

Response to the Consultation on Proposals for Long-Term Capital Investment in Science and Research

Joint response from the Academy of Medical Sciences, the British Academy, the Royal Academy of Engineering and the Royal Society.

Summary

The UK is an attractive and productive place to conduct world class research. The potential of this research to transform society, revitalise the economy, improve health and enhance wellbeing has been demonstrated in recent studies, and in the years to come research and innovation will play an even more central role in our knowledge-driven economy.¹ A pillar of the UK research and innovation system is its 'intellectual infrastructure' of which research capital forms a significant part. As the UK reaps the benefits of past investment it must ensure continued investment for future prosperity given fierce scientific competition from abroad and growing opportunities for international collaboration.

The UK national academies welcome the Government's commitment to longer-term capital investment in science and research, and the opportunity to respond to the consultation on proposals for its allocation. This joint response focuses on high-level principles to guide the allocation of research capital funding and builds on the statement 'Fuelling prosperity'² that lies at the foundation of the academies' thinking around future UK policy for science. It uses the broad interpretation of 'capital' used in the consultation document that encompasses a wide range of investments such as large scale shared facilities both domestic and international, individual institutional equipment, large datasets and the increasingly important e-infrastructure that now underpins most research activity. Given the breadth of disciplines represented, individual academies may comment separately on specific disciplinary requirements.

The academies support the proposed criteria of affordability, excellence, impact, skills, efficiency and leverage for the prioritisation of investment in research capital, with an emphasis on excellence within the context of a wider strategic vision. The academies believe that decision making about capital investment should be guided by the following principles, which are detailed in this response:

- **Balanced capital investment** guided by excellence.
- **Long-term vision** for national and international capital investment spanning at least a decade.
- **Systemic approach** considering the essential interdependence of capital and resources and the broader landscape of research funding.
- **Comprehensive operational planning** including:
 - Ensuring future viability through maintenance, operational provisions and upgrades.
 - Ensuring the provision of skilled staff to extract maximum value from capital investments.
 - Achieving efficiencies and maximizing returns by ensuring collaboration and business access.
- **Disciplinary mix:** investing in research capital to support a broad range of disciplines.

¹ See for example Haskel et al. (2014), *The Economic Significance of the UK Science Base*, <http://www.sciencecampaign.org.uk/UKScienceBase.pdf>; and Glover et al. (2014), *Estimating the returns to UK publicly funded cancer-related research in terms of the net value of improved health outcomes*, <http://www.wellcome.ac.uk/About-us/Publications/Reports/Biomedical-science/WTPo56596.htm>

² UK National Academies (2013), *Fuelling prosperity: Research and innovation as drivers of UK growth and competitiveness*, <https://royalsociety.org/policy/publications/2013/fuelling-prosperity/>

Balanced capital investment guided by excellence

Excellence should be the primary guiding principle for decision making within a wider strategic vision of investment in research capital, as this would align resources with scientific strengths. The success of this approach is demonstrated by the UK being the most productive research nation in the world.³ The academies welcome the emphasis placed on the 'Haldane principle' in the consultation document. An important consideration is the balance between maintaining excellence in areas of strength in the UK whilst identifying important and emerging areas where the UK has the potential to lead. Individual research projects, departments and centres, institutions, regional, national and international research projects each have different capital requirements. These requirements will also vary across disciplines. For UK research to be successful, investment is required across the whole spectrum of research projects, as illustrated by many of the examples in the consultation document.

Long-term vision

The academies welcome the Government's commitment to capital investment in science and research and the important part it will play in the forthcoming Science and Innovation Strategy for 2015-2020. Previously, however, the academies recommended that Government build a stable ten year investment framework for research, innovation and skills.⁴ Five year commitments, although preferable to ad hoc announcements on capital investment that have happened since the 2010 spending review,⁵ are not optimal to ensure the most effective planning and stability.

