Institute of Physics Submission to Phase 2 of the Spending Review 2025

February 2025

About the Institute of Physics

The Institute of Physics (IOP) is the professional and learned society for physics in the UK and Ireland. As a registered charity we are dedicated to maximising public good through the advancement of physics and its applications. To realise this, the IOP advocates for the physics sector to be well resourced and supported, from funding for physics research and development (R&D) to resources for STEM education.

Executive summary

Investment in physics is a catalyst for economic growth and prosperity and, with the right support in place, physics research, innovation, knowledge and skills can play a defining role in the realisation of the milestones set out in the Government's Plan for Change and forthcoming Industrial Strategy.

Investment in physics requires a long-term and strategic approach. That is why we are asking Government to develop and implement a decade-long strategic plan for the physical sciences, to strengthen each of the core pillars of the physics R&D system – discovery science, business innovation, people and infrastructure – and underpin the 10-year Industrial Strategy.

This investment needs to be focused where it is most needed so the UK can realise the full societal and economic benefits that physics offers. As set out in the IOP's strategy 'Physics for our Future',[1] our focus is on science, skills and society.

Science – Many of the industries that are powered by physics will have a significant impact on the government's missions to kickstart economic growth and make Britain a clean energy superpower. But the UK needs a world-class R&D system that is fit for the future. This means increasing R&D investment to match or exceed the top OECD countries and focusing more of that investment on ground-breaking research in physics, cutting-edge innovation, skills development, facilities and infrastructure.

Skills – Physics skills are at the forefront of the new economy, from green energy and nuclear industries to electrical engineering, construction and digital and demand for physics-related skills is large enough to be significant, and underpin high-value jobs and industries, in every part of the UK. Investment and effective cross-government working are needed so the opportunities, knowledge and skills that physics can offer will be truly open to all.

[1] Institute of Physics Strategy 2024-2029.

Society – In the years to come, we will depend more on the knowledge and skills from physics to address the challenges facing us, whether through diagnosis and treatment in healthcare, living more prosperously and sustainably, addressing our energy needs or protecting our biodiversity. Investment is needed to unlock physics' potential to improve our lives in all these ways, and others.

The need for a decade-long strategic plan for the physical sciences

Throughout history, physics has transformed our world. From fibre-optic communications to magnetic resonance imaging, UK physics has been indispensable to many of the world's most impactful and successful innovations. Physics will continue to transform our world in the coming years. A new wave of innovation enabled by physics is set to break, promising low-carbon energy generation, radically accelerated drug discovery, self-repairing infrastructure, and myriad other benefits we cannot yet predict.

But investment in physics requires a long-term and strategic approach. The UK needs a clear, comprehensive and long-term vision for R&D, which instils confidence among researchers and innovators, and fosters ingenuity wherever it is found.

For these reasons and others, the importance of this Spending Review cannot be overstated. The Spending Review takes place against the backdrop of huge fiscal challenges, a turbulent geopolitical context, and a world-wide climate emergency. But we are also seeing the opportunities and possibilities arising from the Fourth Industrial Revolution, and how their fruition is dependent upon scientific discovery and technological innovation.

The Spending Review offers an opportunity for the UK to set the direction of travel for years to come, by charting a sustainable route to a productive economy and a more prosperous society, where the benefits will be available to all.

The Government has recognised the importance of science and innovation to the country's future and economic growth. Now is the time to turn this recognition into action. Despite the difficult choices to be made, the Government must unlock the resources needed to unleash the full potential of physics innovation and make sure everyone, in every part of the UK, can realise the full benefits of the societal and economic revolution that science can deliver.

If the changes and investment needed to build a thriving physics R&D system aren't made now, every part of the UK will miss out on the transformative benefits that it can deliver. The country would lose pace in the global leadership race in science and innovation, failing to reap the substantial economic rewards such leadership offers. And government would fall short in its commitment to create a more productive, equitable and greener economy. Every part of society would be affected, being denied the opportunity to lead more prosperous, healthy and sustainable lives.

So, we need to nurture and support a thriving physics ecosystem that will further innovation, discovery, research and growth. It is now more than 20 years since Labour launched the 'Science and Innovation

Investment Framework' recognising science as one of the key pillars of growth and pledging to set a long-term strategy to improve the UK's R&D and innovation performance. It is vitally important that this Government mirrors that ambition and commitment.

