



# Opportunities for UK Business from Climate Change Adaptation

April 2010

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N.B. This research was carried out prior to the election period. As such, some policy and legislative references may be out of date.

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# 1 KEY FINDINGS

Climate change impacts affect markets and adaptation as a response creates new business opportunities. Increased risk awareness coupled with government legislation and policies help drive positive change.

Business opportunities are most clearly concentrated in the construction and retrofit of long lived assets and improving the resilience of operational sites and supply chains to climate change impacts. However, opportunities are evident across a range of sectors.

Adaptation markets comprise hard engineering solutions as well as important opportunities for service companies. Investments in mitigation are also addressing adaptation issues. Adaptation responses will, however, eventually be integrated into all areas of business planning and management, becoming a standard consideration, not a 'bolt on'.

UK firms gain advantage in adaptation markets through good R&D infrastructure, a world class services sector, strong supply chain capabilities and an increasingly robust policy framework. Investment in developing the UK's resilience will help incentivise the domestic market to adapt and help UK firms build competitive advantage.

Some barriers are the result of the early state of the market, but there are also systemic constraints to address. Specific actions that will help improve the development and adoption of adaptation measures across the economy include:

- a greater effort by companies to factor climate risks and opportunities within their wider investment decisions and operations;
- the use of public investment and public procurement in public buildings, infrastructure and services to drive activity and innovation in the private sector;
- a concerted effort by industry and supply chains to join innovation partnerships (e.g. Knowledge Transfer Networks) and collaborative R&D competitions, such as those funded by the Technology Strategy Board, to further enhance UK competitive strengths in adaptation markets; and,
- a general upskilling of the workforce to better understand climate risks and impacts which will yield significant long term benefits for UK businesses including better informed discussions through the supply chain and the specification of goods and services to meet sector needs.

Understanding climate impacts is a relatively new area, and whilst risk assessment around these impacts is beginning to be understood, opportunities are less well developed. The findings and recommendations in this report and the supporting annexes should therefore be seen as a starting point to increased business engagement around adaptation and development of strategic plans to capitalise on available opportunities.

## 2 SCOPE OF THE REPORT

### 2.1 AIMS

This study was commissioned to identify opportunities for UK business in climate change adaptation in UK and global markets. It focuses on:

- exploitation of **current areas** of competitive advantage;
- **new opportunities** where the UK is well placed to take advantage of future growth (within the next 5-10 years);
- **potential options** for helping business to exploit these opportunities

This report is intended to be a preliminary analysis of a complex area. It aims to stimulate discussion in government and business for possible actions and future areas of investigation.

### 2.2 SCOPE

Businesses which manage risk well, including the risks associated with a changing climate, are likely to be more economically resilient and more attractive to investors. This in itself is an opportunity.

However, this report focuses on specific opportunities from climate change adaptation in the following sectors. They have been chosen because this is where significant economic opportunities are likely to exist within the next 10 years:

- the **built environment** (covering new construction and the retro-fitting of existing buildings as well as adaptation measures that could enhance urban areas);
- **water** (covering management of water resources, distribution, treatment and drainage, primarily from a public water service provider perspective but also for private water abstractors and users);
- **energy** (covering its generation, distribution and related energy efficiency measures);
- **transport** (covering road and rail infrastructure);
- the **agri-food chain** (covering production, distribution, retail); and,
- **insurance services** (covering the wide range of lenders, reinsurance).

These sectors are a starting point. Other sectors, such as ICT, may be good candidates for further analysis.

This report analyses where demand for adaptation measures will increase, where the UK will be more resilient than its competitors and what it will take for UK companies to succeed in an increasingly globalised market.

Where possible, adaptation market sizes have also been identified. In many cases, however, it was only possible to identify the size of overall environmental investments into key sectors which helps to provide some context for potential adaptation investments.

### 2.3 METHOD

The report draws on an extensive literature review and discussions with consultees from the business and research community and government. More detail is provided in the accompanying technical annexes.

Consultations helped to identify the nature and scale of direct physical impacts to different sectors of the economy and how these might translate into market opportunities. They also helped refine our knowledge of the UK competitive position and barriers to market uptake.

### 3 INTRODUCTION TO THE CHALLENGES OF ADAPTATION

As set out in the Stern Review, climate change will prompt shifts in the trajectory of the UK and global economy. This may translate to demand for products and services being modified through people, businesses and institutions seeking increased resilience against greater and more frequent extreme weather events and gradual changes in climate. It will (Figure 1) change:

- The **spatial location** of demand and supply for goods and services, both at a sub-national level (e.g. shifts in patterns of particular crops farmed within the UK) and at a national level (e.g. changes in the distribution of global food production);
- Demand distribution **across sectors**: with increased demand in some areas (e.g. flood protection) offset by declining demand in others (e.g. winter heating);
- Demand distribution **within sectors**: with demand for some products and services (e.g. buildings incorporating natural cooling design and technologies) and demand falling for others (e.g. buildings reliant on energy intensive air conditioning to keep cool).

**Figure 1 Physical changes in climate create new business opportunities**



Climate change impacts are now being felt in an increasing number of places around the world. One obvious example is the greater frequency of extreme weather events which **drives the market for climate risk management solutions to cover short-, medium and longer-term risks**, including:

- **Financial** (e.g. reinsurance products to reduce insurance companies risks against both more frequent and increased levels of claims);
- **Physical** (e.g. flood protection for electricity sub-stations following 2007 floods);
- **Technical** (e.g. infrastructure specifications such as peak load assumptions for drainage systems, the scale of flood defences, power station locations, etc.);
- **Capacity building** (e.g. embedding management practices in organisations such as railway operators to ensure that climate risks are factored into maintenance regimes).

A changing climate also **drives the market for increased or new products and services that would not be feasible beforehand**, including:

- **Diversification of crops** (e.g. growing lavender in Kent and grapes across Southern England).
- **Domestic tourism** (e.g. warmer climate in south-west region could increase tourism).

