Department for Business, Innovation and Skills: consultation on proposals for long-term capital investment in science and research

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?

The Engineering Professors' Council (http://epc.ac.uk) is the representative body for academic engineers in the UK, with 78 university members comprising nearly 6,000 academic staff.

Capital investment at the national level needs to consider the capabilities of the UK in exploiting and leveraging the investment. Our priority should be to invest in long term success. In this regard, we need to consider where we need to invest in the elements of the "ecosystem" which generates this success: people, their skills, resource, research and capital are interdependent, with a particularly large dependency on the capabilities of the individuals involved in the research and of the UK companies exploiting the research.

Access of SMEs to research facilities and people with expertise in its use has been identified in several major reports including the Engineering and Physical Sciences Research Council's Warry Report (2006), the UK Government's Dyson Review (2010, the Wilson Report (2012), the Witty Review (2013) as well as the European Commission as a major impediment to their growth. Capital investment designed to accelerate the growth of a "Knowledge Economy" (the European Commission's strategy for growth within the EU) as far a reasonable should also be distributed across the country. The return – both direct economic and spill-overs on ten smaller capital investments, spread across multiple research teams and companies is likely to be significantly greater and less risky than a large capital investment in a single organisation. Thus, there must be a significant commitment to pump-priming or seed-corn activities. Until these issues are addressed, the UK will continue underperforming relative to equivalent countries in securing economic returns on its research infrastructure investments. Further, we should do so with reference to the 11 industrial segments prioritised in our Industrial Strategy as having the most significant and potential future economic impact and ensure we are supporting skills and capability development for those.

The consequence of these points is that capital investments should be distributed across the nation in distinctive facilities in order to contribute to filling the skills gap and ensure that there are the tools, infrastructure and skills in all parts of the country to ensure that emerging opportunities can be nurtured and developed and that their medium to long term economic impact can be maximised. We should also not falsely distinguish between research and teaching facilities (see 3 below).

Lastly, capital funding risks falling to a level where it is difficult to for individual universities to support "blue skies" research and radical novel ideas can be lost for decades if not supported early because of restrictions on funds. For this reason, Scenario 3 as set out in the consultation document should be ruled out. Scenario 1 seems to best support the priorities we set out here. Further, we cannot ignore the recurrent operational costs associated with maintaining and running capital equipment and business cases and associated funding models need to take account of this. Capital equipment often now needs special rooms / buildings with environmental control etc, and dedicated people - "super-technicians" (these may even be at post-doctoral level) - to get the best from the equipment.

In summary, within the context of the industrial segments identified for priority investment in the Industrial Strategy, we need to invest in:

- Maintaining our leading international position via a small number of large scale specialized experiment developments, commissioning and operation which have application across a number of key sectors (for example – high performance computing, modelling and experimental capability). However it is vital that the scope for potentially revolutionary smaller scale projects is not crowded out. We must distinguish between capital investments which are an 'add-on' to an existing large scale projects and 'one-off' smaller scale infrastructure investments. Upfront, the former will almost always appear to offer better short term value owing to the ability to leverage the existing large scale infrastructure, but the latter may offer a much better potential return in the long term. It is also essential that the long term return of on-going large scale investments is assessed on a regular basis, and that we withdraw from those consistently failing to deliver.
- Providing medium sized, semi-specialized facilities and opportunities at the local and regional level to train and develop the next generation of researchers and provide access to technological innovation to nurture SMEs (open access research and training facilities suitable for academic or industrial researchers to use through a bidding process - either housed at a University or within a business park or similar). These should reflect regional industrial and economic potential and expertise. They would also act as an attractor for overseas investment in support of the regional economies.
- Equipment and facilities suitable for the initial training of engineers and scientists. Currently these are insufficient for the numbers of engineers and scientists needed to sustain the current UK industry in these areas (*Estimating the ability of UK university engineering departments to double their capacity to respond to the demand for trained engineers – Engineering Professors' Council and Engineering UK, 2013*). Doubling student numbers in universities in engineering will require substantial investment in the basic buildings and equipment infrastructure if we are to recruit to both the profession and to develop future engineering research capability. (Current replacement cost of equipment in UK university engineering departments alone is estimated at c.£250M- £300M without the catch-up

investment needed to ensure that students and staff are trained on the very latest equipment – source, EPC analysis of HESA Finance data 2012/13. This does not take account of the ongoing and increasing costs of maintenance and associated operating infrastructure and the increasingly short term life of the equipment owing to the speed of technological development).