The Spending Review presents an opportunity to set out a strategic approach to building the UK's national capability in science and innovation. **The IOP is calling on government to develop and implement a decade-long strategic plan for the physical sciences, to strengthen each of the core pillars of the physics R&D system – discovery science, business innovation, people and infrastructure – and underpin the 10-year Industrial Strategy.**

The social and economic contribution of physics

The UK has an excellent reputation in physics. British physicists have earned more than 12% of all Nobel Prizes in physics. The UK consistently places near the top of global rankings of research output – particularly measures of research impact. And the UK boasts some of the highest-ranking university departments in the world.

Furthermore, UK physics has deeper impacts that rankings and statistics cannot measure. For example the UK, behind the research giants of the USA and China, is leading international efforts to build quantum computers and utilise other quantum technologies which could define whole new industries in the decades to come. Likewise, UK physicists' work on nuclear fusion could provide abundant clean electricity that would fundamentally alter industrial and environmental efforts. We are already in the midst of an AI revolution building on fundamental work by scientists such as Canadian-British Physics Nobel Prize winner Geoffrey Hinton.

All of these technologies build upon decades of excellent work across physics disciplines. For example, UK photonics – the science of light – has been fundamental to advances in fusion energy, laser surgery, and quantum computing, among other areas. Photonics has for many years been a UK strength and remains a hidden economic engine: in 2023, companies manufacturing and delivering services based on photonics technology in the UK produced £15.2 billion in output, employed nearly 80,000 people and contributed £7.1 billion of gross value added (GVA) to the UK economy.

According to the latest OECD statistics, in 2021 the UK spent 2.9% of GDP on R&D compared to 3.2% of GDP in Japan, 3.1% in Germany, 3.5% of GDP in the USA, and 4.9% of GDP in Korea. Yet despite lagging behind these countries in investment in R&D the UK ranks third in the world for highly cited publications behind only much larger nations China and the USA. This shows UK academia has an outsized impact leading many disciplines worldwide. Further along the innovation pipeline however the UK does less well, trailing behind Japan, Germany and Korea in the number of patents registered by UK inventors, with a similar trend for the amount of high-tech goods the UK exports.

Public R&D investment has a significant multiplier effect, leveraging in private spending of £3.09-£4.02 for every £1 of public R&D spending over the long term.[2] Investment in physics is a catalyst for innovation and growth. Physics-based businesses span sectors including manufacturing, energy, and services, contributing around 13% of UK GVA, employing more than 2.7 million people (10% of total UK

[2] NCUB (2024) Unlocking growth: The impact of public R&D spending on private sector investment in the UK - National Centre for Universities & Business (ncub.co.uk).

employment) across the UK. Physics-based businesses alone invested £26.0bn of the £49.9bn business R&D spending that made up the majority of the national £70.7bn R&D spend in 2022.[3] We estimate that physics-based businesses generated £750 billion turnover in 2022, making the sector a significant contributor to the UK economy. And physics-based industries' contribution to the economy has been growing, with GVA from physics-based businesses increasing from £231 billion in 2019 to £291 billion in 2022.

Education and training in physics open doors to fulfilling careers across a range of critical industries, from engineering and construction to health and science, to digital and finance. Around one in 20 jobs in the UK makes use of physics-related knowledge and skills, and demand for physics-related skills is large enough to be significant, and underpin high-value jobs and industries, in every part of the UK. In addition to their broad utility across the economy, physics-related knowledge and skills have a critical role to play in fuelling technological innovation and addressing some of the most pressing challenges facing society, such as meeting the country's carbon emissions target.

University physics departments are an engine room for economic growth, both in terms of new ideas and discoveries which result from university research and the highly skilled workforce that is developed in the process. Around half of the jobs that make use of physics-related knowledge (approximately 850,000 jobs in the UK in 2020)[4] require that knowledge to have been gained via a degree. However, in 2022/23, UK universities were educating only around 23,000 full-time equivalent physics students. This means that we are at risk of failing to produce the workforce that is needed to drive economic growth in every region and nation of the UK and secure a more prosperous, sustainable future.

