House of Lords Science & Technology Committee: Scientific Infrastructure

Response by the Wellcome Trust

1 July 2013

Key Points

- The UK needs a strategic and long-term approach to capital investment if it is to remain competitive. The Research Council UK's Strategic Framework, '*Investing for growth: Capital Infrastructure for the 21st Century*' sets out clear priorities for funding and the Government should use it as a basis for future commitments, matched with an appropriate funding profile.

- Operational support is essential. In addition to the capital requirements, investment decisions must also take into consideration ongoing operational costs and funding requirements. Where the UK already has world class facilities – such as the Diamond Synchrotron – the ongoing operational costs must be supported to ensure that there is maximum return on the investment.

- Capital investment must be made in the most effective and efficient way. Facilities need flexibility in spending plans over several years; the loss of end-year flexibility is not conducive to supporting the development and upkeep of cutting edge infrastructure.

- It is essential to have an appropriate framework to support the delivery of world-class large facilities in the UK, with governance structures that ensure both strategic oversight and efficient delivery of large research infrastructures.

- Researchers are generating ever-growing datasets. The UK must plan now for the infrastructure and technology needed to support the storage and analysis of very large quantities of data. We welcome recent investments in big data, and urge the UK Government to ensure a coordinated approach to tackle the data challenge and maintain the UK's competitive advantage.

- We are pleased that Diamond has proved successful at encouraging industrial activity, and over 20 per cent of beamtime use at Diamond now has direct industrial involvement. Research conducted at Diamond is directly supporting innovation and stimulating the UK's economy.

INTRODUCTION

1. World-class research requires world-class facilities, and world-class leaders to ensure that these facilities are used and developed to maximum capability. Sustainable investment in large facilities, capital and equipment is essential to deliver long-term research impact and economic gains. The Wellcome Trust is therefore pleased to have the opportunity to respond to this important inquiry on scientific infrastructure.

2. The Wellcome Trust provides direct funding to a large number of national and international facilities and research projects, including a number of the facilities identified in the Research Council UK's (RCUK) Strategic Framework, '*Investing for growth: Capital Infrastructure for the 21st Century*', and previous Large Facilities Roadmaps.

3. One of the Trust's key infrastructure investments is the Diamond Synchrotron, in partnership with the UK Government, through the Science and Technology Facilities Council (STFC). Diamond is the largest scientific facility to be built in the UK for 40 years, at a total cost of £483 million. The Trust has supported Diamond Phases I, II and III in partnership with the Government, providing 14 per cent of the construction costs and an equivalent proportion of the ongoing operational costs (both capital and revenue). Diamond has been a real success story for the UK: it was built on time and to budget and specification, and is delivering significant scientific outputs and attracting industrial users.

4. This response draws mainly on our experiences as a funder of Diamond. We also make some points, where relevant, about the availability of scientific infrastructure for the biomedical research community more generally.

Current availability and status of scientific infrastructure

What scientific infrastructure is currently available in the UK, do UK researchers have sufficient access to cutting edge scientific infrastructure and how does this situation compare to that of other countries?

5. UK researchers have access to three world-leading facilities on the Harwell campus: the Diamond synchrotron, ISIS (an accelerator based facility) and the Central Laser Facility (a provider of high power ultra-intense lasers for use by the scientific community). Diamond is a world-class synchrotron light source that serves researchers across all scientific disciplines, from both academia and industry. Construction has taken place in three planned phases. All Phase I and II beamlines are now operational. Phase III funding of approximately £100 million was approved in 2010 to support the construction of an additional 10 advanced beamlines, bringing the total complement of beamlines at Diamond to 32.

6. UK researchers can also access the European Synchrotron Radiation Facility (ESRF) and the Institut Laue-Langevin (ILL), an international research centre at the leading edge of neutron science, through international subscriptions.

