BIS Consultation on proposals for long-term capital investment in science and research

University Alliance response, June 2014

Introduction

1. University Alliance is a non-partisan, non-political organisation working to promote, safeguard and sustain the public benefit delivered by universities.
2. University Alliance brings together 22 of the UK's leading innovative and enterprising universities – major institutions combining science, technology and the creative industries with a focus on delivering for the professions, business and the community. Alliance universities are central to the UK's economy, driving growth in new sectors and markets through the delivery of high quality science, research and industry-ready graduates.
3. By operating a 'revolving door' with business, staff and students are encouraged to move between both throughout their careers. This ensures that the benefits of research are more widely felt by increasing the absorptive capacity of industry through human and intellectual capital. Alliance universities work closely with employers to provide 50% of sandwich work placements, lead over one-third of all UK knowledge transfer partnerships and support graduate entrepreneurialism, resulting in the generation of 46% of all turnover from graduate start-ups.
4. Given Alliance universities' expertise in specialised research areas and capacity to translate the results and benefits of research into real-world impact, they form a unique and vital part of the research and innovation ecosystem, and we are delighted to contribute to consultations on an issue which is critical to the future of this ecosystem.

Summary

5. Universities are central to the UK's science and research ecosystem. HEIs carry out 74.3% of publicly-funded Gross Expenditure on Research and Development (GERD) and 26.5% of total GERD – significantly above OECD average.[1] Substantial value is placed on the knowledge and expertise generated by the UK's publicly-funded university research and researchers – total knowledge exchange investment has risen by 5% over the last year, from £3.4 billion in 2011-12 to £3.6 billion in 2012-13.[2]
6. We welcome the Government's commitment to invest more than £5.5bn in science and research capital, in real terms, over the next five years. The UK's investment in R&D and innovation remains well below average amongst competing nations, however, and

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[1] UUK (2014). *Higher Education in Focus 2014: Research and postgraduate research training. London: UUK*, pp. 6-7.

[2] HE-BCI data.

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significantly lower than OECD and EU averages.[3] We must prioritise investment in existing infrastructure – both capital and otherwise – if we are to future-proof the vitality and competitiveness of the UK science and research ecosystem.

7. We welcome additional funding injections made by government in research capital funding during the last 3-4 years but note that these have only partially offset the large decline (45%) in the research capital budget following the 2010 Comprehensive Spending Review (CSR).[4] Whilst the present consultation and commitment to a strategic capital investment is welcome, we also urge the Government to consider a wider long-term and increased commitment to research spending, and to consider a complementary research resource investment strategy to accompany – even direct – the capital strategy. Capital investment should be led by research expediencies, rather than vice versa. There are concerns that capital investments will not be fully maximised if the resource (including human) does not exist to support it, neither can the capital strategy maximise the UK's research resource if it is planned in isolation from it.

8. In terms of guiding principles for capital funding decisions, a balanced approach is critical – enabling investment in large scale projects whilst protecting our ability to support growth in cutting-edge areas of research that might not easily be predicted. In a sense the approach should mirror the dual funding system (a mix of block-grant funding and project-based funding) for research, which includes the flexibility for universities to invest strategically in new areas. This is critical to maintaining the dynamism and responsiveness of UK research, which involves taking some measure of risk, and therefore a balance of investments weighted towards funding council and research council routes is recommended. Open innovation needs open competition, however – therefore a commitment to the principle of seeking and funding excellence wherever it is found and across the range of research investments must continue to be an essential priority.

9. Connectivity, collaboration and openness is essential to the future of world-leading science, and therefore need to be embedded within the focus and approach of all capital projects. Efficiency savings, for example those made through asset sharing, are another important benefit of collaboration and we are undertaking and supporting efforts at the national level to improve the sharing of resources amongst universities and the wider research eco-system.

10. Identification of priorities to drive decisions in research investment should involve a thorough analysis of current system to identify areas of fragmentation or holes in the UK's science capability, including relevant parties from across the UK's Research & Innovation ecosystem. University Alliance would be happy to help convene discussions about priority areas.

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[3] T. Allas (2014). *Insights from international benchmarking of the UK science and innovation system* (BIS); European Commission (2014). *Innovation Union Scoreboard 2014*.
[4] CaSE (2013). *Response to the Lords inquiry on Scientific Infrastructure*

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Part 1. A World-Class Research Environment

1. What balance should we strike between meeting capital requirements at the individual research project and institution level, relative to the need for large-scale investments at national and international levels?

