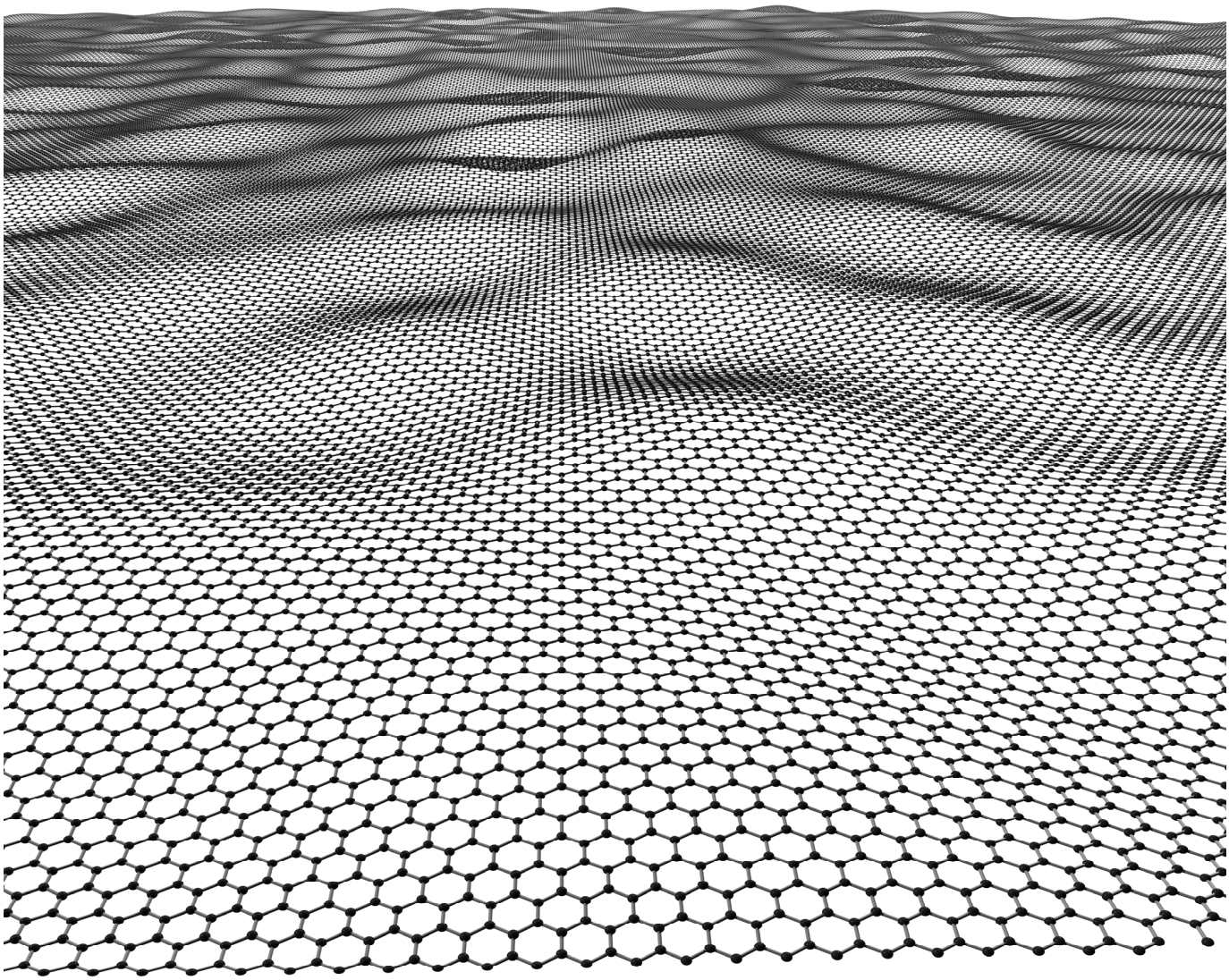

Artist's impression of a corrugated graphene sheet by Jannik Meyer. Image courtesy of the University of Manchester.

# **DELIVERY PLAN** 2011-2015

**Engineering and Physical Sciences Research Council**

EPSRC
Pioneering research and skills

# CONTENTS


EXECUTIVE SUMMARY ..... 2

INTRODUCTION ..... 3

- OUR VISION AND COMMITMENT ..... 3
- OUR STRATEGIC PRIORITIES ..... 4
- THE EPSRC APPROACH: FROM FUNDER TO SPONSOR ..... 6

RESEARCH AND TRAINING PRIORITIES ..... 7

- NATIONAL CAPABILITY ..... 7
- MAINTAINING THE FLOW OF SKILLED RESEARCHERS ..... 8
- LARGE-SCALE RESEARCH FACILITIES ..... 9
- GLOBAL, ECONOMIC AND SOCIETAL CHALLENGE THEMES ..... 11
- CROSS-COUNCIL THEMES ..... 14

ECONOMIC IMPACT ..... 18

DRIVING EFFICIENCY ..... 20

WHAT'S NEXT? ..... 21

END NOTES ..... 23

# EXECUTIVE SUMMARY

## EPSRC is the only dedicated national funder of long-term, fundamental engineering and physical sciences research and training in the UK, and remains absolutely committed to excellence and impact.

Our 2010 Strategic Plan set out how we will keep the UK at the heart of global research and innovation, and deliver greater impact than ever before.

Our Delivery Plan for 2011/12 to 2014/15 builds on this, and shows how we will be more active in partnering with the research community to generate the fundamental knowledge, and develop the skilled people, essential to business, other research organisations and government.

Our Delivery Plan has three core goals:

Delivering Impact: Embedding impact throughout our portfolio by creating an environment in which it arises naturally, in whatever form, from the knowledge base.

Developing Leaders: Nurturing the visionary leaders who set research agendas, and inspirational team leaders who act as role models.

Shaping Capability: Ensuring we have the right people, with the right resources, in the right places to deliver the highest quality long-term research in areas where the UK leads internationally and where there is current or future national need.

Our Delivery Plan is ambitious. We will take strategic decisions to:

- Deliver a programme of transformational change. We will move from being a funder to a sponsor of research, where our investments act as a national resource focused on outcomes for the UK good and where we more proactively partner with the researchers we support.
- Make strategic funding choices based on international excellence and national need, shaping our portfolio in line with UK priorities and strengths.
- Provide our researchers with the space, support and opportunities to foster creativity and to empower them to undertake ambitious work.
- Set a balance between national capability (see page 7) and challenge themes of around 60:40.
- Help rebuild the UK economy by driving an integrated research programme focused on sustainable high-value manufacturing, low-carbon energy, healthcare technologies and the digital economy.
- Further embed impact so that universities deliver it as normal business.
- Emphasise the role of research leaders.
- Give priority to PhD quality.
- Drive efficiency and effectiveness.

