Chemistry: we mean business

The chemical sciences in the UK growth agenda

In an increasingly competitive global market, it is vital that the UK is able to derive the "greatest possible industrial advantage from its impressive science base"[1]. The chemical sciences are a crucial component of our world-leading science base, which will be a key driver for the UK growth agenda.

The chemical science sector spans chemistry and chemical engineering. It also underpins advances in a number of other scientific areas, such as the life sciences, materials science, nanotechnology, industrial biotechnology and process engineering, and includes both the chemicals sector and chemistry-using industries[2], such as energy, pharmaceuticals, transport and many others.

Collectively, this sector will be a vital component in the Government's growth agenda, in creating jobs and in the move towards a knowledge-based, high-tech economy. However, continued investment is necessary for capitalising on the opportunities for economic growth that the chemical sciences offer as part of a strong and diverse UK science base. We have identified three areas where Government action can help to achieve this by:

- providing internationally competitive levels of research funding and the necessary research infrastructure to (i) attract and retain world-leading researchers and (ii) deliver the new knowledge, processes and technologies that will sustain future growth;
- creating a supportive financial and regulatory environment and world class opportunities for knowledge transfer and innovation;
- fostering the best talent pipeline in the world by meeting students' needs, linking the needs of industry with the education system, and thereby safeguarding UK productivity.

Chemical sciences in the UK growth agenda: a ten-point plan

Internationally competitive levels of research funding and infrastructure
1. Return Government investment in science and innovation to inflation-led growth, including capital expenditure
2. Ensure that innovation resources are targeted to strategically important growth areas

A financial and regulatory environment that maximises the opportunities for knowledge transfer and innovation
3. Provide support for SMEs to unlock private sector investment
4. Establish a supportive science-led regulatory environment
5. Facilitate multidisciplinary knowledge transfer by supporting data sharing

The best talent pipeline in the world
6. Establish a coherent strategy for vocational STEM training
7. Provide incentives to strengthen industrial placements for students
8. Develop an immigration strategy to attract and retain scientific talent
9. Extend the Initial Teacher Training scholarship scheme at secondary education level
10. Establish an Initial Teacher Training scholarship scheme at primary education level

The importance of the chemical sciences to the UK growth agenda

The UK has a competitive advantage in the chemical sciences. Compared to its competitors, Britain is more specialised in organic chemistry, biotechnology/pharmaceuticals and basic materials chemistry as well as the chemicals and related industries[3]. The chemistry sector also makes a substantial contribution to the UK economy. Government figures show that the chemicals and pharmaceuticals sectors alone made up 1.9% of gross value added (GVA, reaching £27bn) to the UK economy in 2011.

The UK pharmaceuticals sector, for example, is strongly underpinned by research in the chemical sciences and is the fourth largest in the world. The total of 365 companies generated a combined turnover of £31.8bn in 2011, and employed 77,795 people across 388 sites. 37 of the top 50 global companies have sites in the UK, and 52% of them have turnovers of £5m or more per annum[4]. UK Pharma appears to have the greatest ability to deliver R&D spillovers, and therefore give high social rates of return, than any other sector.

A large number of sectors that are important to the UK economy rely heavily on value capture from the chemical sciences, including the aerospace, automotive, food and drink, farming, water and energy sectors. The rapidly-growing UK industrial biotechnology sector, for instance, is vitally underpinned by strength in the chemical sciences. By 2025, industrial biotechnology could be contributing £150–360bn to the world economy, £4–12bn of which could be based in the UK[6]. Formulation is another area that is heavily underpinned by chemistry innovation and offers strong potential growth for the UK. These growth areas represent excellent opportunities to attract inward investment.

The chemicals and chemistry-using sectors are well placed to achieve the Prime Minister's vision of building local economies and creating jobs regionally, for example through the chemicals industry base in the North of England (the North West chemicals industry is worth an estimated £10bn[5]) and the emergence of clusters focussing on solar energy in Wales and South East England.