11. Maintaining excellence in a broad range of subject areas and research activities will future-proof the UK research and innovation ecosystem in a rapidly changing world. As Government acknowledges, predicting future market changes and grand social and scientific challenges is an inexact science and we need to make sure we are future proof by allowing growth sectors and niche research to thrive. This is why the dual funding system for research, which includes the flexibility for universities to invest strategically in new areas, respond to capital pressures and maximise investment opportunities, remains critical to the dynamism and responsiveness of UK research and has been proven to drive quality.

12. Capital funding investments should follow the same principle: balancing large-scale national investments with significant budgets that can be used more flexibly by institutions to develop their strategic priorities, as has been done with the Catalyst fund and SRIF/RCIF allocations. Capital investments must also be accompanied by a complementary resource investment. For example, developing human capital – the researchers of tomorrow – forms an important part of our universities' strategic research investments, to ensure that dynamic research areas and cutting edge research assets are supported and sustainable.

13. The evidence for the benefits of funding excellence wherever it exists is well established[5] and this principle is an important pillar of the UK's funding system for research. Public research funding should continue to be selectively distributed based on excellence, in order to continue to drive the quality and impact of UK research and secure the future health of the UK research base. In a difficult fiscal environment it is essential that these existing principles are maintained because they have "enabled the Government and funding bodies to maximise the return from the limited public funds available for … research".[6]

14. Capital projects at all levels are important in guaranteeing the capacity and quality of the science base. Likewise, connectivity, collaboration and openness will be essential to the future of world-leading science – the so-called 'Science 2.0'. Connectivity and collaboration therefore need to be embedded within the focus and approach of all capital projects, which need to be shared and accessible to all in the ecosystem.

15. Where national and international-level investments are made in capital projects, these must be neutral and seek to work with – and be accessible by excellent researchers and research teams throughout the UK's research and innovation ecosystem, wherever this excellence is found. Through this collaborative and excellence-seeking approach,

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[5] L. Aston and L. Shutt (2009). *Concentration and diversity: understanding the relationship between excellence, concentration and critical mass in UK research.* University Alliance and Evidence Ltd (2011). *Funding research excellence: research group size, critical mass & performance.* University Alliance

[6] www.rae.ac.uk/Pubs/2004/01/rae0401.doc

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resources will be shared for maximum economic benefit and be able to respond flexibly and innovatively to the great challenges of our day and those of the future.

16. There are also key parts of the research and innovation ecosystem, particularly in the translation of research to commercialisation – sometimes called the 'valley of death' – where national investment into capital projects is welcomed (such as the Catapult system).

17. Smaller level research capital projects must also be supported, however. The autonomy of institutions has been shown to have a direct correlation with the quality of a system, with the UK recognised as being distinct in both its level of autonomy and its quality.[7] It is necessary to ensure that any balance of national and individual-level projects is encouraged to be collaborative, rather than competitive.

18. Of the three scenarios set out in the consultation document[8] **we would recommend that the first scenario – which prioritises investment via funding councils and research council investment – would be the best option of the three to enhance and sustain the UK's science and research infrastructure**. Allocations should seek to fund excellence through rigorous peer-review evaluation processes, and allow institutions to invest strategically both in longer-term and in response to opportunities. Government may also consider an even more extensive weighting towards funding councils, which also invest in national-level capital in responsive mode in tune with the latest developments in UK research and in full recognition of the Haldane Principle.

19. There is strong evidence that the Higher Education sector plans strategically – including collaboratively – around research strengths, resulting in nationally and internationally significant research assets, and allowing the leverage of funding from other sources, as well as engagement with industry to maximise the results of reserach. Sector-inspired plans for investment respond directly to UK research needs and will drive the quality of research further.

    a. **Liverpool John Moores University (LJMU)** are in the process of developing a new £15M 4-metre class robotic telescope ('Liverpool Telescope 2', LT2) dedicated to time domain science, superseding the existing 2-metre Liverpool Telescope (LT) as the world's largest robotic telescope dedicated solely to scientific work.[9] The flexibility and rapid response of robotic telescopes makes them the ideal tool for fast follow-up, and LT2 is planned to be the fastest telescope in the world, necessitating a lightweight design using novel materials. The time domain is a recognised UK scientific strength, and building on LJMU's capability in this area will maximise the potential for the UK community to take a leading role in large projects already identified by BIS for capital investment, such as PLATO, SKA and LSST. These new facilities will discover huge numbers of interesting astronomical objects, but the real scientific gains will result from the follow-up exploitation of these detections by large robotic telescopes. The development of LT2 is also driving innovation in

[7] P. Aghion et al (2008). *Higher aspirations: An agenda for reforming European universities*. Bruegel Blueprint Series, V.