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

Whilst imperfect, there are strategies currently in existence for universities to collaborate in their research and to share equipment (e.g. the EPSRC's equipment sharing scheme). But apart from the recommendations in the Wilson report, the thinking about how to improve access for industry, notably SMEs, to university based research facilities is not well-developed. As recognised by Witty, the Local Enterprise Partnerships (LEPs) do offer potential routes to improving access but these are still nascent and there are a number of issues still to be addressed such as the need to more effectively audit bidding processes and monitor the outcome of their spending plans.

The contribution Catapults could make to effective collaboration also needs detailed review. It appears that much of the current activity results in near-term applied research and development which industry should fund, or receive tax benefits for doing so, rather than further squeezing capital investment in sustainable strategic collaborative research facilities.

Some solutions could be:

- For universities to receive a premium to enable them to meet at least a proportion of the costs of enabling access to these facilities by start-ups, micro-businesses and more established SMEs when they successfully bid for new equipment.
- For the funding application to require a commitment to a degree of industry co-funding with the university(ies) in funding, either in the initial capital investment and ongoing running costs and/or a medium to long term commitment to usage and hence a contribution to an ongoing income stream from outside users. The outcomes of business cases should be closely monitored, potentially through local/regional "peer review" involving all interested parties in the region covered.
- RCUK could themselves manage larger equipment pools, ensuring that researchers can easily borrow the equipment when it is needed. Capital equipment would be better utilised and the equipment maintained if academics and industrial researchers borrowed equipment from a pool, and returned it to the pool when their immediate requirements had been satisfied rather than investing in a single project in a single institution which may or may not then be able to afford to maintain or re-use it once the project for which it was purchased is complete.

To maximise collaboration between universities using national or regional facilities, there are some barriers arising from current policies that produce perverse disincentives to collaboration that will need to be addressed, for example:

- Claims of work for research assessment (Research Excellence Framework) and league table purposes need to be addressed *a-priori* .

- University and RCUK culture of pricing projects at full economic cost – rather than balancing added value (for both the institution and the partners) to charges.

- Allowing for the additional travel costs and travelling time that will arise from this model.

Finally, there needs to be recognition that by its very nature, research is speculative, with the consequence that its funding also contains a substantial element of risk. The consequence is that applications of 100% funding of research equipment should be allowed and the budget increased accordingly. Once again, the need to recognise that there are attendant operating costs in running capital equipment is becoming increasingly pressing.

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

We need to consider the response to this question in the light of the response to 2. above. High value capital equipment or specialist research facilities need to be accessible by researchers from different UK institutions, avoiding, where practical, a situation where access to a particular laboratory or device, paid for by public funds, is effectively only accessible by an individual research team in one university. We have to ensure high value capital equipment is continuously used for many years by different teams of researchers, and is fully maintained for the life of the system.

- *Consideration of the link between research and teaching to provide economic impact:* The question should be adjusted to "what factors should be taken into account when determining the *capital requirement* of the higher education (HE) estate". Funding policies need to recognise that the research and teaching are inextricably linked – particularly for engineering where education at both undergraduate and postgraduate levels must occur within the context of industrial application. Industry expects graduates and researchers to be working with the latest tools and techniques (and developing new ones). Thus, investments in teaching laboratories are also necessary for HE to be able to expose undergraduates and postgraduate to industrially relevant equipment and software if they are to have an impact on industry in the future. Furthermore, engineering is amongst the most expensive of the sciences to resource for research and teaching and with an overall funding system that does not allow the full cost of teaching undergraduates to be recovered, therefore requires public funding intervention.

- *Maintenance and expansion of distinctive regional capacity:* For the reasons outlined earlier, investment in developing the high level skills is needed to underpin long term

economic growth is needed. Research funding concentration in ever-larger facilities and in those institutions that already have large facilities does not meet this need.

- *Consideration given to building in the cost of access by students, particularly postgraduate students:* this should be built into the funding models. Individual grant cost recovery models of the kind currently operated across the HE sector inhibits access by postgraduate students and researchers without specific grant income. This in turn reduces the "research return" in terms of results and training, both to the detriment of the UK's research base. (See also link to work of the Perkins Review in developing specialist (postgraduate) skills).

- *Consideration of the potential for wider exploitation of the equipment:* either at the university (and its regional partners) beyond the initial purpose of the application, potentially with endorsement of the application from the perspective of economic exploitation and growth by the LEP and its regional peer assessment group – as outlined in 2. above.