As part of a strong and diverse UK science base, the chemical sciences can provide technological and sustainable solutions to societal challenges of global importance[7] and will play a vital role in delivering the Government's current infrastructure plans through to 2050. A strong chemical science sector will offer further solutions to fiscal challenges, for instance by underpinning research and development of medicines that facilitate a lowering of healthcare costs within the NHS, without compromising quality.

The chemical sciences will generate future economic and business opportunities and help position the UK as a world-leader in new technological areas, including several of the eight areas recently identified by the Chancellor, such as energy storage, synthetic biology, regenerative medicine and advanced materials.

The chemical sciences will help to enhance the performance of the wider economy in ways that extend beyond simple economic and financial metrics by maintaining and enhancing the reputation of the UK science base, providing a skilled, innovative and highly productive workforce and generating vital non-economic benefits that will improve quality of life.

Internationally competitive levels of research funding and infrastructure

The pivotal role of research and development in assisting growth has been acknowledged in the Coalition Government's plan for growth. The chemical science sector requests that sufficient public funds for research and infrastructure are levied to capitalise on this potential.

Maintaining competitive levels of research funding is vital for attracting world-leading researchers to the UK science base and creating a competitive advantage in emerging sectors. UK investment in science and innovation is currently 1.8% of GDP[8], compared with the 2.5% goal set out in the *2004 Science and Innovation Framework*[9]. This is compared with 2.8% in the US, 3.3% in Japan and 3.4% in South Korea[10]. While UK gross expenditure on R&D (GERD) grew between 2006 and 2010, this is no longer the case,[11] and even in that period we were

outpaced in terms of increasing R&D investment by several key countries (Japan being the notable exception). There is a real risk that the UK will lose its international competitive advantage unless investment is increased (see **Figure 1**). Within Europe, UK R&D expenditure sits below the EU average[12].

The *International Comparative Performance of the UK Research Base 2011* clearly showed that UK returns on investment in research are significantly higher than our key competitors. This is something that we can be proud of, and demonstrates both the quality and efficiency of our science base.

However, future breakthroughs and competitive opportunities in emerging areas will only be realised by further supporting our science base, the breadth and quality of which will be essential to provide multidisciplinary solutions to complex societal challenges.

We welcomed the Government's commitment to the renewed ring-fencing of the Science Budget in 2009 and the recent commitments to capital investment. We are concerned, however, that a continuing decrease in investment in science in real terms will have an adverse long-term effect on UK competitiveness and research excellence. Figures presented by Science Minister David Willetts in December 2012, for instance, show that the seven research councils expected to fund altogether 273 fewer PhD places in 2012/2013 than in 2011/2012, and expect this number to fall by a further 229 to 4649 places in 2013/2014, which is a net decrease of almost 10% in two years[14].