[8] BIS (2014), *Creating the Future: a 2020 Vision for Science & Research: A Consultation on Proposals for Long-Term Capital Investment in Science & Research*, pp.13-14.

[9] http://telescope.livjm.ac.uk/

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approaches to the problems of large data sets, harvesting data streams and machine learning. With big data, robots and advanced materials comprising three of the 'eight great technologies', the LT2 provides great potential for engagement between the university and industry in the Merseyside region and throughout the UK. LJMU has a strong track record in this area, with the original LT project safeguarding jobs and driving upgrades in skills and machinery for local precision engineering SMEs. European collaborators are applying for regional development funding in the Canary Islands region to construct new astronomical infrastructure, a key part of the bid will be the funding for the on-island, civil engineering aspects of the LT2 project. The new telescope will also continue the educational programme of the LT.

b. The **University of Huddersfield** is part of a consortium developing plans for an £18m Triple-beam Materials Ion Irradiation Facility, which will put the UK at the forefront of advanced fission and fusion materials research and should allow British industry to secure a position in a growing global market worth tens of billions of pounds per annum. The collaborators, all of which have substantial existing expertise, are the Universities of Huddersfield, Oxford, Manchester and Surrey, Imperial College, the Open University and the National Nuclear Laboratory. Building on the expertise of these project partners the UK can take the lead in materials design for future generations of nuclear technology, and use its position to leverage a strong strategic IP portfolio and substantial inward investment. The triple-beam ion-irradiation facility meets a national research need – Japan and France (both involved in developing Generation IV (GEN IV) reactors and fusion energy systems) have implemented triple-beam ion-irradiation facilities to simulate reactor environments, but the Japanese facility (TIARA) is not open to UK researchers. Although the French facility (JANNuS) is accessible, poor user experience and limitations on technical capabilities have restricted research development. The UK consortium has plans for outreach in the UK and internationally to ensure the asset's sustainability. Key industry stakeholders will be engaged and attracted by reliable mechanisms to capture the resulting IP and commercialisation opportunities and to ensure these are maximised to the benefit of the UK economy, potentially via the University of Huddersfield's ERDF-funded Enterprise and Innovation Centre, which was created to bring academics and business together in an open innovation environment with a proven track record of success.

1.1. How can we maximise collaboration, equipment sharing, and access to industry to ensure we make the most of this investment?

20. As noted above, collaboration and specialised excellence is key to a successful and efficient research ecosystem. HEIs have proven that they are keen and willing to share resources where possible to maximise the national significance of the products of public funds, in all types of all assets (including data and even 'shelved' IP). Good progress is being made towards a more efficient system following the Wakeham and Diamond reviews, although there is still more to be done.[10]

[10] W. Wakeham (2010), *Financial Sustainability and Efficiency in Full Economic Costing of Research in UK Higher Education Institutions*; I. Diamond (2011). *Efficiency and Effectiveness in Higher Education*.

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21. A good example of this is through asset sharing agreements, although these are not yet comprehensive and in many cases Alliance universities report difficulties in accessing existing networks. **University Alliance** is acting collectively to extend these benefits and efficiencies more widely over the next year, to involve universities and businesses across the country, which will involve an audit of current capabilities. It may be helpful to extend an audit of current sharing capabilities across the entire sector. Alliance universities are already involved in some sharing agreements in specific areas/assets, for example:

   a. The **University of Portsmouth** is part of the South-East Physics Network (SEPnet), an alliance of ten physics departments across the south of England focused on sharing research, teaching and outreach resources to maximise the benefit for all members.[11] SEPnet originally received funding from HEFCE, but, since 2013, has been a mostly self-funded enterprise. The SEPNET Computing Infrastructure for Astrophysical Modelling and Analysis (SCIAMA) supercomputer[12] is at the heart of the University of Portsmouth's Institute of Cosmology and Gravitation (ICG) providing researchers access to state-of-the-art high performance and high throughput computing to model and analysis complex behaviour in a number of scientific areas. In cosmology, SCIAMA is vital to simulate the evolution of structures in the universe, under the influence of gravity, and compare these mock universes to real data. Such simulations are impossible without HPC like SCIAMA. Although mostly funded by SRIF funding to the University of Portsmouth, over 30% of the computing time on the £350k SCIAMA-I supercomputer goes to other SEPnet partners. The £600k SCIAMA-II is due this month, funded by a mixture of RCIF and university money. Another shared SEPnet facility at Portsmouth is the Low Frequency Array (LOFAR)[13] telescope, now funded by STFC.