While the current economic picture constrains the fiscal options available, to achieve sustained economic growth, increased productivity and long-term prosperity, the UK must invest in physics research, innovation, knowledge and skills. With the right support, they can play a defining role in the Government's mission-led agenda, and help realise the following missions:

Kickstart economic growth: Physics is a high-value, high-return subject and vital to economic growth. For example, the median physics-based industry annual salary is more than £4,000 higher than the national average,[5] and physics-based industries have a higher GVA per employee than the national average.[6]

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[3] IOP Analysis of ONS BERD 2022 dataset (Published 27th February 2024).
[4] https://www.iop.org/sites/default/files/2022-01/Physics-in-demand-labour-market-uk-ireland.pdf.
[5] IOP analysis of data from ONS dataset: Earnings and Hours Worked, UK Region by Industry by Two-Digit SIC: ASHE Table 5.
[6] Centre for Economics and Business Research (2021) Physics and the Economy. IOP.

In Great Britain 86% of the physics-based industry workforce is outside London, compared to 81% of all employment.[7] Physics-based SMEs are an engine for economic growth, with many successful, growing businesses flourishing in less-economically active areas of the UK. Approximately 74% of SMEs in physics-based industries are outside of London and the South East, compared with approximately 69% of SMEs overall.[8]

R&D is also linked to increases in labour productivity, which is vital for economic and wage growth.[9] Supporting physics will support above-average paying jobs, with high productivity and added value, in all areas of the UK.

Make Britain a clean energy superpower: We cannot become a clean energy superpower without physics. Most clean technologies are built on physics discovery and innovation and need physics skills for their continued development. For example, 72% of R&D investment from UKRI Research Councils since 2006 in five of the central clean energy technology areas – nuclear, renewables, hydrogen and clean fuels, energy storage and carbon capture, usage and storage – has been for research topics classed by the IOP as 'core physics' and 'strongly physics'. Increasing R&D investment in physics accelerates technologies that will be vital to meeting our carbon emissions targets.

Break down barriers to opportunity: Studying physics opens up a world of opportunity, with good jobs to be found across the country, and in growing industries such as the green economy. Everyone should have the opportunity to pursue physics, regardless of their socio-economic background, gender, or any other characteristic.

The IOP has long campaigned for barriers to physics to be broken down, from challenging stereotypes that have a limiting effect on children's aspirations, to developing solutions to the teacher shortage so we have enough specialist physics teachers to inspire and educate the workforce of tomorrow.

[7] IOP analysis of ONS (2023) Business Register and Employment Survey (BRES) via Nomis.
[8] IOP analysis of ONS (2023) Business Counts Dataset. Ignores microbusinesses. Via Nomis.
[9] R. A. L. Jones (2023) Productivity, Innovation and R&D. The Productivity Institute.

Investment in physics R&D

To unlock and realise the full potential of physics to transform and power the UK's future, and contribute to the missions of kickstarting economic growth and making Britain a clean energy superpower, the IOP recommends that the government should:

- **Protect departmental R&D spending budgets from any reductions as part of the 2025 Spending Review.**
- **Provide an update on the commitment to invest £20.4bn on R&D investment in 2025-26.**
- **As and when public finances allow, increase R&D investment to match or exceed top OECD countries, to boost economic growth, productivity and job creation across all parts of the UK.**
- **Maintain support for strategically important physics technologies identified in the Science and Technology Framework and in the Industrial Strategy Green Paper.** Long-term government support for technologies that are important to the UK's strategic priorities is vital for sustained business investment in these technology areas and indicates to researchers and students that these are areas with long-term potential, further incentivising research and development. Clear, long-standing and strategic government support for quantum science and technology and the semiconductor industry has been extremely positive and has been the foundation for large-scale business investment in the UK. We urge the government to maintain these strategies and associated financial commitments. We ask the government specifically to restate the 10-year, £2.5 billion commitment to the UK quantum strategy which would boost confidence in the sector at a significant time – especially since 2025 is the International Year of Quantum.
- **Increase support for physics-based business innovation with additional funding for early-stage R&D and development-stage activities, a focus on long-term funding schemes** (supporting technology-driven, challenge-led and high-risk, high-reward research), **and a more attractive tax environment to promote the commercialisation of new technologies, manufacturing and exports.**
- **Review and strengthen the financial support available for physics deep tech to make sure that grant, equity and debt-based instruments are working effectively alongside venture capital to help grow physics deep tech businesses.** For example, by introducing dedicated physics deep-tech Investor Partnerships via Innovate UK to ensure that grant matched venture capital investment is available for physics deep-tech businesses. Encouraging greater participation of

international investors, corporate venture capitalists and defined contribution pension funds in physics deep tech will stimulate more later-stage capital for businesses.

