with recent calls from colleagues in the sector and recommend that the Government invests £87m over three years to establish a systematic approach to subject-specific CPD for teachers in the sciences.**

The detailed case for this investment in subject-specific CPD is made in the Institute of Physics' *Subjects Matter* report[29] as well as their submission to the Department for Education ahead of this comprehensive spending review *Driving excellence in science teaching – a pathfinder programme for systematic provision of subject-specific CPD in the sciences*, and the Royal Society's paper *Science education for a research and innovation economy* for the DfE. This is a cost-effective way of addressing some of the most significant problems within the education system, as well as supporting Government ambitions to level up opportunity and cement the UK's status as a science superpower.

2.2 Support early career science teachers whose training was disrupted by Covid-19

The pandemic has put science and scientists front and centre in the race to tackle the global health crisis. And chemistry has been essential at every stage of the world's response to the virus. Chemical scientists of the future will be the ones we look to when tackling the world's health, societal and environmental problems. This is why we must do everything we can to ensure that school students have access to the best possible chemistry education.

A great teacher will have the ability to nurture a young person's passion for science and chemistry. But, for those at the very beginning of their teaching career, the pandemic has had a profound impact on their learning and development. The lockdown restrictions, social distancing and other measures that were in place to slow the spread of the virus meant that teacher training between 2019 and 2021 was significantly disrupted. The lack of opportunities to hone their skills, like teaching practical science lessons and managing student behaviour, has the potential to impact the chemical science pipeline for many years to come – if we don't act now. If teachers lack confidence in leading practical work, they may be less likely to do it. This could be even more prevalent in schools with a higher proportion of disadvantaged students as they are less likely to have specialist teachers.[30] There is also a risk that if teachers have low self-efficacy, they are more likely to leave the profession. Both scenarios could lead to a reduction in a students' practical skills. And a disruption to the skills pipeline.

Whilst we welcome the introduction of the Early Career Framework to support new teachers[31], it was not designed for the purpose of addressing such extraordinary circumstances and resulting shortfalls in initial teacher training experience. **We estimate that additional funding of up to £6 million would ensure that all teachers of the sciences who trained during the 2019/20 and 2020/21 academic years, could access sufficient development opportunities with a focus on teaching using practical work**.[32] We understand the realities of the fiscal conditions the Treasury faces, so whilst our research shows £6 million would

[29] Subjects Matter, Institute of Physics https://www.iop.org/about/publications/subjects-matter
[30] Allen, R. and McInerney, L. (July 2019). The recruitment gap. The Sutton Trust https://www.suttontrust.com/wp-content/uploads/2019/07/The-Recruitment-Gap.pdf
Kirby, P., & Cullinane, C. (2017). Sutton Trust Research Brief – Science Shortfall http://www.suttontrust.com/wp-content/uploads/2017/01/Science-shortfall_FINAL.pdf
[31] Early Careers Framework, Department for Education https://www.early-career-framework.education.gov.uk/
[32] The future of practical science lessons, Royal Society of Chemistry, accessed 20/09/2021 https://www.rsc.org/new-perspectives/talent/practical-science-lessons-future/

provide the greatest benefit, the urgency of the situation means that we would welcome a sum that would work for all parties whilst still delivering for educators.

2.3 Protect the long-term ability of university chemistry departments to develop the chemistry talent pipeline needed for economic growth and net zero

The Government needs to work with higher education institutions to provide the support needed to ensure excellent chemistry teaching and research, for example through recurrent teaching grant allocations for high-cost subjects and QR funding. Whilst chemistry is one of the higher cost subjects to teach, it also returns high value to the economy and society through a highly skilled workforce whose economic contribution and role in solving a range of societal challenges are noted in the introduction to this submission. Chemistry needs to be taught and often researched in well-designed and provisioned laboratory space that meets health, safety, and other regulatory requirements, with specialist practical equipment and consumables, and technical support staff.

Long-term, sustained investment is needed in the different types and scales of infrastructure critical to science. Investing in research and innovation infrastructure is key to Government delivering its R&D Roadmap and its commitment to increasing investment in R&D to £22bn by 2024/25. From world-class UK university labs to regional hubs like the Daresbury Laboratory and world-leading national facilities like Diamond Light Source, leading-edge infrastructure will enable UK researchers to tackle major global challenges, and it will help make the UK an attractive place for scientists, entrepreneurs, and investors.

Investment in infrastructure must go beyond the immediate capital outlay and cover the longer-term costs of employing talented technical professionals and the depreciation and replacement of equipment. Our survey of UK University Chemistry departments in September 2021[33] found that 93% of responding universities had insufficient resource to maintain some or all existing chemistry facilities.

3. Invest in protecting our environment

The chemical sciences play an important part, often alongside other disciplines and sectors, in solving a range of environmental problems. Here we highlight two areas where the chemical sciences show a need for investment to tackle pollution and hazards from plastics, electronic waste, and chemicals.

