



DELIVERY PLAN 2011-2015



Natural Environment Research Council
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Contents		
Executive summary		1
1	Strategic context	3
1.1	Environmental opportunities and challenges	3
1.2	Environmental science for economic growth and well being	4
1.3	Delivering NERC strategy with greater impact and efficiency	5
2	Research and training priorities	7
2.1	NERC priorities for research and training	7
2.2	NERC national capability	15
2.3	NERC contribution to other RCUK integrated activities	17
2.4	Other Government R&D initiatives	18
2.5	Health of the research base	19
3	Economic impact	20
3.1	NERC vision for achieving greater impact	20
3.2	Delivering greater impact	20
3.3	Evidence for and demonstrating impact	22
4	Financial delivery analysis	23
4.1	Resource (programme) budget	23
4.2	Capital budget	23
4.3	Resource (administration) budget	24
Annexes		
A	Financial analysis	25
B	References	27

Executive summary

Environmental science for UK economic growth and wellbeing

Human activities are causing large changes in the environment, jeopardising both natural resources - such as food, water and energy - and the resilience of society and its infrastructures to extreme natural hazards. These same environmental pressures create major opportunities for the UK to seize new markets in the global race to a green economy - the UK environmental economy alone is projected to grow by £48bn in the next eight years.

Environmental science is at the heart of accessing these new economic opportunities and building resilience to environmental shocks. For example, it: unlocks the potential of carbon capture and storage; supplied the evidence that underpins the recent marine bill; reduces insurance losses by predicting extreme weather; provided rapid response to get planes flying after the volcanic ash cloud; and inspires the next generation.

NERC leads for the UK in delivering world-beating environmental knowledge, skills and partnerships with the strongest potential for economic growth and societal wellbeing. Living With Environmental Change (LWEC) is a transformative cross-Government partnership. It provides greater efficiency and impact - accelerating the translation of research into environmental policy, business and society. NERC science and partnerships enable the UK to rapidly absorb and exploit new knowledge and technologies, and to overcome risks that act as barriers to private investment in new technologies and businesses.

NERC strategic agenda

NERC will implement five actions to strengthen delivery of its strategy *Next Generation Science for Planet Earth*. These strategic actions will transform and sustain an efficient portfolio of national capability, research, training and knowledge exchange that delivers excellence with impact for the UK during 2011-15 and beyond:

Action 1: Increase focus on strategic research

NERC will increase the share of its budget allocated to top priority strategic research programmes that address the critical environmental issues for the UK economy and society. Priorities will be driven by RCUK and NERC strategy themes, and informed by business, Government and society - most notably through the LWEC programme (section 2.1.1).

Action 2: Increase economic impact and societal benefit

NERC will maintain the share of its budget spent on support for knowledge exchange. We will strengthen our engagement with business by focusing on five key economic sectors where research can inform business and policy for economic growth: marine renewable energy; environmental management for food and agriculture; water security; resource management; and financial services. We will also lead the LWEC business advisory board with TSB, and further strengthen partnerships between researchers and policy-makers (section 3).

Action 3: Attract and retain top talent for the UK

NERC will sustain the supply of top talent by focusing postgraduate training: towards the strategic skills needs identified by employers of trained environmental scientists; and towards multidisciplinary doctoral clusters of excellence to provide the highest quality training environment. NERC will maintain doctoral training at current levels, and will withdraw from taught-masters training (section 2.1.3).

Action 4: Transform delivery of national capability

NERC's six research centres will operate together to deliver a single, integrated national capability strategy. Integrating our environmental science capability will enhance the delivery of: Earth-system science; international leadership; a single hub for entrepreneurial research partnerships with business and policy-makers; holistic environmental solutions for greater impact; administrative and efficiency savings (section 2.2).

Action 5: Shift resources into front-line science

NERC will continue to drive efficiency savings by working with RCUK, the Funding Councils and HEIs to: integrate corporate services; maximise Shared Services Centre efficiencies; manage down demand for grants; drive the efficiency of peer-review processes; deliver funding through larger investments; and implement the Wakeham Report recommendations for efficiency of research and facilities. Within NERC we will drive efficiency savings in national capability delivery by our centres (action 4 above) and in our corporate operations based in Swindon (section 4).

NERC budget allocations

By the end of the spending period 2011-15, the annual NERC resource (programme) budget will have reduced by 3% (excluding the effects of inflation). This budget will support the vital national capability, strategic research programmes, responsive mode, postgraduate training, knowledge exchange and other activities described in this plan.

The NERC capital budget will be reduced by 50% (excluding inflation) from 2012/13. Additional funds for new RCUK facilities have been allocated through the BIS Large Facilities Capital Fund, including a contribution to replacing a NERC research ship. In the short term, this provides sufficient funds to meet NERC's current capital commitments.

The administration budget is yet to be announced, but is expected to reduce.

Despite these budget reductions, NERC will protect front-line science as much as possible by re-investing efficiency savings, and by investing capital in vital facilities.

1. Strategic context

1.1 Environmental opportunities and challenges

The natural environment provides business, Government and society at large with the essential resources and beneficial services to sustain life, economic growth and societal well-being. These include: food; energy; minerals; clean air and water; regulation of flood, climate and disease; mental and physical health and life expectancy.

The provision of these resources and services is at threat. Human activities are causing large-scale change that is detrimentally affecting climateⁱ, land use and biodiversityⁱⁱ. Rapid economic and population growth are putting increasing pressure on the economy, society and the environment, creating a “**perfect storm**” of water, food and energy shortagesⁱⁱⁱ. Changing climate and water cycle (floods and droughts), together with other natural hazards, are widely recognised amongst the greatest threats to the sustainability of life on Earth.

However, these same environmental pressures create major opportunities to seize new markets in **the global race to a green economy**. Indeed, the UK environmental economy is predicted to grow by £48bn (45%) over the eight years from March 2009, in spite of the economic downturn, creating an extra 400,000 jobs^{iv} ^v. There are even greater opportunities for the UK to lead in global markets where, for example, low carbon goods and services are currently worth £3.2 trillion and estimated to grow to over £4 trillion by 2015^{vi}.

Environmental science is at the heart of accessing these new economic opportunities and building resilience to environmental shocks.

A successful green economy will simultaneously enable economic growth, increased resilience, lower use of carbon and energy, and sustainable environmental services. NERC-funded science is essential for delivering the green economy through:

- **UK competitive advantage:** finding new ways to exploit environmental resources and services optimally, to create and grow new markets and businesses.
- **UK policy leadership:** policy and regulation informed by foresight of environmental opportunities and constraints, and understanding of the process of environmental change.
- **Improving UK business performance:** using environmental technologies, services and solutions to optimise business and environmental sustainability.
- **Transforming UK public services:** enabling a resilient society - protecting vulnerable people, places and infrastructure - providing a secure supply of food, energy and water.

UK competitive advantage

- The UK is rich in energy resources like wind, wave and tidal power, and NERC science unlocks its exploitation. For example: understanding the sea bed, ocean processes and impacts on marine wildlife, reduces investment risk to enable growth in new tidal energy technology, worth up to £1bn to the UK by 2050.
- Carbon Capture and Storage (CCS) could be worth up to £4bn pa and 60,000 jobs to the UK by 2030. NERC science played a key role in getting CCS to the demonstration stage, assessing capacity under the North Sea and the risk of leakage.

UK policy leadership

- The UK is a world leader in environmental policy development due to the strength of UK environmental science. The UK is 1st among G8 nations for science quality (as measured by citation impact) and contributes more to IPCC assessment reports than other nations.
- The UK is rich in marine biodiversity, food, energy and mineral resources. NERC science underpins Government policy and regulation for territorial claims, exploration, exploitation and protection of our seas and natural resources.

Improving UK business performance

- High-resolution climate models developed by NERC scientists with the Met Office are used by the £270bn reinsurance sector to predict hazards. Hurricane prediction alone is worth up to £130m in reduced insurance losses.
- NERC capability enabled Syngenta to develop the right wildflower seed mixes to boost bumblebees and other crop pollinators on 1000 UK farms, and to grow exports. Increased crop production is worth up to £440m pa, 13% of farming income.
- A NERC research spin-out, Salamander, uses new technology to develop water supply monitoring systems. Sales will be worth up to £48m for the UK economy by 2016. Protecting business from burst water mains saves £47,000 per day in a large city.