Our annual programme spend decreases in real terms by 2014/2015. To meet our commitments, we must make difficult choices, including:

- Maintaining funding for high priority research at the expense of the breadth and volume of research.
- Stopping our support for project studentships on research grants; enabling us to protect our quality PhD provision in Centres for Doctoral Training (CDTs) and Doctoral Training Grants.
- Stopping support for our own dedicated public engagement activity earlier than intended. It will be embedded through our research and training investments, enabling us to build a high-quality portfolio more closely linked to the research we fund.

Implementation of the RCUK response to the Wakeham Review of FEC will provide efficiency savings for us to recycle into research funding. However, if this does not release enough headroom for us to continue to develop our research portfolio in the period 2011/2012-2014/15, we may have to reduce our existing liabilities further.

Our sponsor approach represents a significant change to our relationship with those we support. Through close engagement with the research community, Research Councils, Government, industry and other stakeholders, and through increased collaboration with organisations such as the Technology Strategy Board, we will work to ensure that the UK gets the most out of the resources we have, the research we fund, the facilities we use and the leaders who inspire us.

# OUR VISION AND COMMITMENT

**Driven by visionary leaders, over the course of the Delivery Plan period and beyond, the research we sponsor will both be internationally excellent and deliver long-term impact for the health, prosperity and sustainability of the nation and the world.**

**We will achieve this by working with the research community, business, government and other agencies to shape the UK's capabilities in engineering and physical sciences.**

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Engineering and physical sciences are at the heart of the economy.

Thirty per cent of UK GDP, 75 per cent of all industrial R&D, and 80 per cent of all UK exports are heavily dependent on these disciplines[1].

As the only dedicated national funder of long-term, fundamental engineering and physical sciences research and training in the UK, EPSRC remains absolutely committed to this long-term focus and to excellence and impact.

We attract and sponsor the best scientists and engineers to lead and inspire others, foster international collaborations between the best researchers and businesses and keep the UK at the forefront of global research and innovation.

We are building from a highly successful base where, despite increased international competition, UK engineering and physical researchers are among the most productive in the G8.

In supporting such excellence, we ensure the research we sponsor contributes to developing capability in national areas of importance such as critical infrastructure, security and defence.

We also ensure the delivery of scientific advances in areas such as manufacturing, energy, healthcare, the digital economy and creative industries.

We invest for future business success: for example, about 80 per cent of the inventors of major UK blockbuster drugs in the past 40 years, accounting for annual sales of £15 billion, had their PhD training funded by EPSRC[2].

We provide the ideas-driven research that users need but do not themselves fund. We have partnerships with over 2,300 businesses, public sector organisations and charities. We already have a portfolio where 43 per cent of our research grants are collaborative with such users.

To remain an advanced, high-tech society capable of developing the businesses of the future, the UK cannot depend on buying-in its know-how.

The added value of a sustained national research and training capability, with EPSRC as the hub of activity, is the nation's capacity to act as an 'intelligent customer', and ensure sovereign capability, by being able to quickly tackle new problems, recognising where and when breakthrough knowledge and technologies occur and knowing how to exploit them.

In this Delivery Plan period we will work to ensure we have that capability in engineering and physical sciences by integrating our strategic priorities, driven by international research excellence and strategic importance to the UK.

We will base our portfolio development on advice and direction from leading world scientists and engineers and UK business experts.

# OUR STRATEGIC PRIORITIES

**Our 2010 Strategic Plan, endorsed by leading members of our research and business communities, is driving and accelerating our change agenda as we take a more proactive role in shaping research and training to meet national need, consistent with our 1994 Royal Charter.**

We are committed to three high-level priorities:

- Delivering Impact
- Shaping Capability
- Developing Leaders.

## Delivering Impact

Long-term science and engineering research is at the heart of discovery and innovation. Its impact occurs in different ways, and leads to a supply of skills and capabilities for research, industry and the public sector; achieves specific results from strategic investments aligned to areas of national need; and provides essential and informed advice to policymakers. It comes from providing resources to the best people in the right areas.

We will create an environment that promotes excellence, encourages innovation, stimulates creativity and drives cultural, commercial and technological advances.

In September 2010, Professor Andre Geim and Dr Konstanin Novoselov, of the University of Manchester, were awarded the Nobel Prize for Physics for their work with graphene, which has the potential to replace silicon in integrated circuits, and has potential in a host of other applications. Their success would not have been possible without long-term and strategic EPSRC funding, which began almost a decade ago[3].

In this Delivery Plan period we will:

- Help researchers target impact – by actively emphasising priorities against national needs, stating expectations, requirements and responsibilities.
- Ensure the resources researchers need to achieve maximum impact are embedded within our standard investments rather than as distinct schemes. Integrating clearly defined Pathways to Impact within all grant applications will allow seamless development from research ideas to potential applications.
- Encourage our key university, business and Government partners to align their strategies to a national agenda and priorities, and to create spaces for researchers and users to work together as normal business within that strategic framework.
- Make more accessible the data and knowledge about our research and its outcomes, for accelerated exploitation by users.
- Develop enduring relationships between ourselves, business and the research community, by bringing companies together on a sector basis, agreeing important national research challenges and aligning the research we fund and the people we sponsor to meet those challenges.
- Put in place appropriate arrangements, such as stage-gating, for engaging with our researchers so that we can encourage creativity and ambition while monitoring outputs to ensure we have a strong evidence base to guide any new investment.
- Embed public engagement within research. We will encourage our researchers to recognise public interest in contemporary research and to inform, explain and seek the views of the public through engagement at all stages of the research process.
- Enhance researchers' mobility between research disciplines, and between industry and other sectors.

## Case studies: The long-term Impact of EPSRC-Sponsored Research

1. Professor Sir Colin Humphreys' research into gallium nitride in the 1970s and subsequent work on LEDs is poised to dramatically reduce the UK's lighting bill.

2. Professor David Payne's long-term research into fibre-optics and optoelectronics helped revolutionise the telecoms sector.

3. Professor Steve Furber's research in the 1970s led to the creation of ARM, a multi-billion pound business making microprocessors for over half of all mobile phones.

## Shaping Capability

EPSRC is committed to excellent, long-term research in mathematics, chemistry, physics, computer science and engineering, as well as multidisciplinary ventures.

Our ambition is to use our comprehensive view of this portfolio – drawing on evidence and advice from leading world scientists, engineers and UK business experts – to bring greater coherence to the research base, reflecting national needs and maximising limited resources.

We will encourage the free generation of ideas, curiosity and research creativity while basing our investment decisions on intrinsic excellence and the strategic importance of the research and training to the UK.

