

BIS Consultation on Proposals for Long-Term Capital Investment in Science and Research: Imperial College London Response

Executive summary

- Given the significant reductions in capital funding at institution and individual research project level over the past few years, it is vital that capital funding at the Scenario 1 level is provided for the renewal of research infrastructure within institutions.
- Universities and research institutes need to work together to set up collaborations; clusters of peer institutions in close geographical proximity and covering a range of subjects are a good approach.
- National and international facilities are essential for the undertaking of research in a large number of subject areas and hence need to be resourced appropriately; these facilities and universities co-exist and are interdependent.
- It is essential that capital investment is combined with the appropriate resource to enable the maximum return.
- Decisions on research priorities for funding should be completely underpinned by expert advice from academics.

Please note that in addition to this Imperial College London response, there will be other responses from specific areas of the College's academic community.

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 the national and international levels?

A substantial majority of funding should be allocated to meeting capital requirements at the institution and individual research project level, based on the criterion of research excellence. Given the significant reductions in capital funding for this over the past few years, further direct allocations of capital funding are vital to ensure the sustainability of research infrastructure within institutions. In particular, investment in small-scale and mid-range facilities within institutions is crucial to the health of the national research base as it supports core underpinning research infrastructure. Recurrent capital funding to institutions should therefore be increased, and more funding for research equipment should be provided as part of research grants. Whilst bidding processes may sometimes be the most appropriate way to respond to particular emerging priorities, providing an appropriate amount of capital funding on a recurrent basis to institutions is essential to ensuring the long-term sustainability of the UK research base and attracting internationally excellent researchers and funding to the UK. Substantial damage could be caused by short-term fluctuations in funding.

It should be noted that for many disciplines the UK's world-leading research is concentrated in institutions; national or international facilities also play an important role for other (sub-) disciplines. Sufficient funding should therefore be allocated at the institutional and project level to make up for previous underfunding and to ensure the sustainability of the UK research base. Under current arrangements for the full economic costing of research, activity relating to capital investments is not sustainable. It is essential that there is a balanced landscape where the base of the knowledge-generation pyramid in universities is strengthened to enable an appropriate feeding-through of knowledge, skills and IP. Without this, there is a risk of generating an inverted and unstable structure that will not withstand well-funded international competition. National and international facilities and universities co-exist and are interdependent. These national and international facilities will need to be resourced appropriately. In particular, funding for the major facilities through the Research

Councils should be maintained based on the criterion of research excellence, with the Research Councils working in partnership with other stakeholders to break down barriers and support an integrated national infrastructure.

High-quality research infrastructure within institutions is essential to: (a) the undertaking of world-leading research and the sustainability of the UK research base; (b) attracting and retaining high-quality, internationally excellent staff from across the world and thus maintaining the global competitiveness of the UK research base; (c) ensuring that preparatory work of the required standard can take place within institutions in advance of using a major national or international facility, thus maximising the benefits of such research; (d) developing the underpinning research base for facility-focused technology creation and facility development; and (e) training researchers in the skills required to use the major national facilities, ensuring that the pipeline is maintained. Such research infrastructure within institutions also sustains the industrial base for equipment manufacturing and attracts funding from industry.

Of the three allocation scenarios given in the consultation document Scenario 1 is preferable, though for the reasons set out above it would be better to divert more of the remaining £1.7bn for major projects to capital funding at the project and institution level. In the longer term, there will need to be flexibility to switch between various scenarios as priorities develop. It would be helpful for the Government and Ministers to work together with a high-level science advisory committee made up of expert academics to establish an agreed and common set of priorities for research funding. In addition to this, it will be important to ensure that the funding available is not diluted by including organisations and activities outside the current ring-fence, e.g. RTOs and IROs (as discussed below), and the new requirements around research data management. The direction of funding should be determined by researchers and depend on the funding requirements and circumstances of the time.