- **Consider physics deep tech in the Transforming Public Procurement programme design and implementation, to bring to bear the positive effects of government procurement for physics deep-tech businesses.** For example, that Contracts for Innovation (formerly SBRI), which is delivered by Innovate UK, provides more opportunities for physics deep tech businesses to deliver innovation to the public sector, de-risking their technology.

This near-term expenditure would stimulate longer term growth through productivity gains and positive externalities from research and development leading to greater long-term revenue for the Exchequer.

We welcome the stability and long-term commitment of 10-year funding cycles, announced by the government last summer. We would like to offer some thoughts ahead of implementation:

- 10-year funding cycles must not result in lower overall levels of research funding. Allocating funding further in advance makes it vulnerable to inflation eroding the real-term amount available for research. Equally, changes in fiscal headroom that make more research funding available should not be ignored due to longer-term funding settlements. Any policy should take these considerations into account and be sure to mitigate the risks inherent in longer funding cycles.
- Research Councils should have sufficient funds to advance priority technologies mid-cycle, especially in strategic areas that are emerging and have the potential to contribute to the achievement of the government's five missions.
- A possible solution is for a 5+5 years funding model, where the last five years are indicative following a light touch mid-term review. This would provide the advantages of sustained funding, a process for addressing change, and some level of longer-term policy assurance.

Investment in university physics departments

Universities' physics departments have played an indispensable role in many of the technological developments that have driven the UK's economic growth and shape the society we live in. Their outputs – fundamental knowledge, novel insights and highly skilled, adaptable people – will also be needed to maintain the country's advantages in key technologies that will shape the coming decades, such as quantum, photonics, space, green technologies and data science (including AI).

The university teaching and research base is a foundational part of this capability, but the picture is very stark. Currently, UK universities are experiencing the most significant financial challenges that they have faced in decades, with 72% of universities expected to be in deficit by 2025-26,[10] according to analysis by the Office for Students. As a comparatively expensive subject to teach and with significant facilities requirements, physics is at particular risk in this environment. There have already been announcements about staff cuts and course closures at various institutions, as they take measures to deal with escalating financial pressures.

The R&D budget settlement in Autumn for the main public funders of the research and innovation system, as part of phase one of the Spending Review, has presented difficult choices. While the announcement that UKRI will increase postgraduate research students' stipends by 8% in the next academic year is welcome, it increases the likelihood that tougher choices will need to be made elsewhere.

Phase two of the Spending Review will be another pivotal moment. It presents an opportunity to stabilise higher education funding, to strengthen the position of already vulnerable departments and to avoid unplanned closures or unforeseen collapses in parts of the university physics base. If stabilising measures can be put in place, other, more fundamental change will then be necessary to ensure the longevity and growth of our physics teaching and research base, so the country can fulfil its science and innovation potential for decades to come. As a matter of urgency, the following actions are needed to address the immediate challenges facing physics departments:

- **Increase support to allow the proportion of the full economic cost recovered on all publicly funded research grants to return to sustainable levels of at least 80%**, to safeguard the sustainability of the world-leading research that takes place within the higher education sector

[10] See page 9 at: https://www.officeforstudents.org.uk/media/s32lw2vq/financial-sustainability-of-higher-education-providers-in-england-november-2024-update.pdf

and ensure long-term capacity exists in all universities, in all parts of the UK, to maintain and improve our national physics capability.

- **Ensure levels of quality-related (QR) funding take account of rising inflation and running costs**, creating a more sustainable balance between QR and Research Council funding to allow universities to continue to forge new partnerships with business and industry, invest in the talent pipeline, build research capacity, support ground-breaking discovery science and use R&D to help power future economic growth.
- **Provide additional funding to modernise and upgrade physics facilities in universities, coupled with funding for the technical staff required to run them and support for universities to be able to share these facilities when practicable**. This will have the double effect of improving the teaching and research environment available to students and researchers in universities and helping universities to realise additional efficiencies by sharing facilities.
- **Ensure funding for 'very high-cost STEM subjects' such as physics covers the full cost of teaching, including lab-based teaching.** Despite additional targeted allocations set out by the Office for Students in its Strategic Priorities Grant for 2024-25, physics is often still being taught at a loss, due to the academic staff, tutorial time and lab hours required.

