

Stern Review on the economics of climate change
Evidence submitted by the Engineering and Physical Sciences Research Council (EPSRC)

Introduction

1. EPSRC is the main UK government agency for funding research and training in engineering and the physical sciences, investing around £500m a year in a broad range of subjects – from mathematics to materials science, and from information technology to structural engineering.
2. The Council operates to meet the needs of industry and society by working in partnership with universities to invest in people and scientific discovery and innovation. The knowledge and expertise gained maintains a technological leading edge, builds a strong economy and improves people's quality of life.
3. The work of EPSRC is complementary to other research investors including other Research Councils, government agencies, industry and the European Union. The Council actively engages in and encourages partnerships and collaborations across disciplines, boundaries and internationally.
4. EPSRC also actively promote public engagement in science, engineering and technology.

Background on the EPSRC's Energy and Climate Change portfolio

5. The Government recognises the challenge of climate change and the importance of technological innovation to identify causes of climate change, to devise potential mitigation strategies and to identify the likely adaptation necessary to cope with future climate shifts. Climate change is also one of the drivers behind supporting research, development and innovation to encourage the development of longer term low carbon and sustainable energy options.
6. EPSRC has a large portfolio of research relevant to energy research activities include technologies associated with the extraction of energy resources (principally coal, oil and gas), energy production (utilising carbon-based, nuclear, and renewable sources), and electricity transmission and distribution. The transmission and distribution of electricity encompasses research relating to power systems management, protection and control systems, energy vectors such as hydrogen, energy storage and recovery and embedded generation. Research funded includes also some areas of research underpinning the current and future activities in the power sector such as nuclear physics. EPSRC also funds a diverse range of research into the development and introduction of potential energy efficiency measures in areas extending from the built environment to industrial processes and products, from materials to power generation, and from markets and regulation to organisational and individual behaviour. From April 2005, EPSRC co-ordinates the Research Councils' Energy Programme, involving BBSRC, CCLRC, EPSRC, ESRC and NERC. For further information on EPSRC support for energy research please see the EPSRC website: <http://www.epsrc.ac.uk/ResearchFunding/Programmes/Energy/default.htm>

Climate Change –

7. In collaboration with NERC and ESRC, EPSRC contributes to the overall budget for the Tyndall Centre, the national UK centre for trans-disciplinary research on climate change.
8. EPSRC's own Climate Change portfolio focuses on the engineering and technical solutions to the effects of a changing climate, taking into account also socio-economic implications. This portfolio includes research into likely adaptation and mitigation measures stimulated by collaborations between academia and businesses. This partnership has a significant potential to provide solutions contributing towards the economic challenges generated by climate change.

Adaptation to changing climate

9. EPSRC, in partnership with the UK Climate Impact Programme, supports with £3.2 million the initiative Building Knowledge for a Changing Climate (BKCC). BKCC was designed to improve understanding of the multidisciplinary research challenges raised by the necessity to adapt UK buildings and infrastructure to changing climate patterns, particularly the *adaptation measures* necessary within the built environment, transport and utilities. The overall outputs of BKCC will also include messages for stakeholders in commerce, industry, independent trusts, central and local government and civil society on the measures they will need to adopt, or should be promoting more widely, if they and their clients are to adapt successfully to the effects of climate change: messages for the research community on the innovative research challenges that will need to be addressed to implement these adaptation strategies. To ensure the delivery of these stakeholder-focussed outputs, each of the BKCC projects involves close collaborations between research groups and stakeholders in the public and private sectors. Details of the projects, their expected outputs, research groups and stakeholders involved are provided in Appendix I. The stakeholders provide a vital function in the projects by ensuring that the research outputs are useful for stakeholder decision-making. Stakeholders are also providing input data and actual sites for use in the research projects. These close collaborations are a key defining element of the BKCC portfolio. In addition to these close collaborations, a unique structure, incorporating an Integrating Framework and a Stakeholders Forum, guarantees communication and discussion of common issues across the BKCC portfolio. Researchers address issues of common interest for all BKCC projects through the Integrating Framework, consisting of biannual meetings, intranet and external website, e-newsletters and common data management facilities. The Stakeholders Forum brings together representatives from industry and government at six-monthly intervals to advise EPSRC and UKCIP on whether the portfolio is delivering stakeholder-focussed, solutions-driven research. Dissemination of results from the BKCC projects is now under way, with the help of the active stakeholder communities. An example of achievements so far is the contribution of the project AUDACIOUS to the Defra consultation 'Making space for water' (<http://www.defra.gov.uk/corporate/consult/waterspace/>).
10. The most evident gap in the BKCC portfolio at this stage is research into the adaptation of existing and new buildings to the changing climate, and a call for proposals in this area is planned for early 2006. Other gaps concern research into cross-sectors adaptation measures, evaluation of the impact of adaptation solution on mitigation strategies and collaboration between climate change modelling community with both businesses and the engineering and technology research base to build users' requirements in the next generation of climate change models.