7. In addition to these large facilities, UK researchers also need to have access to innovative research resources, infrastructure, and underpinning tools and technology on which research depends. Examples include Biobank and the Clinical Practice Research Datalink. The Government has a crucial role to fund and support these platforms. We welcome the Government's announcement in '*Investing for Britain's Future'* that the

Department of Health will provide £150 million of capital investment in 2015-16 to fund health research infrastructure in the areas of dementia, genomics and imaging. There are enormous opportunities to capitalise on the value of genomic data for research if there is appropriate infrastructure available.

Is sufficient provision made for operational costs and upgrades to enable best use to be made of the UK's existing scientific infrastructure? Is it used to full capacity; and, if not, what steps could be taken to address this?

8. Operational support for scientific infrastructure is absolutely essential. There is little point in building world-class research facilities and resources if they cannot be operated effectively or sustainably. Large facilities require ongoing support to maintain and operate them effectively, and to ensure they can be refreshed and upgraded to remain as state-of-the-art cutting-edge facilities. Where the UK already has world class facilities – such as the Diamond synchrotron – they must receive appropriate levels of operational funding, both capital and resource, to ensure that they are operated to their full potential, and that there is maximum return from the investment.

9. The Wellcome Trust has stressed the importance of ensuring operational funding throughout our involvement with Diamond. The need for ongoing operational support was included as a core principle in the initial Joint Venture Agreement and we have continued to give it priority over the last few years, despite the difficult economic climate. Most recently, our funding for Phase III was conditional on the Government ensuring that there was sufficient operational costs for all Diamond's beamlines.

10. There have been occasions where we have been concerned that the longer-term operational costs have not been fully considered when capital decisions have been made. For example, when a new Dual Imaging and Diffraction beamline (DIAD) was given funding in the 2012 Autumn Statement, no provision was made for operating costs in the longer term. Similarly, the STFC funding for the physical sciences element of a new cryo-electron microscopy facility at Diamond only relates to the capital costs, whereas the funding from the Wellcome Trust, BBSRC and MRC also includes funding for ongoing maintenance and upgrades.

What substantial increases in scale would allow new areas or domains of science to be explored (analogous to Large Hadron Collider and Higgs boson)?

11. The volume of research data is doubling every three years. A key emerging issue that cuts across almost all research disciplines is the availability and quality of infrastructure for data storage and analysis. With the quantities of data being produced from research projects ever-growing, as well as the greater focus on data as a research resource in itself, it is increasingly important that the UK should plan for the infrastructure and technology needed to support the storage and analysis of very large quantities of data, both now and in the future. The RCUK Strategic Framework recognises the importance of e-infrastructure as one of its overarching priorities and identifies a number of different elements including hardware, software, data curation, skills and training, and efficient networks. It is important to note that these will require ongoing operational support as well as capital investment.

12. Typifying this is the European Life-Science Infrastructure for Biological Information (ELIXIR), which is aiming to develop an integrated and sustainable platform for biological data. The Trust supports the aims of ELIXIR and has joined as a partner. We also

welcome the £75 million that has been invested by the UK, through BBSRC, in the European Bioinformatics Institute (EBI), as the ELIXIR hub. However, ongoing revenue for the EBI has not been adequately ensured, and it is therefore vital that the government continues to advocate at European Union level to ensure the provision of the long-term funding required to sustain ELIXIR and other key data infrastructures that will be critical to underpin the research endeavour.

13. The US National Institutes of Health has recently launched the Big Data to Knowledge (BD2K) initiative, which aims to facilitate broad use of biomedical big data, develop and disseminate analysis methods and software, enhance training, and establish centers of excellence for biomedical big data. The UK does not have a similar co-ordinated initiative across its major funders in the life sciences. However, the Government has recently committed substantial investment in big data and we welcome the announcements last week, in '*Investing for Britain's Future'* that the Government will invest in a new national network of Big Data institutes. There is a high degree of coordination in funding, joint initiatives and policy formulation to ensure the UK maintains its competitive advantage. Elixir will also aim to further some of the same co-ordination goals as the BD2K initiative at European level.