Investment in physics education and world-class teaching

The IOP has identified four high-priority areas in education where investment is most needed, to equip the next generation with physics skills and knowledge and to accelerate the progress of the government's missions of kickstarting economic growth and breaking down barriers to opportunity:

- **Recruit more teachers, through targeted investment in initial teacher training (ITT).**
- **Improve retention, with subject specific support for early career teachers.**
- **Improve training and retraining through investment in schools that enables their teachers to undertake professional development or retraining opportunities.**
- **Provide financial support to ensure all students can undertake practical classes, which are vital to understanding physics.**

Research shows that access to a specialist physics teacher improves student attainment in the subject, so it is vital that as many students as possible have access to a specialist physics teacher. This is important because the knowledge and capabilities gained from studying physics at secondary and higher level are in extremely high demand amongst employers and university admissions tutors. Physics is a gateway subject for individuals, and it will underpin growth in an innovation-based economy. It is also a driver of social mobility and higher lifetime earning potential.

Yet there are chronic and serious shortages of specialist physics teachers across all the nations of the UK. In England, the current shortfall is of 3,500 specialist physics teachers.

To address this, we are recommending a holistic approach aimed at drastically improving the recruitment, retention, and retraining of physics teachers – the 3Rs. This will require investment in each of the areas. However, investment in the second two will reduce the cost of the first one; and, importantly, the investment will pay off through improvements to lifetime earning potential of a more complete and more experienced teacher workforce.

Recruitment

To improve recruitment, the IOP recommends that, as well as incentivising potential trainees through scholarships, the government looks at means of managing the national target for physics teachers; a target that has been consistently missed over the last four years, with only 30% of the target being met in 2024.[11] This could be done through individual targets or incentives to ITT providers to recruit physics

[11] IOP responds to physics teacher recruitment figures | Institute of Physics

teachers. We also recommend reviewing, revitalising and funding long-form, high-quality, intensive pre-ITT Subject Knowledge Enhancement (SKE) courses so that graduates in subjects other than physics can train to become physics teachers.

Retention

The high attrition rate of teachers (over 40% of all teachers had left within five years in 2024[12]) incurs enormous costs to the system. It adds a huge burden to recruitment costs, and it means that the teaching workforce loses experience. This loss of experience will diminish student performance and progression rates and reduce lifetime earning potential. We recommend investing in subject-specific teacher support throughout a teacher's working life and especially during their early career.[13]

As part of any approach to improving retention there is also a need for the government to invest in an overhauled and nationally coordinated system of subject-specific continuous professional development (CPD) for teachers. This need is now particularly acute in the sciences given decisions over the last 12 months to incrementally de-fund teacher CPD across the sciences.[14] IOP research shows that teachers want to develop their expertise in their chosen discipline. Improved funding for CPD will support this and help retain teachers whilst also improving outcomes for students due to their teachers being greater experts in their chosen subject. However currently there are financial barriers for science teachers in England who wish to attend subject specific professional development. The 2023 teacher survey[15] showed that for 49% of schools there was insufficient funding for a cover teacher, and for 63% the cost and associated expenses of attending a course was too high. Funding needs to be available for schools to enable their teachers to undertake subject-specific CPD.

Retraining

Recruitment and retention alone are likely unable to fill the 3,500 physics teacher shortage quickly enough, which is why retraining of existing teachers is also needed. Although the existing Subject Knowledge for Physics Teaching (SKPT) programme is working well, we recommend intensifying it by providing further funding in the form of bursaries and covering the cost of releasing teachers to attend SKPT training. This approach will generate new physics teachers with ready-made teaching experience

[12] New data reveals the scale of the teacher retention crisis | Tes
[13] Subjects Matter, A report from the Institute of Physics
[14] Labour cost-cutting spree now hits STEM programme
[15] Only a minority of teachers have sufficient subject-specific professional development

exactly where they are needed. Additionally, it is a cheaper and faster alternative to recruiting a brand-new teacher.