Transforming UK public services

- NERC capability is rapidly mobilised for national emergencies such as the volcanic ash cloud, oil spills and earthquakes. Getting planes flying after the Iceland volcano saved airlines \$400m each day in lost revenue.
- Predicting coastal storm surges, and surface and underground flooding safeguards the London economy (£94m per flood day), future investment (£2.1bn pa), property (£2bn pa) and lives (£31bn pa).
- NERC atmospheric research informs Government policy on sulphur emissions, saving the UK £1bn pa associated with hospital admissions and premature deaths.

1.2 Investing in environmental science for economic growth and wellbeing

Now is a critical time to ensure that the required environmental knowledge is available and developed for the UK to lead the charge for a productive economy, a healthy society and a sustainable world. **Environmental science inspires** young people to understand how planet Earth works and how we can live sustainably in a changing world. It is vital also in enabling the current generation to invest now to secure well-being for current and **future generations**. By bringing together Government, business, policy and public partnership, we enable society to generate solutions. Without rapid advances in the science the solutions will not be feasible, effective or credible.

Fundamental environmental research and development in the UK depends overwhelmingly on public funding, where NERC is the dominant funder of long-term, strategic, multidisciplinary national capability. The Higher Education Funding Councils focus on institutional and disciplinary health through core funding. Smaller volumes of funding are provided by Government departments and agencies (such as Met Office, Environment Agency, Natural England), the Royal Society, EU and charities. Business R+D builds on, but does not substitute for, publicly-funded research.

The distinctive role shared by all Research Councils in relation to other funders is to provide strategic leadership and partnership in shaping research priorities and capability whilst delivering impact. Hence, in a complex research – policy – business landscape involving many players and disciplines, NERC plays a unique role in shaping environmental research priorities, national capability and infrastructure to deliver strategic research and skills.

Central to our plan is NERC leadership of the globally unique **Living With Environmental Change** (LWEC) programme. The LWEC partnership brings together top business leaders^{vii} with all the key government departments, devolved government departments and agencies that together can drive research and innovation. Through LWEC, NERC and its partners will transform the environmental research and training needed to ensure the UK is a leader in building new enterprises, driving innovation in existing businesses and building resilience to environmental change.

More generally, government investment through NERC supports the research excellence^{viii} and skills that enable the UK to:

- Generate the environmental science knowledge with the strongest potential for economic growth and societal well-being
- Rapidly absorb and exploit new knowledge and technologies from the UK and abroad^{ix}
- Lead international policy and regulation in key areas, such as climate policy, emissions targets^x
- Gain competitive advantage in new and existing markets, and create jobs^{xi}
- Attract private and foreign investment that generates economic growth^{xii}
- Transform public services, enabling public agencies, society and businesses to build resilience to environmental change^{xiii} and seize opportunities at national and local scales.

NERC leading key strategic partnerships for the UK

- Living With Environmental Change (LWEC) is a transformative cross-Government partnership that is accelerating the translation of research into policy, business and society with greater synergy, impact and cost-efficiency.
- NERC works with the Met Office to develop climate science and related services for government and business. This partnership will enable the UK to lead the world in providing climate information for decision-makers.
- With the US National Science Foundation, NERC co-leads global coordination of the environmental change research agenda through the Belmont Forum of research funders. The Forum will deliver knowledge to support national and international government action to mitigate and adapt to global and regional environmental change and associated hazards.

1.3 Delivering NERC strategy with greater impact and efficiency

Our strategy *Next Generation Science for Planet Earth* confronts the unprecedented environmental opportunities and challenges facing society and leads to NERC's strategic goal for CSR 2010 (see box right). The critical knowledge needed by business, governments and society at large will be delivered through strategic science and training investments, transformative partnerships and a reformed organisation, all supported by a world-leading research base.

NERC has a 10-year vision to deliver this strategy with even greater impact and efficiency. This vision comprises five key actions (below) that will **transform** the way NERC delivers. Together, the NERC strategy and vision will shape the actions we take during 2011-2015.

NERC strategic goal for CSR 2010

Secure competitive advantage for the UK in the race to a global green economy, and ensure the nation is resilient to environmental crisis by:

- Delivering strategic environmental knowledge with the strongest potential for the nation.
- Creating vibrant business and policy partnerships to co-design research and maximise its benefits.
- Transforming the delivery of NERC science to provide the most effective and efficient support.

Action 1: Increase focus on strategic research

NERC will increase the share of its budget allocated to top priority strategic research programmes. Priorities will be driven by NERC's strategic goal, and informed by business, Government, local authorities and society - most notably through the **LWEC** business and partners' boards, and public engagement (section 2.1.1).

Action 2: Increase economic impact and societal benefit

NERC will especially strengthen **engagement with business**. We will implement our new "impact action plan" to focus engagement on the key economic sectors where research can inform business and policy for near-term economic growth and emerging new markets. We will also lead the LWEC business advisory board with TSB, and further strengthen partnerships between researchers and policy-makers (section 3).

Action 3: Attract and retain top talent for the UK

NERC will increasingly **focus** postgraduate training: towards the strategic skills needs identified by users of trained environmental scientists; towards multidisciplinary doctoral clusters of excellence to provide the highest quality training environment; and by withdrawing from taught-masters training (section 2.1.3).

Action 4: Transform delivery of national capability

NERC's six research centres will operate together to deliver a single, **integrated national capability strategy**. This will strengthen our ability to direct NERC investments towards the critical multidisciplinary science priorities, and strengthen impact by driving entrepreneurial partnerships between researchers and the private sector. It will also deliver important administrative and efficiency savings (section 2.2).

Action 5: Shift resources into front line science

NERC will continue to **drive efficiency** savings. We will work with RCUK, the Funding Councils and HEIs to: integrate corporate services; maximise Shared Services Centre efficiencies; increasingly manage down demand for grants; drive the efficiency of peer review processes; deliver funding through larger investments; and implement the Wakeham Report recommendations for efficiency of research and facilities. Within NERC we will drive efficiency savings in national capability delivery by our centres (action 4 above) and in our corporate operations based in Swindon (section 4.3).

2. Research and training priorities

2.1 NERC priorities for research and training

2.1.1 NERC strategic research programmes (RP)

Strategic research priorities are driven by NERC's goal to *secure competitive advantage for the UK in the race to a global green economy, and ensure that the nation is resilient to environmental crisis* (see section 1.3). NERC will increase the share of its budget allocated to strategic research programmes (RP) to ensure the delivery of the new knowledge needed to achieve this goal. Strategic research addresses the highest priority environmental issues for the UK economy and society — such as flooding, drought and water quality; renewable energy, CCS and bioresources; and climate change.

Economic and societal benefit is at the heart of each investment, with all programmes contributing to the delivery of our 'impact action plan' (section 3). Recognising the multidisciplinary nature of the environmental opportunities and challenges facing society, many NERC research programmes are delivered through RCUK cross-Council themes and other partners. Such partnership is mandatory to the success of the cross-Council programmes, and enhances the impact of NERC science by providing its full disciplinary and societal context.

NERC contribution to RCUK cross-Council programmes

NERC priorities for RCUK programmes

- Increase the share of NERC budget invested in the following RCUK strategic programmes:
 - LWEC:** How to make vulnerable people, places, infrastructure more resilient to environmental change?
 - Energy:** How will renewable energy generation be optimised in the environment?
 - Global Food Security:** How to increase food production and sustain ecosystem health and services?

NERC will make particularly critical contributions across closely linked areas of three RCUK cross-council programmes - LWEC, Energy and Global Food Security - in a way that brings substantial partnership, leverage and impact. Together these RCUK programmes address the opportunities and challenges posed by the "perfect storm" of pressures on food, water and energy, exacerbated by population expansion and environmental change (see section 1.1). NERC investment in these three programmes, as with its overall strategic RP budget, will grow as a proportion of the total NERC budget. NERC will continue to lead the RCUK coordination of LWEC.

Living with Environmental Change (LWEC)

LWEC will transform environmental research and training to ensure the UK is a leader: building new enterprises, driving innovation in existing business, and building resilience to environmental change. The ten-year LWEC programme connects business, policy-makers, the public and other key stakeholders with world-leading researchers (across natural, engineering, economic, social and medical sciences plus cultural, arts and humanities research). LWEC will ensure national and international leadership for solutions to the challenges faced during this crucial period of environmental change. It will provide the knowledge and tools to make informed choices about the future.