The UK's international collaborators and competitors are already committing to long-term investment in research capital. Since 2007 the EU has extended its Framework Programmes for Research and Technological Development from five to seven years, and China's 18 year medium-to-long-term plans for infrastructure also include research infrastructure.⁶ The UK Government's National Infrastructure Plan⁷ (covering transport, telecommunications and flood defence) spans decades and *the academies recommend that Government should approach investment in research capital with the same long-term perspective*. Mechanisms such as the Government's industrial sector strategies and 'eight great technologies' (plus quantum) can also help to inform long-term investment decisions.

As recognised in the statement from the first G8 joint Science Ministers and National Academies meeting jointly hosted by the Royal Society and Government in June 2013,⁸ large scale international research projects are of great scientific value. Long-term planning and commitments are needed for the UK to participate effectively in such projects, and when it engages early, such as in ELIXIR (the Cambridge-based European infrastructure for biological research funded by an EU FP7 grant), the UK is able to attract significant inward investment and talent.⁹ Joining the planning process late could mean that the UK has limited input in the direction of some such projects with the risk that talented staff may be attracted abroad. *The academies recommend timely UK participation in international research infrastructure projects to achieve maximum benefit and influence, and taking a long-term view of at least a decade when making decisions about such investments.*

³ Elsevier (2014). International Comparative Performance of the UK Research Base – 2013
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263729/bis-13-1297-international-comparative-performance-of-the-uk-research-base-2013.pdf

⁴ UK National Academies (2013), *Fuelling prosperity, Research and innovation as drivers of UK growth and competitiveness*,
<https://royalsociety.org/policy/publications/2013/fuelling-prosperity/>

⁵ House of Lords Select Committee on Science and Technology, 2nd Report – *Scientific Infrastructure*, par 10
<http://www.publications.parliament.uk/pa/ld201314/ldselect/ldsctech/76/76.pdf>

⁶ Ibidem

⁷ <https://www.gov.uk/government/publications/national-infrastructure-plan-2013>

⁸ G8 Science Ministers statement, London 2013 <https://www.gov.uk/government/publications/g8-science-ministers-statement-london-12-june-2013>

⁹ <http://www.elixir-europe.org/>

Building flexibility into a long-term funding system by maintaining a proportion of unallocated capital funding is important, as it permits the research base to respond to new opportunities. However, there is a risk that unplanned capital expenditure unbalances existing research programmes when resources for unplanned facilities have to be drawn away from existing commitments. Moreover, should substantial capital funding remain unallocated, this may lead to uncertainty or investment not being driven primarily by excellence. *The academies support the Government's suggestion to reserve a portion of capital investment for responsive projects. However, this should be coupled with adequate resources for recurring costs from the outset (see below) and be allocated on the grounds of research excellence.*

Systemic approach

The academies welcome the Government's commitment to accompany the existing ring-fenced science budget with capital investment over the next five years.¹⁰ However, an essential interdependence exists between capital and resources. While capital investment has been restored to pre-2010 levels and guaranteed in real terms for the next five years, a flat-cash arrangement has led to the erosion of the science budget since 2010 due to inflation. *The academies recommend that the resource budget is - at least - similarly protected, to create maximum synergy between the two budgets. The academies also recommend that the UK keeps pace with other leading research nations in research investment, to address the systemic underinvestment highlighted in the recent report on the international benchmarking of the UK science system published by BIS.*¹¹

Research capital is also supported by funders outside the higher education funding bodies and the Research Councils, so public investment in research infrastructure should be viewed in the context of the whole UK research and innovation system. For example, capital investment by the Department of Health, through the National Institute for Health Research, has created enviable networked research capability: this investment would need to be sustained to allow the NHS to remain a 'well founded laboratory' for clinical research. Charities and industries invest in and conduct a substantial share of UK research. As highlighted in a recent study, private and public sector research expenditures are not interchangeable but act in a complementary way that contributes to economic growth.¹² Public funding of capital infrastructure leverages charity and private investment in research. *The academies recommend that any discussion of research capital takes into consideration the full breadth of publicly and privately funded capital to ensure the two are complementary and to leverage additional investment from other sectors. The academies encourage consideration of this broader picture when developing the forthcoming Science and Innovation Strategy.*

