IOP Institute of Physics Response to the Nurse Review

About the IOP

The Institute of Physics is the professional body and learned society for physics in the UK and Ireland. The Institute promotes the transformative impact of physics, and, working with members, partners and stakeholders across the UK and overseas, encourages and measures the research, development and innovation (RDI) activities of the sector.

Evidence

1. **Evidence of how physics collaborates with other elements within the ecosystem (including universities, institutes and laboratories, across UK government and the devolved administrations, public, private and non-profit sectors)**

Physics is a fundamental science which underpins productive industries in every part of the UK, from business to research establishments and universities. Continued investment into both those trained in physics and physics-based RDI is required across the science and business landscape to enable a cohesive ecosystem.

Physics and the private sector

Research commissioned by the IOP on the role of physics in the RDI ecosystem shows that the physics sector is a foundation stone for UK research and development (R&D) activity, and continued and increased investment in the sector is vital for a thriving RDI ecosystem. Physics-based industries (PBIs)[1] account for two thirds of all business-based R&D (61%),[2] and physics research makes up a third of business conducted R&D.[3]

The sector is highly productive and creates substantial returns to the UK economy. In 2019, the sector directly generated £229bn in gross value added (GVA), accounting for 11% of total UK gross domestic product (GDP).[4] This figure rises to £563bn when indirect and induced economic contributions are included. The sector is growing from strength to strength: between 2010 and 2019, direct GVA contribution grew by 21%, and turnover increased by £123 billion, a 24% rise.

In 2019, 350,135 physics enterprises were operating across the UK. Powering these enterprises is a substantial workforce. In 2019, the physics sector directly employed 2.72m full time equivalent (FTE) employees, accounting for 10% of total UK employment. When indirect and induced enterprise FTEs are included, this figure rises to 7.62m. In the same year, labour productivity in the sector sat at £84,300 per worker per year.

The physics sector performs strongly compared to other sectors. In 2019, the physics sector had a turnover totalling £634bn; more than double that of the Transport & Storage and Construction sectors, and £2.5bn greater than the Retail sector. In terms of GVA, the physics sector's £229 billion was more than double that of the Construction (£105bn), Transport & Storage (£98bn) and Retail

[1] Physics-based industries (PBIs) are industries whose enterprises demonstrate A) ongoing research and development (R&D) which consistently makes use of physics knowledge (and the R&D activity can be expected to significantly affect the fortunes of businesses within the industry), or B) those where underlying technology supporting the industry requires significant physics knowledge for continued operation.
[2] Including non-physics R&D.
[3] Physics-intensive industries (PIIs) are industries where ongoing physics research is concentrated.
[4] https://www.iop.org/sites/default/files/2022-01/IOP-Contribution-of-Physics-to-UK-Economy.pdf

(£77bn) sectors. The physics sector also outperforms comparative sectors in terms of employment and labour productivity.

PSREs

Many of the UK's Public Sector Research Establishments (PSREs) are world leading, and most rely on physics-based skills and technologies. PSREs are crucial infrastructures which facilitate private- and public-funded RDI; from blue-skies research to cross-TRL (technology readiness level) project work and business driven late-stage development. This directly progresses domestic innovation activities, supporting the UK's high standing on the RDI world stage.

Investment in PSREs can create stronger links with, and support for, private organisations. Equipping R&D active businesses with good access to publicly owned research tools, techniques and standards improves their R&D outcomes, leading to greater levels of future investment.[5] PSREs therefore play a key indirect role in private RDI outcomes, which create economic benefits for the public; a more innovative business landscape would create higher returns to the Treasury, increase jobs and deliver new and improved products and services for citizens and consumers.[6]

Universities

UK universities are among the top performing in the world, and four sit within the top ten globally for research and performance. University physics departments play a strong role in this; In 2018/19, nearly two fifths of university physics staff were talent from outside the UK (37%).[7] Research by physics departments has enabled transformative developments in our society, and will be fundamental to supporting the *seven technology families of UK strength and opportunity* in the UKs Innovation Strategy.[8] To make sure the UK is able to continue driving transformative developments, and to realise the full societal and economic benefits, our university physics research base needs to remain world-leading. That means strengthening our research and innovation ecosystem and building more productive ties between universities, research institutes, businesses and government. Research funding for physics needs a sustainable footing.[9]

Both elements of the UK's dual support system, the block grant largely comprising quality-related (QR) funding and Research Council funding to support specific research projects and programmes, provide essential support to the world-leading research that takes place in UK universities.