LWEC's outcomes will stimulate the growth of the green economy so that the opportunities inherent in environmental change are captured by the UK. It will help to make better predictions and analysis of environmental change so that we can adapt and become more resilient, as well as helping people to mitigate or avoid the worst impacts as our environment is altered. Strategic co-ordination through LWEC delivers more value for the taxpayer at less cost.

LWEC will build on its existing foundation to become increasingly transformational: (1) in the way research is co-designed, co-ordinated and co-delivered into policy and business with greater impact and efficiency across 22 (and growing) Government departments and delivery agencies, together with local authorities and major companies; (2) in delivering outcomes that enable a “big society” where people, business, NGOs and local government can themselves adapt to environmental change and exploit new opportunities for green economic growth and wellbeing^{xiv}.

The LWEC Business Advisory Board is identifying business priorities and commercialisation opportunities for environmental research. Working with TSB, this board comprises business leaders from major UK companies (see reference vii), together representing key business sectors which can benefit from, and build resilience to, environmental change. NERC leads the overall LWEC partnership on knowledge exchange, and the LWEC partnership provides NERC’s principal mechanisms for engaging business, public sector and society on environmental change research and impact.

NERC’s leadership role in LWEC and in the ‘Belmont Forum’^{xv} of international funders presents a very strong opportunity for international leverage of NERC funding, notably with nations benefiting from increased spending on science. LWEC is a ‘ready-made’, unique partnership model that is ripe for upscaling to an international level. NERC seeks to accelerate and strengthen UK opportunities: for leverage with our international partners of choice; to secure policy leadership; to help UK businesses access global as well as national intellect and resource; and to de-risk new green technologies.

NERC will invest a total of £305m in LWEC over the CSR period 2011-15. This includes £15m of LWEC research to be closely integrated with the Global Food Security (GFS) Programme and £20m with the Energy Programme – in both cases this is additional to NERC’s direct investment in those RCUK programmes (see below), to ensure environmental change can be fully taken into account.

Selected LWEC deliverables 2011-15

1. **Climate change foresight and tools for policy-makers and businesses** to provide information at the local, regional and national scales to inform mitigation, adaptation and resilience through probability estimates.
2. **Valuation of ecosystems and their beneficial services for people** to enable local and national decision-making on the multi-functional use of land, freshwater and sea, and to optimise the services provided by the environment (food, water, energy, building material, etc).
3. **Transformed understanding of links between environment and human health** so that the role of environmental change in infectious diseases and pollution are built into public health plans and outcomes.
4. **Completion of Virtual Observatory pilot and extension to marine areas** demonstrating how novel technology can be used to intelligently monitor the multiple variables needed to understand environmental complexity and dramatically improve the efficiency of environmental monitoring.
5. **UK hosting of international conference in 2012: *Planet under pressure*** which will attract 2,500 global change researchers, policy makers, NGOs, development experts and business leaders to the UK, raising the international profile of UK research and strongly informing the subsequent UN Earth Summit in Rio de Janeiro.

Energy Programme

The NERC contribution is to optimise energy generation potential from the environment and to take a whole-system approach that considers multiple benefits, costs and trade-offs. For example, NERC science identifies the scale, location and opportunity of wind, wave, tidal and land-based renewable resources available for energy generation. By taking a whole-system approach – and drawing on related LWEC research – decisions for new energy installations can optimise energy generation alongside the sustainable supply of other services such as healthy soils, clean water and food supply. NERC also makes important contributions to oil and gas exploration, geological disposal of nuclear waste, and characterising carbon capture and storage capacity.

NERC will spend £20m over 4 years, supported by similar investment in energy-related LWEC research, to deliver:

1. **Whole-systems energy research and co-ordination** through the UK Energy Research Centre.
2. **Approaches to renewable energy sustainability** including land-based and marine renewables (including geothermal), algal bioenergy and methane hydrates.
3. **Support to industry in locating, developing and efficiently exploiting marginal North Sea oil and gas reserves** through improved knowledge of basin geology.
4. **Environmental potential for carbon capture and storage** by identifying UK underground sites for storage of carbon dioxide from power generation, assessing physical and chemical interactions, and informing risk-based predictions of long-term sustainability and environmental impact.
5. **Increased confidence in the underground disposal of nuclear waste** by assessing and addressing gaps in understanding of the associated physical and chemical interactions.

Global Food Security (GFS)

NERC investment of £15m over 4 years – supported by similar investment in food-related LWEC research – will focus in areas where the sustainability of ecosystems is essential to the security of both food production and of reducing greenhouse-gas emissions. The research will substantially integrate findings from LWEC on future environmental conditions.

As its main focus NERC will co-lead with Defra the Resource Efficiency theme in GFS, which aims to improve the efficiency with which water, energy, nutrients, pesticides and other inputs are used, whilst reducing waste throughout the food supply chain.

Global Uncertainties

NERC's minimum £4m spend over 4 years will include co-funding with ESRC a new interdisciplinary programme to build the resilience of populations to the increasing frequency and severity of multiple natural hazards in earthquake-prone and volcanic regions. Through research and knowledge-exchange activities, the programme will improve forecasting and uptake of scientific advice whilst increasing people's understanding of vulnerability and risk. NERC will also drive joint working between LWEC and Global Uncertainties on infrastructure, civil emergencies and engaging NGOs.

NERC strategic research programmes

NERC priorities for its strategic research programmes

- Increase the share of NERC budget invested in strategic research programmes.
- Develop and fund research programmes that deliver NERC's seven priority strategic themes.
- Leverage at least £130m of partnership funding during the CSR period 2011-15.

The NERC strategy identifies seven priority themes (see table below). The strategy has been co-developed with the RCUK cross-Council programmes, and its delivery is strongly dependent on the future success of LWEC, Energy and Global Food Security in particular. Accordingly, many of the strategic research programmes developed to deliver NERC's seven science themes are explicitly designed with partners to both deliver to, and benefit from, these broader RCUK themes.

Partners and beneficiaries of NERC strategic programmes (beyond the academic community) include:

1. **Strategically important UK business sectors** – for example: energy; food and agriculture; water; minerals; waste; construction; and financial services - which are reliant on environmental science to create new business opportunities. NERC impact will improve existing business performance and de-risk major infrastructure investments.
2. **Government departments and agencies** – eg: DEFRA; DECC; DFT; DFID; DCLG; devolved governments; Met Office; Environment Agency; Committee on Climate Change - which are reliant on independent environmental science to support intelligent, evidence-based environmental policy and regulation.
3. **Third-sector organisations** – development, environmental and membership-based charities and NGOs provide a very strong channel to public engagement, and rely on independent environmental science to shape their policies.
4. **International organisations** – environmental research funders, users and UN organisations in the developed and developing world, with which NERC develops international partnerships to achieve our shared goals.

NERC aims to leverage at least £130m of partnership funding during the CSR period 2011-15, building on the £71m partnership funding leveraged during the period 2008-11. There is a risk this ambition may not be realised if key partners are too constrained by declining budgets. Thus far, however, discussions with NERC's major UK and international partners indicate that the environment remains a high priority, and that partnership is even more important to them in austerity. Many of our international partners are beneficiaries of increasing science budgets, thus providing greater opportunity and stimulus for NERC international partnerships. Further new opportunities for leverage and impact arise from strengthening engagement with business (section 3). Hence we believe our leverage target is challenging but achievable.