Long-term needs, setting priorities and funding

What are the long-term needs for scientific infrastructure?

14. The Research Council UK's Strategic Framework, '*Investing for growth: Capital Infrastructure for the 21st Century*' sets out the long-term requirements for scientific infrastructure across all research disciplines. It is not possible to say whether it is more important to invest in large, national infrastructure or medium infrastructure: any decisions must be science-driven.

15. In relation to the biomedical community, one of the immediate priorities is improvement in high-end imaging. The UK has traditionally been strong in the development of new imaging technologies, and there is a need for continued investment in order to maintain this strength. Imaging for biophysics and neuroscience is a key priority, and continued investment in high-end imaging facilities and equipment, particularly nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI), will be crucial. NMR spectroscopy provides one of the most versatile methods for the analysis of materials at the molecular level and has an increasing impact in drug discovery as it has become a method of choice for small molecule screening and provides the basis for many existing and potential collaborations between academia and industry.

16. There is concern that infrastructure and facilities for high-end imaging projects in the UK are not keeping pace with demand. The acquisition of state-of-the-art NMR instrumentation is now beyond the budgets of most Higher Education Institutions and so there is an urgent need for the UK to improve the provision of NMR instrumentation, particularly as the next generation of higher field NMR instruments come on stream. The RCUK Strategic Framework for Capital Infrastructure recognises high-end imaging as a priority area for investment.

What role should the Government play in ensuring that there is an effective long-term strategy for meeting future scientific infrastructure needs?

17. The UK needs a strategic and long-term approach to capital investment if it is to remain competitive. The Research Council's UK Strategic Framework, '*Investing for growth: Capital Infrastructure for the 21st Century'* usefully sets out clear priorities for funding and recognises the importance of providing long-term support. Without an overarching strategy, there was a real risk that a series of piecemeal announcements relating to capital would prevent the UK from taking a long-term view. The Government should use the Framework as a basis for future commitments, matched with an appropriate funding profile.

18. Capital investment must be made in the most effective and efficient way. A major challenge for large complex projects is the need for flexibility in spending plans over several years. Facilities need the ability to carry over funding from one year to the next as required, to respond to external events and unexpected budgetary circumstances. Delays in government decision-making can often have significant knock-on effects to multi-year spending programmes. For example, although there were significant delays in the Government's approval for Diamond Phase III as a result of a change in Government, it was not possible to rephase the capital spend when the funds were eventually released.

19. The loss of end-year flexibility is a particular challenge when trying to develop and maintain a world-leading, state-of-the-art facility. It is difficult to push the boundaries of technology, and access the most cutting edge equipment, if decisions have to be made on the basis of any single year without the ability to carry over any underspend. A significant benefit of partnership funding for large facilities is that other funders can provide cash flow flexibility and help to develop phased spending programmes.

Since the last Comprehensive Spending Review, a series of additional announcements have been made on investment in scientific infrastructure. How were the decisions on investment reached and what have been the impacts of this approach to funding scientific infrastructure?

20. Capital spending was excluded from the Science Budget ring-fence in 2010. An additional investment of £100 million for research capital was announced in Budget 2011, a further £100 million to support major new university research facilities was announced in Budget 2012, and the Autumn Statement 2012 included further investment in infrastructure. While these commitments demonstrate the Government's recognition of the importance of spending on infrastructure, there is a real risk that a series of piecemeal announcements will prevent the UK from taking a strategic approach to capital investment. As described above, the Research Councils must be able to map out their funding priorities for capital at an early stage, allowing other funders to engage at the planning stage and maximising the opportunities for partnership. This strategic approach also allows funders to plan for both capital investment and operational costs.

21. We welcome the Government's commitment in the Spending Review 2013 to increase investment in capital for science, and we are particularly pleased to see the explicit recognition of the need for stability in capital budgets to enable long-term planning and sustainability. However, as discussed above, there must be adequate provision for operational support as well as capital funding.