   b. **Oxford Brookes University** holds a new £1 million Zeiss 3D scanning electron microscope – currently the best in the UK – which is regionally shared (with the University of Oxford). Following original funding from BBSRC, Oxford Brookes are developing plans to build a new lab around the microscope to improve performance and researcher accessibility.

   c. **Manchester Metropolitan University** (MMU) has assembled a unique aircraft exhaust measurement facility (Alfa) with the Universities of Sheffield and Manchester. The joint facility comprises: a gas and aerosol-sampling rake capable of traversing the core of the aircraft plume; high-resolution time of flight Mass Spectrometer (WToFMS) system for incorporation into an existing Aerodyne Aerosol Mass Spectrometer (AMS) at the University of Manchester; and a fully equipped mobile combustion laboratory at the University of Sheffield. Elements of the Alfa joint facility have been used by the three partners in a number of programmes. These include work for Shell and Rolls Royce on aircraft engine exhaust emissions composition.

22. Accessibility and collaboration both within other university partners and with industry is essential to the missions of Alliance universities. Further examples of strategic industry

[11] www.sepnet.ac.uk
[12] www.sciama.icg.port.ac.uk/sciama%20ack.htm
[13] www.lofar-uk.org

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collaborations resulting in significant research and innovation assets can be added to the examples of businesses co-locating with universities outlined in Annex B3 of the Government's consultation report:

a. The collaboration of **Siemens** with the **University of Lincoln** in a £37.5M joint venture, resulting in the building of a new Engineering School[14] and generating a wide portfolio of research projects (over £2M since 2010) with immediate commercial benefit, retention of over 1,000 jobs in the UK and further expansion of Siemens' business in the Lincoln area. The strategic partnership leveraged £500K investment and a 10-year lease on space from Siemens, underpinning the sustainability of the build and the assets in it. Furthermore, through the partnership Lincoln has access to the turbines that Siemens locate within their workshop for training and development, alongside all the control kit. The collaboration brought in a further £3.2M of public grant, £1.8M ERDF and £1.4M Single Programme funding. The School and the activity around it underpins the Greater Lincolnshire LEP's focus on Engineering as a priority sector for the area.

b. **Coventry University** and the Unipart Group have joined forces to develop a new Engineering and Manufacturing Institute on Unipart's manufacturing site in Coventry.[15] The £32 million project will see the creation of an international centre of engineering and manufacturing excellence, which will be the base for a sustained programme of innovative research activity, teaching and learning, and product development. The project has been awarded £7.9 million from the Catalyst Fund. Unipart itself is contributing £17.9 million towards the creation of the new facility, with a further £5.6 million towards student scholarships and product research and development, and including support for the new undergraduate and postgraduate programmes in manufacturing and the advanced engineering and management programmes that will emerge as a result of the initiative. This collaborative project establishes a sustainable research partnership integrated with a new and innovative teaching environment that will create a step change in the higher education model for manufacturing engineering degree courses through enhanced activity-led learning.

23. University Alliance also supports new initiatives by the Technology Strategy Board and National Centre for Universities and Business (NCUB) – to develop national brokerage systems to improve connectivity within the research and innovation ecosystem. These will help integrate and connect different actors within the research and innovation ecosystem and help direct access to relevant equipment, data and research, as well as business expertise – to help translate the cutting edge science into real world innovations.

24. Alliance universities are already ensuring their significant capital research assets are available and productive for a wider cohort of users, including industry of all sizes. In addition to strategic partnerships with large businesses (some examples cited above), they are supporting small and rapidly innovating businesses with research and

[14] www.lincoln.ac.uk/home/engineering/
[15] www.unipart.co.uk/UserFiles/File/Coventry%20University%20Joins%20Forces%20With%20Unipart.pdf

development. This is the constituency which will drive UK growth in the future: innovation was responsible for two-thirds of productivity growth between 2000 and 2007 and was the common defining feature of the fastest growing 6% of businesses between 2002-2008. Innovating businesses generated half of all new jobs created during this time and were predominantly SMEs.[16] Nevertheless, SMEs need support to increase its R&D investments, which lag behind against international comparators. Opening university research facilities to these businesses is an essential element in the integration of the research and innovation ecosystem and realising the benefits of the UK's world-leading research environment.