Summary table of challenge-led strategic RP priorities

NERC strategy theme	Challenge-led priorities
Climate systems	<p>Next generation weather and climate prediction: A new approach to atmospheric modelling designed for next generation supercomputers will enable extreme weather and climate forecasts of sufficient detail and accuracy, seasons to decades ahead, for UK business and government to make better decisions and policy across many sectors.</p> <p>Changing water cycle: To develop predictive capability of the intensified water cycle, and its impacts, so as to enable business and government to build resilience, mitigate problems, and adaptive solutions to flooding, drought and water quality issues.</p> <p>Climate change impacts: Identifying and reliably measuring the impacts of climate change will allow businesses and governments to design appropriate adaptation measures and to reduce investment risk in major infrastructure projects.</p>
Biodiversity	<p>Harnessing biodiversity for the sustainability of ecosystems and beneficial services: Rigorous scientific assessment of how much biodiversity is required for ecosystem services (food, clean water, fresh air, healthy soils, etc), to inform sustainable management and policy decisions.</p> <p>Ecosystem services for poverty alleviation: Providing decision-makers in developing regions with the evidence they need to manage ecosystems in a way that contributes to poverty reduction and sustainable growth.</p>
Sustainable use of natural resources	<p>Marine renewable energy: Research to optimise the environmental benefits of wave and tidal energy systems required to meet UK government marine renewable targets.</p> <p>Effects of climate and land-use on nutrients and resources: Understanding how essential macronutrient cycles (nitrogen, phosphorus, carbon) interact will provide policy-makers and businesses with critical understanding of: the capacity of the biosphere to sequester carbon and nitrogen; improved measurement of greenhouse-gas emissions; risks to the quality of soil, freshwater and biodiversity.</p>

NERC strategy theme	Challenge-led priorities
Natural hazards	<p>Storm and flood-risk mitigation: Integrating information from weather and climate impact models will enable the design of short-term strategies to minimise risks from mid-latitude storms that are likely to be a main cause of loss of life or assets in the UK in coming decades. Catchment research will critically inform radical new approaches to flood-management based on the adaptation of natural systems.</p> <p>Building resilience in earthquake-prone and volcanic regions: Interdisciplinary research to improve the forecasting of multiple natural hazards, which are increasing in frequency and severity, will increase people’s understanding of vulnerability and risk.</p>
Environment, pollution and human health	<p>Environmental pollutants and impacts on human health: Combined environmental and medical research will inform cost-effective, evidence-based policies and practices to reduce the adverse health effects of infectious pathogens and contaminated water, land, food and air.</p>
Earth system science	<p>Arctic change and its feedbacks on the global Earth system: Arctic ice is melting, with potentially large impacts on the UK climate and economy. This research will greatly improve our ability to predict these changes and impacts months to decades ahead.</p> <p>Ice-sheet stability and sea level rise: Understanding why the loss of ice from the West Antarctic Ice Sheet has recently accelerated will strengthen our ability to predict future ice losses and to plan for the resulting sea-level rise that will impact people in the UK and globally.</p> <p>Ocean acidification: The oceans are acidifying. Research co-delivered with Defra and DECC to understand the effects will enable evidence-based policy decisions on marine bio-resources, habitats and biodiversity.</p>
Technologies	<p>Technology proof of concept: High-risk, high-reward investments will drive the development of new and innovative technology for applications in environmental science, with strong emphasis on pull-through into commercial products and services.</p>

2.1.2 Responsive research (RM)

NERC priorities for responsive mode

- Sustain the flow of excellent, innovative research and leaders by maintaining the share of NERC budget invested in RM projects and fellowships.
- Recognise and promote the outcomes, impacts and benefits of responsive funding.
- Reduce demand for research grants.
- Implement the Wakeham recommendations for efficiency of research and facilities in HEIs and institutes.
- Consolidate RM schemes and processes, and balances between them, to deliver NERC strategic needs.
- Enable responsive mode to better inform NERC strategy development.

Responsive mode supports excellent research projects and fellowships in response to unsolicited ideas in any area relevant to NERC's remit. It sustains the UK's position as a world leader in environmental sciences to drive essential discovery and innovation, and to develop the next generation of research leaders. It embraces the full spectrum of research drivers and approaches including pure, applied, policy-driven, technology-led, adventurous, collaborative and multi- or inter-disciplinary research.

While responsive mode funding is predicated on science excellence, much of the research supported through this mechanism also incidentally contributes to NERC's strategic priorities. NERC will ensure that major investments of this ilk are brought into the delivery of relevant strategic research programmes.

NERC priorities for developing responsive mode during 2011-15 are summarised in the box above and detailed in the NERC Responsive Mode Action Plan^{xvi}. This plan was developed alongside evolving RCUK plans to further harmonise research-funding processes and to manage demand for grants. In addition to "pathways to Impact", NERC will increase the economic and societal impact of RM by promoting outcomes of the 2010 evaluation of RM, and by targeting knowledge exchange support where it contributes to priority business sectors and emerging markets (see section 3).

Demand management: Research Councils are working together through RCUK on how best to manage demand for funding in their communities, recognising that demand levels and demand management practice currently vary between councils. Councils have agreed the following core principles to guide their approach to managing demand. Councils will:

- Work in partnership with research organisations to develop a collaborative approach to managing demand and quality-assuring research proposals.
- Discuss plans for demand management with stakeholders.
- Develop and share tools for demand management across RCUK and research organisations, share good practice and strive for continual improvement.
- Maintain awareness of the effects of demand management on the wider community and stakeholders.

NERC already employs various measures to manage demand and to maintain success rates at around 20%, such as: limiting the number of proposals a principal investigator can submit; rejecting around 40% of proposals prior to external peer review through a triage-type sift; limiting resubmissions; requiring pre-application outline-bids for large grants; and publishing the success rates of research organisations to encourage self-management of demand and quality. From 2011/12 NERC will, in addition:

- Develop explicit strategic agreements with research organisations to manage levels of demand and to foster pre-submission quality assurance.
- Consolidate and streamline grants schemes.
- Implement the recommendations of a current project (due to report early 2011; includes assessment of tools used by other councils) to further strengthen demand management in the NERC community.

Implementing the Wakeham Report^{xvii} on financial sustainability and efficiency in full economic costing of research HEIs: RCUK is exploring, as a matter of urgency, how to implement the Wakeham recommendations to deliver substantial efficiency savings in HEIs and NERC research centres. NERC will work with RCUK and research organisations to deliver these efficiencies, including facilities pooling, from 2011/12 (see section 4.1).

2.1.3 Postgraduate training

NERC priorities for postgraduate training

- Sustain the flow of top talent by maintaining the share of NERC budget invested in doctoral training.
- Withdraw from taught masters training.
- Concentrate training in clusters of excellence that provide the highest quality training environment.
- Freeze doctoral stipends for two years in line with the public sector pay freeze and RCUK policy.
- Focus training to deliver strategic skills needs for business, policy and research.
- Target post-doctoral (early-career) fellowships to sustain the next generation of strategic leaders.

Economic success in an information- and service-based society relies on the availability of advanced skills. At a time when the UK needs both to build a green economy and to address urgent environmental problems, the need for highly skilled people in the research and user communities is overwhelming^{xviii}.

Targeting strategic skills needs: It remains important at doctoral level to maintain the breadth and diversity of the research base and to ensure that the community generates, and is responsive to, new ideas. Enabling training providers to select topics for PhD training from across NERC's remit achieves this objective. Increasingly this approach will be complemented by a more focussed doctoral training strategy linked to NERC's strategic priorities and to the skills needs identified by our community.

Over the last two years NERC has consulted industry, business, regulatory agencies and policy makers who use the skills NERC supply, universities and research centres who provide the training, as well as those with a direct interest in the outcomes such as learned societies, etc. The report '*Most Wanted: skills needs in the environmental sector*'^{xix} published in October 2010, highlights specialist and transferable skills that are needed urgently to build a strong, vibrant economy and to tackle environmental challenges. The report will guide NERC's investments, and will focus on areas such as:

- Increasing the number of modellers in environmental research.
- Training more people to be able to work across disciplines (including some disciplines not traditionally recognized as part of the environmental sciences community).
- Providing sufficient people who are able to deal with risk assessment and management at a complex level (recent events such as volcanic ash clouds and oil spills clearly demonstrate this need).

Doctoral training: NERC will maintain doctoral training numbers (currently c460 graduates pa) . In line with the public sector pay freeze and RCUK policy, NERC will freeze doctoral training stipends for at least two years. Providing the highest quality training environment for the next generation of scientists is a priority for NERC. We will build critical mass and quality by concentrating doctoral training in clusters of excellence, and by supporting collaborative research and training with industry and the third sector. Such multidisciplinary doctoral training clusters will become an important mechanism to deliver future strategic skills needs.

Masters training: Masters training remains important for the UK: as a stepping stone into a research career; for discipline-hopping; and in providing key skills for the economy. However it is increasingly funded by users, and by students themselves as an investment in their careers, and NERC plays only a small role in the wider masters training landscape. In line with RCUK policy, to focus NERC training funds where they can provide the biggest strategic benefit, NERC will withdraw from supporting taught-masters training.

2.1.4 Research concentration

Environmental science necessarily spans a very wide range of disciplines and is highly collaborative (see section 1). NERC therefore has to fund a large number of research organisations, and often several departments in any single organisation, for excellent, multidisciplinary environmental research to be undertaken. Selecting only the most excellent proposals, through peer review, already provides a strong level of concentration. For example 80% of NERC responsive funding is currently concentrated in just 25 HEIs. The remaining 20% of responsive funding is distributed more widely among essential pockets of niche excellence. Whilst NERC funding will remain open to niche excellence, the demand management measures described in section 2.1.1 will lead to further concentration of this funding. NERC will also work with RCUK and HEFCE to manage levels of research concentration across the overall dual-support system.