22. The recent series of announcements focusing on capital investment have not allowed adequate provision for operational funding requirements. For example, a new beamline for Diamond was partially funded as part of the Autumn Statement, but there was no provision for additional resource to complete construction or operate that beamline. In addition, the timeframes introduced by one-off announcements are often extremely challenging for large capital spends.

23. The Autumn Statement included £189 million capital funding for big data and energy efficient computing. This included £34 million to establish the Administrative Data Research Network, and £55 million for medical bioinformatics: £20 million to be spent in 2013/14 and £35 million to be spent in 2014/15. The initial £20 million of the latter, to be spent in 2013/14 will be used to strengthen the UK's capability in the eHealth Informatics Research Centres (eHIRC), by creating a virtual institute, co-locating eHIRC researchers with NHS staff and increasing access to clinical and population databases. The second tranche of funding (£35 million) includes both capital and resource funding, and will be used to build capability, capacity and infrastructure. The MRC launched a call for expressions of interest in Medical Bioinformatics in March 2013. These investments are extremely welcome to help unlock the value of data for research.

24. One of the most successful capital announcements was the UK Research Partnerships Investment Fund, and we welcome the Government's continued commitment. A £300 million public investment has already leveraged over £650 million from industry, charities and universities for investment in university research facilities. The Wellcome Trust has been pleased to be part of this initiative, supporting successful bids from the University of Dundee and Queen's University, Belfast. However, funders must be engaged at an early stage to maximise opportunities for partnership. The RPIF could have been even more effective if the timetable had allowed other funders to coordinate investment decisions.

If the current funding level is maintained or reduced, what would be the longer term impacts on scientific infrastructure in the UK?

25. Evidence suggests the demand for capital funding is increasing. The ring-fenced capital budget held by the Research Councils' was reduced by 50 per cent in the 2010 Spending Review. The Large Facilities Capital Fund is fully allocated until 2014/15 and Research Council funding for small and medium items is in high demand. Requests to the Wellcome Trust for capital expenditure have more than tripled since 2005/06.

26. Sufficient funding for running costs is required to ensure sustainable operation. If current funding levels are reduced, it may not be possible to continue to operate all the UK's large scientific infrastructure at existing levels. However, it is important to recognise that for facilities such as Diamond and the ISIS neutron facility, more than 80 per cent of the costs are fixed. It will not save money to operate only a few of the beamlines or instruments, or to reduce the number of days that a facility is open. Any decision must ensure that those facilities that are kept running are operated to their world-class potential. This includes the provision of appropriate funding for maintenance and upgrades to keep facilities at the cutting-edge.

Governance structures

Does the UK have effective governance structures covering investment in scientific infrastructure, how do they compare to those of other countries, and are there alternatives which would better enable long-term planning and decision-making?

27. It is essential to ensure an appropriate framework to support the delivery of world-class large facilities in the UK. The establishment of the Large Facilities Steering Group (LFSG) has enabled the Research Councils to work much better together to consider competing priorities across all disciplines. The Wellcome Trust has observer status on the LFSG. From this position, we believe that the Research Councils, through the LFSG, are now working effectively to forecast researcher requirements and demand for large facilities each year. The LFSG must have access to clear and transparent information about the business models and future delivery plans of large facilities in order to reach an informed position about operational priorities.

28. It is also important to have governance structures that ensure both strategic oversight and efficient delivery of large research infrastructures. The STFC has a number of different roles in relation to large facilities: ensuring strategic oversight; directly operating some facilities, such as ISIS and the Central Laser Facility; and operating others at arms-length, including Diamond through partnership and involvement with others through international subscriptions (ESRF and ILL). It is important that the governance arrangements allow STFC to fulfil these different remits effectively, in order to operate and deliver world-class facilities. STFC must be able to respond to the priorities identified by the LFSG, and make decisions that are driven by the science, in order to maximise the return on investment.

Are effective and fair arrangements in place for access and charging for public and private scientific infrastructure?

