**The importance of long term investment in fundamental research**

RSC position statement 15.07.10

This statement summarises the RSC's position on the importance and value of the funding of fundamental science research to the UK economy and the wider economical and societal benefits of such research. The position is supported by the publication of two major reports: A report commissioned by the Engineering and Physical Sciences Research Council (EPSRC) and RSC on The Economic Benefits of Chemistry Research to the UK (to be published Summer 2010) finds that the UK's upstream chemicals-producing sector and downstream chemistry-using sectors contributed a combined total of £258 billion in 2007, equivalent to 21 % of UK GDP, and supported over 6 million UK jobs. The second report (June 2010), commissioned by the Institute of Physics (IoP) and the RSC on the Finances of Chemistry and Physics Departments in UK Universities, shows that the chemistry departments surveyed were operating at a deficit in 2007/8.

1. Long term investment.

The RSC believes that a clear long term plan for the funding of science research is essential for the UK economy. Our ability to compete in the global economy depends upon the health of the entire skills pipeline; education in schools and universities providing a steady supply of talented, highly skilled individuals who will become the next generation of scientists. Continuous long-term investment in SET must not only be maintained, but steadily increased to meet this challenge and to match the efforts of our international competitors. The Obama administration recently announced a 6% increase in non-defence research spending and the German government will inject an extra £15.7 billion into research and higher education over the next ten years[1]. UK SET helps to make us the top destination for foreign direct investment in Europe, creating jobs and a stronger science base; this position will be damaged by the lack of a long-term plan for funding. Maintaining investment will keep us at the forefront of global science. If we lose this domestic competence, principally through a "brain drain" of talented researchers to countries which support science more strongly, we may never be able to catch up. The recent International Review of Chemistry highlighted the excellent state of equipment and infrastructure within UK Universities; however maintaining this excellence requires sustained long term capital investment.

Near-term investment is important, but this should not be at the expense of long term investment. Taking the energy sector as an example, if we focussed research funding on near to market technology this would damage the research needed to develop more efficient energy technology for the long term. Near-term investment may be more appropriately funded by the private sector, by financial institutions and industry, whilst public funding primarily supports long term research. The time taken to develop solutions and bring them to market means that major state investment is needed to maintain strength in fundamental science. Just as today's economic and social returns reflect the fruits of many years' of investment in chemistry research, on-going fundamental research is essential to ensure a continuing flow of future scientific and technological breakthroughs that will derive substantial benefits to the UK economy.

2. Direct economic benefits of fundamental research.

There is strong evidence that long term chemistry research has a significant economic impact. A major report on The Economic Benefits of Chemistry Research to the UK (to be published Summer 2010) was commissioned by the Engineering and Physical Sciences Research Council (EPSRC) and the RSC. In the report the UK's chemistry-reliant industries are split into two categories: the upstream, consisting of chemical-producing industries; and the downstream, chemical-using industries. Today the UK's upstream chemicals industry supports over 800,000 jobs, including those in its supply-chain, contributing £36.5 billion to the UK's economy in 2007. The 15 identified downstream chemistry-using industries (e.g. aerospace, automotive, electronics, health and textiles, etc.), in which chemistry research is a necessary but not sufficient condition for their operation, support an additional 5.1 million jobs and directly contributed £222 billion to the UK's GDP in 2007. Taken together, the 'upstream' and 'downstream' industries made a £258 billion value added contribution to UK economy in 2007, equivalent to 21% of UK GDP, and supported 6 million jobs.

Education and scientific research lead to a scientifically literate workforce which is able to understand and exploit scientific knowledge. A greater proportion of science graduates pursue careers that require a graduate qualification as compared with those from other subjects. Over a lifetime, the economic value to the individual of completing a degree stands at ca. £129,000, and for chemistry and physics graduates this rises to ca. £187,000. The additional taxation revenues to the Exchequer over a working lifetime exceed £130,000.[2]

3. Wider economic and societal benefits of fundamental research.

The RSC believes it is essential that the UK maintains capability across a broad research base if the UK is to achieve a sustainable balanced economic recovery. However, the outputs of investment into research are so much more than economic outputs.

Fundamental chemistry research will continue playing a vital role in providing solution to some of the most important technological and societal challenges facing both the UK and the wider world: such as climate change, solving food-supply issues, improving efficiency and environmental sustainability of energy generation, enhancing public safety and homeland security, and improving medical treatments.