A shift towards a low-carbon economy is **helping drive the market for adaptation solutions where these fit with mitigation approaches**, including.

- **Retrofitting energy saving measures** such as shading office windows in the summer will help reduce energy use and keep the office cooler. This will reduce the use of energy intensive air conditioning.

## 4 ADAPTATION MARKET DRIVERS

### 4.1 Adaptation markets are growing as a result of increased awareness by industry of the impacts of a changing climate

Prudent management of future climate risks will create longer term competitive advantage against rivals who fail to take account of potential resource impacts. For example, both Coca Cola and Cadbury (Box 1) are addressing adaptation risks across their operations.

#### **Box 1: Water Management at Cadbury.**

Cadbury is a global confectionery company operating in more than 60 countries<sup>1</sup>. Climate change presents a number of risks to the business including:

- Climate change impacts on agriculture result in increased prices for ingredients and reduced crop yields (especially for sugar, cocoa and milk).
- Reduced rainfall and water availability impacts on the core operations as water is used in cleaning, cooling, as a process aid (e.g. dissolving) and as an ingredient.

Cadbury has implemented a programme of water management to minimise water use, switch to more sustainable sources of water and recycle water on site. The initial focus has been on sites in water scarce areas such as Australia, and a target has been set to ensure all 'water scarce' areas have water reduction programmes in place.

Whilst a few companies are progressive in this respect, industries and consumers overall still tend to focus on the management of near-term risks. A general lack of information on future climate risks and potential impacts compounds this problem. To illustrate this, a survey of flood victims found 80% of respondents did not plan any changes to protect their properties from future floods<sup>2</sup>. Farmers in some regions already experience more volatile weather conditions and some sectors are increasingly affected by water scarcity, although responses are still modest. Consequently there is a need to improve awareness of risks, particularly for smaller companies and consumers.

### 4.2 Adaptation markets are created through top-down pressure on supply chains and could also be stimulated by greater risk management by firms and insurers

Supply chains are one area companies are looking at in order to understand their exposure to climate risk. In the food sector, a repeat of high food prices in the UK could be prompted by weather-related problems in a key food producing region elsewhere in the world. Large food companies will be exposed to this risk. UK consulting firms have skills in water foot-printing, risk assessment and management, and supply chain audit that will be increasingly marketable in this respect.

Ensuring robust local supply chains will require a greater understanding of risks and feedback loops as part of supply chain continuity planning and day to day operations. One example concerns the use of local biomass residues for use in energy plants or, in the future, as a feedstock for novel 'bio-refineries'. Climate risks such as prolonged periods of drought might jeopardise local biomass feedstock sources. Such threats are prompting innovative insurance products such as CropWater Stress Insurance from Allianz Australia that cover corporate clients for yield loss in large-scale crops due to erratic rainfall.

Insurers are also increasingly training their underwriters and risk engineers to be expert in assessing climatic risks on a site-specific basis. They are developing appropriate risk

<sup>1</sup> Source: The Impacts of Climate Change on European Employment and Skills in the Short to Medium-Term, GHK Consulting for DG Employment, May 2009

<sup>2</sup> ICM, Flood Resilience Research Report (for Norwich Union (now Aviva), 2005)

transfer products, which are applicable to major companies with multiple sites and suppliers across the globe.

#### 4.3 Adaptation measures can be linked to mitigation responses

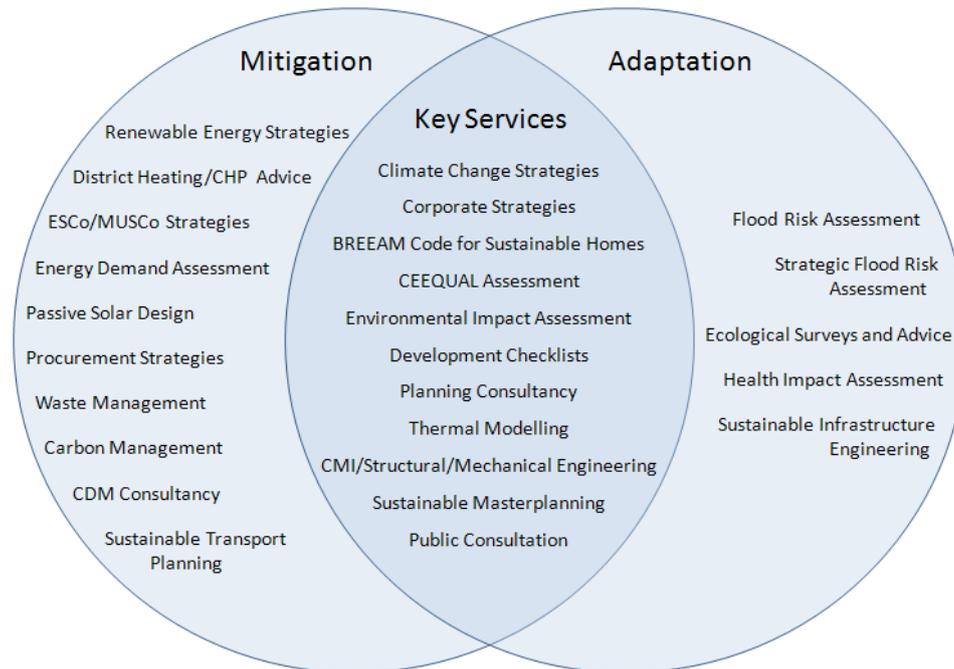
Companies looking to reduce climate costs and risks in their operations create opportunities for technology firms to provide appropriate solutions. For example:

- Cleaner production investments in process industries and manufacturing sectors can reduce energy and water use which improves resilience and reduces operational risks should water shortages occur.
- Developing on-site renewable power generation capacity over the medium to long term in water companies will reduce energy costs and a firm’s carbon footprint, while enhancing the overall resilience of assets to disruption from power cuts and stressed grids.

Researchers are also investigating how organisations can adapt their buildings and operations to increase resilience to climate change whilst meeting carbon reduction goals and performance requirements, for example in the NHS Retained Estate<sup>3</sup>.