Comprehensive operational planning

Building a laboratory or the architecture of a data system, or buying a piece of equipment, is merely the beginning of the life cycle of infrastructure. Any such initiative will require ongoing funding for maintenance, staffing, refurbishment, insurance and upgrades. Technological advances can also quickly render new equipment out of date, so consideration should be given to the long-term financial sustainability of key capabilities. These requirements, alongside a description of how they will be provided, should be clearly detailed at the outset in a business plan. This has to take into account maintenance and running costs, the provision of a skilled workforce to extract maximum value, and the potential for efficiency savings through sharing. Responsibility for the successful running of research facilities falls on project leaders and research institutions, which have to carefully plan ahead for the future requirements associated with any new project, and funders who have to ensure that appropriate mechanisms are in place to cover these costs.

¹⁰ Government Response to the House of Lords Science and Technology Committee Report: Scientific Infrastructure, <http://www.parliament.uk/documents/lords-committees/science-technology/ScientificInfrastructure/GovtresponseScientificInfrastructure.pdf>

¹¹ Allas T (2014) Insights from international benchmarking of the UK science and innovation system https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277090/bis-14-544-insights-from-international-benchmarking-of-the-UK-science-and-innovation-system-bis-analysis-paper-03.pdf

¹² Haskel et al (2014) The economic significance of the UK science base. <http://www.sciencecampaign.org.uk/UKScienceBase.pdf>

Maintenance, operational costs and upgrades

Investment in new major capital infrastructure projects should be accompanied by a long-term commitment to maintenance, operational and upgrade costs to ensure their future viability and competitiveness. Whilst funds must be distributed based on competitive application processes to ensure excellence, further effort is required to minimise the bureaucratic burden associated with such processes. *The academies recommend that Government reviews the varied current mechanisms through which maintenance funds are secured, and ensures that sufficient resources are allocated to cover operational expenses (see above). The academies also recommend that upgrades form an integral part of capital investment planning to ensure maximum return in the long-term.*

Human capital

Buildings and facilities need people to deliver the research for which they are designed and to create maximum value from the investment. This involves activities such as running and maintaining equipment, designing experiments, capturing and analysing data, distributing, disseminating and applying knowledge. Moreover, core infrastructure is the foundation for the training of the next generation of leading researchers. Ongoing investment must be made in the skills and training of staff to populate and continually develop the UK's research facilities. Clear stable career paths are needed to attract, develop and retain these research and technical staff vital to research facilities, and their contribution should be properly recognised in the evaluation and funding processes.¹³ This would need to align with the broader skills agenda in the UK to ensure a pipeline of future research and technical staff. *The academies welcome the Government's commitment in response to the House of Lord's report on scientific infrastructure to consider training and associated costs as part of the overall resource requirement for each capital project.*¹⁴

Efficiency

Good business planning should also take into account the potential to achieve efficiencies through sharing, both among publicly funded institutions and with external commercial partners. Several examples of successful equipment sharing are detailed in the consultation document, including regional initiatives such as the N8, M5, SE5 and GW4 groups of universities, and thematic initiatives such as the Midlands Physics Alliance and the National Marine Equipment Pool. These initiatives are resulting in the pooling of capabilities and intelligence on asset management, and in time will have the power to change procurement practice. Public funders are increasingly evaluating the impact of their schemes and in 2010-11 the higher education sector saved £462 million through efficiency measures. *The academies welcome initiatives to encourage equipment sharing, but the impact of efficiency savings should be closely monitored to avoid harm to the research base.*