In this Delivery Plan period we will:

- In concert with our partners in business, academia and government, co-define more explicitly the landscape of research we wish to support.
- Focus the science base around areas where the UK is an acknowledged leader or shaper, protecting the country's international reputation in the face of rising global competition.
- Concentrate more of our research and training support in clusters of excellence, to ensure necessary critical mass and foster greater collaboration and networking amongst our leading individuals and teams.
- Encourage the UK's best minds to engage with society's most important research problems with the aim of securing maximum impact from our long-term research investments.
- Enable the researchers we sponsor to raise their ambitions and maximise their creativity.

## Developing Leaders

Maintaining the national engineering and physical sciences capability to respond to future challenges and opportunities does not happen by accident. It requires visionary thinkers who set and drive research agendas, and lead research communities. It also needs inspirational leaders who can nurture and build the cross-disciplinary teams required to tackle the many global challenges we face.

We will work closely with the research community to support and promote leadership role models who can inspire others and can integrate the efforts of their peers to deliver greater impact from our investment.

In this Delivery Plan period we will:

- Identify and invest preferentially in current leaders, supporting them with flexible, strategic packages.
- Develop our future leaders, providing them with flexible and tailored resource packages that expose them to broader experiences and environments and allow them to fulfil their potential.
- Increase focus on developing a cohort of both current and future leaders and encourage networking and mentoring within that cohort.
- Provide tailored support for individuals with leadership potential across all career stages.
- Provide an increased proportion of support to individuals, as opposed to projects[4].
- Develop the next generation of scientists and engineers, ensuring that early career researchers with the greatest potential are well-supported.

# THE EPSRC APPROACH: FROM FUNDER TO SPONSOR

## To achieve the core goals of Delivering Impact, Shaping Capability and Developing Leaders, we cannot work alone.

## We will work closely with our university and business partners, and with other stakeholders and sectors, as we further align the engineering and science base for the good of the UK as a whole.

As a research sponsor, in this Delivery Plan period we will work more proactively with the researchers we support to:

- Provide direction using strategic advice.
- Obtain regular feedback from our sponsored researchers and use it to inform future funding.
- Secure commitment and engagement from researchers in meeting our goals.
- Advocate for engineering and physical sciences.

To do this we need to be clear about the new responsibilities we collectively take on as we move from being a funder to a sponsor of research, where our investments act as a national resource focused on outcomes for the UK good.

We understand that this approach represents a significant change to the existing relationship that EPSRC has with those it supports.

The new focus is exemplified by the transformational strategies built into our plans.

# NATIONAL CAPABILITY

**National Capability is defined as EPSRC's support for excellent, long-term disciplinary and multidisciplinary research, in engineering and the physical sciences. The UK has an enviable reputation for undertaking leading research and our strategies within national capability will ensure that reputation is maintained.**

Our vision is to ensure these capabilities also continue to help drive economic growth, both through disciplinary research and multidisciplinary endeavours.

We will achieve this while retaining the ability to successfully respond to new challenges and opportunities, as well as provide underpinning support essential[5] to advances in other research areas including biology, medicine, social science and environmental science.

It is difficult to predict where the next advance or discovery will occur, for that reason we need to have a balanced portfolio that enables transformative impact to arise from our core national capability, characterised by ambitious, longer and larger programmes, and from a complementary set of strategic themes.

Accordingly, we have set a balance between national capability and challenge themes of approximately 60:40.

In this Delivery Plan period we will:

- Apply 'International Excellence' and 'Importance to the UK' as selection criteria, so that our funding choices nurture and protect capabilities viewed as essential in the long-term national interest for their applications and potential in other areas of research and technology development.
- Work with the research community to encourage areas that need further support and identify those which are over-capacity or which are of lower importance to the UK[6].
- Promote state-of the-art knowledge, skills and capabilities by nurturing new emergent themes of research and their application in a fast and flexible manner.
- Generate leading-edge research at the interface between disciplines.
- Enable the most creative and potentially transformative research to flourish by increasing the proportion of flexible, longer and larger awards which emphasise creativity and long-term vision in research activity, and with a greater emphasis on collaboration with internationally excellent researchers. This will be coupled with our promotion and sponsorship of creative thinking techniques such as sandpits.
- Ensure research users, such as industry, have early access to results and, where appropriate, are involved in shaping research programmes.
- Bring upstream and downstream research together to accelerate the impact of our investments and ensure efficient use of resources.

# MAINTAINING THE FLOW OF SKILLED RESEARCHERS

## Our vision is to support the most talented and forward-thinking researchers, investing in the next generation of scientists and engineers.

This Delivery Plan builds on our successful approach to training, instigated in 2008, which focused on the £300 million investment in Centres for Doctoral Training.

These centres support students in four-year cohorts in highly innovative, research-excellent environments where both depth and breadth are championed. Students trained in this way are much sought-after by business and academia for their quality productivity, and employability.

More broadly, we will develop the next generation of scientists and engineers, ensuring that the highest potential early career researchers have access to the support they need.

In this Delivery Plan period we will:

- Further increase the quality[7] of the PhD through a cohort-based approach to student training. Furthermore, to protect our PhD provision in Centres for Doctoral Training and Doctoral Training Grants we will no longer support project studentships on research grants.
- Enhance the mobility of researchers moving between academia and industry to promote the transfer of new knowledge and enable greater exploitation and innovation in the economy.
- Increase the proportion of our PhD students trained in areas of strategic importance – such as manufacturing and energy.
- Target our Industrial CASE support more strategically.
- Broaden the exposure of our students to different environments to better equip them for future careers, through collaboration with business, charities, overseas institutions and public sector organisations.
- Attract the very best international students to train with leading research teams in the UK to increase our global presence and influence.

### Transformative Research

EPSRC has already been successful in introducing methods for facilitating the transformative research that can revolutionise existing fields, create new subfields, cause paradigm shifts, and support discovery.

For example, our Ideas Factory template is recognised as a best-practice benchmark[8].

We will continue to develop a range of such approaches, embedding creativity into researchers' thinking and operation.

The Creativity@Home module[9] has already received accolades from researchers.

We will pilot the use of technology, such as virtual 3-D collaboration software, to assist networking, collaboration and idea-generation, and use role models and case studies to spread best practice.

# LARGE-SCALE RESEARCH FACILITIES

## Internationally-leading engineering and physical sciences research cannot be done without access to large-scale infrastructure, facilities and equipment.

Our vision is to ensure that our community has the tools, equipment and infrastructure necessary to maintain and develop its internationally-leading status, and to ensure that our university-based capital investments are internationally competitive.

For the facilities that serve a range of users supported by a number of funders, the Research Councils collectively, in consultation with the Wellcome Trust, have agreed on a package of access that balances their research needs and affordability over this spending review period.