The consultancy sector also benefits from the requirements of business to address both the mitigation and adaptation agenda, for example as part of an organisation’s climate change strategy. The ability of UK firms to service this market is illustrated by UK consulting firm, Scott Wilson (Figure 2).

**Figure 2: Addressing adaptation needs will become a mainstream business opportunity for consultancies**



Source: Scott Wilson<sup>4</sup>

#### 4.4 Government action is driving adaptation via legislation, public procurement and planning policies. Future action could include new regulation and standards.

Governments often need to take a longer term perspective than firms. In a UK context the frameworks put in place by government play an important role in stimulating

<sup>3</sup> [www.ukcip-arcc.org.uk/index.php?option=com\\_content&task=view&id=633&Itemid=542](http://www.ukcip-arcc.org.uk/index.php?option=com_content&task=view&id=633&Itemid=542)

<sup>4</sup> [www.scottwilsongroup.com/PDF/Climate\\_Change\\_brochure.pdf](http://www.scottwilsongroup.com/PDF/Climate_Change_brochure.pdf)

behavioural change while helping to incentivise and catalyse the uptake of goods and services. For example:

- **The Climate Change Act 2008** gives the government power to direct certain organisations (those with functions of a public nature and statutory undertakers) to produce reports on the current and future predicted impacts of climate change on their organisations and proposals for adapting to climate change. Over 100,000 eligible reporting authorities exist but a short list<sup>5</sup> has been produced which sets out priority organisations that are required to report. Within the statutory guidance, reporting organisations are expected to highlight potential opportunities as well as risks. This power is the primary legislative lever available to government to influence behaviour on climate change adaptation.
- **Planning Policy Statement 1** (PPS1) sets out clear expectations on how adaptation should be integrated into planning, while the revised **Planning Policy Statement 25** (PPS25)<sup>6</sup> from 2006 sets out Government policy on development and flood risk. Besides reinforcing the long life times of developments it highlights opportunities to reduce flood risk, e.g. creating flood storage and flood pathways when looking at large-scale developments. Such policy can also help insurance companies to tailor their products and services to stimulate demand.
- **Public procurement** in the UK is estimated at £220 billion a year, £47 billion for capital projects<sup>7</sup>. Investment should provide long-term value for money to the public. This includes addressing the risk from climate change throughout the lifetime of an asset or service. Adapting public procurement is an opportunity for the public sector to show leadership and ensure public investment is cost effective in a changing climate change. It is also likely to have the added benefit of encouraging and incentivising innovation across suppliers and contractors in the private sector on adaptation – leading to more adaptation techniques and technologies being incorporated within capital projects and leading to reduced costs. This will benefit both the public and private sectors. The importance of public procurement has already been recognised by Government with joint Office of Government Commerce and Defra guidance – *Adapting Your Procurement* – on how to incorporate adaptation within the public procurement process.
- **Regulations and pricing mechanisms** also help to change behaviour. For example, abstraction licensing and the IPPC regime are helping to drive change in the UK agri-food sector.
- **Standards** could help encourage the take-up of adaptation measures because they instil consumer confidence in the protective properties of technologies and can help make adaptation decisions less complex. The Code for Sustainable Homes for example includes minimum mandatory standards for water efficiency.<sup>8</sup>

<sup>5</sup> <http://www.defra.gov.uk/environment/climate/documents/rp-list.pdf>

<sup>6</sup> <http://www.communities.gov.uk/publications/planningandbuilding/pps25floodrisk>

<sup>7</sup> [www.ogc.gov.uk/About\\_OGC\\_news\\_9922.asp](http://www.ogc.gov.uk/About_OGC_news_9922.asp)

<sup>8</sup> [www.planningportal.gov.uk/uploads/code\\_for\\_sustainable\\_homes\\_techguide.pdf](http://www.planningportal.gov.uk/uploads/code_for_sustainable_homes_techguide.pdf)

## 5 SCALE OF BUSINESS OPPORTUNITIES

5.1 **Currently, the largest adaptation opportunities exist where large scale investments in long life assets are needed so they are better protected from future climate risks**

### 5.2 **Design and Construction**

Opportunities for firms to provide adaptation solutions are concentrated in sectors where substantial investments are being made both as part of the UK's low carbon transition and in response to long-term economic and social need. These include:

- new public and private sector housing and non-residential buildings;
- new energy infrastructure;
- transport networks.

***In most cases adaptation measures are best factored in at the outset***, particularly during design and construction stages (see Box 2). Indeed, the set of draft Energy National Policy Statements<sup>9</sup> and the Ports National Policy Statement<sup>10</sup> set out clearly that applicants for new nationally significant infrastructure should demonstrate to the Infrastructure Planning Commission that they have considered and planned for the impacts of climate change on their proposal, i.e. the design, build and operation of the new infrastructure. Allowance should also be made for adaptive responses to be easily integrated in the future as and when there is more information and greater certainty about what is required.

**Box 2: Infrastructure Design:** High Speed One, England's first new railway for over 100 years, is a good example of how very large infrastructure project (£5.8bn) should factor in future climate related events. Arup worked with the Environment Agency to ensure an appropriate degree of protection from predicted peak flood events with a modelling process that took account of a "climate change factor". This ensured an appropriate balance between capital cost of the new infrastructure and protection from predicted future increases in flood risk for the Thames estuary. In another part of the line, where groundwater abstraction was required to prevent line flooding, a solution was applied that resulted in abstracted water being supplied to a local water utility, improving the resilience of London's water supply.

### 5.3 **Retro-fitting**

The UK and many other countries have infrastructure and assets which will continue to operate up to and beyond the middle of the current century and which will therefore be affected by future climatic impacts. Around 80% of the UK buildings that will be occupied in 2050 have already been built.<sup>11</sup> Long-term adaptation retrofit strategies are necessary to ensure that the built environment is sufficiently resilient. ***Opportunities, in the UK and overseas, will cover both building retrofit (homes, office, industry etc.) and the redesign and re-engineering of towns and cities, for example through 'green infrastructure'***<sup>12</sup>. Significant opportunities for providers of adaptation goods and services exist across the entire construction sector value chain (e.g. urban planners, architects and refurbishment specialists, suppliers and installers of innovative technologies and systems).