Recommendations

1. Government investment in science and innovation should return to inflation-led growth and include capital expenditure

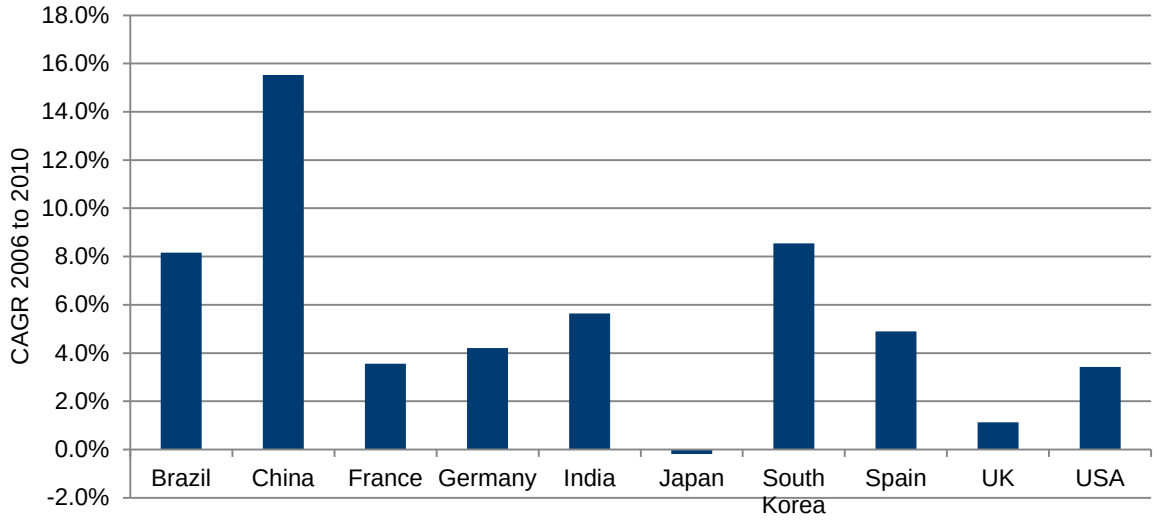
We understand that there are budgetary constraints, but ask the Treasury to remove the 'freeze' on science spend with a return to inflation-led growth. Over the period of the 2010 comprehensive spending review the cash terms freeze will account for an approximately 10% cut in real terms. We welcome the recent

reinvestment of funds for capital expenditure, but ask that this change is made permanent and that future capital spending is secured within the science funding ring-fence. Analyses from the Organisation for Economic Co-operation and Development (OECD) suggest that increasing public expenditure lifts (or 'crowds-in') industry investment. Increased governmental investment would likely encourage additional contributions from industry to the UK's research base.

2. Ensure that innovation resources are targeted to strategically important growth areas

We recommend that the Department for Business, Innovation and Skills (BIS) commissions a review of innovation funding and strategy to ensure that resources are most

Figure 1: Compound annual growth rate (CAGR) in GERD in selected countries



effectively targeted to strategically important growth areas in science, including the eight priority areas that were recently outlined by the Chancellor. It is also important to develop a coherent approach that links, for example, to the current *Triennial Review of the Research Councils* and to the findings of last year's House of Commons Science & Technology Select Committee inquiry into *Bridging the Valley of Death*. Funding for fundamental research, supported by the seven research councils, will form the bedrock of knowledge and scientific breakthroughs as part of the pipeline towards new technologies and solutions to global challenges.

A financial and regulatory environment that maximises opportunities for knowledge transfer and innovation

The UK's science base will not thrive through research funding alone, but must be supported by a positive financial and regulatory environment that ensures that our innovative R&D programmes can be effectively translated into commercial successes for businesses. To capitalise on the economic value of the chemistry sector, the UK needs first rate mechanisms for innovation, commercialisation and translation of R&D into processes and products that are in line with our first-rate academic research base.

Recommendations

3. Provide support for SMEs to unlock private sector investment

We welcome the Government's efforts to address market failures due to lending and the 'equity gap' through schemes such as the Enterprise Finance Guarantee (EFG), Enterprise Capital Funds (ECF), Community Development Finance and National Loan Guarantee Schemes[15]. Government could further de-risk the proposition to investors, for instance, by expanding the models that the Government is already using to stimulate investment in the aerospace industry into other sectors. The creation of a single agency that unifies existing Government interventions under a single brand would help to aggregate support mechanisms into one place. Improvement of the taxation system to incentivise private investors offering seed and start-up funds should be coupled with an increase in public funding for public-private partnerships. Initiatives to support management and business planning skills for chief executive and chief financial officers would address a lack of investment readiness in start-ups and SMEs.

4. Establish a supportive science-led regulatory environment

Regulatory legislation needs to strike a balance between protecting human health and the environment, while encouraging innovation, economic growth and a benefit to society. We welcome the Government's recent plans to cut red tape for the chemicals industry by introducing more effective, less burdensome enforcement of the Control of Major Accident Hazards (COMAH) regulations. We would like to see similar measures in other sectors, such as agri-science and food, to ensure that there is sufficient flexibility in regulations to nurture growth in new businesses, but also that testing and monitoring procedures keep pace with scientific developments in different sectors[16].