29. Diamond is free at the point of access for researchers, provided results are placed in the public domain. Academic users apply to conduct research at Diamond through a competitive application process. All applications are reviewed for scientific merit and also for safety and technical feasibility to ensure that the experiment can be undertaken at Diamond. This application process ensures that experiments are of a high quality, prioritised against other proposals, and scheduled to ensure that the facility is put to best possible use.

30. A range of different modes of beamtime allocation are used to ensure the different needs of users can be met. The macromolecular crystallography community has developed an innovative approach for the more efficient use of beamtime at synchrotron facilities, termed Block Allocation Groups, which permit greater flexibility in the choice of projects and samples during a given allocation period and offers users the benefit of access to more regular periods of beamtime. Other communities are now looking at using a similar model at both Diamond and ISIS. Industrial users can also access Diamond through a range of models including proprietary research.

Are effective structures in place for funding of medium-sized scientific infrastructure and enabling sharing among Higher Education Institutes and Research Institutes? Are regional research alliances proving effective in enabling access to funding for medium-sized infrastructure? Should more be done to support or incentivise approaches to collaborative funding and sharing of medium-sized infrastructure?

31. Universities are increasingly looking to optimise their resources by sharing equipment between research groups. There are now a number of examples of research-intensive universities working together more effectively: the N8 partnership in the north of England, the M5 group, the GW4 group, and most recently the announcement of the Science and

Engineering South Consortium, which includes Imperial College London, University College London, and the Universities of Cambridge, Oxford and Southampton.

32. Equipment sharing enables efficiency and costs savings, increases collaboration and allows resources to be pooled to buy large pieces of equipment, but it must be supported by an appropriate governance and management framework. Sharing is simplified where funders cover the full capital costs of the facilities initially.

Partnerships

To what extent do funding structures in the UK help or hinder involvement in EU and international projects, and should the level of UK involvement be improved?
To what extent are EU and international programmes effective in promoting collaborative investment in scientific infrastructure projects?

33. The UK has good relations with other international facilities, and these collaborations are important to ensure that world-class facilities complement each other rather than competing unproductively. There are a number of benefits of engaging in partnerships with other facilities, for example exchange arrangements allow researchers to access a wider range of specialist beamlines without everything having to be available at one location. Collaborations also ensure access for users during periods of shutdown, for example Diamond recently experienced a surge in industrial users while ERSF was in extended shutdown as part of their upgrade programme; and enable facilities to maintain state-of-the-art technology.

34. One facility that the UK initially decided not to be part of is the European X-ray Free Electron Laser (X-FEL), currently under construction in Hamburg, Germany. This international project involves 12 participant countries, and aims to produce x-ray light in synchronisation, resulting in high-intensity x-ray pulses with the properties of laser light at intensities much brighter than those produced by conventional synchrotron light sources. It is anticipated that this new technology will open up a large number of biological processes to study which are currently not accessible to synchrotron radiation.

35. There is now a possibility for the UK to become more engaged with X-FEL, and to buy into a structural biology beamline. There would be significant benefits for the UK structural biology research community to be able to access such infrastructure. While it was appropriate for the UK not to participate initially, now would be an opportune time to be involved and we hope to see the Government capitalise on this.

36. The Trust previously participated in the ERA-Instruments initiative for promoting infrastructure funding in the life sciences[1], which aimed to bring together a network of European partners including research centres and funding councils to develop a common model for instrumentation and infrastructure funding in the life sciences. BBSRC and MRC were also partners. The recommendations in the summary report may be of interest to the Committee, and include the need for greater networking across Europe when planning scientific infrastructure. One of the key findings was that there is an increasing use of mid-size facilities to allow access to leading edge instrumentation while also providing the expertise and experience to ensure best use of new equipment.

[1] http://www.era-instruments.eu/index.html

What impact does publicly funded scientific infrastructure have in terms of supporting innovation and stimulating the UK's economy?

37. Diamond has already had a key role in boosting the UK's industrial competitiveness. Recent applications include drug development, manufacturing technology, forensics, geology, space science and food processing (see Box 1 for examples).