a. The £19 million Marine Building at the **University of Plymouth**[17] contains the Coastal Ocean and Sediment Transport (COAST) laboratory and the Marine Navigation Centre. The facilities are a centre of excellence for research, teaching, training and engagement with enterprise in the marine and maritime sectors and position Plymouth as a global centre for marine energy research, harnessing innovation and helping diversify and drive economic growth in the region. For example, the COAST laboratory contains cutting-edge wave tank testing facilities that are unmatched in Europe,[18] allowing researchers and businesses to design, conduct and report on bespoke experiments, particularly in offshore renewable energy. The wave tank facility is co-located with the Marine Innovation Centre (MARIC), which aims to make the South West's marine and maritime businesses globally competitive; accelerating growth by creating intelligent connections between organisations, world-class knowledge, technologies, people and infrastructure. The equipment and technical and research expertise provided by COAST has catalysed the marine and maritime sectors and has already helped to attract leading researchers and commercial clients to the University from across the globe. In 2013, WITT Ltd became the first commercial customer to use Plymouth University's Wave Tank and was subsequently awarded the $100,000 Gulfstream Navigator Award for its ground-breaking renewable energy harvesting device.

b. The **University of Salford**'s Energy House and Lab[19] is the world first and only full size house within a fully environmentally controllable chamber, in which climatic conditions can be maintained, varied, repeated and patterns monitored. ERDF-funded, the Energy House can provide researchers with a range of weather conditions – rain, snow, wind and temperature can be specified to high levels of accuracy – to meet their requirements. The building currently installed represents 21% of UK housing stock, rebuilt using the traditional methods of the time, and is classed as a hard to treat property in terms of energy efficiency due to the lack of cavity walls. Salford Energy House therefore provides a unique testing and development facility in which leading researchers can work collaboratively with industry to develop and test new technology and solutions to improve the energy efficiency of existing projects and processes.

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[16] S. Shanmugalingam et al (2010). *Rebalancing Act.* NESTA

[17] http://www1.plymouth.ac.uk/location/campusdevelopments/marinebuilding/Pages/default.aspx

[18] www1.plymouth.ac.uk/location/campusdevelopments/marinebuilding/Pages/The-Coastal-Ocean-and-Sediment-Transport-(COAST)-laboratories.aspx

[19] www.salford.ac.uk/energy/business/facilities

Salford University also owns THINKlab,[20] a futuristic and spacious research environment which facilitates research related to Information and Communication Technologies – developing innovative digital solutions to the challenges faced by industry, commerce and the community. State-of-the-art facilities stimulate interdisciplinary research, collaboration and innovation amongst its users, which include local government, industry and universities researchers from the University's Schools of Built Environment, Arts & Media, Computer Science, Engineering, Health and Social Science.

c. **Nottingham Trent University** opened the £4.4 million Rosalind Franklin Building[21] in October 2012, providing customised research space for x-ray imaging/diffraction, multinuclear NMR, new chemistry research laboratories, and other analytical equipment; and provides a showcase of research capability and expertise as part of the School's industrial engagement strategy.

d. Assets are also made available for other users, including community based and practitioner users. **Cardiff Metropolitan University**'s National Centre for Product Design and Development Research[22] underpins collaborative research in partnership with Abertawe Bro Morgannwg University Health Board funded through the Advanced Surgical and Technologies Network. Three-Dimensional scanning devices allow community-based users to acquire anatomical data in a non-invasive accurate way for the production of medical prostheses.

1.2. What factors should we consider when determining the research capital requirement of the higher education estate?

25. Excellence in research exists throughout the system, which should be recognised at every stage of decision-making in capital investments – both where initial investments are made, and how they are used and made accessible subsequently.

26. Continued and long-term investment in the higher education estate is critical to maintaining international competitiveness in research and higher education, including in attracting the best researchers and research collaborators from across the world. It is also an important draw for students at all levels, both domestic and international, in an increasingly competitive global HE market.

27. The commercialisation and impact of research should also be a major consideration in capital investments, balanced with investment in 'blue skies' research: investing excellence across the broad range of research activities and ensuring that the research and innovation ecosystem is fully integrated.

28. Investments must recognise and support the full reality of ongoing maintenance and staffing costs for capital resource within the higher education estate. Currently, universities often need to cross-subsidise from other funding streams in order to maintain research capital due to under-funding of ongoing costs, which threatens the future capability of the ecosystem.

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[20] www.thinklab.salford.ac.uk/

[21] https://ntu.ac.uk/sat/facilities/rosalind_franklin_building/index.html

[22] www3.cardiffmet.ac.uk/English/Research/Pages/PDR.aspx

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29. The issue of depreciation of research capital resource, both in cost and relevance (where infrastructure may be rendered outdated or obsolete by new technology before the end of the expected life of that infrastructure) is also significant. The current Full Economic Costing (fEC) model does not fully support cost recovery, and often does not cover the cost of depreciation of equipment and facilities. This feeds into the issue of stability and sustainability of the research estate, and the need to maintain state-of-the-art standards over the long term.