3.1 Protect our environment and prevent future waste

[33] The survey was sent to 64 UK-based members of the Heads of Chemistry UK policy group, which currently comprises the heads of chemistry departments at 69 universities across the UK and Ireland. The figures quoted are based on responses received from 29 departments by the time of this submission. Full findings will be published by the Royal Society of Chemistry in winter 2021. Please contact policy@rsc.org for more information.

The Government has set firm and ambitious targets to achieve net zero by 2050. We need to act globally across the scientific community and the breadth of society to address these challenges.

All sectors of the economy need to take action to reach net zero, including the so-called "hard to abate" sectors of metals manufacturing, minerals and chemical processing that operate in the UK. Interventions which incentivise scientific advances, support the workforce to innovate and delivers clean business operations are essential to delivering a productive economy, sustainable society and growing back greener.[34]

There are many facets when considering a transition towards a greener and more sustainable future, including the approach we take to waste and recycling. **There needs to be adequate investment in the infrastructure for recycling plastics**, in support of clear recycling goals and backed by the right regulation and incentives. [35]

The UK creates the second highest amount of electronic waste in the world[36], and at present if every household were to start recycling their electronic waste en masse the large-scale infrastructure to extract the rare elements in these items simply does not exist. **The Government needs to address this through investment in large-scale methods of recycling materials and recovering rare elements**.

Alongside investment in vital recycling facilities and infrastructure, investment in research and innovation needs to **support researchers to address fundamental questions related to net zero, develop new sustainable materials, understand our ongoing impact on the environment, and generate circular economy strategies including new methods for recycling plastics.**

3.2 Invest in the UK Chemicals Strategy and in global chemicals policy agendas through world class science and regulatory leadership

Following the UK's departure from the EU, new processes are in place for the continued safe delivery of the chemicals sector. These processes have become fragmented, inefficient, and inconsistent, involving a range of Government agencies. To address this **we support the establishment of a dedicated UK-wide Chemicals Standards Agency for all matters relating to a one-substance-one dossier approach to chemicals safety, regulation and standards for non-food and non-medicinal chemicals.**[37]

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[34] Holyrood Election Manifesto Briefing, Royal Society of Chemistry https://www.rsc.org/globalassets/04-campaigning-outreach/policy/policy/royal-society-of-chemistry---holyrood-election-briefing---2021.pdf

[35] The Future of Recycling, Royal Society of Chemistry https://www.rsc.org/globalassets/22-new-perspectives/sustainability/progressive-plastics/explainers/rsc-explainer-4---the-future-of-recycling.pdf

[36] House of Commons Environmental Audit Committee report 'Electronic waste and the Circular Economy' https://committees.parliament.uk/publications/3675/documents/35777/default/

[37] Drivers and scope for a UK chemicals framework, Royal Society of Chemistry https://www.rsc.org/globalassets/22-new-perspectives/sustainability/a-chemicals-strategy-for-a-sustainable-chemicals-revolution/rsc-uk-chemical-framework-drivers-scope-2020.pdf

A new UK Chemicals Agency must have the expertise to lead and act as the primary UK point of technical and regulatory cooperation and collaboration with other chemicals agencies of similar standing in the world. This will take targeted action and investment from Government to enable high standards of regulation to be maintained transparently and on sound scientific advice.

In order to deliver on these ambitions and those of the upcoming chemicals framework, **we believe there is also a need for Government investment in a new independent UK Science Hub for Chemicals Standards** that could lead on all areas of new science for assessing exposures, hazards, and risks of chemicals to humans and wildlife. It should be a central institute or hub, independent of Government, sited in academia, which can liaise with other scientific bodies across the world. It can help to manage the provision of independent scientific advice in the UK by connecting to the world's best scientists and scientific networks, ensuring science-driven approaches to new risks and hazards from chemicals.

Finally, the UK can be a world leader in the provision of scientific advice into UNEP activities and provide political and scientific leadership on the UN strategic approach to international chemicals management (SAICM) and via the OECD. **To do this requires a dedicated and well-funded science-policy interface, such as the creation of an Inter-Governmental Panel for Chemicals & Waste Management (IPCWM). The UK Government should lead the way and provide its share of funds for this to be established by the UN in 2022**[38]. In addition, overseas development aid should assist developing nations with capability development in chemicals regulation, i.e., in countries where chemicals regulatory systems are not embedded to aid in achieving globally harmonised regulations to support new trading relationships based on high standards. One such area relevant for global action and where the UK could be a world leader is through developing impactful regulation of per- and poly-fluoroalkyl substances (PFAS).

Contact:

The Royal Society of Chemistry would be happy to discuss any of the issues raised in our submission in more detail. Any questions should be directed to policy@rsc.org.

[38] A chemicals strategy for a sustainable chemicals revolution, Royal Society of Chemistry https://www.rsc.org/new-perspectives/sustainability/sustainable-chemicals-strategy/