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

It is important to have the “right” equipment in the “right” place and to ensure that there are clear benefits for all involved. Clusters of universities made up of peer HEIs in geographical proximity and covering a range of subjects are a good approach. An example of this is SES (Science and Engineering South Consortium), which was initiated in May 2013 to pool the collective insights and resources of Imperial College London, UCL, and the Universities of Oxford, Cambridge and Southampton. The SES member institutions are sharing major research facilities, exploring how their shared infrastructure and training can be used to stimulate further international, national and regional synergy, and seeking further engagement with industry to promote economic growth. Another example is the London Centre for Nanotechnology (LCN), the collaboration between Imperial College London and UCL that in the last ten years has brought the UK’s first monochromated Titan TEM and first neon-ion microscope to researchers at the two institutions. The LCN’s shared fabrication facilities are used extensively by the two institutions as well as others in London (e.g. King’s College London). It is important to recognise that research-intensive universities such as the College are in a position to provide regional scale facilities on their own and that there are efficiency savings to doing so. However, an alliance between universities such as the SES or the LCN can add value to industrial uptake by extending reach and providing a more diverse infrastructure to meet the full range of industrial needs.

There is a need for a management structure to ensure that up-to-date information on all the facilities available, such as their location and costs, can be easily accessed by interested parties. Approaches to collaboration, equipment sharing and access to industry should also take into account the fact that the same piece of equipment can be used in different ways by

different researchers (e.g. one might be using it to take routine measurements while another might be developing new ways of using it), and that additional funding will be needed to maintain equipment after the initial capital investment. There are strong arguments in favour of the routine replacement and updating of existing equipment as the required space and staff expertise are already in place. In order to optimise this, resource would need to be available to professionalise access to these facilities, e.g. facility managers and research technologists.

b. What factors should we consider when determining the research capital requirements of the HE estate?

Capital funding should be allocated to HEIs with the highest research quality. Institutions that leverage external investment should not be penalised by having their capital funding from public sources reduced, as maintaining a high-quality institutional research infrastructure is vital to the sustainability of the research pipeline and to the future leveraging of further external investment. In addition to this, a recent research report on the economic significance of the UK science base ([CaSE](#), March 2014) found that public investment in research increases rather than diminishes private sector investment, meaning that investment in science and innovation is not and should not be seen as a zero-sum game in which they are substitutes (for example, the report calculates that for every £1 spent by the Government on R&D, private sector R&D output rises by 20p per year in perpetuity by raising the level of the UK knowledge base).

It will also be important to ensure that the ongoing costs of operating, maintaining and upgrading infrastructure are supported. Whilst the College is supportive of the principles behind fEC, in practice it does not fully cover such costs. This should be recognised when determining the research capital requirements of the HE estate.

We would estimate based on experience that the vast majority of scientific research undertaken within universities is performed with small-scale equipment that needs to be available locally on a daily basis, for reasons of required feedback timescales and capacity. There has been a systematic underfunding of small-scale equipment caused by RCUK policy on equipment funding (RCUK funders ask for a 50% contribution for items up to £134,000 including VAT, and anything costing more than that has to go through a separate two-stage strategic equipment process, where basic small-scale laboratory equipment is unlikely to be funded because it tends not to be viewed as “strategic”). The difficulty faced in re-capitalising the equipment base in universities, therefore, is a threat to the UK’s international competitiveness. Supporting investigator-led, transformational research through provision of the instrumentation it relies on (with opportunities to share research equipment taken where possible) will build on the UK’s national strengths, ensure that early career researchers can flourish, and attract leading researchers to the UK. As above, this will help to ensure that there is a balanced landscape where the base of the knowledge-generation pyramid in universities is strengthened to enable an appropriate feeding-through of knowledge, skills, and IP.

c. Should – subject to state aids and other considerations – science and research capital be extended to RTOs and IROs when there are wider benefits for doing so?

