

Adaptation and Resilience to a Changing Climate

Recommendations for future research priorities in the UK Energy Sector and its Infrastructure

July 2010

Recognising the limited scope of current research to inform decision makers on adaptation and resilience to a changing climate in the UK energy sector, the EPSRC requested the Adaptation and Resilience to a Changing Climate (ARCC) Coordination Network (ACN) to develop recommendations for future research in this area. Using the outcome of previous consultations with stakeholders and researchers as a basis, an internet workshop was held with participants invited to explore current challenges, to identify knowledge gaps and to suggest priority areas for potential research into climate change adaptation in the UK energy sector and its infrastructure.

This report synthesises the issues and priorities raised during the internet workshop and during those previous consultations for the purpose of informing the development of a call for research. Identified stakeholder needs and research gaps are brought together with the intention that the resulting research projects would be delivered as part of the ARCC programme.

Background

In 2008, the ARCC programme was established by the EPSRC under the 10-year Living with Environmental Change (LWEC) programme which is providing decision makers with the best information to effectively manage and protect vital ecosystem services and is improving the tools and knowledge needed to build resilience, mitigate problems, and adapt to environmental change. The ARCC programme relates to one strategic focus of the LWEC programme: *'to make infrastructure, the built environment and transport-systems resilient to environmental change and to develop more sustainable, less energy-intensive systems and approaches that are socially acceptable, economically advantageous and more environmentally harmonious'*.

Building on the knowledge gained through the earlier built environment EPSRC/UKCIP programme, Building Knowledge of Climate Change, (BKCC) a series of stakeholder and researcher workshops were organised in 2007 and early 2008 as part of the subsequent transfer network, Sustaining Knowledge of Climate Change, (SKCC). These workshops identified challenges and knowledge gaps concerning climate change and the UK built environment, infrastructure and utilities and prioritised research needs (detailed reports of these workshops are available at <http://www.k4cc.org/>). As a result, six projects worth nearly £6m are currently funded by the EPSRC within the ARCC framework focusing on the adaptation of aspects of existing buildings and urban environment infrastructure, including transport and water resources systems. One key area highlighted at the workshops but not picked up within the currently-funded research is the UK Energy Sector and its Infrastructure.

Future research priorities

To update the understanding of current vulnerabilities and knowledge gaps within the energy sector, an open two-day internet workshop was organised (14th and 16th June 2010). Stakeholders were invited to participate on the first day to consider information needed from the research community to enable organisations to further adapt to climate change and to meet society's energy needs in the future. On the second day, researchers were asked to consider the stakeholder priorities to help define clear research topics and themes. This process also provided an opportunity for participants to

form new partnerships both within and between stakeholders and researchers. Stakeholders who were involved in the first workshop were also invited to take part on the second day.

Gaps and potential opportunities associated with energy supply and demand and infrastructure identified at the 2007 and 2008 SKCC workshops were used as the basis of nine headings used to initiate on-line discussion:

- Impacts of climate change and response strategies on future energy demand taking into account spatial and temporal variations
- Effect of climate change and mitigation options on future energy mix, fuel choices and national energy security
- The role of renewable energy and emerging technologies in a changing climate
- Building resilience to climate change, including extreme events, into new and existing infrastructure
- Influence of policies and regulations, and other environmental, strategic and operational issues, on climate change adaptation measures
- Interdependencies with other utilities and infrastructures
- Requirements for guidance for on-going assessment and decision-making
- The role of stakeholders and links with research
- How best to structure future research projects

Participants were then invited to comment under any or all of these areas, starting discussion groups on individual priority themes as appropriate. All participants were welcome to respond to any existing priority theme or to start a new theme.

A wide range of users, stakeholders and researchers representing government, academia, industry and NGOs were invited to take part. In addition, the Government's Adapting to Climate Change (ACC) Programme identified possible areas for research on adaptation in the energy sector based in part on early responses under the Adaptation Reporting Power and an initial scoping study for the Climate Change Risk Assessment.

A full transcript of the workshop and a list of participants are available at www.ukcip-arcc.org.uk.

Emerging research priorities

Knowledge gaps requiring further research for consideration in the development of an EPSRC call are listed below and have been established on the basis of the outcome of the internet workshop, from the previous consultation exercises and from discussion with Defra ACC.

Many of the issues and associated knowledge gaps and research needs by their nature will require a cross-disciplinary and integrated approach that is unlikely to be deliverable by a single team. It was also suggested that there was a need to combine top-down macro-scale modelling approach that can address broad energy system issues with aggregated bottom-up studies looking at specific aspects and processes. This combined approach was identified as being particularly important for engaging stakeholders with national interest (e.g., policy and regulatory communities) and those with more specific interests (e.g., local authorities, energy providers, planners, voluntary sector, etc.).

In addition, specific mention was made regarding consideration within the research of the different timeframes relevant to researchers and stakeholders and to ensuring that the outputs optimise benefits to both researchers and stakeholders (including practical applications).

1. Energy demand

Need for a systems approach to understanding energy demand. Changes in demand as a result of the direct impacts of changes in climate and as determined by proposed adaptation and mitigation

strategies within the energy sector and other energy-dependent sectors (industry, business, telecommunications, transportation, water, waste, etc.). Improved understanding of the determinants of current and future energy demand (social, political, economic and cultural), including those associated with variations and peaks in demand (e.g., daily, seasonal, and annual). The roles of adaptation, lifestyle choices and behaviour choices in determining energy demand. Identify and assess strategies to enhance the resilience of the energy sector in terms of meeting current and future demands, including variations and peaks.