This collective view is based on a key principle that where facilities are supported the UK must ensure that they remain world-class.

For the future it has been agreed that it may be preferable to support fewer facilities in a more sustainable way rather than more facilities at a sub-optimal level.

Sustainable operation is defined as the provision of the operations costs that allow the approved levels of operation of the available beamlines/instruments, and provide a level of funding for maintenance and equipment replacement that keeps the facility at the leading edge with an acceptable risk of unplanned downtime.

As part of the RCUK Large Facility Funding Model project, mechanisms will be put in place to monitor the operation levels and spend on these facilities.

Based on this collective view and budgetary allocation we will provide:

- Full Diamond operations, including the operation of all the Phase 2 and 3 beamlines available for operation within the spending review period.
- Reduced ISIS operations programme based on 120 days per year of neutrons. In addition not all instruments on Target Station 1 and 2 will be able to operate simultaneously.
- Reduced operations at the Central Laser Facility with the operation of the high power laser system Vulcan as the first priority. The planned recurrent budget for CSR 2011/12-2014/15 is £28.876 million.
- Reduced access to the ESRF; the UK contribution to the ESRF budget will be reduced from 14 per cent to 10 per cent over the next three years with the resulting decrease in beam time being managed by the Research Councils. There is a potential option to further revise our contribution in the future.
- Continued access to the ILL as a full partner; the UK contribution will decrease in line with the budget reductions agreed with our partners.

We consider the need to maintain a balanced portfolio to be of fundamental importance underpinning our national capability.

In this Delivery Plan period we will:

- Reform provision of equipment with a national prioritisation of needs. We will increase the strategic use and sharing of capital items. Working in partnership with universities, we will develop approaches to aid multiple use of advanced research equipment across institutions, and provide the necessary technical support for 24/7 usage.

- Use more targeted support so leading groups can maximise the return from large-scale computational infrastructure by investing in multi-use software.

- Engage with multi-stakeholder projects that provide opportunities for EPSRC-sponsored researchers – providing them with access to facilities such as the Research Complex at Harwell, and through the Partnership for Advanced Computing in Europe (PRACE).

- EPSRC, working with NERC and BBSRC, has supported the high performance computing service HECToR since 2007. In this Spending Review period, EPSRC will continue to support a high performance computing service for use by its research community working with other Research Council partners. The HECToR service will, as originally planned, have its final upgrade in 2011. If capital funds are allocated to the ARCHER project (a proposal for a new high performance computing service to start in 2014 after the planned closure of the HECToR service) from the BIS Large Facilities Capital Fund, EPSRC will allocate appropriate recurrent costs to enable this new service to operate to benefit computational simulation and modelling studies across EPSRC's portfolio.

- Encourage research facilities to provide complementary services to industrial users (where there is a market), thereby securing leverage on public investment, the profit from which will be reinvested into service improvements for all users.

# GLOBAL, ECONOMIC AND SOCIETAL CHALLENGE THEMES

**Our vision is for the research we sponsor to help solve some of the most serious challenges facing the UK, including the need to build a strong, resilient economy, produce sustainable low-carbon energy, develop a resilient integrated national infrastructure and a healthy society with personalised healthcare for everyone.**

We will set a balance between national capability and challenge themes of approximately 60:40.

We cannot afford to invest in everything, so we are focusing our resources on supporting four main themes: Manufacturing the Future, Energy (an RCUK cross-Council initiative), the Digital Economy (an RCUK cross-Council initiative), and Healthcare Technologies.

Working with partners, including other Research Councils, the Technology Strategy Board, government, business and the third sector, we will increase the proportion of our research devoted to these socio-economic challenges.

These themes, however, will only succeed because of the investments we will also be making in long-term research within our funding for national capability.

## Manufacturing the Future (MtF) – an EPSRC-Specific Theme.

Against many measures, manufacturing makes a major contribution to the UK economy[10], but the nation must particularly invest in high-value and specialist manufacturing, underpinned by the research base[11]. Manufacturing the Future is a new EPSRC strategic theme, and builds on existing investments.

In Manufacturing the Future we will focus on skilled leaders, sustainable manufacturing and training more researchers.

In this Delivery Plan period we will:

- Shape our portfolio towards the needs of manufacturing industries, growing capability in areas where the market opportunity is well-developed but where there are still significant technological challenges to overcome, and in frontier manufacturing, where the research opportunity is strong but applications are nascent.
- Establish centres which link upstream with downstream research and which provide UK focus for European networks and opportunities.
- Deliver research to enable the UK economy to develop and adopt sustainable, resource-efficient, low-carbon, low-pollution and low-waste manufacturing.
- Deliver highly motivated individuals with the advanced technology skills required by a modern economy and with the potential to progress to senior positions in the boardroom and in academia.
- Better integrate the manufacturing research base, creating stronger links between disciplines and sector domains, and between discovery and UK industrial infrastructure.
- Increase the proportion of collaborative studentships within our Doctoral Training Grants.
- Increase company involvement in our provision of doctoral training.

## Case Study Example of Manufacturing the Future Theme Impacts

EPSRC-funded research has helped replace copper wiring with flexible printed circuits in cars. The techniques are already being used by Mercedes, Vauxhall and BMW and have resulted in weight reductions of up to 70kg. Initial production cost savings are estimated as between £130 and £240 per car.

## Energy – an RCUK Cross-Council Theme

EPSRC leads the RCUK Energy theme, bringing strategy to UK energy research in support of government targets. We are working with bodies such as the Low Carbon Innovation Group to secure a low-carbon future and meet the UK's $CORR_2$ reduction targets through reliable, economically viable energy systems while protecting the natural environment, resources and quality of life. We are also ensuring multidisciplinarity through the sponsorship of research in collaboration with the environmental, biological, economic and social sciences.

Success in realising the potential of the theme's investment is critically dependent on the long-term capacity of core engineering and physical sciences capability and the support of Grand Challenge-led research to meet the UK's 2050 climate targets.

In this Delivery Plan period we will:

- Accelerate the deployment of alternative energy technologies, working with TSB, ETI and others on joint challenges in offshore renewables, bioenergy, carbon capture and storage and eco-efficient technologies.
- Work with the Low Carbon Innovation Group[12] to target technologies with the potential to meet the UK's $CO_2$ reduction targets.
- Maximise the relevance of our portfolio and accelerate the route to impact by exploiting our partnerships with over 500 public and private sector organisations.
- Pursue high-risk, high-return speculative research to define future energy options – for example, the UK Fusion Programme and Grand Challenges such as next generation renewables and transport.
- Exploit our major links with China, India and the US, enabling leading researchers to address global energy challenges together.
- Support research on the social, environmental, economic and technical implications of energy research in order to understand future energy options.
- Train and develop new researchers, policymakers and business leaders in order to build UK capacity and vision of the whole energy innovation landscape.