Science and research capital funding should not be extended to other organisations as this could have the effect of diluting the funding available to HEIs, putting at risk the sustainability of the UK research base and reducing the impact of the funding received. A better way to achieve wider benefits would be to support universities (through incentive mechanisms such as HEFCE Business QR funding) in creating strong links with businesses to, for example, strengthen and develop equipment manufacturing capabilities within the UK.

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

Priorities should include:

- UK National Space Programme.
- Continued investment in high-profile international organisations where the UK plays a leading role such as the European Space Agency (ESA), the European Southern Observatory (ESO), and CERN.
- Continued investment in national facilities such as ISIS and Diamond.
- Engineering Structures & Systems (Annex A, 5.7) - if it is subject to an open call for proposals and builds on existing centres of excellence in structural testing.
- Centre of Excellence for Sustainability and Resilience of National Infrastructure (Annex A, 5.5).
- UK X-Ray Free Electron Laser (UK XFEL)

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

Excellence should be the primary and over-riding criterion for prioritising projects, with skills the secondary criterion.

Capital investment in research infrastructure can have a significant impact on economic growth. For example, the co-location of research, business and healthcare at the College's new Imperial West campus is aimed at stimulating new investment in research, yielding economic growth, and playing a leading role in the regeneration of White City, an economically deprived area of London. Its initial focus will be a £150M Research and Translation Hub, a 42,000m² facility due for completion in late 2015 which has been funded partly by the College, partly by UKRPIF, and partly by the private investor Voreda. However, given the difficulties around foreseeing long-term impact at the point of investment decisions, impact should be of lower priority.

The leveraging criterion should include an institution's ability to leverage its multidisciplinary research activity. Leveraged funding should not replace funding from the government.

In relation to affordability, it should be noted that any movement of resources from old in-use facilities to new facilities should take into account the space and staff expertise already present at in-use facilities. It is also essential that a holistic "total costs of ownership" approach is taken to capital equipment of different types:

- a. National facilities: funding should not be invested in national facilities that then cannot afford to run full-time.
- b. Regional/shared facilities: given the often considerable administrative overheads of sharing equipment, there needs to be significant added value that more than compensates for the associated overheads.
- c. University facilities: the cost of maintaining equipment and the staff required to run/use it is often a "hidden leverage" funded by the institution. This should be taken into account in the leveraging criterion.

Short-term efficiency savings should not be sought to the extent that the long-term sustainability of the research base is undermined.

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

Priorities for facilities on the national scale should include the following:

- National Centre for Metrology and Standards in Synthetic Biology – synthetic biology (one of the Government’s eight great technologies) is the design and engineering of biologically based parts, novel devices and systems as well as the redesign of natural biological systems. Many of the major industries developed in the late 19th and 20th centuries use oil as a basic feedstock. An alternative to the finite resource of oil is to use a wide range of biologically-based feedstocks (including man-made waste and sunlight) and to apply synthetic biology to produce new processes and products. The market for synthetic biology applications is growing rapidly and is predicted to be \$17bn by 2018¹.

Because synthetic biology is the engineering of biology and has important industrial applications, metrology and standards are becoming increasingly important. However, in synthetic biology both are at a relatively early stage of development. Imperial College currently has what is arguably the leading synthetic biology centre in Europe in the Centre for Synthetic Biology and Innovation (CSynBI) and the National Innovation and Knowledge Centre (IKC) for the industrial translation of synthetic biology, currently with seven multinational companies and around 30 SMEs as well as 17 UK universities as academic partners. The College is therefore a national hub for synthetic biology in the UK and also has major collaborative links with the US (e.g. Berkeley, Stanford and MIT; the IKC is also the only foreign member of the US national consortium for synthetic biology, SynBERC).