Private companies can also benefit from access to publicly-funded research facilities. Making capacity available to them can be beneficial to both parties, by allowing private companies to access research capabilities that would otherwise be prohibitively expensive, and publicly-funded facilities to recover part of their costs. A good example is the Advanced Composites Centre at Bristol University, with its close links to the National Composites Centre and the High Value Manufacturing Catapult, providing expertise and facilities that industry may not be able to access on its own. The Scottish Innovation Centres also provide an example of public money being used to bring together academia and industry – including industry co-investment – to focus on transdisciplinary challenges such as stratified medicine, digital health, and sensors and imaging. Private companies can also be valuable partners in direct capital investment, and initiatives such as the UK Research Partnership Investment Fund (UK RPIF) can help leverage funds from the private sector to support research infrastructure. *The academies support the House of Lords Science and*

¹³ See for example the 2011 workshop report from the Academy of Medical Sciences, *Look west: UK-Brazil tropical medicine and parasitology*, p.15 <http://www.acmedsci.ac.uk/viewFile/publicationDownloads/13433706662.pdf>

¹⁴ *Government Response to the House of Lords Science and Technology Committee Report: Scientific Infrastructure*

Technology Committee's recommendation for Government to encourage and facilitate further access to scientific infrastructure by industry, particularly for small and medium enterprises, and efforts to leverage additional resources.¹⁵

Disciplinary mix

Many of the most important challenges of the 21st century, such as the impacts of an ageing population, food security and climate change, require expertise and collaboration across the full range of the engineering, social, human, physical, medical, chemical, biological and mathematical sciences.¹⁶ As research becomes ever more interdisciplinary the boundaries between different types of research fields, and thus their capital requirement, are likely to become ever more permeable.

Inevitably the appropriate magnitude of investment in capital will vary across disciplines. In the humanities and social sciences, for example, the return on relatively low levels of investment is high. This is well demonstrated by referring to longitudinal studies, which tend to appreciate in value over time. These historical datasets, which become richer over time, inform the development of robust evidence-based policies. One example is the internationally recognised British birth cohort study. These are world-leading collections of social, economic and biological data that are vital in understanding health and development in early childhood. The findings have informed numerous government inquiries on issues including education and equality of opportunity; poverty and social exclusion; gender differences in pay and employment; social class differences in health; changing family structures; and anti-social behaviour.

The academies recommend that the UK supports research capital that is useful for a wide range of disciplines. The academies also recommend that, when making investment decisions, 'hidden capital' such as the infrastructure underpinning major longitudinal studies, software and research libraries and archives, is considered alongside the need for equipment such as telescopes and particle accelerators.

Big data in particular presents a significant opportunity for multiple disciplines. For example, recent advances in sensor and information technology open the possibility of the instrumentation of the environment to collect data on a wide range of topics from traffic flow to soil moisture that can form the basis for future cross-disciplinary research. To exploit all that these resources have to offer, the UK needs to ensure that it builds the infrastructure to develop, handle and link up data sets. It is important to ensure that bottle-necks do not arise that might slow the pace of research outputs (for instance large-scale experimental facilities with little or no analytical capability). *As with other physical facilities, the academies recommend further sharing of analytical and computational facilities between universities. In addition sustainable access for academia and industry to High Performance Computing (HPC) facilities is critical.*

About the academies

The **Academy of Medical Sciences**, the **British Academy**, the **Royal Academy of Engineering** and the **Royal Society** are working together to highlight the value of research and innovation to the UK, and to support researchers, industry and policymakers to make the UK the location of choice for world class research, development and innovation. We are working with our research communities to maximise the value of research funding and to support the translation of knowledge into benefits for individuals and society at large. We look forward to working with policymakers, industry and broader society to create the conditions that will secure the UK as the best place in the world to explore, discover and innovate.

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¹⁵ House of Lords Select Committee on Science and Technology, 2nd Report – *Scientific Infrastructure*, par 43
<http://www.publications.parliament.uk/pa/ld201314/ldselect/ldsctech/76/76.pdf>

¹⁶ UK National Academies (2013), *Fuelling prosperity, Research and innovation as drivers of UK growth and competitiveness*,
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