## Case Study Example of Energy Theme Impacts

Aquamarine Power Ltd was formed from EPSRC-funded research at Queens University Belfast. Its wave farms, based around the Oyster wave energy converter, will be powering homes worldwide by 2013.

### Case Study Example of Digital Economy Theme Impacts

The 'How was school today?' project, which uses technology developed by EPSRC-funded scientists to enable children with disabilities such as cerebral palsy and learning difficulties to have conversations in a faster, more interactive way, won the Outstanding ICT Learning Initiative of the Year award at the 2010 Times Higher Education Awards.

## Digital Economy – an RCUK Cross-Council Theme

EPSRC leads the RCUK Digital Economy theme to transform lives through the novel design and use of information and communications technologies (ICT) and digital technology to deliver improved health and a more inclusive society.

The theme is driven by user need, and has 400 partners from diverse organisations ranging from the Alzheimer's Society to Amazon, O2 and Ordnance Survey.

In this Delivery Plan period we will:

- Ensure that companies and individuals benefit from the opportunities offered by novel uses of digital technologies.
- Promote research in new economic and business models to enable the UK to benefit from an increasingly global and borderless economy.
- Inform government policy by providing a long-term perspective on key social policy decisions and helping to transform the delivery of public services.
- Identify opportunities for the UK to provide high-value services across the globe.
- Deepen our engagement with government at both the national and local levels, to ensure the opportunities for people to have control of their lives using IT are realised rapidly, but with appropriate ethical and security considerations.
- Provide research outputs to enable communities to improve their lives with digital technologies which enhance interaction.
- Develop the trained people required for the new multidisciplinary research areas, new business growth and improved public policy and delivery.

## Healthcare Technologies – an EPSRC-Specific Theme

The growing, ageing and increasingly overweight UK population presents challenges to the public health bill. Such a challenge creates opportunities for UK companies within the healthcare technologies and pharmaceuticals sectors, among the strongest and fastest-growing markets in the world.

Our Healthcare Technologies theme, building on previous investment, will aim to build critical mass and strengthen translation pathways against this backdrop.

The research we support creates transformative healthcare technologies to enable earlier and better diagnosis, treatment and management of health conditions[13]; advancing the engineering and physical sciences knowledge and techniques essential to pull-through biology[14]; and enabling future healthcare systems that deliver more efficient personalised and localised care[15].

In this Delivery Plan period we will:

- Develop a coherent and integrated Healthcare Technologies theme with more focus on capability, priority areas and greater multidisciplinary working.
- Invest in emerging and potentially transformative research areas, including transformative diagnostics and therapies.
- Strengthen research leadership on key healthcare challenges, for example regenerative medicine and drug delivery.
- Partner with other healthcare research funders, including business, to increase the translation of transformational research into early stage clinical research and new products and practice.
- Partner in the cross-Council Ageing: Lifelong Health and Well-Being theme, led by the Medical Research Council.

### Case Study Example of EPSRC's Contribution to UK Healthcare Improvements

ApaTech, a spin-out company born out of EPSRC-supported research, and a world-leader in bone graft technologies, was sold for $330 million in March 2010. It was the UK's fastest-growing medical technology company in 2007, 2008 and 2009.

# CROSS-COUNCIL THEMES

**We are a partner in all other cross-Council themes, working to integrate the contribution of research and PhD training in the engineering and physical sciences within each theme.**

## Living With Environmental Change (LWEC)

EPSRC is a key member of LWEC, a 10-year partnership of major public sector funders and users of government research that aims to optimise the effectiveness of UK environmental research funding.

In this Delivery Plan period we will:

- Ensure the design and delivery of multidisciplinary programmes, as well as linkage to policy and practice.
- Stimulate and support new activity on large-scale solutions to water scarcity.
- Address key questions in the design, operation and maintenance of critical UK infrastructure, including waste, water, transport and the built environment.

## Global Uncertainties (GU)

With a long track record in crime and security research, we make a major contribution to this theme. All our core programmes contribute, and we are the largest Research Council sponsor of this topic.

In this Delivery Plan period we will:

- Shape the portfolio around the government's strategy for countering terrorism[16], providing cyber security, and citizen safety.
- Continue to secure impact by partnering with relevant organisations including the Home Office, GCHQ, and the US Department of Homeland Security.

## Lifelong Health and Well-Being, Global Food Security and Connected Communities

Our contribution to these themes will be embedded within the Healthcare Technologies, Manufacturing the Future and Digital Economy themes.

### Societal Issues

Each of our priority challenge themes faces questions relating to ethics or conduct, and public engagement, deriving from the interaction of upstream research with society at large.

In this Delivery Plan period we will:

- Where appropriate, extend our involvement of the public in shaping research strategy through dialogue with the public.
- Continue embedding and accelerating the use of such approaches to contextualise sensitive research, and to generate researchers' awareness of these tools so they can improve their ideas while retaining the trust of society.

# INTEGRATED RCUK ACTIVITIES

## Public Engagement with Research

We will continue to support through RCUK coordinated activities aimed at engaging the public with research. The detailed programme will be finalised in early 2011. The new Concordat for Public Engagement provides a key focus for this activity.

With the advice and guidance of its Societal Issues Panel, EPSRC has supported its own public engagement programme that complements the RCUK effort and has made major progress in inculcating the value of public engagement within its portfolio and within the research community.

As well as our support for the RCUK engagement activities, in this Delivery Plan period we will:

- In line with the Concordat, accelerate the delivery of our vision to more fully embed public engagement into our research and training portfolio by, for example, using Pathways to Impact and promoting 'responsible innovation'.
- Continue to operate a strategic advisory process that provides high-level advice on our public engagement efforts.
- Strategically use public dialogues to inform our thinking in those specific programmes and themes where consideration of ethical and societal issues will be of most value.
- Cease to support dedicated public engagement activity while expecting our research leaders to engage with the public.
- Collect and evaluate the results of our embedding strategy through our commitment to the RCUK Research Outcomes Project.

## International Collaboration

For UK research to have maximum impact, our researchers need to work with the very best on the global stage. RCUK international offices have helped to achieve this: EPSRC has committed £48 million to joint activities with agencies in the USA, China and India.

In this Delivery Plan period we will:

- Focus on collaborations in our high priority activities.
- Identify with our key universities those overseas institutions where exchange programmes for students can broaden their research experience – and help develop the next generation of leaders.
- Gain a better understanding of the international research landscape to enable the UK to remain an 'intelligent customer' and to decide where the opportunities are for UK investment.

## Research Careers and Diversity

We remain committed to the development of early career researchers, both to develop the skills to benefit the wider economy and to ensure the continuing pipeline of excellent researchers for the nation. Skills and leadership are foremost in our plans.