Mitigation

11. EPSRC and the Carbon Trust have committed £ 7 million each to “Carbon Vision”, a joint R&D programme on low carbon innovation, with additional funding from ESRC and NERC. The commitments by EPSRC and Carbon Trust are initially for four years from December 2003. This Programme is supporting research to underpin the development of tomorrow’s low carbon technologies. Carbon Vision current activities are research consortia in low carbon buildings and low carbon industrial processes. The £5.4 million Carbon Vision Buildings consortium, started in October 2004, aims to create and assess a range of options whereby the owners and operators of the national building stock can reduce carbon emissions significantly in comparison with today’s performance. A description of the projects within the Carbon Vision Buildings consortium can be found at <http://www.epsrc.ac.uk/ResearchFunding/Programmes/Energy/Funding/CarbonVision/BuildingsProjects.htm>. The Carbon Vision industrial processes consortium (£1million) started in June 2005 and aims to develop a methodology for a systematic life-cycle estimation of carbon inventories in different industries (food, chemicals, plastic, construction and biomass). EPSRC and ESRC have also invested further £0.8 million in a Carbon Vision project started in October 2005 and aiming at developing detailed understanding of the barriers that apply at times of disruptive innovation towards low carbon systems, and at identifying responses to these barriers that will promote step changes in carbon efficiency. The Carbon Vision programme includes management arrangements to encourage close co-operation between the research teams. An Engagement Group of key research users is being established for Carbon Vision Buildings to provide advice and guidance to ensure that the Carbon Vision portfolio delivers high quality stakeholder-focused, solutions-driven research. As a final phase of the current Carbon Vision Programme, EPSRC and the Carbon trust are planning to fund two awards to develop future research leaders in low carbon technology and, in particular, in energy efficiency. Each award will be £1 million to provide research support in terms of staff and other items to excellent researchers with the potential to become international leaders. We will also be looking for commitment from the university in terms of longer term support for the research group and for exploitation. The successful candidates will also be provided with contacts and mentoring to help them develop international and high level business and policy-related contacts.

Appendix I

Table 1 lists the projects that form BKCC with participating Universities and industrial partners.

Table 1 BKCC projects

| <i>BKCC project</i> | <i>Participating universities</i> | <i>Industrial partners</i> |
|--|--|--|
| CRANIUM: Climate change Risk Assessment: New Impact and Uncertainty Methods | Newcastle, Bristol, UEA, Leeds | Arup, Halcrow, Halliburton KBR, Environment Agency, Network Rail, Scottish and Southern Energy, Hadley Centre |
| BETWIXT: Construction of climate scenarios for the built environment, transport and utilities | UEA, Newcastle, Hadley Centre | Environment Agency |
| Engineering Historic Futures (EHF): Adaptation of Historic Environments to Moisture-Related Climate Change | University College London, Glasgow Caledonian University | Ecclesiastical Insurance, Munters Dehumidification Ltd |
| AUDACIOUS: Adaptable Urban Drainage - Addressing Change in Intensity, Occurrence and Uncertainty of Stormwater | Sheffield, Imperial, Aberystwyth, Heriot-Watt, CEH Wallingford | HR Wallingford, Yorkshire Water, Environment Agency, Thames Water, Scottish Water, City of Bradford MDC |
| GENESIS: Climate Change Impacts assessment on the Electricity Supply Industry and Utilities | Loughborough, Bristol | Building Research Establishment, National Grid, Powergen, Garrad Hassan & Partners, Renewable Energy Systems, Oscar Faber & Partners |
| ASCCUE: Adaptation Strategies for Climate Change in the Urban Environment | Manchester, Southampton, Cardiff, Oxford Brookes | TCPA, BRE, ARUP, Environment Agency, RTPI, ODPM, ABI, SE and NW climate groups, Ciria, Institute of Public Health, Cabe Space, English Partnerships |
| BIONICS: Biological & Engineering Impacts of Climate Change on Slopes | Newcastle, Durham, Dundee, Nottingham Trent, Loughborough, Bristol | British Waterways, Cementation Foundations Skanska Ltd, CIRIA, Highways Agency, Geotechnical Observations Limited, Metronet Rail SSL, Ltd Mott McDonald, Network Rail, Rail Research UK, Rail Safety & Standards Board, Scottish Crop Research Institute |
| BESEECH: Economic & Social Information for Examining the Effects of Climate Change | Policy Studies Institute | |
| Impact of Climate Change on UK Air Transport | Imperial College London | |