At a ***global level***, the Stern Review in 2007 suggested the additional costs of making new infrastructure and buildings resilient to climate change in OECD countries could be

<sup>9</sup> [www.energynpsconsultation.decc.gov.uk/energy/](http://www.energynpsconsultation.decc.gov.uk/energy/)

<sup>10</sup> <http://www.dft.gov.uk/consultations/closed/portsnps/>

<sup>11</sup> [www.raeng.org.uk/education/vps/pdf/Engineering\\_a\\_low\\_carbon\\_built\\_environment.pdf](http://www.raeng.org.uk/education/vps/pdf/Engineering_a_low_carbon_built_environment.pdf)

<sup>12</sup> Redesign and re-engineering of urban environments to develop networks of open space, woodlands, wildlife habitat, parks and other natural areas, will help improve resilience (e.g. water supplies, reduce overheating) as well as improve citizens' quality of life ([www.greeninfrastructure.co.uk](http://www.greeninfrastructure.co.uk))

between £9.5bn and £94.8bn<sup>13</sup> per year (i.e. between 1% and 10% of the total construction investment of £0.95 trillion per year). A recent World Bank report<sup>14</sup> estimates annual adaptation costs relating to infrastructure in developing countries to be between £5bn and £27.8bn, including existing infrastructure stock and new build.

At the **UK level**, minimising increased flood risk impacts requires risk management and planning and investment in the maintenance and construction of new defence structures. It has been estimated that investment in flood defences would have to increase by 80% (in real terms) by 2035 to maintain the current level of protection against flooding<sup>15</sup>.

At the **specific project level**, Box 3 shows how this can translate into business opportunities for different types of supplier.

**Box 3: Flood Defences in Carlisle:** The Environment Agency has spearheaded a £40m project to protect Carlisle against a repeat of the January 2005 floods. 9km of raised flood defences are being built to protect homes from flooding. Other protective measures include: building floodwalls and earth flood embankments; raising footbridges to reduce the risk of debris; installing a new pumping station; reopening the natural floodplain downstream of Carlisle; and, creating four areas of improved habitat for wildlife.<sup>16</sup>

Individual examples of UK organisations or sectors investing in adaptation, or beginning to calculate the potential liabilities arising from climate risks, provide an illustration of the **scale of the market opportunity across sectors**. For example:

- **Water** - Anglian Water is investing £95m in measures to protect assets and improve resilience. In the 2010-2015 price review, Ofwat has included, within a package of measures aimed at addressing adaptation, £414m for improving network and asset resilience across water companies in England and Wales;<sup>17</sup>
- **Insurance** - New residential and commercial properties in the Thames Gateway represent a 15% flood exposure increase in London over the £126bn worth of assets currently at risk in the Thames floodplain;<sup>18</sup>
- **Energy** - the energy industry and the Met Office undertook a major project in 2008 which is helping to develop innovative new techniques, models and tools. For example, the project investigates how urban heat island effects may change energy demand, so that network companies may have more resilient infrastructure, and models future soil conditions and their impact on cables<sup>19</sup>;
- **Transport** - Network Rail has pledged £160m to upgrade drainage systems between 2009 and 2014, as part of its adaptation strategy. Forward-thinking local authorities have also been looking at their highway network's generic and specific vulnerabilities to climate change impacts and how they will need to re-shape their inspection and maintenance strategies (see Box 4).

**Box 4: Highways Network: The Three Counties Alliance Partnership (3CAP)**<sup>20</sup> comprises Leicestershire, Derbyshire and Nottinghamshire County Councils, working with Scott Wilson Group plc. 3CAP conducted a study on climate change adaptation looking specifically at the partners' Highway Network Policies and Standards. Areas identified as most affected and those with greatest potential for adaptation were bridges and other structures, drainage, grass cutting, materials, resurfacing, tree and hedge maintenance and winter maintenance. The

<sup>13</sup> Stern Review: The Economics of Climate Change, 2007

<sup>14</sup> World Bank, Economics of Adaptation to Climate Change, September 2009

<sup>15</sup> Economics of Climate Change Adaptation Working Group, Shaping Climate Resilient Development, 2009

<sup>16</sup> Environment Agency: <http://www.environment-agency.gov.uk/research/planning/109005.aspx>

<sup>17</sup> [www.ofwat.gov.uk/pricereview/pr09phase3/det\\_pr09\\_finalfull.pdf](http://www.ofwat.gov.uk/pricereview/pr09phase3/det_pr09_finalfull.pdf)

<sup>18</sup> [http://www.abi.org.uk/display/File/Child/554/Making\\_Communities\\_Sustainable\\_housingsummary.pdf](http://www.abi.org.uk/display/File/Child/554/Making_Communities_Sustainable_housingsummary.pdf)

<sup>19</sup> [www.scottishpower.com/uploads/MetOfficeProjectExecSummary.pdf](http://www.scottishpower.com/uploads/MetOfficeProjectExecSummary.pdf)

<sup>20</sup> [http://www.leics.gov.uk/index/highways/commercial\\_services/alliances/3\\_counties\\_alliance\\_partnership.htm](http://www.leics.gov.uk/index/highways/commercial_services/alliances/3_counties_alliance_partnership.htm)

work has enabled the councils to identify the places on the highway network that are most at risk from climate change and need most attention.

## 6 NATURE OF BUSINESS OPPORTUNITIES

### 6.1 Some adaptation measures require substantial hard engineering solutions, entailing new technologies and large construction projects. Opportunities are also available across various types of services, from consulting and design through to insurance

In the water, transport and energy sectors a mixture of opportunities combine technology, manufacture and construction with 'softer' service elements such as consulting, asset management, planning and institutional capacity building. This plays to UK supply side capabilities. The built environment offers opportunities for niche technology providers to sell technologies and systems into new build and retrofit developments. The food sector is already taking action to prepare shops for a changing climate. In addition to the immediate benefits of increased resilience, it is also providing opportunities for a variety of technology suppliers and experience for designers, engineers and project managers.