2. Energy Supply – Security and energy mix, including renewable

A systems approach for assessing the viability of different energy supply strategies in terms of increasing resilience and security in the context of a changing climate, including considering the viability of current and future energy supply strategies in meeting seasonal variations and peaks in demand. Improve understanding of the potential for system failures (interruptions in supply) as a result of changes in climate and extremes, and of the nature and viability of contingency options. The vulnerability of energy supply systems and infrastructure to changes in climate, including the identification of pinch points as a direct or indirect result of those changes, with implications from a local to national perspective. Consideration, in the context of a changing climate, of the role of different energy supply strategies in improving (and limiting) resilience of supply.

Examine the impacts, vulnerabilities and viability of renewable energy options, and the associated technologies and infrastructure in the context of a variable and changing climate. Development of methods for analysing the nature, scope and effectiveness of adaptation measures towards enhancing the viability and resilience of renewable energy options. Improve the understanding of potential tensions between renewable energy and other economic, social and environmental systems (e.g., agriculture, environmental services, cultural and social well-being) and of options to resolve those tensions. The role of renewable energy sources in fuel/infrastructure-poor areas in terms of improved resilience of energy supply.

3. Interdependencies with other sectors

Assess interdependencies of the energy sector and other energy-dependent sectors (e.g., transport, water supply, telecommunications, agriculture, forestry, health and social infrastructure, and land-use planning), including operations, security and critical infrastructure vulnerabilities and opportunities for collaborative adaptation to provide win-win options and to minimise existing and potential conflicts. Development of holistic models able to incorporate along with climate change implications, broader social changes in exploring future energy demand, supply and infrastructure vulnerabilities and adaptation strategies. Consideration of an integrated approach to adapting energy supply and infrastructure that includes providing energy for other critical economic, environmental and social needs (e.g., implications for land-use planning and linkages with other utilities and services).

4. Energy Infrastructure – Understanding vulnerabilities and resilience towards adaptation

Understanding spatial and temporal fitness and vulnerabilities of the current and planned energy infrastructure to current and projected climate and its impacts (including variability and extremes), including the nature and scope of pinch points (in time and space), thresholds and sensitivities. Understanding the timeframes over which the current energy infrastructure will remain fit-for-purpose. Understanding vulnerabilities of the energy sector workforce as a result of climate variability and change. Understanding of the vulnerabilities of terrestrial, aquatic and marine environment as a result of climate change and how these (e.g., changes in land capabilities, reduced river flows, reduced water temperatures, potential for flooding and erosions) can have implications for energy systems. Limitations and barriers (technology, policy, regulatory and capacity) to adaptation of

energy infrastructure, including coping, transformational and transition strategies needed to support adaptation within an evolving energy sector. Understanding the relative viability of adaptation measures designed to improve the resilience of the energy infrastructure, including the infrastructure needed to affect the required transformation of the UK energy sector (e.g., low/zero carbon, and increased accessibility, security and resilience).

5. Managing Risks

Explore the ownership of risk within the energy sector, including areas of relative responsibilities and risk management among the energy and energy-dependent sectors (e.g., water and telecommunications) in the context of failure of supply/services resulting from energy supply disruptions. Identify in the context of current and projected climate change acceptable levels of risk for energy-dependent sectors and services. Identify current responsibilities for carrying the loss and penalties enforced in times of disruption, roles and responsibilities of investors and difference in these relationships among regulated and non-regulated sectors. Explore the potential of failure of energy-dependent sectors, including multiple interdependent system failures (e.g., energy, water and transport), as a result of energy supply failure caused by extreme events. Identify and explore options, their viabilities, connections and associated tradeoffs for enhancing risk management across the energy-dependent sectors in the context of climate variability and changes. Explore the potential and limitations of local generation, community level engagement, innovation, regulations, compliance and enforcement in risk management.

6. Adaptation and Mitigation – building resilience into existing and new energy

Understand the interaction of adaptation and mitigation in shaping future energy supply, demand and infrastructure (i.e. how the changing climate will shape energy practices and at the same time how concerns about climate change and the resulting mitigation efforts will also reconfigure energy supply, demand and infrastructure). Understanding the relative roles of policy and regulation in defining existing and future energy supply and demand. Understanding the short- and long-term equity issues associated with different adaptation and mitigation options.

7. Supporting assessment and improved decision making

Develop tools and other resources to inform decision and policy making in the face of uncertainties and that allows for the integration of climate change with other factors that shape demand and supply. Explore criteria for appraising the viability of proposed adaptation options and evaluating their performance over a range of timescales. Develop capabilities to map vulnerabilities of the energy sector in space and time, including those that can identify vulnerable components of the energy system and vulnerable populations. In terms of climate information, there is a need: to translate probabilistic climate projections into a format that energy stakeholders can use; for provision of climate projection data required by stakeholders but not currently available (e.g. wind, snow, lightning and ice).

Considerable interest has been expressed by both participants in the workshop and existing ARCC projects in seeing this research undertaken within the ARCC Coordination Network (ARCC CN). This interest stems in part from the perceived benefits of shared learning, shared stakeholder interest and bringing research on the energy sector into considerations of enhancing the resilience of an interdependent built environment. As such, it is recommended that proponents should be advised that successful proposals are expected to include participation within the ARCC CN within the work programme, including stakeholder engagement within the research proposal and delivery and researcher and stakeholder engagement within the Network.