QR funding is long-term and flexible, allowing universities to act strategically and explore new and high-risk research that underpin future innovation. This funding has led to discoveries such as graphene, genomics, opto-electronics, and new tests and treatments for everything from bowel disease to diabetes, dementia and cancer.[10] However, there has been a 14% real-terms decline in QR across the higher education sector in England between 2010/11 and 2020/21, and the balance of funding between QR and Research Council funding has fallen from 80p in the pound in 2007 to 50p in the pound in 2018.

[5] King, M; Renedo, E (2020) Achieving the 2.4% GDP target: the role of measurement in increasing investment in R&D and innovation. NPL Report. IEA: 3

[6] https://www.iop.org/sites/default/files/2020-09/IOP-Comprehensive-Spending-Review-submission-FINAL.pdf

[7] IOP (2021). Physics staff in UK universities: data brief. Based on data gathered and licenced by the Higher Education Statistics Authority (HESA) [available on request].

[8] https://www.gov.uk/government/publications/uk-innovation-strategy-leading-the-future-by-creating-it

[9] https://www.iop.org/sites/default/files/2021-10/Institute-of-Physics-representation-to-2021-Spending-Review.pdf

[10] Russell Group (2021). Underpinning our world-class research base – the importance of QR funding https://www.russellgroup.ac.uk/policy/policy-documents/underpinning-our-world-class-research-base-the-importance-of-qr/

To keep UK university research at the forefront of global science, the Government and UKRI need to address the decline in the value of QR funding and return support to at least 2010 levels. As additional investment is made in line with 2.4% investment, a more sustainable balance between QR and Research Council funding will allow universities to continue to forge new partnerships with business and industry, invest in the talent pipeline, build research capacity and use R&D to power future economic growth.

In addition, research in the UK's universities is currently funded at levels below the full cost of performing that research. The total deficit for research activity in universities in England and Northern Ireland reached more than £4 billion in 2019/20.[11] In particular, universities only recovered 71% of the full economic costs (FEC) of research funded by the Research Councils, substantially less than the 80% committed to.

This deficit requires universities to cross-subsidise research from other income-generating activities and leads to an unsustainable system in which research capacity is dependent on factors, such as tuition fee income from overseas students, which have been negatively impacted by the Covid-19 pandemic and which vary between institutions.[12]

The Government should increase the proportion of FEC recovered on all publicly-funded research grants to safeguard the sustainability of the world-leading research that takes place within the higher education sector and ensure long-term capacity exists in all universities, in all parts of the UK, to deliver an increase in research activity. As QR funding is a devolved matter, the appropriate devolved administrations should review the dual system to create bespoke solutions.

2. Physics and international collaboration

International collaboration in science is essential for tackling the global challenges we face, from climate change to public health crises. No individual country can solve these alone, and the UK must take part in international RDI which puts science first, in order to maximise outcomes for the health, wealth and prosperity of the world. The physics discipline thrives on international collaboration. Space exploration, particle physics, photonics and quantum physics are all areas that have seen their research and innovation advanced by different countries working together. Doing so is a matter of performance and economics.

Financially, the infrastructure required for next-generation innovation is expensive. The people and the skills required to achieve this must be sourced from around the world. The UK faces significant physics-skills shortages (around 9,000 physics-demanding roles were vacant during one period in 2021, and job adverts remain online longer than in other sectors),[13] and with challenges facing the Treasury, it makes economic sense to share talent, ideas and resources with those overseas working towards a common goal. Positive and successful examples of this can be seen in the UK contribution to European Organization for Nuclear Research (CERN), based in Switzerland.