Our consultations indicate that technical and advisory services are an important part of the adaptation market place. These range from support with strategy, capacity building (e.g. training) and prioritising options and finance, through to detailed technical design.

Table 1 shows where market demand for solutions, if not already present, is expected to emerge and strengthen within the next 5-10 years, i.e. within the long-term planning horizon of most businesses.

**Table 1: High level opportunities for key sectors in UK and global markets**

Sector	Short-term (5 years) opportunities	Medium term (5 years plus)
Built environment	<p>New commercial and domestic developments will drive innovations in energy and water management and control technologies.</p> <p>Increased adaptation awareness by property developers and domestic owners will create greater demand for both innovative retrofit solutions (e.g. insulation, ventilation, flood protection, water saving) and training and support services for building managers.</p>	<p>Global new build and retrofit markets are likely to grow substantially, requiring technologies and design, engineering and construction services.</p> <p>Opportunities for green infrastructure and re-designing/re-engineering urban areas for climate resilience will start to become important.</p> <p>Eco-towns in the UK will provide good demonstration site potential.</p>
Water	<p>Opportunities where adaptation and cost-effectiveness measures overlap, e.g. water efficiency, reuse and recycling, as well as flood resilience. Includes consultancy and service provision such as modelling, risk assessment, and monitoring systems. Integrated drainage solutions, e.g. with built environment.</p>	<p>Opportunities will emerge in managing surface water and drainage more effectively, and upgrading and building new water collection and supply infrastructure – in both the UK and globally, particularly in countries with water scarcity issues. Greater use of ICT systems for risk management.</p>
Energy	<p>Adaptation measures must be factored into new build of generation capacity, particularly renewable and nuclear. Adapting existing infrastructure (e.g. substations, oil and gas storage sites) will provide opportunities in asset management and maintenance.</p>	<p>Opportunities from integrating smart technology into networks, distributed power systems and energy storage to improve resilience, including for other and in developing economies (which may be building assets without measures).</p>

Sector	Short-term (5 years) opportunities	Medium term (5 years plus)
Transport	Research, planning, risk management and modelling services are needed for immediate assessment of adaptation needs across 250,000km of roads and over 20,000km of railway lines in the UK.	New build and upgrading network with ICT to aid monitoring and maintenance. Innovation in durable materials is expected to provide long term opportunities. Export of this expertise into global markets.
Agri-food chain	Adaptation in production and processing overlaps with investment in resource efficiency with immediate bottom line benefits, such as water-saving technologies. Climate-adapted, low carbon retail stores will also drive demand for solutions.	Resilience measures set to deepen throughout the supply chain. Adoption of more efficient irrigation systems, and systems that provide supply chain transparency vis-à-vis water management. Development of drought resistant crops.
Insurance services	New products and services (e.g. weather related derivatives, risk transfer mechanisms). Provision of more information to consumers on links between premiums and risk and providing incentives for installing adaptive measures.	Provision of greater incentives for adaptive investments. Developing forward looking models and collaborating with partners for developing best practices and innovative products.

## 6.2 Opportunities will arise from addressing interdependencies between sectors.

Interdependencies between sectors, exacerbated by climate change, offer a potentially fertile ground for firms to investigate new opportunities and innovate. For example, uncertainty surrounding future climate change could lead to development of new modelling and risk management tools to better understand related impacts across sectors. Figure 3 provides an overview of key interdependencies, a few of which are illustrated below:

- Water is essential for cooling power plants so a supply shortage or increased water temperature could have serious consequences;
- Energy is necessary for powering heating, ventilation and air conditioning systems to ensure the built environment can tolerate extreme temperatures;
- Integrated drainage systems affect the water sector and the built environment;
- In situations where infrastructure carries critical utilities and IT networks, a bridge failure could cascade to other sectors, as was recently observed in the Cocker mouth flood in 2009.
- The ICT sector<sup>21</sup> is crucial for all sectors and can offer solutions for better risk management (e.g. monitoring vulnerable structures in transport networks) and controls (e.g. within the water and power sector).

**Figure 3: Adaptation opportunities arise at the interface between sectors**

	Transport	Energy	Water	Agri-food	Services & Insurance
Built Env	Planning Retrofit network	Micro-generation Retrofit buildings	Water efficiency Sustainable drainage	Natural fibre products Resilient buildings	Modelling & risk assessment Eco-design ICT systems
Transport		Decarbonised power for electric vehicles	Retrofit drainage Flood protection	Bio-fuels Risk management	Insuring products for supply chain ICT & logistics

<sup>21</sup> ICT was outside the scope of this research study but it is regarded by experts as a vital cross-cutting issue

Energy	Resilient water supplies for power generation cooling and hydropower	'Chill chain' needs uninterrupted power Energy efficient heating/cooling Biomass crops & residues	Asset management ICT systems Grid balancing services (e.g. dynamic demand in industry/business)
	Water	Irrigation Water supply, reuse, recycling	Modelling & risk assessment ICT systems Insurance
		Agri-food	Resource planning Remote sensing & logistics

New business opportunities will depend however on close collaborations between organisations affected by these issues and funding being provided.

**6.3 Adaptation requirements are likely to continually evolve in all sectors as risks and available responses are better understood. This will ultimately lead to adaptation management becoming standard business practice**

In the medium to long term, improvements in modelling and forecasting will enable business to plan their responses to climate change impacts with greater confidence. ***Adaptation responses will eventually be integrated into all areas of business planning and management: becoming a standard consideration, not a 'bolt on'.***

Operational areas where climate risks should be considered include risk management, health and safety, routine inspection and maintenance regimes, and disaster management (e.g. dealing with dislocations to supply chains during events such as flooding). There are skills and training implications for companies and sectors, and thus opportunities for those who service them.