Financial support for practical learning

In addition to the importance of having a specialist physics teacher in the classroom, there is a need to further financially support practical science lessons. Practical science is vital to properly understand many of physics' core concepts, and significantly furthers a student's understanding of the subject. This is why it is concerning that so many schools are struggling to provide practical lessons. 34% of mainstream schools in England identified the cost of consumables, and 33% the lack of equipment as barriers to them undertaking practical science lessons, according to the 2023 Science Teaching survey.[16] Practical lessons are a vital part of a physics education. They teach students experimental technique and reinforce the link between theory and experiment that is the essence of the scientific method.

The opportunities available to those with an education in physics are increasing with fast-growing sectors such as AI and quantum. The sooner the UK addresses the teacher shortage that is creating a bottleneck in the education pipeline, the faster these jobs can be filled by a diverse, talented and well-trained cohort of people from across the UK.

[16] Underfunding is having a negative impact on science teaching and learning

Investment in physics skills

For the UK to fully seize the opportunities offered by increased investment in R&D, and build a more innovative economy, we need an equally dramatic increase in the scale and diversity of the R&D workforce. To achieve the government's mission of kickstarting economic growth, the IOP recommends:

- **Investment in growing a diverse workforce with the right physics-based skills.**
- **Changes to tax reliefs which incentivise employers to invest in employee upskilling and reskilling.**

Physics skills are central to the government's new industrial strategy, offering routes to productive employment in growth sectors and rewarding careers, and fuelling technological innovation. They also offer an effective tool to boost regional economic growth and improve living standards.

However, existing skills shortages threaten to derail plans to increase investment in physics-based R&D/innovation, causing delays to projects, missed targets and missed opportunities. There is significant unmet demand for physics skills – research commissioned by the IOP identified nearly 9,000 high-duration vacancies persisted in being hard to fill (mid-2021).[17] Responding to an IOP-commissioned survey, 66% of physics-based businesses reported suspending or delaying R&D/innovation activities in the previous five years because of skills shortages. Almost one third of respondents said they had missed goals or scaled back production (30% for production goals and 30% for sales/financial goals).[18]

Investment in growing a diverse workforce with the right physics-based skills

Long-standing stereotypes and other barriers have prevented young people (especially those from under-represented groups) from pursuing study, training or work in physics after the age of 16. The IOP's Limit Less campaign has found that, from an early age, too many young people are denied the opportunity to pursue physics or feel they just don't fit in because of misconceived ideas about what physics is or outdated stereotypes about who can study physics.[19]

Investment should be made in schools to ensure that young people and their families receive accurate and up-to-date careers information and encouragement from community and youth leaders to consider choosing physics as a subject or career opportunity. Teachers should be trained in inclusive teaching so

[17] IOP/Emsi Burning Glass (2022) Unlocking the Potential of Physics Skills in the UK and Ireland (p. 2). https://www.iop.org/sites/default/files/2022-01/IOP-unlocking-the-potential-of-physics-skills.pdf
[18] IOP/CBI Economics (2021) Paradigm Shift: Unlocking the power of physics innovation for a new industrial era (p.10). https://www.iop.org/sites/default/files/2021-10/Paradigm-Shift-physics-innovation-final-oct-2021.pdf
[19] IOP (2020) Limit Less: Support young people to change the world. https://www.iop.org/sites/default/files/2020-11/IOP-Limit-Less-report-2020-Nov.pdf

that they can achieve these robust standards. This should be in both their initial teacher education and their continuing professional development.

Further down the education pipeline, the physics apprenticeships landscape is also starkly lacking in diversity: the IOP's Solving Skills report found that, in 2021, only a fifth (21%) of new physics apprentices in England were women. In Wales, women made up just 6% of new starts, and in Scotland, only 4%.

There are systemic, financial, and cultural barriers affecting uptake and completion of physics apprenticeships:

- In England and Northern Ireland, more than four out of 10 physics apprentices dropped out in 2020/2021 (41% and 45% respectively).[20]
- The cost burden on businesses is profound, particularly on smaller businesses, as shown by the fact that in 2018 43% of micro and small businesses did not provide any training.[21]
- Citing low sector pay, training providers also told the IOP that there is a shortage of skilled educators to deliver physics-related apprenticeships, creating barriers to meet local needs.

Given the distinct labour market demand of physics skills, any interventions aimed at strengthening their provision should ensure availability of a variety of physics education and training pathways, as well as complementary transferable skills development, all informed by close engagement between educators, employers, researchers and innovators.