5. Facilitate multidisciplinary knowledge transfer by supporting data sharing

Scientific data-sharing, specifically during the early stages of R&D, is crucial to maximising the economic returns from research, and we would like to see more initiatives encouraging this, for example by extending research-related tax relief to include costs associated with making data available to others (eg through purchasing IT infrastructure or publishing open access articles). Tax relief could also be a powerful instrument in enabling researcher mobility across sectors and disciplines, which is a strategic area identified recently by the incoming UK Government Chief Scientific Adviser[17].

The best talent pipeline in the world

Maintaining and building on the UK's position as an international leader in scientific development requires a world-class talent pipeline. This will

largely depend on an education system that enables our STEM graduates, postgraduates and postdoctoral research fellows to thrive, a supportive business environment that can capitalise on home-grown talent, and an immigration policy that can attract and retain talented scientists from overseas.

An environment that encourages permeability between scientific disciplines as well as between academia and industry will ensure that our scientific workforce can collaborate to develop new technologies and solve global challenges, and have experience of the needs of a working environment.

British companies need a steady supply of skilled technicians with robust vocational skills. Highly qualified university graduates are unlikely to fill some of the technical and analytical positions companies require, or to stay in such roles for long. This is leading to a loss of productivity that companies cannot afford.

The *Working Futures 2012* report published by the UK Commission for Employment and Skills (UKCES) estimated that the UK will need 723,000 science, research, engineering and technology professionals and 194,000 associate professionals between 2010 and 2020. It is therefore crucial to maintain the scientific talent pipeline from schools to employment in the longer term. The UK workforce demographic is aging – unless we address the challenges this presents, we risk encountering talent shortages which could mean businesses struggle to compete and the number of SMEs shrink as businesses fail to attract workers[18].

Recommendations

6. Establish a coherent strategy for vocational STEM training

Incentives to support vocational training in the chemical sciences would ensure that our chemistry-using industries have an appropriately-skilled workforce to delivery economic growth and can capitalise on new technologies that will strengthen Britain's international competitiveness.

A national strategy should tackle the lack of vocationally-focussed science courses in the Further Education sector. New courses would provide the pool of individuals for apprenticeships in both SMEs and larger companies. Reducing the level of red tape involved in apprenticeship applications will encourage small businesses to take on apprentices.

A comprehensive, flexible programme that encourages vocational training within and outside the workplace could have a large impact in addressing rising youth unemployment, provide incentives to return to work from career breaks, help to address reskilling in the expanding 50+ age bracket[19], and address shortages in supplies of technicians within certain industry sectors.

7. Provide incentives to strengthen industrial placements for students

Industrial placements provide an excellent vocational training mechanism to ensure graduates are industry-ready and equipped to explore technological opportunities. The Government's *Strategy for UK Life Sciences* highlighted that industrial placements provide an excellent route for embedding practical and employability skills into academic programmes to ensure graduates are industry-ready[20]. Additional incentives and information for SMEs and larger companies would encourage increased engagement and commitment to host placements for STEM students, similar to the model used under the Government's existing Youth Contract scheme. Pump-prime investment from Government will be needed to support SME placements and drive uptake.

8. Develop an immigration strategy to attract and retain scientific talent

To ensure that the UK economy benefits maximally from its trained workforce, we must ensure that we continue to attract and retain expertise from abroad. Excluding qualified science professionals from the Government's cap on immigration numbers, and automatically granting a Tier 1 visum to foreign researchers in receipt of the most prestigious academic fellowships, would make a bold statement in demonstrating to the world the UK's status as a major international science hub.