30. As the Government recognises, it is also essential to ensure that investment in capital resource is complemented by investment in human capital, to exploit and progress scientific and innovation developments, not only in historic strength areas but in niche and novel research areas which often require an element of risk. This requires a commitment to developing an appropriately-skilled workforce (including technicians that can run high-tech research capital resources) and the researchers and innovators of the future.

31. The future pipeline of research skills is threatened, however, especially for domestic talent supply. Taught postgraduate (PGT) numbers have dropped steadily over the last 4 years, with the numbers enrolling falling by 10% in total. Figure 1 shows how the proportion of home PGT students is also decreasing within this, falling by over 17%, meaning UK students represent only 58% of the first year cohort in 2012/13.[23] These statistics have worrying implications for a 'broken bridge' to postgraduate research from undergraduate, with the majority of PhD candidates now usually required to hold a masters.

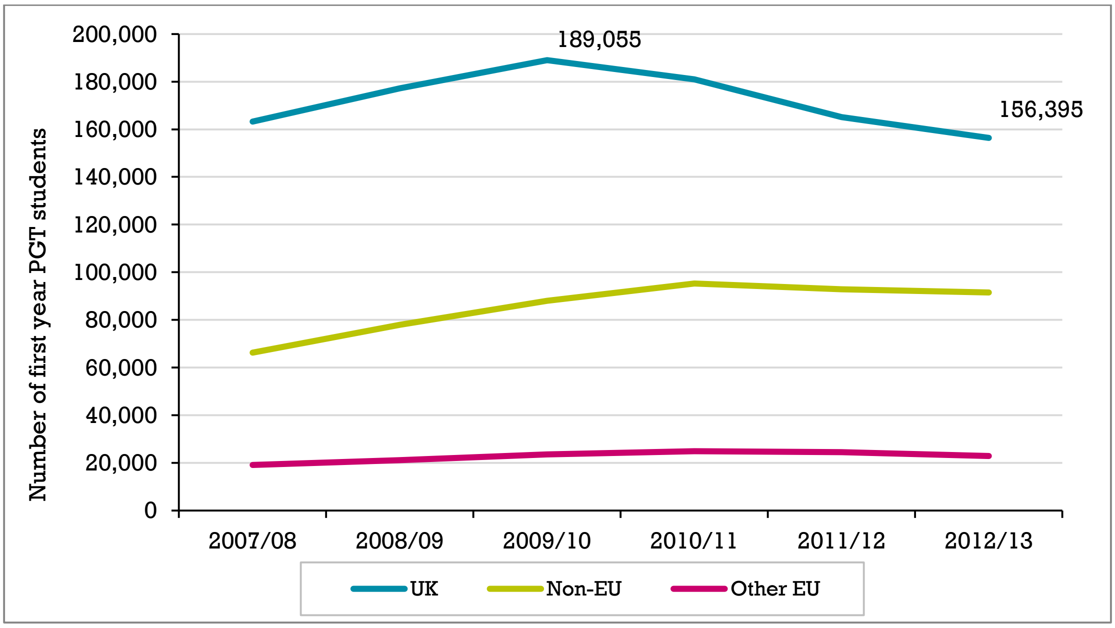

Figure 1. Number of first year PGT students by domicile

[23] HESA, HE Students data – First Year postgraduate students.

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32. Funding systems that include access to loans for taught postgraduate students, such as proposed by University Alliance, would provide a more sustainable postgraduate population.[24] In order to encourage more cross-funding for PGT, the narrative around industry involvement in postgraduate support also needs to be changed. Pilot schemes run by three Alliance universities, the **University of Greenwich**, **Nottingham Trent** and **Kingston** universities are innovating around business/professional access, internship models and skills development, as part of Hefce's £25 million 'lifeboat fund'[25] and are examples of efforts to change the paradigm around business involvement in sustaining the supply of highly skilled workers in the UK and investing in the workforce.

33. The UK also needs to ensure it has a diverse and far-reaching research training system that is flexible and responsive to fast-moving research environments. Consideration of how industry-sponsored training programmes might be encouraged should be considered as part of this to ensure that we are supporting a future research base that has the skills to link effectively with business. The House of Lords' Science and Technology Committee 2012 report into higher education in STEM subjects noted the importance of maintaining a diverse complement of training mechanisms, recommending that a variety of PhD delivery models be utilised to ensure that the UK's current breadth of expertise in science and technology is maintained.[26] Current funding mechanisms which narrow the pool of training centres and supervisors for doctoral students and industrial partners are working against this aim, however.