38. Diamond has recently been used to help develop a new vaccine against Foot and Mouth Disease (FMD). The outbreak of FMD in 2001 cost the UK economy over £8 billion. Now, scientists funded by the Wellcome Trust and the Biotechnology and Biological Sciences Research Council (BBSRC), have produced a new vaccine which overcomes many of the issues of vaccination against FMD. Using the Diamond synchrotron, researchers were able to visualise the FMD virus at the atomic level.

Box 1: Examples of Diamond's achievements

- examining the corrosion of stainless steel at a molecular level. This work is changing the way that corrosion is modelled – a key feature of long term nuclear storage;
- determining the structure of novel materials with unprecedented capacities for hydrogen storage – giving the UK a competitive advantage over other countries;
- developing expertise in the study of nanomagnetism – key to the development of high density storage devices;
- improving our understanding of wear of hip transplants to improve longevity of medical devices;
- developing new approaches to drug discovery, by analysing how potential drugs bind to protein targets;
- determining the mechanical properties of human tissue, by mapping the three-dimensional fibrillar organisation of tendons;
- improving cancer treatment: the structure of a rescue complex of protein p53 – estimated to be implicated in about 75,000 new cancer cases each year – has been determined, providing a new lead for therapeutics;
- discovered a new enzyme that could prove an important step in the quest to turn waste (such as paper, scrap wood and straw) into liquid fuel.

39. Diamond also has a role in stimulating the local economy in the short-term. Many of Diamond's 450 staff are from the local area, and many local suppliers have been used during the construction process. Diamond also undertakes a range of public engagement activities, to enlighten, engage and inspire people of all ages and career stages.

How accessible is publicly funded scientific infrastructure in the UK to industry and small and medium sized enterprises? Is there room for improvement?

40. Diamond has been very successful at encouraging industry activity and collaboration. In 2012/13, 35 industrial companies paid for access to Diamond, 4.9 per cent of beamtime was used for proprietary research, and income increased by 13 per cent to £1,104,241. Figures from Diamond's Industrial Liaison Group show that customer retention is good and that existing customers are, overall, paying more for access and services at Diamond year on year. The pharmaceutical and biotechnology sectors are the biggest

users, generating 70 per cent of income, but Diamond is successfully developing its industrial user base in other areas, including engineering and consumer products.

41. Diamond has worked with Rolls Royce on aerospace and energy applications, Pfizer and GlaxoSmithKline on drug discovery and development, and Johnson Matthey on improve emissions control catalysts. Unilever and a major oil company signed contracts with Diamond for the first time last year, and a significant car manufacturer also became a new customer.

42. Diamond has adopted a number of approaches, including reducing the cost for first time users and offering discounts for multiple uses, to ensure that the facility is accessible to all industrial users, including small and medium sized enterprises. For example, Heptares Therapeutics, a biotech company that develops new medicines targeting G protein-coupled receptors, a super-family of drug targets linked to a wide range of human diseases, has used Diamond to help discover the structure of receptors and drug candidates.

43. Much of Diamond's industrial use is also through collaborations with academia, meaning that over 20 per cent of beamtime used at a Diamond has direct industrial involvement. This compares very favourably with other synchrotron facilities, particularly Spring-8 which typically quotes 20 per cent industrial engagement. Almost half of the proposals to use the I12 beamline (Joint Engineering, Environmental and Processing) involve industry.

Are Government policies successful in encouraging industry to co-invest in scientific infrastructure?

44. There is a significant need to maintain funding and collaborative links with industry, and to develop opportunities for partnerships where appropriate. With smaller capital infrastructure, the Research Partnership Infrastructure Fund has proved to be a very effective mechanism for encouraging partnerships with industry. However, industry is typically less likely to invest capital in large scientific infrastructure, while being willing to pay market rates for access. It is therefore important for the Government to focus on ensuring that world-class facilities are available to attract industrial users to the UK.