The first six projects listed in Table 1 were funded through a £ 2 million ring-fenced call for proposals. The last three projects in Table 1 were funded in competition with the engineering research base, and added to the BKCC portfolio to provide integration within the EPSRC funded research into adaptation to climate change..

Expected outputs by project:

GENESIS:

A method for a utility, such as the electricity supply industry, to manage risk within its complex, interrelated functions under climate change

- Information on impact on the ESI of changing consumer demand patterns, driven by both climate and socio-economic change
- Information on climate impacts for wind power generation

End date: March 2006

Engineering Historic Futures:

- Report of detailed investigations of moisture profiles through different fabric structures
- A combined building and fabric, transient heat conduction and moisture movement model
- Guidance on drying historic buildings for use by heritage professionals as well as the wider public

End date: March 2006

CRANIUM:

- New uncertainty analyses of climate scenarios with particular reference to climate variables relevant to the built environment, transport and utilities
- New practical methods for analysing how systems respond to uncertain climate variables
- Demonstrations of new techniques for robust risk-based decision-making for railway, hydro-electric, flood defence and other infrastructure systems

End date: March 2006

BIONICS:

- Fully instrumented embankment with climate control system
- Database of embankment performance, including the effects of planting, rainfall, heating and compaction levels on embankment condition
- Model simulations of each embankment test plot
- Identification of effects of climate on vegetation and relationship with soil properties and on vegetation invasion and ecosystem function

End date: March 2008

BETWIXT

- Daily/hourly future time series of eight variables related to temperature, rainfall, moisture, sunshine and wind for up to ten case study locations
- 'RainClim' software package to generate future hourly and 5-minute rainfall for any UK location
- Report describing analysis of changes to urban and rural temperatures and humidity
- Technical briefing notes

End date: March 2006

BESEECH:

- Assessment of how the key determinants of adaptive capacity evolve under each UKCIP socio-economic scenario (were the key determinants of adaptive capacity are defined here as economic resources, technology, information and skills, (social) infrastructure, (social) institutions, equity)
- A consistent framework within which specific socio-economic storylines can be developed
- Projections for twelve UK regions for key socio-economic parameters- population, household numbers and gross value added (by sector)
- A common template for integrating findings on adaptive capacity across other BKCC projects

End date: September 2006

AUDACIOUS

- Tools for drainage managers and operators to take account of climate change and other changing land use factors
- Enhanced urban drainage models
- Guidance on procedures to evaluate and manage performance of local drainage systems
- Whole-life cost evaluations
- Case study applications in Glasgow & Bradford
- More sustainable urban drainage!

End date: March 2006

ASCCUE

- City-wide assessment of climate-related risks to, and constraints on, development in two contrasting urban areas, Lewes and Manchester
- Reports on scope for climate adaptation through strategic planning and urban design (e.g. planting more trees in urban spaces) and developing adaptation strategies for planners and decision makers
- Examination of interaction between adaptive strategies and measures to reduce greenhouse gas emissions

End date: April 2006

Impact of climate change on UK air transport

- Understanding of sensitivity of UK air traffic system to wind changes
- Information on changes in contrail formation caused by temperature and humidity changes
- Identification of existing or proposed airports or routes particularly vulnerable to climate change and those likely to have increased impact on climate as a result of changing local atmospheric conditions
- Identification of sensitivities of mechanisms through which aviation contributes to climate change

End date: Autumn 2007