- South East Manufacturing Futures Hub – the vision for this Hub is to create a versatile manufacturing research facility that will support leading academic researchers at Imperial College London and the Universities of Cambridge and Oxford (lead partners) together with UCL and Southampton and provide critical underpinning capability for the UK’s advanced manufacturing base. It will provide facilities to support research in advanced materials and devices, synthetic biology, bio/pharmaceutical processing, additive manufacturing and biomedical manufacturing, and will include a range of multi-purpose clean-rooms that can be reconfigured to support individual projects on a roll-in, roll-out basis.
- UK Digital Systems Security Laboratory – hosted by the College’s Institute for Security Science and Technology, this would be the UK’s national research laboratory for investigating the security of the digital systems that are integral to the Critical National Infrastructure of the future. It would serve as the national platform for UK-led collaborative research on digital systems security between academic, industrial and government stakeholders. The Lab would be co-located with the London Node of ICT Labs (supported by EU funding) at Imperial West. This project has support from the EPSRC Global Uncertainties programme.
- Big Data Visualisation Facility – hosted by the College’s Data Science Institute, this would provide a national core facility for research, industrial collaboration, training and education in the field of big data visualisation, with particular focus on applying advanced big data analysis technology for predictive decision making. It has strong synergies with the proposed Centre for Resilient and Sustainable National Infrastructure, for example in providing a means of visualising real-time data from urban systems (such as transport and pollution monitoring) for supporting decision making in urban development and risk management. Other applications would include the visualisation of medical data to better understand the complex aetiology of major diseases such as cancer and brain diseases. The facility would also serve as the education and training base for visual analytics for the College and partner institutions as well as for companies in the London area and beyond.

¹ <http://www.transparencymarketresearch.com/>

- Robotics Centre – building on the College’s strengths in medical robotics and recent initiatives such as the formation of the London Robotics Network, several new CDTs and the Dyson Centre for Robotic Vision, the proposed Robotics Centre would have the mission of developing opportunities in new application areas in this exciting and rapidly evolving area.
- Dial-a-Molecule Institute – this would maintain and provide access to small- to mid-range equipment not readily available to synthetic chemists in the UK. Such a facility will be vital in advancing the key strategic aims of the EPSRC ‘Dial-a-Molecule’ Grand Challenge Network to achieve a step-change in delivering molecules quickly and efficiently for a more sustainable future, e.g. lower-cost healthcare, energy solutions, cleaner/greener processes.
- MRC-NIHR National Phenome Centre – continued investment is required in national human phenotyping capabilities that will benefit the whole UK translational medicine community, such as continued investment in and expansion of the MRC-NIHR National Phenome Centre. Provision, at scale, to analyse both patient-based and population-based samples for biomarker discovery and validation, to improve patient stratification through development of robust diagnostic and prognostic markers, and to enable early identification of drug efficacy and safety as well as other responses to treatments is critical to improving patient care.

There is also a need for the following facility:

- H3 – as Imperial West develops as a major international research and innovation centre (exemplified by the recent £40M donation to establish the Michael Uren Biomedical Engineering Hub), there is a need to develop state of the art facilities commensurate with the strength and depth of biomedical research excellence, including Good Manufacturing Practice and clean room facilities for translational regenerative medicine. The College and the MRC Clinical Sciences Centre are working with the MRC to create a flagship animal research facility to ensure that current and future needs are properly catered for as well as to transform pre-clinical research capabilities at a national level.

Further details on the above are available on request.

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

It is sensible to maintain a proportion of unallocated capital funding to respond to emerging capital priorities (which it will be important to identify through further consultation with the sector). The current focus, however, should be on immediate needs.

The College would support the allocation of some of the remaining funding for major projects through streams such as UKRPIF.

- g. 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?

The College has interests at various levels in many of the international projects referenced in the consultation document and would support continued investment in them. We are not aware of any other major international projects (current or proposed) that are not on the list.

We recognise that in many areas of research, in particular astronomy and particle physics, the scale of activity requires truly global collaboration and facilities. However, in these cases it is important that there is sufficient investment in national infrastructure, including in universities, to fully support the use of international facilities. The squeezing of staff time on rolling grants in order to reduce associated indirect costs is short sighted and threatens the sustainability of UK activity in such areas.