In this Delivery Plan Period we will:

- Continue to support the implementation of the Concordat on Researcher Development[17].
- Work across RCUK and with other partners to ensure that the investment of 'Roberts' money is sustained in the longer term through the embedding of skills development within normal business.
- Work with universities to ensure a better understanding of our expectations for researcher development.
- Enable mobility to widen horizons and develop better researchers.

# OTHER GOVERNMENT RESEARCH AND DEVELOPMENT INITIATIVES

## Collaborations with other Government Departments

We have strong links with over 10 government departments; and our Council and senior advisory bodies have CSA representation. In addition to contributing to policy development in areas such as climate change, transport and nuclear power, we have a high-profile collaboration with DfT on sustainable transport; we are supporting a jointly-funded Natural and Environmental Risk Centre with Defra[18]; and we are working with the MoD on projects such as the generation of electricity from human movement that will make soldiers 'battery-free'.

In this Delivery Plan period we will:

- Build, or maintain, strong relationships with key departments both to provide advice and share information on future research priorities.
- Create routes for timely policy advice to ministers and provide policymakers with better access to our current portfolio.
- Combine resources to create strategic programmes attracting business leverage.
- Secure multiplier effects for public funding.

## Partnerships for Critical National Infrastructure

Our research supports the government's ambitions for an effective and modern infrastructure and is critical in many areas including energy, the environment and digital communications.

Within our current, substantial portfolio[19], we draw on user needs to shape the research, in turn feeding into decisions about future infrastructure.

In this Delivery Plan period we will:

- Make new investments in research into the planning, building, maintenance and operation of more efficient, resilient and sustainable transport.
- Invest in the construction aspects of manufacturing, communications, water and energy networks and waste management systems.

## Partnership for a Low-Carbon Economy¬ with the Energy Technologies Institute (ETI)

The ETI public-private partnership is a 10-year initiative established in December 2007 to address the challenges posed by climate change and energy security within a UK low carbon context.

EPSRC and the Technology Strategy Board provide the public sector funding in ETI, matching core member contributions from a limited number of industry members. We will work with ETI with the aim of maintaining a focus on a limited number of systems-level development and demonstration projects to ensure it has maximum impact in high priority areas, rather than seeking expansion. EPSRC will encourage ETI not to add more partners unless they offer exceptional additional value.

The value we will be seeking from ETI is:

- Continued pull-through of ideas and skills from the research base into ETI strategy development and projects.
- Demonstrable impact of ETI projects, highlighting the exploitation of knowledge generated through Research Council funding.
- ETI funding for new training and capacity building, joint with the RCUK Energy Theme.

## Partnership for Economic Growth and Prosperity – with the Technology Strategy Board (TSB)

Our partnership with the TSB is a key component of our contribution to the UK's economic growth, social benefit and prosperity because of the joint and complementary areas of research we invest in and their relevance to business and growth.

Without the knowledge we generate and the skilled people we develop, TSB would not be able to support many of the innovation activities in which it excels. We will protect funding in programmes that link directly to the TSB and hence such support will increase as a proportion of our portfolio.

The precise use of our funding between the modes of TSB activity will depend on the nature of the relationship in the priority themes, and the TSB budget settlement, but we can expect a mixture of larger and longer investments through approaches such as Innovation Platforms and Innovation and Knowledge Centres as well as joint funding within specific collaborative R&D calls.

We will continue to have a high level of involvement with TSB priority areas and have, through RCUK, agreed a suite of themes which run across Research Council interests.

Top priorities for EPSRC, on which we expect to lead and which are critical for economic growth, are: High Value Manufacturing, Digital Economy and Energy. Our plans protect these areas.

In this Delivery Plan period we will:

- Build joint programmes that complement the TSB's, underpinning priority themes include high-value manufacturing and development of high-risk, emerging technologies to grow existing markets and develop new industries.
- Create and reinforce critical mass in identified areas of core national capability, particularly through our Innovation and Knowledge Centres (IKCs) and centre approach, especially in advanced manufacturing.
- Increase the accessibility of our portfolio to users by working closely with, for example, the TSB Knowledge Transfer Networks and the TSB e-Connect system.

## Partnerships for Growth – Technology Innovation Centres (TICs)

We will work closely with TICs to help bridge the gap between universities and business – helping to commercialise the outputs of our current and future investments in world-class academic research.

In this Delivery Plan period we will:

- Enable opportunities for close alignment of EPSRC investments with appropriate TICs to provide business-inspired training support for our Centres for Doctoral Training.

### Case study: EPSRC Investment Alongside the Technology Strategy Board[20]

Accelerating the commercial potential of emerging technologies such as photonics and electronics manufacture and regenerative therapies, EPSRC is investing £25 million in four Innovation and Knowledge Centres (IKCs) with additional contributions from the TSB of £5 million and BBSRC of £3.5 million.

# ECONOMIC IMPACT

## A world-class research base generates economic and social benefits. We will embed the delivery of impact throughout our entire portfolio.

### What users need

Impact starts with our commitment to the most excellent long-term, fundamental research. Studies[21/22] show that companies are attracted by skills or preferentially locate near to universities, and that[23] industry emphasises the importance it places on access to new methodologies and instrumentation developed from discovery-led research.

Our strategic partners in industry and other user organisations stress they cannot justify their own funding of the fundamental research EPSRC supports and which can only be expected to have economic and social outcomes in the much longer term – they therefore look to us.

### UK priorities

Engineering and physical sciences impact on all key UK sectors. We will secure maximum impact from our entire portfolio, including through the measures we will take to shape capability and deliver impact.

Through careful selection of priorities within challenge themes, we will meet user needs where pull-through of capabilities is paramount.

Manufacturing the Future, Digital Economy, Energy and Healthcare Technologies are all crucial for the success and sustainability of the UK economy and as a proportion of our portfolio our investment in these themes will increase.

### Brokering relationships

We already have a portfolio where 43 per cent of our research grants are collaborative, where our researchers work with some 2,300 user organisations and where we leverage a contribution of £700 million from such partners.

As a sponsor of research we will make the contents of our portfolio more readily available to a wider set of users to further build on our work and develop a more sophisticated sector-based partnership with business.

We will identify where the research strengths are within our portfolio, and then broker relationships so that our strongest academic groups focus on the key user-related challenges.

## Co-creation

Recent research[24] demonstrates that impact is maximised when users and academics work together to formulate problems and work in 'shared spaces'.

We will ensure the user community plays a significant role in shaping research directions.

This builds on past success: our 29 strategic partnerships enable us to work with user organisations to form new programmes and support individual projects.

We have leveraged £179 million as a direct result of these partnerships but, more importantly, we have funded research where the opportunities for impact are maximised.