During the period 2011-15 NERC will concentrate its funding primarily to enhance strategic science priorities, to focus on impact opportunities, to strengthen the quality of doctoral training, and to integrate its national capability. These measures will also lead to further concentration in the number of organisations funded. The NERC actions will be:

- (i) **Strategic prioritisation** (Action 1) – NERC will concentrate a higher share of its funding in RCUK and NERC strategic research, leading to increased concentration in those strategic challenges (see section 2.1.1).
- (ii) **User focus** (Action 2) – NERC will increasingly concentrate the translation of its strategic research and training on specified policy and business sectors through LWEC, TSB and other partnership mechanisms (section 3).
- (iii) **Doctoral training clusters** (Action 3) – NERC will concentrate doctoral training in multidisciplinary clusters of excellence to deliver high quality training that meets national skills needs (section 2.1.3).
- (iv) **Integrated national capability** (Action 4) – NERC will concentrate national capability (NC) by creating an integrated NC strategy delivered through its research centres operating together in a multidisciplinary way, and by withdrawing from lower priority activities (section 2.2).
- (v) **Efficiencies** (Action 5) – NERC will concentrate funding through demand management and by allocating strategic research through larger grants.

2.2 NERC national capability (NC)

NERC priorities for national capability

- Develop a single, scientifically integrated and prioritised NERC national capability (NC) strategy.
- NERC's six research centres to operate together to deliver the integrated national capability strategy.
- Maintain a critical mass of NC to support strategic and responsive research, training and knowledge exchange, to provide community access to essential facilities, and to respond to national emergencies.
- Reduce the proportion of NERC budget spent on national capability by scientifically prioritising NC activities and by reducing infrastructure to ensure long-term sustainability.

NERC national capability (NC) enables the UK to deliver world-leading environmental science, support national strategic needs, and respond to emergencies. It includes the research and development activities which keep this capability at the cutting-edge. Examples of national capability include:

- **Major platforms for Earth-system science:** polar bases, aircraft, ships, unmanned autonomous vehicles, access to satellites and other international platforms.
- **Environmental sensing and observation:** instrumented observatories, sensor development, long time series of continuous observations.
- **Analysis, interpretation and modelling:** understanding and predicting environmental processes and change (Earth-system models).
- **Data and information:** state-of-the-art data, collections, informatics tools, information products.
- **Scientific advice:** to inform UK and international policy, regulation and enterprise.

NERC recognises an enduring strategic need to invest in national capability (NC) to underpin current and future science priorities, responsive research, training and knowledge exchange. This provides the whole research community with the ability to access or measure all parts of the Earth system - from pole to pole, from deep ocean and deep Earth to upper atmosphere - and maintains valuable scientific assets over the longer term. As well as supporting science needs, NERC-funded NC also helps the nation respond to emergencies and support some other national needs.

NC is delivered primarily by six NERC research centres (see box), with some services and facilities run by other providers. NERC centres provide leadership in the major environmental disciplines, through strategic partnerships with the HEI community, and are integral to the delivery of NERC mission. NERC currently invests a little over 50% of its budget in NC.

NERC Research Centres

British Antarctic Survey
British Geological Survey
Centre for Ecology & Hydrology
National Oceanography Centre
National Centre for Atmospheric Science
National Centre for Earth Observation

Transforming the delivery of NERC national capability

Driven by our strategic vision (section 1) NERC will transform the delivery of its national capability to enable critical environmental research. Key changes and benefits will include:

- Single-point responsibility for delivering a NC strategy to integrate multidisciplinary Earth-system science.
- Greater critical mass and integration of Earth-system science.
- Enhanced international research leadership, excellence and support for the wider UK research community (particularly in HEIs).
- A single hub for entrepreneurial research partnerships with business, policy-makers and delivery agencies to drive holistic solutions (eg water supply and flooding in all their aspects) and greater impact.
- Greater ability to direct NERC investments towards the critical multidisciplinary science priorities through an integrated research community.
- Administrative and efficiency savings (see section 4).

We will create a single integrated NC strategy, driven by NERC's science and KE priorities (in place of the current six sector strategies). Our six research centres will operate together to deliver the integrated NC

strategy and to achieve the benefits listed above. By operating together, building on their existing sectoral strengths and brands, NERC centres will provide enhanced scientific leadership and focus for working with other partners to deliver critical environmental science challenges with economic and societal impact.

Through these actions NERC will: (i) maintain a critical mass of NC to support strategic and responsive research, training and knowledge exchange - to provide community access to essential facilities and to respond to national emergencies; (ii) reduce the share of its budget spent on national capability. The latter is necessary for NERC to increase its focus on strategic research programmes (sections 1.3 and 2.1.1) and to ensure a sustainable future where NC infrastructure costs are affordable and commensurate with NC activity levels. In developing NERC's integrated NC strategy, and reducing NC expenditure, all NC activities and infrastructure are being reviewed. Future NC activity will be focussed on the highest scientific priorities delivered through efficient use of infrastructure and estates. NERC will downscale some national good services that contribute little to scientific priorities or to our capability to respond to national emergencies, particularly where users do not pay.

Whilst maintaining a smaller core of NERC NC we will enable cost-effective community access to essential complementary capabilities elsewhere through selected UK and international partnerships, such as:

- UK high-performance computing (HPC) service.
- UK-EOF (Environmental Observation Framework).
- ESFRI (European Strategic Forum on Research Infrastructures).
- International bartering arrangements for research ships, aircraft, marine and polar facilities.
- NASA Global Hawk high altitude platform.
- Options for advantageous outsourcing of routine facility management services.

2.3 NERC contribution to other RCUK integrated activities

NERC priorities for other RCUK activities

- Implement the RCUK and NERC public engagement with research (PER) strategy, focussing on activities that engage the public in developing environmental science research of societal importance.
- Implement the RCUK and NERC international strategy, focusing on partnerships through the Belmont Forum of global research funders and on emerging nations.
- Implement the RCUK and NERC research careers and people strategies through targeted initiatives.

This section addresses only the RCUK activities that are not explained elsewhere in this document.

Public engagement with research (PER)

NERC delivers PER explicitly within the framework of the RCUK PER strategy, which supports the Government's science and society strategy. NERC will actively work with delivery partners to help achieve this, and will champion the 2010 Concordat for Engaging the Public with Research.

Our focus will be on activities that engage the public, especially young people, in environmental science issues of societal importance, with emphasis on those areas where: (1) public engagement will benefit the development of research priorities and the delivery of impact; (2) NERC can uniquely provide public access to environmental research, exciting infrastructure and researchers.

International partnership and overseas offices

The world-leading impact of UK environmental science positions NERC well to leverage additional foreign investment. We achieve this by leading international partnerships, aligning overseas initiatives with UK and NERC strategic priorities, and establishing collaborative delivery mechanisms (see sections 1 and 2.1).

NERC will continue to co-lead global coordination of the environmental-change research agenda through the Belmont Forum of research funders. This will deliver knowledge that supports national and international government action to mitigate and adapt to global and regional environmental change and associated hazards.

NERC will continue to work through RCUK to support a focused and strategic presence in China, Europe, India and the USA. RCUK is reviewing how best to provide this presence under reduced budgets, either through its existing offices in these countries or through the Science and Innovation Network (SIN). Such activity helps to strengthen existing links and broker new partnerships with the best research funders and providers. For example, a new partnership between NERC and the Indian Ministry of Earth Sciences (MoES) on the changing water cycle was brokered in 2010 by NERC with support from the RCUK India Office. The unprecedented 2010 monsoon floods in South Asia have highlighted the importance of such links.

Research careers and diversity

NERC is committed to the development of early-career researchers, both to provide skills that benefit the wider economy and to develop the next generation of research leaders. To deliver the people and skills aspects of NERC strategy, we will continue to engage and invest through RCUK in multi-agency initiatives such as the Research Careers Concordat, the Daphne Jackson Trust Fellowships for female returners, and to manage the transition of the Vitae programme towards a self-sustaining position. As an employer of c2,500 scientists in its Research Centres, NERC is also implementing its own initiatives such as:

- i. The *Personal Deal* to enhance career development.
- ii. Leadership for NERC training programme designed to ensure that both scientific and organisational leaders, within the NERC community, have the skills to deliver NERC priorities.
- iii. The NERC research associate programme that offers fixed-term employment in NERC Research Centres to undertake work experience with a defined training element.