9. Extend the Initial Teacher Training (ITT) scholarship scheme at secondary education level

The need for a skilled talent pipeline needs to be tackled at the school level in the first instance, and we welcomed the Government's plans to invest £2.7m in the chemistry Initial Teacher Training (ITT) scholarship scheme for secondary teachers this year. There is a need to sustain this type of investment and the Royal Society of Chemistry (which is a partner in this programme) can work with the Government to further develop the chemistry ITT scholarship scheme, with a Government commitment to continue the project until 2024.

10. Establish an Initial Teacher Training scholarship scheme at primary education level

Recent figures for England show that only 3% of teachers at primary level are science specialists (ie someone with both a degree and an initial teacher training qualification in science)[21] and this shortage needs to be addressed. It has led to teachers with low confidence in teaching science[22] and, subsequently, in teaching practices that emphasise the learning of facts and procedures[23], rather than employing a practical and investigative approach. We welcome the Department for Education's plans to increase the flow of science specialists into the primary school system[24] and suggest that the chemistry ITT scholarship scheme be extended to the primary sector.

Closing remarks

The chemical sciences are of vital importance to the Government's growth agenda. Chemical science research and innovation positively contribute to improving the UK skills base, creating private-sector jobs, rebalancing the economy, and securing Britain's position as a world leader in science and emerging markets. The Government's continued commitment to this sector has already led to significant economic successes in a wide variety of areas. Maximising the benefits from current opportunities requires sustained support for fundamental research, innovation and the talent pipeline, and we look forward to working with the Government to continue to build on the good work to further develop these areas in the coming years.

About this document

This document was prepared by a group of leading organisations in the chemistry sector, spanning both academia and industry. It includes the Royal Society of Chemistry (RSC), the Chemical Industries Association (CIA), the Institution of Chemical Engineers (IChemE), the Society of Chemical Industry (SCI) and Chemistry Innovation Knowledge Transfer Network (CIKTN) and close collaboration with the organisations involved in the industry-led Chemistry Growth Strategy Group that is currently in dialogue with the Department for Business, Innovation and Skills. We represent the breadth of the chemical science community, which makes us well-placed to inform policy in this area and to share insights into how the sector can most effectively contribute to the Government's growth strategy.

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The Royal Society of Chemistry

The RSC is an international learned society for advancing the chemical sciences and the UK's professional body for chemical scientists. Supported by a network of over 47,000 members worldwide and an internationally acclaimed publishing business, our activities span education, qualifications and professional conduct, international conferences, science policy, and the promotion of the chemical sciences to the public.

The Society of Chemical Industry

SCI is a multidisciplinary membership organisation which connects scientists and business people in order to advance the application of chemical and related sciences for the benefit of society. We have over 3,000 members drawn from academia and industry in over 70 countries. We share knowledge and create networks through our journals, C&I magazine and our conference programme as well as our member interest groups and outreach activities, such as public lectures.

The Chemical Industries Association

The CIA is the organisation that represents chemical and pharmaceutical businesses throughout the UK. We represent all sizes of chemical and pharmaceutical businesses, of which approximately 70% are overseas headquartered. This illustrates the increasingly international nature of the industry. We lobby and campaign at the UK and EU level on issues of importance to the industry to ensure that it operates safely, profitably and with due care for the interests of future generations.

Institution of Chemical Engineers

IChemE is the global professional membership organisation for people with relevant experience or an interest in chemical engineering. Founded in 1922 as a professional institution for chemical and process engineers, IChemE has grown to its current status of more than 38,000 members across 120 countries. Our activities aim to develop an international professional community, to promote the importance of chemical engineering and to support chemical engineers at all career stages.

Chemistry Innovation Knowledge Transfer Network

Chemistry Innovation is a knowledge exchange business at the forefront of the chemistry-using industries. It's one of 15 Knowledge Transfer Networks (KTNs) in the UK. Chemistry is a key enabling science for a major part of the UK economy and it is Chemistry Innovation's mission to support the chemistry-using industries, driving innovation and value across the chemistry-using industries. This includes chemical and pharmaceutical sectors, chemistry-dependent sectors and sectors that require substantial chemistry input.

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