Chemistry research helps enhance the performance of the wider UK economy. The UK has many world leading chemistry research departments and specialist research centres. According to the latest (2008) Research Assessment Exercise, the UK has 12 higher education establishments whose chemistry and chemistry related departments classed as world-leading or internationally excellent. The second International Review of UK Chemistry Research highlighted several world-class and often world leading areas of research including chemical biology, materials and supramolecular chemistry. UK chemistry PhD programmes are recognized by industry as providing an innovative workforce with the knowledge and skills needed to pose and answer difficult questions. Furthermore, there is something particular about post-graduate training in the UK that provides UK-trained chemists with the edge in the corporate world. UK chemistry trained PhD students occupy a number of senior positions in leading multi-national companies such as BP and Novartis, and many have set-up successful spin-out companies off the back of their PhD research.

PhD students are the life blood of any discipline. We need to support and nurture capability rather than disciplines, but how do we understand that capability and what are the outputs currently being achieved?

UK chemists are internationally renowned for their quality and are shown to be a significant factor in causing companies to locate in the UK, or retain an UK-based research presence. Ongoing funding is very important to continue the supply of skilled PhD students. PhD students may go on to use their skills and knowledge in areas outside of research and indeed outside of science. For example, many of them become science teachers, science writers, entrepreneurs, policymakers, or work in healthcare, regulation, patent law, etc. A training in chemistry provides a unique combination of manual, theoretical, analytical, numerical, and problem solving skills which are highly prized. The process of conducting fundamental research in universities, research centres and in industry will ensure the UK maintains a highly skilled and innovative workforce that is well placed to adopt and advance new ideas, and successfully exploit new technologies. This will fuel economic activity as new and better products and services are developed, and provide a necessary condition for attracting inward investment to the UK.

4. Shortfall in science research funding.

The RSC has found that the two main streams of public research funding available, QR funding (funding on the basis of research performance) and RC funding (Research Council grants for specific projects), do not cover the total research costs of University chemistry departments. A recent report (June 2010) commissioned by the Institute of Physics and the RSC on the Finances of Chemistry and Physics Departments in UK Universities shows that the departments are in deficit in both teaching and research activities. The average deficit on all activities for the chemistry departments was 31.7% of total income. Many chemistry departments find themselves in a financially precarious position despite

making significant efficiency savings in the use of human and capital resources and receiving extra funding from the Higher Education Funding Council for England (HEFCE) for the teaching of strategically important and vulnerable subjects. In Northern Ireland, Scotland and Wales, where there is no additional funding, the situation is considerably worse. The RSC believes that SET departments in UK Universities should be fully funded.

5. Single discipline and Multi-disciplinary funding.

It is vital to ensure a balance of funding between single disciplines ahead of multi-disciplinary activity. Cross-Research Council funding should be particularly encouraged. Many research areas do not sit neatly within the remit of one Research Council and may be in danger of not being funded at all by any Council. Furthermore, the current funding system has a strong bias towards single disciplines, although recent advances have been made in multi-disciplinary funding. The RSC would support more cross-Council and multi-disciplinary funding to address the big challenges that the UK faces. Chemists are at the heart of much multi-disciplinary research, leading the effort to push back the frontiers of science.

6. A supply chain of skills

For our future prosperity, we must have a steady supply of talented people going into science, technology, engineering and mathematics (STEM), as well as a scientifically literate workforce who have the understanding to take advantage of advances in scientific knowledge. Sustained support for the entire pipeline of skills – science education, research and training in our universities, and partnerships between academia and industry – is vital if we are to rebalance our economy and to keep pace with our international competitors. This means an increase in the number of knowledgeable, talented science teachers with an entitlement to regular training and good laboratories in every secondary school. It means funding that covers the full cost of teaching these subjects in our universities.

Overall, £2.3bn is needed over the next three years to secure the future of chemical science education and research in the UK.

In universities, the chemical sciences need:

- Funding which fully covers the costs of teaching. For instance, by an increase in the weighting for expensive, laboratory based subjects applied to the unit of funding for each undergraduate from 1.7 to at least 3.0
- £76m to address the shortfall in funding for chemistry research

Chemical science in UK schools needs:

- £1.55bn to upgrade all UK school laboratories to a good standard, including facilities for storage and preparation
- An additional £73m per annum for equipment and consumables
- An additional £26m per annum to provide all science teachers and technicians with 2 days of off-site training (including teacher cover)

References

[1] Chemistry World, June 2009. http://www.rsc.org/chemistryworld/News/2009/June/08060901.asp
[2] Follow-up Study of the Finances of Chemistry and Physics Departments in the UK Universities, RSC and IOP, Manuscript in Preparation