In this Delivery Plan period we will increase the potential value of our strategic alliances through multiple partnerships across sectors and with other sponsors.

## Key partnerships for prosperity

Our partnerships with the TSB, the ETI, and in due course with TICs, are a key component of our contribution to economic growth and prosperity.

Our vision is to ensure a seamless exchange of ideas and outputs to deliver innovation opportunities developed from the long-term research we sponsor.

We support the discovery end of innovation, delivering excellent research and training, and recognise that the value to the nation is through the effective use of those outputs by others.

In this Delivery Plan period we will maintain our successful partnership with TSB and ETI to ensure that their expertise in industry-led innovation complements ours in long-term sustained knowledge and skills creation.

## Skilled people

Highly-skilled people are the most important output[25] from our research investments, and with industry warning of STEM skill shortages[26], it has never been more important to ensure our people have the skills most valuable to industry.

We will act to further improve the quality of PhDs by increasing the proportion of students funded via cohort approaches.

## User-focused students

With some 30 per cent of all studentships (such as Industrial CASE) being collaborative and with 1,000 user partners, we are already highly successful in leveraging funds and ensuring our students develop the appropriate skills.

Our commitment to increasing impact will result in further incentives to universities to increase the proportion of collaborative studentships within our Doctoral Training Grants.

# DRIVING EFFICIENCY

## We will do more to ensure the UK gets the best value for money from our investments by providing stable funding to key individuals and by continuing to drive efficiencies.

We have already achieved a saving of £160 million by reducing the proportion of budget spent on administration; growing the co-funding of research; reprioritising funding to target new and emerging opportunities; and implementing more efficient practices[27].

One of these practices has been to manage the demand for research funds, which has led to increased efficiency of the grant application system and influenced university behaviour, encouraging applicants and senior university management to think more strategically about, and therefore submit fewer, research applications.

The introduction of our demand management policies has resulted in a sustained improvement in success rates such that across the research portfolio our average success rate is now at 35 per cent (32 per cent for responsive mode) and fully in line with the target we had established for the policy.

Building on our success in this Delivery Plan period we will:

- Transform research and training administrative processes by, for example, further pooling resources across Research Councils through initiatives such as merging retained IT support.
- Through strategic dialogue with university leaders, we will encourage a more cohesive, nationally-focused approach across the research sector, emphasising: commonality of purpose, efficient use of resources (including facilities and equipment), and complementary approaches rather than just relying on competitive modes of working.

  More of our capital investments in the future will be in shared facilities and will be located and sustainably resourced so that they can meet the needs of research organisations. This may include ceasing support for larger routine capital on research grants and instead requiring applicants to identify where they will source access to equipment available elsewhere.
- Obtain better value by building critical mass in our research groups.
- Focus our strategic partnerships with industry, charities and public sector partners and further encourage collaboration on our grants with the aim of attracting additional funding in cash and kind.
- Our participation in the RCUK Shared Service Centre will result in a streamlined and more consistent experience for our community, leading to efficiency gains both in the Research Councils and in the community.
- Implement the RCUK response to the recommendations contained in the Wakeham report. With other Research Councils, we are committed to working with research organisations to drive down the full economic cost of research undertaken whilst retaining their commitment to funding research on the current Full Economic Cost (FEC) basis. Research Councils are examining further options for driving efficiency savings which in turn will be reinvested in research. It is expected that these recommendations will be implemented from 2011.

# WHAT'S NEXT?

Having received our budget settlement, we will now develop our detailed implementation plans.

The planned annual resource expenditure in 2014/2015 represents a decrease of three per cent in resource and of 50 per cent in capital compared with our expenditure in 2010/2011.

The following tables show our planned Programme Resource and Capital Expenditure on an annual basis for the period 2011/12 to 2014/15. The 2010/11 baseline expenditure is shown, presented to compare with the 2014/15 Delivery Plan mechanisms and themes.

These figures by mechanism and research theme are planning figures, the actual spend may vary.

## PLANNED EXPENDITURE BY MECHANISM

| | Resource | Baseline | Allocation by mechanism by financial year | | | |
|---|---|---|---|---|---|---|
| | | 2010/11 £ million | 2011/12 £ million | 2012/13 £ million | 2013/14 £ million | 2014/15 £ million |
| Near Cash Programme Resource | Research grants | 433 | 409 | 385 | 382 | 372 |
| | Studentships | 129 | 133 | 137 | 138 | 142 |
| | Fellowships | 51 | 44 | 44 | 44 | 46 |
| | Multi-user council owned/sponsored facilities (HPC) | 11 | 11 | 11 | 11 | 11 |
| | International subscriptions | 0 | 0 | 0 | 0 | 0 |
| | Knowledge transfer activities (excluding ETI) | 150 | 152 | 156 | 154 | 154 |
| | ETI | 7 | 15 | 17 | 19 | 21 |
| | Programme operations | 12 | 12 | 12 | 12 | 12 |
| | **Total** | **793** | **776** | **762** | **760** | **758** |
| Near Cash Programme Resource Income | Co-funding | -16 | -12 | -11 | -10 | -8 |
| | Earned income | -6 | -4 | -3 | -2 | -2 |
| | **Total** | **-22** | **-16** | **-14** | **-12** | **-10** |
| **Net Near Cash Programme Resource Expenditure** | | **771** | **760** | **748** | **748** | **748** |
| Programme Depreciation | | 10 | 11 | 11 | 8 | 7 |
| **Programme Resource Expenditure** | | **781** | **771** | **759** | **756** | **755** |
| Programme Capital Expenditure | | 49 | 46 | 35 | 25 | 25 |
| **Total Programme Expenditure** | | **830** | **817** | **794** | **781** | **780** |

## PLANNED EXPENDITURE BY THEME

| | Resource | Baseline | | Allocation by mechanism by financial year | | | |
|---|---|---|---|---|---|---|---|
| | | 2010/11 £ million | | 2011/12 £ million | 2012/13 £ million | 2013/14 £ million | 2014/15 £ million |
| Near Cash Programme Resource | Manufacturing the Future | 74 | | 78 | 79 | 82 | 83 |
| | Energy | 104 | | 109 | 109 | 109 | 112 |
| | Digital Economy | 24 | | 26 | 26 | 27 | 27 |
| | Healthcare Technologies | 74 | | 76 | 76 | 76 | 76 |
| | Other themes (LWEC, GU) | 18 | | 17 | 17 | 17 | 17 |
| | National capability | 458 | | 427 | 412 | 406 | 400 |
| | ETI | 8 | | 15 | 17 | 19 | 21 |
| | Programme operations | 12 | | 12 | 12 | 12 | 12 |
| **Net Near Cash Programme Resource Expenditure** | | **771** | | **760** | **748** | **748** | **748** |
| Programme Depreciation | | 10 | | 11 | 11 | 8 | 7 |
| **Programme Resource Expenditure** | | **781** | | **771** | **759** | **756** | **755** |
| Programme Capital Expenditure | | 49 | | 46 | 35 | 25 | 25 |
| **Total Programme Expenditure** | | **830** | | **817** | **794** | **781** | **780** |

**Notes for tables**

EPSRC will consider using the flexibility to vire resource into capital where necessary. We have not had confirmation of Administrative Expenditure allocation.