Collaborating internationally, both through students studying abroad and those in the workforce working internationally, facilitates the flow of talent, ideas and knowledge which creates domestic improvements otherwise not seen. This is particularly important post-Brexit, where the UK must be open and inviting to become a Global Britain.[14] The UK's points-based immigration system favours STEM workers, but the minimum salary threshold for this route should be reduced for those in STEM

[11] Office for Students (2021). Annual TRAC 2019-20 https://www.officeforstudents.org.uk/publications/annual-trac-2019-20/
[12] HEPI (2021). Regional policy and R&D: evidence, experiments and expectations https://www.hepi.ac.uk/2021/05/13/regional-policyand-rd-evidence-experiments-and-expectations/
[13] Findings from the IOP Workforce Skills project (2021) https://www.iop.org/strategy/productivity-programme/workforce-skills-project
[14] https://www.iop.org/sites/default/files/2020-09/IOP-Comprehensive-Spending-Review-submission-FINAL.pdf

to ensure early career researchers and younger talent are able to come to the UK to work, especially at a time when the UK faces severe STEM skills shortages. The visa system is not currently competitive due to cost. Upfront costs should be reviewed to make the Innovator visa, the Global Business Mobility visa, and the Global Talent visa more accessible and internationally competitive.[15] The Global Talent visa should be extended to enable early career STEM researchers and innovators to apply. These steps will attract and retain international talent to study and work in the UK.

Greater efforts should be made to maintain a positive relationship between UK and EU physics.[16][17] As historical partners and neighbours, the UK and EU share the same fundamental values and challenges. From its time as a member state, the UK has a long history of collaterally sharing resources and ideas with EU partners and has benefitted from internationally collaborative projects such as the European Centre for Medium-Range Weather Forecasts (ECMWF) and the European Extremely Large Telescope (ELT).

The IOP calls for the UK government to secure the UK's association to the Horizon Europe programme. This research infrastructure and its programme of work is of vital importance to the prosperity and productivity of the UK physics community, and indispensable for the UK to secure Science Superpower status. Continued delays to the UK association will significantly limit the economic returns the programme creates and damage relationships.[18]

3. **How is best to secure an organisational landscape now and in the future that delivers high-quality RDI outputs, and which is sustainable and cost-effective?**

In 2022, the IOP will be developing an R&D roadmap for physics, setting out how core elements of the R&D system can be strengthened, and the conditions and policy environment for R&D improved, so that we can realise the full societal and economic benefits of the new industrial era. This will centre on four pillars: scientific discovery; business; people and skills; and infrastructure. The IOP will share these insights when they are developed.

4. **Targeted interventions in the public sector to enhance the quality and diverse mix of RDI-performing organisations through our policy framework and the policies of the devolved administrations.**

IOP recommendations to support the UK's R&D strengths

The UK has an incredible track record in physics, and a world-leading and highly productive research base. To maintain this leadership in both physics and foundational science, investment must match or exceed that of international comparator nations. A significant proportion of UK business R&D takes place in industries with high physics intensity.[19] Despite this, the UK invests relatively little in R&D by international standards. Increasing R&D expenditure to 2.4% of GDP by 2026/27, and 3% in the longer term, is crucial for the UK's ability to develop and build on scientific discoveries and innovations, which are vital for raising productivity, prosperity, and long-term economic growth.[20]

Currently, combined public and private spending sits at 1.7% of GDP. A greater public uplift is required to meet the 2.4% target: public R&D investment needs to increase by nearly 50% to reach