34. Research Councils use a variety of different mechanisms and allocation methods to fund postgraduate study. The majority of funding for PhDs is channelled into block grant awards through Doctoral Training Partnerships (DTPs), Centres for Doctoral Training (CDTs – also called Doctoral Training Centres – DTCs) and CASE awards. The introduction of block grants and Doctoral Training Centres, coupled with the removal of PhD researchers as a viable cost in other research grants, has closed off Research Council funding for postgraduate researchers (PGRs) for many university departments and – consequently – for many disciplinary areas where excellent research is undertaken, which threatens the future diversity of the research base. During its last round the EPSRC, the largest funder of DTCs, funded 80 Centres, but these were based at only 28 institutions. Across its three main schemes for postgraduate research, 46 universities are in receipt of postgraduate funding, to the exclusion of excellence in other university departments and disciplinary expertise. Open innovation needs open competition – therefore a commitment to the principle of seeking and funding excellence and developing talent in those same areas must be an essential priority underlying all investments and resulting resources.

35. Our universities continue to cross-subsidise in order to invest in the researchers of the future in strategic research areas, but this model is not sustainable or efficient. National funding structures which do not support universities' strategic development of the research base threaten the future strength and depth of the ecosystem. Public funds should support the dynamism of the UK research base by following the principles

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[24] University Alliance (2014). *H.E.L.P. UK: A new Higher Education Loan Programme: adding to the debate on funding*
[25] www.hefce.ac.uk/news/newsarchive/2013/news85254.html#projects
[26] www.publications.parliament.uk/pa/ld201213/ldselect/ldsctech/37/37.pdf

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outlined above and implicit in the dual funding system: universities must be able to invest strategically in human capital as in other research investment decisions, and funding structures should support them in this.

36. It is also important to consider wider connectivity in the research and innovation ecosystem – operating a revolving door will ensure that strong, sustainable relationships are maintained between the HE research base and innovators in industry. Changes in public funding for Industrial CASE studentships (iCASE) – which co-fund research postgraduates in partnership with innovative companies – has limited iCASE awards from some research councils to those institutions already in receipt of a Doctoral Training Grant (DTG).[27] This restricts eligible academic partners to 44 HE institutions for the largest funder (EPSRC), disbarring institutions with excellent track records in iCASE studentships and business relationships from the system and preventing them from delivering the benefits of their strong industry relationships and collaborative research training offering to students and other business partners.

    a. Funding offered by **EDF Energy** for CASE awards in mechanical engineering to **Oxford Brookes University** could not be leveraged after the changes to EPSRC funding ruled this institution outside of public funding mechanisms for postgraduate training. The same effect was felt by several SMEs engaged with the university via Knowledge Transfer Networks.

    b. **Teesside University** were given 'exceptional' dispensation to run an iCASE award from June 2013 with their partner, **TATA Steel**, only after direct intervention by the company, although the university does not hold a DTG. Eligibility for iCASE awards would allow them to build further on the industry collaboration success that they have achieved in delivering KTP projects (41% of Teesside's KTP projects are graded as 'outstanding', compared with less than 10% nationally).

37. The concentration of funding in these ways limits the diversity of future high level skills. Supporting postgraduates in only a limited number of research institutions narrows the range of the future skills base, excluding many areas of research expertise in institutions outside of these funding mechanisms. It affects the future health of the research ecosystem as universities are being shut out from experiencing, developing and demonstrating capability in these areas. The funnelling effect of both DTGs and iCASE awards also curtails opportunities to involve important strategic business partners in the innovation system – often SMEs – who have strong relationships with those institutions who are currently outside of the DTG system.

38. The concentration of doctoral training, particularly in STEM, into fewer institutions also raises questions about the diversity of PhD supervisors involved in the delivery of training. There are pressures for PhD students to come out fully formed in research and knowledge exchange capabilities, but the existing PhD format – and the restricted number of delivery outlets – may not be optimally designed to help PhD students fulfil their full potential. For example, it is possible that we are not making the most of senior academics – currently outside of the funding system – with relevant expertise and skills, including those from outside of academia, in supervisory roles for PhD students, to act as advocates for the wider skills bases required of doctoral researchers.

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[27] www.epsrc.ac.uk/skills/students/coll/icase/Pages/intro.aspx

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1.3. Should subject to state aids and other considerations – science and research capital be extended to Research and Technology Organisations and Independent Research Organisations when there are wider benefits for doing so?