## 7 UK STRENGTHS IN ADAPTATION MARKETS

**UK firms gain advantage in adaptation markets through good R&D infrastructure, a world class services sector, strong supply chain capabilities and an increasingly robust policy framework**

The UK is already considered a world leader in low carbon goods and services and recognised as a world leader in business adaptation to climate change.<sup>22</sup> It is home to a diverse range of world-leading low carbon businesses and organisations<sup>23</sup>. Many of the companies operating in low carbon markets also offer adaptation-related technologies and services.

The UK has ***core strengths in environmental and engineering consultancy, insurance, finance and business related services***. UK consultancies and financial and business services - by virtue of their experience, world class expertise and global reach - are well placed to capture both short- and long-term opportunities across all sectors. The UK has firms skilled at providing 'blended' consultancy approaches (e.g. linking risk assessments with hydrological modelling, scenario building and impact mapping) and solutions appropriate for local issues (e.g. through community engagement projects). Increasingly, the UK is considering adaptation and mitigation measures simultaneously. The UK insurance industry also plays an important role for

<sup>22</sup> Network for Business Sustainability, 2009

<sup>23</sup> UKTI, UK Low Carbon International Marketing Strategy, 2009

the UK economy: gross insurance premiums accounted for 16% of UK GDP in 2008 and 11% of the global total<sup>24</sup>.

In consultation, the majority of sectors identified the **UK's world class R&D base**, both in the public and private sector, as a key factor in its competitive advantage. R&D in low carbon technology development, climate modelling and forecasting, and ICT in the transport sector are particularly identified as some of the most advanced in the world. UK institutions are helping to enhance this offer (see Box 5)

**Box 5: Infrastructure and Buildings Research:**

The Engineering and Physical Sciences Research Council (EPSRC) has funded the **Adaptation and Resilience to a Changing Climate** (ARCC) research programme<sup>25</sup>. This brings together research projects involving existing buildings and infrastructure, including transport and water resource systems, in the urban environment. The £6m programme will enable the design of urban systems that are more resilient to climate change.

The Technology Strategy Board consulted with experts for its June 2010 **'Design for a Future Climate'**<sup>26</sup> technology competition which will cover new build and refurbishment. It identified several areas where action is necessary to fill current knowledge gaps including modelling and knowledge sharing.

Other areas of competitive advantage include: diversified and highly capable supply chains, the existence of both niche markets (e.g. carbon markets) and specific manufacturers of adaptation technologies (e.g. flood protection, sustainable urban drainage, water efficiency, ventilation, sensors, building systems), and well developed transport and logistics services. UK organisations could collaborate with firms and research institutes in overseas countries that have sectors such as the built environment, energy, transport, etc. that are already affected by more extreme conditions than the UK faces. This could provide valuable commercial joint ventures which could enhance competitive advantage.

The UK's competitive advantage is underpinned by a **robust policy and institutional framework**. The government has set out ambitious climate policy frameworks for tackling climate change (e.g. Climate Change Act 2008), elaborated in various strategies and action plans. The CBI noted that the Act, and the statutory reporting requirements contained within it, will help provide first mover advantage to UK firms. Consultees in the energy, water and insurance sectors commended the role of national policy and support agencies (e.g. EST, Environment Agency) and trade bodies such as ABI in helping businesses develop new products and services. Overall, UK's favourable market conditions appear conducive for exploiting new adaptation opportunities.

A summary of UK strengths identified in each of the technical annexes is shown in Table 3. It illustrates **strong supply chain capabilities across most sectors**.

**Table 3: UK strengths in adaptation markets**

Built Environment	Water	Transport
<ul style="list-style-type: none"> <li>Diverse strengths across the supply chain</li> <li>World class R&amp;D base in many areas</li> <li>Leading UK manufacturers of products such as flood protection, insulation, natural ventilation</li> <li>Ability to integrate</li> </ul>	<ul style="list-style-type: none"> <li>Strengthening supply chain and expanding overseas</li> <li>Integrated consultancy approaches, e.g. linking risk with impacts, whole life costing/carbon accounting in operations</li> <li>Niche suppliers, e.g. sustainable drainage,</li> </ul>	<ul style="list-style-type: none"> <li>Very strong capability in transport research and planning</li> <li>Advanced R&amp;D into ICT systems</li> <li>Construction sector experienced in delivering infrastructure projects</li> <li>Mature, well-equipped</li> </ul>

<sup>24</sup> International Financial Markets in the UK, November 2009

<sup>25</sup> [http://www.ukcip-arcc.org.uk/index.php?option=com\\_content&task=view&id=591&Itemid=542](http://www.ukcip-arcc.org.uk/index.php?option=com_content&task=view&id=591&Itemid=542)

<sup>26</sup> [www.innovateuk.org/assets/pdf/FutureClimateleaflet.pdf](http://www.innovateuk.org/assets/pdf/FutureClimateleaflet.pdf)

technologies into construction projects <ul style="list-style-type: none"> <li>• 5 of top 20 European construction companies</li> </ul>	sensors, leakage control <ul style="list-style-type: none"> <li>• Asset management capabilities</li> <li>• Appropriate local solutions</li> </ul>	supply chain capability <ul style="list-style-type: none"> <li>• Well developed asset management systems</li> </ul>
<b>Energy</b> <ul style="list-style-type: none"> <li>• World class modelling and operational weather forecasting expertise</li> <li>• Turbine and power island, boiler island, transmission and distribution technologies</li> <li>• High supply chain capability and ability to integrate new technologies</li> <li>• Leading centre of project financing</li> </ul>	<b>Agri-food</b> <ul style="list-style-type: none"> <li>• Sophisticated, innovative and competitive food market in which business practices are regularly examined by NGOs and influenced by consumer opinion.</li> <li>• Large firms with resources to test and deploy solutions, and scale to influence supply chains.</li> <li>• Scientific base/expertise in biotechnology, climate forecasting, remote sensing, animal welfare.</li> </ul>	<b>Insurance services</b> <ul style="list-style-type: none"> <li>• Insurance sector largest in EU and third largest in world</li> <li>• Specialist firms across value chain</li> <li>• Strong public/private research base</li> <li>• Expertise in risk analysis</li> <li>• Diverse range of innovative products</li> <li>• Expertise in communicating risk to consumers</li> </ul>