- *Research excellence and impact:* these should remain fundamental criteria in support of regional economic need and the Industrial Strategy and in whatever institution they are found.

4. 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?

The UK model is for universities and some not-for-profits to carry out research. Without the above requirements, public funding will be diluted and there appear to be very few benefits to investing in additional research organisations: the UK does not have a "Fraunhofer" or research institute model (yet). However, those which have a leading and unique position and/or are commercial entities could be asked to put a joint proposal together with a university and co-fund these activities. This is a benefit to all concerned.

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

Our over-riding priority for public funding should be to invest where science / engineering can make an impact on our national priorities for the future and in particular, where there is market failure which prevents this from happening.

The UK has an ageing infrastructure which needs significant capital investment. Companies will not invest in the UK unless we can guarantee reliable infrastructure, fit for purpose. A developed country must ensure it has the capability to design the next generation of infrastructure it cannot rely on importing technological solutions.

The long term prosperity of the UK depends on our energy, telecommunication, transport and water networks. It cannot purchase a smart, low carbon transmission and distribution network from other countries, it must design and build it using UK expertise and facilities, while integrating internationally-sourced products.

6. What should the criteria for prioritising projects look like?
The prioritisation criteria should seek to maximise the long term economic benefits for the UK. The 11 sectors identified in the Industrial Strategy, together with the 8 Great Technologies, provide the sector focus (and therefore, to some extent, the regional focus since industry tends to be regionally specialised). There should also be a strong element of high level skills development to ensure that the UK has the capability to satisfy its own technological needs and grow export opportunities.

- Match with national priorities now into the future
- Development of skills and capabilities (including collaborative capability)
- Sustainability of the project (do we pay once and it runs itself or is this something we need to keep paying money into to keep it running)
- Value for money and impact

Affordability, excellence and impact provide the underlying priorities for funding selection in the consultation document, however, we have also proposed skills development, efficiency and leverage here as important. An emphasis on a wide range of creative inter-organisational collaboration beyond the existing large companies already strongly embedded in UK research would seem to provide greater leverage to develop higher level skills across the nation as a whole.

7. Are there new potential high priority projects which are not identified in this document?
The UK must emphasise a balance between investment in blue-sky science research and investment in engineering. Investing in underpinning infrastructure, modelling, simulation, emerging technologies etc which might be difficult to justify on their own and hence fall into the category of “market failure” will provide tangible contributions to UK prosperity in the long term.

While it would be inappropriate for the Engineering Professors’ Council as a membership organisation representing the majority of UK university engineering departments to promote specific projects, we would reference the responses of individual member organisations to this consultation, for example those which support our nation’s infrastructure and hence our focus of regional and sectoral capability development, particularly in transport, energy and climate change:

- Rail signalling and development of intelligent rail rolling stock
- Development of home insulation and power efficiency technologies for pre-existing (older) homes

- Nuclear power developments (where the UK used to be world leading)
- Projects to address climate change and associated infrastructure and energy supply
- Projects that exemplify good university-industry collaborative practice and apply a range of current and emerging technologies in support of identified segments in the Industrial Strategy (for example support for the full-scale aero-acoustic moving ground wind tunnel as a resource for the automotive industry)
- Agri-technology: food security and reducing and using waste to cope with growing population
- Healthcare technologies: especially prevention and maintenance than just treating the sick

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

Yes – see 7 above.

The emphasis on capital funding must be related to the long term prosperity of the UK. If some of the technologies now being supported fail to deliver, or global pressures change, we need to have the flexibility to respond. Given that the priority should be to ensure we invest in success that bring economic benefits, rather than success that only brings short term prestige, our recommendation is that the greater proportion must be spent on ensuring we have the underpinning capabilities and infrastructure rather than large single projects.

UK has one of the lowest levels of investment as a proportion of GDP among developed countries. It is about half that of Germany and France and well below the levels of Korea and Japan. Until this is addressed this lack of investment in research and development, we shall not achieve the type of balanced growth we need. This requires rebuilding our industrial base, which requires much higher investment in technology and engineering research.

9. 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?

We must reduce our future dependency on imported energy and ensure the UK can deliver a reasonable proportion of its energy from domestic low carbon sources. This is a major challenge for the EU and must be a priority in our future international collaborations, thus projects in developing nuclear energy capabilities, solar concentrator technologies (thermal and PV) and UK national expertise in power generation, for example, should be prioritised.