2.4 Other Government R&D initiatives

NERC priorities for other R&D activities

- Work with key partners to deliver strategic programmes, foster business partnerships and deliver the impact of NERC research:
 - Met Office - through the Joint Weather and Climate Research Programme.
 - UK Space Agency and Harwell International Space Innovation Centre.
 - Energy Technologies Institute and UK Energy Research Centre.
 - Technology Strategy Board (TSB).
 - Other Government departments and agencies (including Defra, DECC and Environment Agency).

Beyond the substantial strategic partnership programmes mentioned in preceding sections, NERC works closely with numerous government departments (especially Defra and DECC), delivery bodies (such as the Environment Agency, Met Office) and the Technology Strategy Board (TSB) to provide environmental science evidence for policy, regulation and business. Key NERC priorities will include:

1. **Foster close engagement of the research base with the Met Office through the Joint Weather and Climate Research Programme (JWCRP)** to ensure the UK sustains a critical capability for policy and economic impact that is much admired by other nations.
2. **Work with the new UK Space Agency and Harwell International Space Innovation Centre (ISIC)** to strengthen collaboration with the growing space sector^{xx}, building on our partnership with the Met Office, in particular in the area of Earth observation and climate services.
3. **Work with the Energy Technologies Institute (ETI) and UK Energy Research Centre (UKERC)** to deliver low-carbon and renewable energy solutions that optimise energy generation alongside other environmental benefits, costs and trade-offs (see RCUK Energy Programme, section 2.1.1 above).
4. **Work with the Technology Strategy Board (TSB)** through the RCUK-TSB strategic partnership (see RCUK Strategic Vision, section 6.1) and bilaterally to:
 - Co-lead the LWEC business advisory board of top business leaders (see LWEC, section 2.1.1 above).
 - Co-invest in national challenge programmes (eg LWEC, Energy, Global Food Security) plus emerging business opportunities and sectors that can use environmental research for economic growth (see section 3 below).
 - Support research-business partnerships, through LWEC and through mechanisms such as knowledge transfer networks (KTNs) and partnerships (KTPs).
 - Identify candidate Technology Innovation Centres (TICs) proposed by the Hauser review^{xxi} and now supported by Government. Candidate TICs of interest to NERC may include marine renewable energy (with EPSRC) and space technology (with STFC).

RCUK has developed a process with TSB for agreeing joint priorities and co-funding once Research Council and TSB allocations for 2011-15 have been announced. We understand that decisions on which TICs to invest in will be made in April 2011, and the TSB Delivery Plan will be published at the same time. Meanwhile NERC will continue to work with TSB on the basis that provisionally agreed joint priorities and co-funding will proceed. On this assumption, NERC will set a growth target to invest at least £12m in co-funding with TSB during 2011-15 (compared with £5.5m in the period 2008-11). This co-funding target is additional to significant TSB and NERC funding that is closely aligned through RCUK challenge programmes (LWEC, Energy, Global Food Security) to help business gain wider access to research and knowledge (see section 3).

5. **Collaborate with other Government Departments (OGDs) and delivery agencies** to deliver strategic partnership programmes relevant to our complementary roles and remits, such as LWEC (involving 22 OGDs and agencies) and other NERC-led programmes (see section 2.1.1). Whilst Research Councils are not directly delivery arms for OGDs, NERC fosters particularly strong strategic partnerships with key departments such as Defra, DECC and others to mutually deliver national challenge programmes.

2.5 Health of the research base

Priorities

- Sustain a healthy research base through a range of research, training and national capability support.
- Work with RCUK and users of skilled people to monitor the impacts of changes on the research base.
- Identify vulnerable areas and strategic skills gaps for targeted action.

A healthy research base is one aspect of the UK capability identified by BIS as essential for green economic growth^{xxii}. The Earth-system science needed to tackle environmental opportunities and challenges depends on a broad range of disciplines working together in multidisciplinary teams. NERC strategy is to *create and support vibrant, integrated research communities* - through a range of research, training and national capability investments - rather than to support specific disciplines *per se* (as other funders also contribute to the health of underlying disciplines). Hence, NERC will continue to prioritise challenge-led strategic research that contributes the most to UK priorities for sustainable economic growth, rather than prioritising particular science areas or disciplines.

UK environmental science, supported primarily by NERC, currently leads the G8, ahead of the USA, in excellence as measured by citation impact. To exploit this strength for international leadership, absorptive capacity and economic growth, NERC will sustain a healthy research base through the research and training investments described in this Delivery Plan. We will work with RCUK and users of skilled people to monitor the impacts of wider changes in the research base (in HEIs and research centres) and to identify any vulnerable areas and strategic skills gaps for targeted attention.

3. Economic impact

NERC priorities for delivering impact

- Maintain the share of NERC budget spent on central support for knowledge exchange.
- Focus on environmental business sectors with near-term growth potential and on emerging new markets.
- Increase engagement between environmental research and business.
- Develop and sustain the capability of NERC researchers and users to evidence and demonstrate the impacts of research.

3.1 NERC vision for achieving greater impact

NERC research and innovation enables a successful green economy by providing UK competitive advantage, informing policy leadership, improving business performance and transforming public services (see section 1).

During the current spending period 2008-11 NERC took a more strategic approach to knowledge exchange to drive a step-change in economic impact. All our investments and partnerships now focus on delivering excellent research with impact. To deliver the RCUK impact strategy and NERC strategy (section 1), NERC has developed a new “impact action plan”^{xxiii} which will deliver the changes described below. Through these changes, during 2011-15, NERC will deliver the next level of impact by engaging more strongly with business, targeting those sectors where research has the strongest potential to boost economic growth.

The UK’s success in the green economy depends on having the right policy and regulatory frameworks to enable sustainable economic growth. Recent examples where NERC research has made major contributions to policy include: the UN Intergovernmental Panel on Climate Change; the Climate Change Act (2008); the EU Water Framework Directive; the UN Law of the Sea; the Marine and Coastal Act (2009). NERC research will continue to directly inform such policy and regulation.

By engaging with business, Government policymakers, local authorities and society - most notably through the LWEC business and partners’ boards - NERC is able to identify and prioritise the environmental sectors and new markets with most potential for green economic growth. For example, industry has identified aspects of marine renewable energy that need environmental research to help unlock investment and growth potential.

NERC already works with a wide range of business sectors, including leading companies in oil and gas (eg BP, Shell, Chevron Texaco, Esso), mining (eg Rio Tinto, BHP Billiton, AngloAmerican, XStrata) and water (eg Anglian, Southwest, Thames, Wessex). We support the UK’s global environmental consultancies (eg Atkins, Halcrow, Enviro) as well as emerging business sectors such as space, renewable energy and carbon financing. Many of the businesses engaged in NERC projects are SMEs, who provide a significant proportion of the innovative products and services in the environmental sector. Over the next four years NERC will target and strengthen its engagement with business in the key sectors shown below.

3.2 Delivering greater impact

Focus on key business sectors for economic growth

NERC has identified five environmental business sectors that provide near-term opportunities for the UK to invest for green economic growth and for NERC to make an impact through partnership with Government departments, other research councils, TSB and businesses. NERC will focus its central KE support to facilitate impact in these priority sectors, using the mechanisms described further on in this section. NERC’s five priority sectors are (see box overleaf for more detail):

- Marine renewable energy
- Environmental management for food and agriculture
- Water security
- Resource management (including minerals and waste)
- Financial services: risk management and valuation.

NERC priority sectors

Marine renewable energy

Offshore wind capacity is growing rapidly and is predicted to be worth £9.75bn in 2014/15. The UK has some of the greatest tidal ranges globally and 10% of estimated global wave power potential. Demonstrators are being installed on the Pentland Firth and elsewhere. NERC has a broad range of research capabilities for optimising generation capacity whilst addressing environmental impacts and benefits. To harness these capabilities for the green economy NERC will work with policy/regulatory and funding partners (including Scottish Government, Defra, DECC, Crown Estate, EPSRC and TSB) and business partners (such as Aquamarine Power, Atlantis Resource, Blade Offshore, EDF, E.On, Marine Current Turbines, nPower, Open Hydro, Scottish & Southern Energy).