39. UK higher education institutions are the central conduit of publicly-funded national R&D and essential to the UK R&D base as a whole, carrying out 74.3% of publicly-funded GERD and 26.5% of total GERD (significantly above OECD average).[28] Whilst alignment and cross-collaboration in science, research and innovation is essential across both the state and the independent sectors. Public investments must be focused on public benefit, to complement private funding in research funding. There is strong evidence that increasing public investment also increases private investment in R&D (where the UK is weak) – for every £1 spent by the government on R&D, private sector R&D output rises by 20p per year in perpetuity.[29] In a tight fiscal environment, investments must be certain to reap public benefit and therefore the leverage of private investment through our world-class Higher Education system is the best route for providing value for money for public funding.

Part 2. Science Strategy for Major New Projects

2. What should be the UK's priorities for large scale capital investments in the national interest, including where appropriate collaborating in international projects?

40. Large scale projects in the national interest should aim both to address fundamental weaknesses in the UK's research and innovation ecosystem. Following a recent benchmarking study, it is evident the UK's capacity to commercialise research needs to improve, currently lagging behind international competitors.[30] Priorities should expand on our existing research strengths, especially in near-to-market research, and build the UK's capacity to exploit large international markets. Priorities which map on to a defined and long-term strategy (i.e. Industrial Strategy and Great Technologies) are useful for research base to align and complement some of their own resources to achieve national aims.

41. However (as above) to ensure and to drive quality, all national, large scale capital resources must remain neutral and accessible to the most excellent researchers and innovators within the UK, which will involve a commitment to outreach and autonomy. Furthermore, investments in national capital projects should be balanced with greater funding streams through the funding and research councils, with a more integrated approach to how those resources are shared and made accessible as part of a truly international infrastructure.

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[28] UUK (2014). *Higher Education in Focus 2014: Research and postgraduate research training. London: UUK*, pp. 6-7.
[29] J. Haskel, A. Hughes and E. Bascavusoglu-Moreau (2014). *The Economic Significance of the UK Science Base*
[30] T. Allas (2014). *Insights from international benchmarking of the UK science and innovation system* (BIS); European Commission (2014). *Innovation Union Scoreboard 2014*.

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2.1. What should the criteria for prioritising projects look like?

42. In Annex B2 of its consultation document, the Government proposed criteria for prioritisation of projects: affordability, excellence, impact, skills, efficiency and leverage.

43. In tight fiscal environments, affordability is clearly important. When selecting research partners, the guiding principle for prioritising projects must be to invest in excellence, wherever it is found, established by peer review. This involves a balance of projects and range of partners that will achieve responsive short/medium-term impacts as well as 'blue skies'/long-term ones. Our views on skills development are outlined in detail above. Leverage is also key – although a full range of industrial partners of all sizes should be given the opportunity to match their resources to public funds: currently this is not always the case (as with the restriction of iCASE industry partners mentioned above; and the high (£10 million) threshold for the Research Partnership Investment Fund), which demonstrates a missed opportunity.

44. CritKeria for national projects should align to long-term transparent priorities such as outlined in the Industrial Strategy and Great Technologies to allow greater complementarity of the research system. Projects should be prioritised if they are enhancing the UK's existing strengths and if they are building capability to exploit large international markets. Funding should also continue to support niche and experimental research at institutional level.

2.2. Are there new potential high priority projects which are not identified in this document?

45. We consider that decisions regarding the identification, evaluation and investment in large-scale high priority projects should follow the principles outlined above.

2.3. Should we maintain a proportion of unallocated capital funding to respond to emerging priorities in the second half of this decade?

46. It is essential that there is a range of mechanisms that integrate different types of research and that these mechanisms are appropriately supported and 'geared'.

47. Maintaining an unallocated capital funding stream that can respond to emerging priorities is essential to the future health of the UK's research and innovation ecosystem, as outlined above (at n.11). As Government acknowledges, predicting future market changes and grand social and scientific challenges is an inexact science especially given the pace of progress, and we need to make sure we are future proof by allowing growth sectors and niche research (any of which is potentially critical to tomorrow) to thrive. This is why the dual funding system, which includes the flexibility for universities to invest in new areas and fundamental research, remains critical, and why capital funding decisions should follow the same principle to allow both alignment and strategic development, and responsiveness to novel knowledge and research opportunities.

2.4. Are the major international projects identified in the consultation the right priorities for this scale of investment at the international level? Are there other opportunities for UK involvement in major global collaborations?

See answer to Question 2.2.

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