## 8 UK RESILIENCE TO CLIMATE CHANGE

### Investment in developing the UK's resilience to today's extreme weather and the future climate will boost the domestic market and help UK firms build competitive advantage

There are already very good examples of proactive strategic plans and actions being undertaken across the UK economy which in many cases will require the skills and expertise of UK firms for their implementation. For example:

- **Transport sector** (e.g. through the Highways Agency and Network Rail, both of which now have adaptation strategies);
- **Water suppliers** (see Box 6);
- **Energy companies** - an energy sector-wide group now exists for sharing knowledge, experience and best practice in adapting to climate change<sup>27</sup>.
- **Agriculture**, in which a recent study<sup>28</sup> concluded that the UK was generally well adapted to current climate variability;
- Some **large public and commercial property owners** - for example Lend Lease now has an adaptation strategy for new UK developments which it plans to roll out to all of its occupied offices and managed assets through 2010.

**Box 6: Price Review 2009 stimulates adaptation** - Whilst regulated water companies in England and Wales have tended to focus more on capacity building (e.g. risk management, emergency planning etc.) than implementing adaptation actions<sup>29</sup>, in the 2010-15 price review<sup>30</sup> Ofwat included £414m for improving network and asset resilience. Utilities will have to protect more than 150 critical, 'at risk' assets and initiate thirteen network resilience schemes. Furthermore, one hundred catchment management schemes are included in the price limits compared to just two in the last price review. The price review also made provisions for further adaptation investment if deemed necessary following the results of on-going work between the

<sup>27</sup> Met Office, Energy Project 2. <http://www.metoffice.gov.uk/climatechange/businesses/casestudies/energy.html>

<sup>28</sup> Adaptation and Mitigation Strategies: supporting European climate policy. D-A2.7: Adaptation in agriculture: historic effects of extreme events on UK agriculture and an assessment of the economics of adaptation. Tyndall Centre for Climate Change Research and School of Environmental Sciences, UEA, Norwich, UK

<sup>29</sup> Tyndall Centre for Climate Change Research, An Inventory of Adaptation to climate change, July 2009

<sup>30</sup> [www.ofwat.gov.uk/pricereview/pr09phase3/det\\_pr09\\_finalfull.pdf](http://www.ofwat.gov.uk/pricereview/pr09phase3/det_pr09_finalfull.pdf)

Environment Agency, Defra, UKWIR and Ofwat to understand the implications of the UKCP09 scenarios on water resource planning<sup>31</sup>.

To build on this and to continue to increase the UK's resilience to climate change the public sector must show leadership on adaptation. Central to this is the use of public investment and public procurement in public buildings, infrastructure and services to drive activity and innovation in the private sector.

Infrastructure UK, set up in December 2009 in provide a strategic overview of the level of investment required on our infrastructure has recognised that climate change is one of a number of long-term challenges our infrastructure faces over the next 50 years. Infrastructure UK

While the Infrastructure Planning Commission will play an important role in ensuring that new nationally significant infrastructure is able to adapt over its lifetime to current and future climate impacts. These are all likely to lead to increased UK resilience to climate change and more market opportunities for British business.

The Climate Change Committee's Adaptation Sub-committee will also play an important role in ensuring that the Government's programme for adaptation enables the UK to prepare effectively for the impacts of climate change.<sup>32</sup>

Experience gained developing techniques and solutions in the UK **will strengthen skills and capabilities, and provide demonstration sites, which can be used to support a drive into global markets**. By 2015, it is also likely that many of the adaptation technologies tested and adopted across the UK (such as in the water, energy and transport sectors), will have been **refined and value-engineered**, facilitating wider adoption in global markets.

Overall, **key markets for UK adaptation exports in the short term appear likely to be to the USA, the Gulf region, China and India, and the EU** (where there is a close match in many cases to UK climate change impacts and therefore adaptation solutions). Immediate opportunities also exist in water stressed parts of the world, such as Australia, where UK businesses and UKTI are already targeting opportunities

## 9 BARRIERS TO GROWTH IN ADAPTATION MARKETS

Despite the good position of many UK supply side businesses in emerging adaptation markets, there is evidence of constraints in some areas. These are restricting the demand for adaptation measures. For example, information barriers and knowledge gaps, and the nascent state of the market overall all act as a brake on investment. Young companies trying to bring new and innovative adaptation technologies to market also encounter commercialisation barriers.

### 9.1 **Although there has been increasing awareness of the impacts of climate change, there is still more to be done.**

Various parts of the economy are starting to make good progress in building resilience to climate change. However, **there is some way to go before all sectors are sufficiently resilient to withstand the wide range of climate impacts that might plausibly arise**. For example, whereas water and energy companies are now investing for improved resilience, particularly around the impacts on water resources and flooding, corporate responses to water-related risks across business and industry are

<sup>31</sup> Consultation with Mike Keil, Head of Climate Change Policy, Ofwat

<sup>32</sup> [www.theccc.org.uk/about-the-ccc/adaptation-sub-committee](http://www.theccc.org.uk/about-the-ccc/adaptation-sub-committee)

highly variable, and in a recent report of 100 large firms operating globally, for example, most failed to provide investors with an adequate evaluation of these risks<sup>33</sup>.

Likewise, while commercial property developers in the UK are becoming increasingly aware of climate risks, helped by the presence of market-leading companies, domestic homeowners generally have a lack of awareness of the risks from climate change and the benefits of investing in adaptive measures. They may also lack incentives to act.

Improved climate models will clearly help change behaviour if risks are translated appropriately for consumers and business – as UKCIP and others are trying to do at the moment. Greater involvement of sector trade associations and professional bodies in understanding risks and translating these into sector-specific actions to improve awareness will also help to drive sector change in business.