[15] Research from Wellcome has shown that physicists applying through this route face an upfront cost over £13,000 for a family of four on a five-year Global Talent Visa, whilst the French Talent Visa would cost approximately £1,000 for the same family: uk-role-global-research-report.pdf (wellcome.org)
[16] https://www.iop.org/sites/default/files/2019-10/Sub-Adrian-Smith-review-collab-res-innovate.pdf
[17] https://www.iop.org/sites/default/files/2019-09/physics-following-no-deal-brexit.pdf
[18] https://www.iop.org/sites/default/files/2021-10/Institute-of-Physics-representation-to-2021-Spending-Review.pdf
[19] https://www.iop.org/sites/default/files/2022-02/IOP-Contribution-of-Physics-to-UK-Economy-new.pdf
[20] https://www.iop.org/sites/default/files/2021-10/Institute-of-Physics-representation-to-2021-Spending-Review.pdf

the Government's existing target of £22bn by 2026/27 (a 48% increase from the current £14.9bn).[21] To see significant returns, physics should be targeted for this investment. Investing an additional £8.8bn into R&D in the UK physics sector would generate a GVA increase of £34.3bn and additional turnover of £52bn.

Optimising RDI across the UK's nations and regions – levelling up

Currently, there is not an equal distribution of physics-based enterprises, grant funding or physics-based RDI activities around the nation. In London and the South East, GVA contributions from physics-based industries sit at £40.7bn and £35.8bn respectively, however in the North East, this is just £8.3bn. In Northern Ireland and Wales, these figures are £3.5bn and £7.3bn respectively. Similar trends are seen in the turnover output and enterprise and employment numbers within these UK nations and regions outside of London and the South East.[22] All regions and nations need sufficient funding and support in order to stimulate local economies and boost productivity.[23]

An IOP-commissioned survey by CBI Economics showed that 59% of physics innovators plan to increase investment in R&D in the next five years if the right conditions are in place.[24] However, in some regions/nations, physics innovators were more likely to report experiencing challenges to undertaking R&D/innovation activity. To address this and unlock the vast potential of increased R&D investment by physics-based businesses outside of the Greater South East, the UK government must level up its own innovation and business-support policies.

Sufficient representation from devolved governments/nations in executive/strategy setting bodies within UKRI, as well as robust governance for engagement between governments.

Appropriate representation from across the UK in funding bodies is essential. Representation should include geographic considerations to ensure each of the UK's nations and regions are present within UK-wide research and funding organisations. There is currently no Welsh representation on the UK science and innovation funding councils which oversee a £9bn budget.

Physicists need to navigate complex research policy frameworks, and different funding schemes are delivered by different administrations with different economic policies. Planning and engagement between Governments is needed when new initiatives are created to avoid confusion and administrative burdens. Similarly, access to funding should be as easy as possible; the underpinning capacity and infrastructure in struggling regions and nations does not always allow for swift absorption of funds. Schemes should not deter nations and regions with a large proportion of SMEs, such as Wales, where 98.6% of enterprises in Wales are micro or small.[25]

Economic development, science and research are devolved policy areas, but the Research Councils and UKRI are reserved.[26] Consent has been granted for the Advanced Research and Invention Agency Bill (ARIA), which will include a memorandum of understanding for all four governments on the agency.[27] The success or otherwise of that memorandum could prove instructive. An alternative route for meaningful engagement is the new Inter-Ministerial Groups and Inter-Ministerial Standing Committees, which could allow for better co-ordination when relevant.[28]

[21] https://www.iop.org/policy/autumn-budget-and-spending-review-21-analysis
[22] https://www.iop.org/sites/default/files/2022-02/IOP-Contribution-of-Physics-to-the-English-Economy-summary.pdf
[23] https://www.iop.org/about/blogs/no-levelling-up-without-physics
[24] https://www.iop.org/strategy/productivity-programme/innovation-survey
[25] StatsWales (2019). *Business structure in Wales by size-band and measure*. Cardiff: Welsh Government.
[26] *Government of Wales Act* (2006). c. 32.
[27] Senedd Cymru (2021). *Legislative Consent: Advanced Research and Invention Agency Bill*. Cardiff: Senedd Cymru.
[28] Cabinet Office and BEIS (2022). *Review of intergovernmental relations*. London: UK Government.