Changes to tax reliefs which incentivise employers to invest in employee upskilling and reskilling

Changes to tax reliefs which incentivise employers to invest in employee upskilling and reskilling would also help to address current skills shortages. Greater clarity regarding which types of expenditure are eligible for tax relief would be particularly welcome.

An IOP survey found that only one in five firms (19%) sought to address skills shortages by raising investment in staff training.[22] This reflects the highly specialised nature of R&D-intensive roles. In previous consultation with our members, the IOP has heard how the retraining of staff is a much wider issue than R&D tax credits, but there is an enduring value to a business of having upskilled staff assets.[23]

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[20] IOP (2023) Solving Skills: Powering growth through physics-related apprenticeships (p.5). https://www.iop.org/sites/default/files/2023-02/IOP-Solving-Skills-report.pdf
[21] IOP/Emsi Burning Glass (2022) Unlocking the Potential of Physics Skills in the UK and Ireland (p.9). https://www.iop.org/sites/default/files/2022-01/IOP-unlocking-the-potential-of-physics-skills.pdf
[22] IOP/CBI Economics (2021) Paradigm Shift: Unlocking the power of physics innovation for a new industrial era (p.38). https://www.iop.org/sites/default/files/2021-10/Paradigm-Shift-physics-innovation-final-oct-2021.pdf
[23] IOP (2020) The scope of qualifying expenditures for R&D Tax Credits: Consultation. https://www.iop.org/sites/default/files/2020-10/RD-Tax-Credits-qualifying-expenditures-consultation-IOP-response.pdf

If businesses were allowed more flexibility on how to spend their Growth and Skills Levy contributions, they could choose to use a greater proportion to meet their specific needs and address their staff training gaps. Investment in qualifications and upskilling is crucial to keep up with new developments in science.

Investment in physics infrastructure

Physics R&D infrastructure underpins an innovation economy. Researchers and innovators require ready access to a range of equipment, facilities and networks to develop new ideas, technologies, products and services. Cutting-edge domestic infrastructure, as well as access to major international facilities and collaborations, are essential to positioning the UK as an R&D leader and location or partner of choice for overseas researchers, innovators and businesses. Investment in new R&D infrastructure, as well as in upgrading, maintaining and widening access to existing domestic and overseas infrastructure, will strengthen the UK's capability to undertake world-leading science and innovation, and attract international talent, collaborators and investment.

To ensure the UK develops the world-class infrastructure required to kickstart economic growth, the IOP recommends that the government:

- **Implement a long-term funding strategy to maintain research infrastructure.**
- **Invest in new models of collaboration.**
- **Make it easier to build the kind of research infrastructure local economies need.**

Implement a long-term funding strategy to maintain research infrastructure

Physics research infrastructure is typically expensive to establish and run, requiring decades of investment and planning. However, preliminary consultations conducted by the IOP for a forthcoming project on physics infrastructure have highlighted a fundamental problem in how infrastructure is currently funded. Many of those consulted by the IOP for its physics R&D blueprint remarked that the UK's national laboratories are under-resourced and under-utilised compared to those of competitor nations.[24] The current funding model means capital is provided for construction or development, but not for operations or programmes of work. This lack of ongoing investment for maintenance and operations means that there is a real risk that UK infrastructure will become dated and 'time out'. The future cost of replacing infrastructure will be significantly greater than investing in its maintenance now.

Given the expense and lifespan of R&D infrastructure, it is essential that it is used effectively and strategically, with an appropriate balance between investment in new capabilities and continued operation and further development of existing facilities. National physics infrastructure needs

[24] IOP (2022) Physics: investing in our future. Powering the new industrial era. https://www.iop.org/sites/default/files/2022-09/Physics-Investing-in-our-future.pdf

predictable and ongoing investment to support excellent science. This is particularly important in light of recent increases in the cost of energy, which can significantly impact the budgets of large-scale facilities.

Investing in the development of strategically significant domestic physics facilities, such as Diamond Light Source, the Central Laser Facility, the ISIS Neutron and Muon Source (all based at the Harwell Research Campus), the Daresbury Laboratory, will ensure the UK remains a centre for world-class science. It will also contribute to the government's mission to kickstart economic growth, thanks to the concurrent benefits that hosting a flagship international science infrastructure provides, such as the attraction of high-quality intellect, the clustering of technology businesses and the associated GVA and jobs.