The total RCUK planned spend in this Delivery Plan period for Energy is £540 million and for Digital Economy is £129 million. The spend in the theme table is based on attributing activities to one theme only, giving priority to Manufacturing the Future, Energy and Digital Economy. Some activities make significant contributions to more than one theme. Allowing for this, our planned spend over the Delivery Plan period for the other cross-Council themes is: Global Uncertainties - £64 million; Living with Environmental Change - £54 million and Lifelong Health and Wellbeing - £23 million. We plan to spend £95 million in total over the Delivery Plan period in collaboration with the Technology Strategy Board (TSB); this is dependent on TSB's allocation and plans.

## Implementation Plan

We will develop an Implementation Plan, to be published before April 2011, in which we will define specific activities and set targets for the Delivery Plan period.

Subsequent detailed plans will describe our activities under each of our three principal goals, Delivering Impact, Shaping Capability and Developing Leaders, and explain how we will integrate all three.

Following that, and working with our advisory streams, we will define and publish in early summer our first landscape of UK capability to guide investment choices.

Over the coming months, we will also be transitioning our approach from a research funder to a research sponsor and we look forward to working even more closely with the leading groups in our research community and research users to keep the UK at the heart of global research and innovation and to create a stronger, healthier and more prosperous UK.

# END NOTES

1 'Engineering and Physical Sciences in the UK', SPRU, 2003 – report commissioned by EPSRC and updated in 2009.

2 Adapted from article by David Lathbury, at the time Head of Process Chemistry, Astra Zeneca, in Chemistry World, September 2009.

3 "EPSRC is the best, most fair and least bureaucratic [funding] system I have ever experienced...This leaves some time for actual research." Andre Geim, winner of the 2010 Nobel Prize for Physics, quoted in Physics World, November 2010.

4 "In the US, there is some evidence of success of investigator-focused funding. The Howard Hughes Medical Institute Investigator program provides long-term funding to individuals. When compared with scientists of equal calibre receiving conventional funding, HHMI investigators are more productive and more likely to conduct research in frontier areas." The Scientific Century, Royal Society 2010, p48.

5 One example of this is the basic technology work to develop an electric potential sensor for measurement by the University of Sussex, which has been applied to date in 13 different instruments from neuro-physiology to materials imaging.

6 Further details outlining the future shape of the research and training landscape that we will support will be published in spring 2011.

7 "Research Councils should consider resource 'packets' across the system, in a way that reduces the lower value margin while enhancing the rest. For example, there could be fewer but better funded studentships to encourage higher-quality candidates." The Future of Research, UUK, July 2010.

8 For example, adoption of the methodology by the NSF.

9 Creativity@Home is an EPSRC initiative to generate and nurture creative thinking and transformational research using professional facilitators to work with researchers.

101/7th of the economy; 14.3% of GDP; 50% of exports; 75% of business R&D; three million people employed, Advanced Manufacturing, BIS, 2009.

11 "In the process of knowledge creation leading to innovation, companies rarely operate in isolation. Rather, they draw on multiple sources of knowledge and information including university research... Policies should seek to develop a good science base." – NESTA, Rebalancing Act, 2010.

12 The Low Carbon Innovation Group is made up of the Department of Energy and Climate Change, the Technology Strategy Board, the Carbon Trust, the Department of Business Innovation and Skills, EPSRC for the Research Councils and the Energy Technologies Institute.

13 For example, medical imaging and data visualisation, drug design, novel drug delivery, personalised medicine, tissue engineering, robotic surgery.

14For example, chemical biology, integration of biomarkers and diagnostics, regenerative medicine, stem-cells, medical modelling and simulation.

15For example, information-driven healthcare, digital inclusion, point-of-care diagnostics and devices, computational statistics, systems engineering.

16 Pursue, Prevent, Protect, Prepare: The United Kingdom's Strategy for Countering International Terrorism (CONTEST), March 2009 & A Strong Britain in an Age of Uncertainty – the National Security Strategy.

17 The Concordat to Support the Career Development of Researchers – An Agreement between the Funders and Employers of Researchers in the UK, 2009.

18 With ESRC and NERC.

19 Within both our core National Capability and in strategic programmes such as the Sustainable Urban Environment Programme, Adaptation & Resilience to a Changing Climate, and Digital Economy.

20 Our commitments partnering with TSB in the previous Delivery Plan period are around £90 million, within a total portfolio of over £320 million with TSB and industrial support.

21 University Research and the Location of Business R&D (2006); Abramovsky, Harrison and Simpson, Institute of Fiscal Studies, WP07/02.

22 The implications of R&D off-shoring on the innovation capacity of EU firms, (2007) Helsinki School of Economics, Pro-Inno Europe Initiative, European Commission.

23 PACE Report: Innovation Strategies of Europe's Largest Firms: (1995) Arundel et al in The Benefits from Publicly Funded Research, Paper No 161. (2007) Martin and Tang, SPRU.

24 Valuing Knowledge Exchange: a summary of recent research (2009) Philip Ternouth and Cathy Garner.

25 For example, The economic effects of basic research: evidence for embodied knowledge transfer via scientists' migration (2003) Zellner Research Policy 32 pp 1881-1895 in The Benefits from Publicly Funded Research, Paper No 161. (2007) Martin and Tang, SPRU.

26 Stronger together – Businesses and universities in turbulent times, CBI, September 2009.

27 Savings will arise from more effective and efficient operations by working with HEIs to remove lower quality bids from the process and reducing administration and processing costs. In addition, further savings will be made (in 2010/11) by constraining the inflationary aspects of research grants already in operation.

**This Delivery Plan provides a high-level overview of our plans for the period 2011/12 to 2014/15. It describes our principles and priorities, and outlines the approaches we will use. We have been guided by the aspirations set out by the government for science and engineering to be strong, sustainable and effective, and to play a key role in economic growth, social benefit and sustainability. We will set out more detailed plans in separate publications over the coming months.**


**Address**

TEngineering and Physical
Sciences Research Council
Polaris House
North Star Avenue
Swindon
SN2 1ET

**EPSRC Helpline**

For general enquiries call 01793 444100
or email infoline@epsrc.ac.uk

**www.epsrc.ac.uk**


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