Environmental management for food and agriculture

In 2007, the agri-food sector contributed £80.5bn in GVA to the UK economy (an increase of 27% from 2000). In 2009 it employed 3.6 million people. Policy changes are decoupling subsidies from production to encourage sustainable practices and the development of wider ecosystem services. NERC will provide access for policy-makers and business to the research capabilities needed to tackle global food shortages and increase the resilience of the agri-food sector to environmental change. To achieve this we will work with policy/regulatory and funding partners (Defra, BBSRC, TSB and others) and business partners (such as Bulmers/Heineken, PepsiCo, Proctor & Gamble, Quaker Chemical, Sainsbury's, Syngenta, Unilever and other related businesses).

Water security

Water supply and waste water treatment are worth £8.1bn pa and 71,000 jobs to the UK economy in 2008/9, and predicted to grow to £10.4bn pa by 2015. This sector faces business and policy pressures to reduce carbon emissions whilst maintaining the quality and quantity of supply. Significant export opportunities exist in a global water market worth \$483bn. To provide users with access to the research they need, NERC will work with Defra, EPSRC, ESRC, TSB and the major water utilities, environmental consultants and trusts that provide services and management in this sector.

Resource management (including, for example, minerals and waste).

As an example, the waste management sector is projected to continue growing from £16.5bn in 2007 to £21.7bn in 2015. NERC will work with TSB and EPSRC to help business develop sustainable resource management practices through research on resource depletion and the environmental impacts of extraction (including biodiversity loss, water availability). To achieve this we will build on existing relationships in the mining sector and broaden our engagement to other businesses involved in resource management.

Financial services risk management and valuation

Early adopters of environmental science within this sector are the insurance industry (UK turnover £270bn, 11% of global market). They are beginning to use data and modelling of environmental risks to transform their business supply chains and create new business opportunities. Other financial services are more interested in valuation (eg forest carbon, water scarcity, habitats) with a risk management element. To provide businesses with access to key research capabilities and knowledge, NERC will partner with Defra, DECC, ESRC, TSB and a growing number of business such as Credit Suisse, Experian, Forest Re, Hiscox, Lloyds of London and Willis Re.

Going forward, NERC will engage policy and business leaders (eg through LWEC), and build new partnerships, to scope the role of environmental science in new markets. These emerging business opportunities may be immature as yet, but have potential for significant UK leadership and growth that can be unlocked by NERC science. Initial priorities are:

- Climate services - working with the Met Office to develop shorter term, higher resolution climate knowledge and predictions for decision-makers.
- Ecosystem services - tools for sustainable environmental management of multiple environmental services.
- Environmental monitoring - collaborative development and exploitation of new systems for a wide range of markets.

NERC is also working with TSB to identify candidate Technology & Innovation Centres (TICs, see section 2.4) in technology sectors such as marine renewable energy and space.

Increase engagement with business

NERC will strengthen its engagement with, and offer to, business through the following mechanisms:

New interfaces to link research with business - For each focus business sector described above, NERC will establish an integrated KE programme hosted by the NERC research centres. Each programme will be led by a research-business champion, and will create a hub for business to access relevant knowledge and skills - from across NERC's investments in national capability, strategic research and responsive mode - for holistic research solutions (eg water supply and flooding in all their aspects; managing ecosystem services for food retailers; impacts of space weather on power generation and transmission). The hub will be supported by business interest groups, KE Fellows, increased investment in KTNs, and strong engagement with relevant HEIs.

Business engagement and entrepreneurial culture - NERC will draw on best practice in business engagement in our current centres (eg BGS), and HEIs, to create a culture for entrepreneurial research partnerships throughout the integrated NERC research centres and in the broader environmental research community.

Shaping research strategy, priorities and delivery – NERC will co-design and co-deliver research with business through LWEC and NERC advisory bodies, TSB collaborative R&D, NERC partnership grants.

Access to people and skills – NERC will grow its investment in KTPs, internships and doctoral (CASE) students.

Access to data and data products (eg predictive models) – NERC will provide environmental data free of charge or at marginal cost, and license value-added information products. We will work in close partnership with operational service providers (eg Met Office, Environment Agency, etc) and business to ensure the market can benefit to the fullest extent from new data and information.

Access to knowledge – In addition to the hub, NERC will provide contract R&D and specialist consultancy.

All NERC research contributes economic impact and societal benefit, and strategic research in particular contributes strongly to the priority business sectors specified above (see section 2). NERC aims to leverage at least £100m from business sources through national capability and strategic research during 2011-15.

Commercialise NERC-owned IP

NERC will continue to commercialise intellectual property (IP) generated from the research activities of its own institute. The main products will be licensing and sales of value-added data products, technology, and spin-out companies. Operating NERC research centres more closely together (see section 2.2) will enhance NERC's capability and opportunity for commercialisation by integrating, for example, hydrological, geological and biological data to provide users with a more complete package of solutions

Key tools to stimulate the commercialisation of NERC IP will include innovation funding schemes for market analysis and IP landscaping (up to £20k) and for developing innovative products and solutions (up to £200k). Under the KE Fellows scheme, "entrepreneurs-in-residence" will be embedded in the NERC centres to facilitate culture change and enhance pull-through from research to commercial opportunities.

3.3 Evidence for and demonstrating impact

Delivering greater impact, as outlined above, depends critically on NERC's capability to assess and communicate the impact of its research, and to evaluate potential markets. Over the last three years NERC has used expert consultancies to assess the economic impact of its research. We have already begun to in-source cutting-edge impact evaluation capability by learning from our consultants, by employing staff with key skills (particularly in market analysis and environmental economics), by drawing upon expertise in our research centres and RCUK, and by drawing upon BIS expertise through staff secondment. The next step will be to collaborate with RCUK and NERC research and user communities so that they are equipped to assess and understand the impacts of NERC research, and to demonstrate it to users. Such sharing of expertise and resources will enable NERC to prioritise and sustain our capability and capacity for evidencing and demonstrating impact.

4. Financial delivery analysis

4.1 Resource (programme) budget

The NERC resource budget allocation for front-line science is shown in Annex A, Table 1. During 2011-15 the programme budget will reduce by 3% in cash terms, or approximately 12% when inflation is taken into account. However this reduction will be partly offset by reinvesting efficiency savings in front-line science.

BIS has identified £324m of efficiency savings to be achieved across the Science Budget through pay restraint and by implementing the recommendations of the Wakeham report. RCUK and NERC are committed to playing their role in delivering these savings. We will work with research organisations to drive down the full economic cost (fEC) of research undertaken from April 2011, whilst retaining our commitment to funding research on the current fEC basis. In addition RCUK will test and model the estimated savings to identify whether further savings are possible. These efficiency savings will be retained within the resource budget and reinvested directly into strategic science priorities.

With this budget NERC will deliver its strategic agenda for transformative change as described in section 1. This means increasing the share of NERC budget invested in strategic research (section 2.1.1) and reducing the share invested in national capability (section 2.2) whilst maintaining the share invested in responsive mode (section 2.1.2) and knowledge exchange (section 3) as shown in Annex A, Table 1. To achieve this, NERC will reduce or stop some activities as described in earlier sections, particularly national capability and taught masters training. All such reductions will be driven by NERC strategic science priorities - as informed by business, Government, the research community and society, especially through RCUK, LWEC, peer review and public engagement.

Reducing national capability science activities will lead to inefficiency in the current infrastructure and management levels. If NERC takes no mitigating action, this will result in high overhead rates, loss of competitiveness, loss of external income and unsustainable load on the Science Budget. Hence NERC will adjust its infrastructure and management levels to ensure their long-term sustainability in supporting front-line science.

4.2 Capital budget

The NERC capital budget allocation is shown in Annex A, tables 1 and 3. By 2013 the capital budget will reduce by 50% in cash terms, excluding the effects of inflation. However NERC has been allocated additional funding in 2011-12, plus £38m over 2011-14 from the BIS Large Facilities Capital Fund, to support existing contractual commitments: ie to replace the research ship RRS Discovery; to complete the upgrade of BGS Keyworth facilities; and to complete the replacement of the Halley VI Antarctic research base.

NERC's capital programme comprises scientific projects (some with partner organisations), major research platform and facility projects, plus research centre equipment and site maintenance. Implementing the steep reduction in the capital budget is challenging, and constrained by existing contractual commitments. NERC is rigorously reviewing all its capital commitments and plans, based on scientific priority and contractual commitment, and will curtail future capital investments not yet contracted to achieve the budget reduction target. Contracted commitments already underway will not be affected. Precise impacts on future science capital investments will be announced as necessary once negotiations and decisions are concluded.