Invest in new models of collaboration

A relative lack of nationwide planning or strategic coordination has led to a fragmented innovation landscape, limiting the accessibility of the UK's research infrastructure to businesses conducting R&D. This means that the world-class research infrastructure based in the UK is being underutilised.

Responding to a survey as part of the IOP's Paradigm Shift report, 17% of physics innovators reported a lack of access to suitable equipment and facilities as a major barrier to undertaking R&D.[25] The IOP's Physics R&D blueprint highlighted a 'complex' landscape of research organisations.[26] Changes to the planning framework should work alongside a long-term funding strategy and improved collaboration so that businesses and researchers across the UK can access facilities.

Investing in new models of collaboration could foster innovation across supply chains and deepen business-university links. EPSRC's National Research Facilities (NRFs) are an example of how this is done in practice. NRFs support strategic resources of national importance to provide leading-edge capabilities and technique development at a national level in response to community need. Another example is the Bristol Quantum Technology Enterprise Centre (QTEC) which over five years has helped to create a third of funded quantum startups in the UK. However, the programme closed because of a lack of funding.

Well-funded public sector research establishments (PSREs) and R&D organisations such as the Catapult Network should be used as part of a network of infrastructure, alongside localised clusters. These clusters are spread across the country, and the facilities within them are essential in fostering

[25] OP/CBI Economics (2021) Paradigm Shift: Unlocking the power of physics innovation for a new industrial era (p. 39). https://www.iop.org/sites/default/files/2021-10/Paradigm-Shift-physics-innovation-final-oct-2021.pdf
[26] IOP (2022) Physics: investing in our future. Powering the new industrial era. https://www.iop.org/sites/default/files/2022-09/Physics-Investing-in-our-future.pdf

collaboration between industry and academia. Grant support for these networks could see increases in the number of businesses scaling up their operations to later-stage development activities, such as testing and demonstration.

The UK is home to a diverse range of public and non-profit research organisations. These include public sector research establishments (PSREs), research and technology organisations (RTOs), Catapults and innovation centres. Increasing collaboration between researchers and these centres of innovation can help support with development activities such as testing and demonstration. In the Paradigm Shift survey, 18% of respondents supported greater access to infrastructure for large scale development.[27]

Improved accessibility means that business innovation could improve, but it also helps to support the drive to fill future skills needs. Well-maintained, operational facilities like the ones that form part of the UK's PSREs provide the opportunity to train and develop a future workforce, even if they move into other areas. The Government's Industrial Strategy identified key growth-driving sectors that rely on physics knowledge, including Advanced Manufacturing, Clean Energy Industries, Digital and Technologies and Defence. The infrastructure businesses in these sectors require for R&D need to be accessible and operational alongside investment in a well-trained, skilled and diverse workforce.

Make it easier to build the kind of research infrastructure local economies need

The IOP supports the introduction of policy frameworks that promote the development and use of research infrastructure, which can also support regional development efforts. This can directly progress domestic innovation activities through improved access while supporting the UK's high standing on the world stage.

Implementing new plans that improve infrastructure planning can also enable physics to help the UK's sovereign capability and economic growth. For example, engagement as part of the IOP's report 'A vision for quantum technologies in the UK' recommended that infrastructure – through effective planning – will be necessary to grow UK quantum innovation.[28] Physics-based innovations like quantum are central to the growth of the UK's digital and technology sector (as set out in the recently published Industrial Strategy green paper).

[27] IOP/CBI Economics (2021) Paradigm Shift: Unlocking the power of physics innovation for a new industrial era (p.56). https://www.iop.org/sites/default/files/2021-10/Paradigm-Shift-physics-innovation-final-oct-2021.pdf
[28] IOP (2022) A vision for quantum technologies in the UK (p.6). https://www.iop.org/sites/default/files/2022-11/iop-a-vision-for-quantum-technologies-in-the-UK.pdf

The IOP is supportive of the Government's recognition that the current planning framework needs updating to better enable science-based infrastructure to be built. Including infrastructure, such as laboratories, within an updated National Planning Policy Framework (NPPF) could make it easier to build the kind of research infrastructure that a local economy needs.