4.3 Resource (administration) budget

NERC will be allocated an administration budget that, for the first time, is separate from the programme budget. This budget will be announced early in 2011 and, in line with other public sector organisations, we expect it to be reduced from current levels.

Administration costs include core functions in NERC research centres (such as HR and Finance) and the majority of Swindon head office operations. Scientific leadership, knowledge exchange and direct research operations in Swindon Office are excluded from this definition. Significant administrative resource is essential to build strategic research programmes and partnerships (such as LWEC) that deliver economic and societal impact, and NERC will continue to invest in such strategic leadership.

NERC is committed to playing its part in public sector efficiencies, to ensure that the maximum amount of public funding can be invested in front-line research, and will:

- (i) Further rationalise and integrate administrative operations and teams across NERC (Swindon and research centres), partly as a response to changes in programme delivery but also as an efficiency objective.
- (ii) Further integrate and harmonise shared corporate services across the seven councils in RCUK - this will not only generate direct savings but is a key enabler for SSC savings too.
- (iii) Maximise the benefits of the recently created shared services centre, RCUK SSC Ltd. The SSC has already contributed to back-office cost reduction, and will need to create further efficiency savings as it consolidates and grows its administration services. RCUK and member Councils are working with SSC to deliver the necessary administrative savings whilst maintaining the quality and value for money of services. Key elements to be agreed soon are the scope of future SSC services and associated charges.

These measures are additional to the efficiency savings being driven by RCUK and NERC in other areas such as managing demand for grants and driving efficiencies in the peer review process, thereby making savings for NERC, SSC and HEIs (section 2.1.2).

Annex A: Financial analysis

Table 1 Summary of NERC budget allocations, and change, by the end of the period (£m)

Funding Stream (resource)	CSR baseline ¹	2014/15		
		Cash allocation	Cash change	Real terms change ²
National Capability	125	112	-13 (-10%)	-24 (-19%)
Research Programme	54	65	11 (+20%)	6 (+11%)
Responsive Mode	100	96	-3 (-3%)	-12 (-12%)
Knowledge Exchange	16	16	0 (-3%)	-2 (-11%)
Efficiency	3	0	-3	-3
Total programme resource	298	289	-9 (-3%)	-35 (-12%)
Capital^{3,4}	36	18	-18 (-50%)	-21 (-59%)
Administration	25	To be notified		

Notes

1. Agreed 2010/11 baseline excludes transfer to UK Space Agency
2. Real terms estimates future inflation in line with HM Treasury GDP deflator of 8.9% over the 4-year period
3. Capital allocation excludes BIS Large Facilities Capital Fund (see table 3)
4. Capital allocation is confirmed for 2011/12 and indicative thereafter

Table 2 Resource (programme) expenditure profile by funding mechanism (£m cash terms)

Funding mechanism	CSR baseline		CSR 2011-15		
	2010/11	2011/12	2012/13	2013/14	2014/15
Research Grants	107	115	117	123	130
Doctoral studentships	20	21	23	23	23
Masters	4	2	0	0	0
Fellowships	10	10	10	10	10
Institutes programme costs	195	191	186	183	161
Multi-user Council facilities	1	1	3	1	2
International subscriptions	5	6	6	6	5
Knowledge exchange activities	9	10	9	9	10
Organisation restructuring: cash	7	0	0	0	0
Resource Income	-48	-42	-40	-38	-38
Co-funding Income	-12	-16	-16	-16	-14
Total Resource	298	299	297	300	289
Science Budget – Programme	298	299	297	300	289
Surplus / (Deficit)	0	0	0	0	0
Cumulative Surplus / (Deficit)	0	0	0	0	0
ADDENDUM: Depreciation					
Total ring-fenced resource DEL	26	38	38	39	41

Table 3 Capital expenditure and income profile (£m)

Capital category	CSR baseline ¹	CSR 2011-15			
	2010/11	2011/12	2012/13	2013/14	2014/15
<u>Expenditure</u>					
Capital grants	4	2	3	1	1
Large facilities	25	48	18	7	1
NERC capital	21	7	11	22	15
Total capital expenditure	49	57	31	29	17
<u>Income</u>					
BIS capital allocation ²	36	32	18	18	18
BIS Large Facilities Capital Fund	10	20	12	6	0
Sale of assets	3	5	0	1	0
Total capital income	49	57	30	25	18

Notes

1. Agreed 2010/11 baseline excludes transfer to UK Space Agency
2. Capital allocation is confirmed for 2011/12 and indicative thereafter
3. NERC will consider options for finding any further capital savings as future allocations are confirmed

Annex B: References

- ⁱ IPCC Fourth Assessment Report 2007. Stern Review on the Economics of Climate Change 2006: overall costs of climate change will be equivalent to 5-20% of global GDP each year.
- ⁱⁱ Millennium Ecosystem Assessment 2005: nearly two-thirds of natural life-support services are in decline. The Economics of Ecosystems and Biodiversity (TEEB) 2010: ecosystem degradation is costing Euro50bn pa, and welfare losses could rise to 7% of global GDP by 2050.
- ⁱⁱⁱ The Government Chief Scientific Advisor, Professor Sir John Beddington, refers to an approaching “perfect storm”, where human activity and population growth cause pressures on the security and supply of water, energy and food, exacerbated by climate change.
- ^{iv} (<http://www.berr.gov.uk/files/file50253.pdf>).
- ^v TEEB 2010: around one European job in every six is somehow dependent on the environment.
- ^{vi} Minister of State for Energy and Climate Change, Greg Barker, The Times Low Carbon Business Supplement, 1st September 2010.
- ^{vii} The LWEC Business Advisory Board comprises Board Directors and Chief Executives of FTSE companies that depend on environmental research and innovation: Anglian Water; Allianz; Arup; British Maritime Technology; Costain; Credit Suisse; Marks & Spencer; National Grid; Ricardo; Serco; SITA; Surrey Satellite Technologies; Syngenta; Viridor.
- ^{viii} UK environmental science leads the G8 nations for citation impact, ahead of the USA (International comparative performance of the research base, BIS, 2009) and leads Europe in winning EC Environment funds.
- ^{ix} BIS: A strategy for sustainable growth, July 2010.
- ^x NERC-funded UK scientists contributed disproportionately to the IPCC Fourth Assessment Report 2007 (sharing the Nobel Prize) and to Lord Stern’s economic analysis of the Copenhagen emissions scenarios for Decc.
- ^{xi} Council for Science & Technology: a vision for UK research, 2010. Adapting institutions to climate change: 28th report of the Royal Commission on Environmental Pollution, March 2010.
- ^{xii} D Guellec & B Van Pottelsberghe de la Potterie. From R&D to productivity growth: do the institutional settings and the source of funds of R&D matter? Oxford Bulletin of Economics and Statistics 66, 2004. CaSE working paper: research funding, 2010. The scientific century: securing our future prosperity, Royal Society, 2010.
- ^{xiii} How well prepared is the UK for climate change? Committee on Climate Change, Adaptation Sub-Committee, First Report, September 2010.
- ^{xiv} Government response to the conclusions and recommendations of the Environmental Audit Committee: Adapting to Climate Change, Sixth Report of Session 2009-10, August 2010.
- ^{xv} W Reid, et al. 2010. Earth System Science for Global Sustainability: Grand Challenges. Science (In Press)
- ^{xvi} <http://www.nerc.ac.uk/research/responsive/documents/rmap-2010.pdf>
- ^{xvii} Sir William Wakeham: Financial sustainability and efficiency in full economic costing of research in UK higher education institutions. Report of RCUK/UUK Task Group, June 2010. <http://www.universitiesuk.ac.uk/Publications/Pages/FinancialsustainabilityandefficiencyinfulleconomiccostingofresearchinUKhighereducationinstitutions.aspx>
- ^{xviii} BIS: A strategy for sustainable growth, July 2010
- ^{xix} ERFF: Most Wanted: skills needs in the environmental sector, report 07; October 2010 <http://www.lwec.org.uk/publications/most-wanted-skills-needs-environment-sector>
- ^{xx} The £6bn UK space industry is expected to grow to £40bn by 2030, creating 100,000 new jobs.
- ^{xxi} Current and future role of Technology Innovation Centres in the UK. Dr Hermann Hauser, March 2010.
- ^{xxii} BIS: A strategy for sustainable growth, July 2010. Science and Innovation Investment Framework 2004-14.
- ^{xxiii} <http://www.nerc.ac.uk/using/introduction/documents/impact-action-plan.pdf>