***Designing for adaptation is likely to be less costly for new build in the longer term than responding to critical incidences later*** and having to install retrofitting protection measures. Where assets are already in place, however, a lack of economic incentives also appears to inhibit uptake of new measures. This is a particular issue for domestic property owners and one that the insurance sector is addressing. Swiss Re has observed that the adaptation market lacks far reaching incentivising measures (equivalent to the role played by emissions trading in the mitigation side of the climate response) that could catalyse investment.<sup>34</sup>

## 9.2 **General upskilling of the workforce to better understand climate risks and impacts will yield significant long term benefits for UK businesses**

Improved understanding of climate risks and impacts is required across most sectors of the economy. Not only will this advance respective sectors' ability to plan and execute resilience measures - it should also ***enable better informed discussions through the supply chain and the specification of goods and services to meet sector needs***. In some cases, such a proactive stance on adaptation training might also lead to the successful development of new goods and services.<sup>35</sup> Furthermore, training at work will often engender good practices that are carried to the home environment.

Skills shortages, especially in science, technology, engineering and maths (STEM), have been identified as a key constraint in the medium to long term for tackling climate change<sup>36</sup>. Indeed, over 500,000 engineers are forecast to be required over the next ten years and ***new training such as 'systems thinking' to include adaptation will need to be integrated into engineering courses***.<sup>37</sup> There is strong requirement to train and develop a larger pool of qualified designers, engineers and fitters to meet the potential levels of demand for the development and installation of adaptation technologies, systems and measures across most sectors. This constraint is shared with the mitigation agenda and the adoption of low carbon technologies.

The national Skills Strategy, 'Skills for Growth' (November 2009)<sup>38</sup>, highlighted the need to consider skills of strategic importance including "*skills to adapt to climate change*". Government also tasked the UK Commission for Employment and Skills (UKES) with producing an annual National Strategic Skills Audit to provide a comprehensive and authoritative evidence base. The first audit, published in March

<sup>33</sup> Ceres, Murky Waters? Corporate reporting on water risk, February 2010

<sup>34</sup> Henderson, Insight Investment (2008)

<sup>35</sup> This situation is already occurring in several large European firms which have been stimulated by climate change policies to train staff which in turn has led to the identification of new business opportunities. See DG Environment study: <http://ec.europa.eu/social/main.jsp?catId=88&langId=en&eventsId=172>

<sup>36</sup> [www.stemnet.org.uk/news/press\\_office.cfm?widCall1=customWidgets.contentItem\\_show\\_1&cit\\_id=382738](http://www.stemnet.org.uk/news/press_office.cfm?widCall1=customWidgets.contentItem_show_1&cit_id=382738)

<sup>37</sup> Source: *Engineering, Infrastructure & Climate Change Adaptation* conference, Defra and Engineering Institution, 1<sup>st</sup> December 2009, Royal Society

<sup>38</sup> [www.bis.gov.uk/Policies/further-education-skills/skills-for-growth](http://www.bis.gov.uk/Policies/further-education-skills/skills-for-growth)

2010<sup>39</sup> **recognises that climate change and a transition to a low carbon economy will impact on skills supply and demand including the need for high level STEM skills<sup>40</sup>** and future management and leadership skills to cover the key issue of climate change. A cross-government Low Carbon Skills Strategy consultation document will be published alongside the Budget in 2010 to help further develop this skills agenda.

**9.3 Adaptation designs and technologies have yet to be developed to the same degree of sophistication as those for climate change mitigation**

Adaptation technologies have received less attention and less investment than mitigation technologies. The market is generally less developed.

Greater focus and spend by business on resilience measures will increase market penetration, driving technologies down the ‘cost curve’, pulling R&D out of the research labs, and helping more innovative solutions come to market.

On the supply side, our consultations with several innovative SMEs (particularly those operating in the built environment) have illustrated the challenges faced by new businesses in trying to commercialise technologies and enter established markets. This includes testing costs and the difficulties of navigating certification procedures for technologies that fall outside existing standards. These issues need to be resolved since the **testing of new technologies under UK standards helps businesses demonstrate credibility in both domestic and international markets.**

## 10 CONCLUSIONS

This study has illustrated the diverse array of opportunities (comprising ‘hard’ engineering solutions and ‘soft’ measures such as risk assessment, capacity building and insurance services) arising from climate change adaptation that UK businesses can take advantage of. These opportunities are emerging or are likely to be available in the medium to longer-term, both domestically and globally (see Figure 4).

**Figure 4: The UK is well placed to capitalise on domestic and overseas markets**

Strengths	Opportunities
<p><b>Leading technologies:</b> examples include building control systems, intelligent building materials, ventilation and cooling, flood defence systems, sustainable drainage, risk management software and modelling</p>	<p><b>UK / Overseas markets:</b> Large markets for adaptation solutions from suppliers are emerging in the UK (including where ageing infrastructure and old building stock require significant upgrading), and in overseas markets (such as the USA, the Gulf region, China and India as well as European countries)</p>
<p><b>International services:</b> Suppliers have broad capabilities to work in many parts of the adaptation market. Consultancies and financial, insurance and business services are already strong</p>	<p><b>‘Soft’ skills required:</b> ‘Hard’ engineering opportunities exist but opportunities are also shifting from technology, manufacture and construction towards ‘softer’ service elements. Strong adaptation interdependencies exist between key sectors</p>
<p><b>World class R&amp;D:</b> UK is a leader in climate science and its public and private sector R&amp;D base is a key factor for UK competitive advantage.</p>	<p><b>Innovation:</b> Refinements to adaptation designs, models, technologies, models and systems will play to research expertise</p>
<p><b>Regulatory framework:</b> Robust political and institutional framework and agencies are helping to drive adaptation and support businesses in developing new products and</p>	<p><b>Policy and regulation refinements:</b></p>

<sup>39</sup> [www.ukces.org.uk/reports/skills-for-jobs-today-and-tomorrow-the-national-strategic-skills-audit-for-england-2010-volume-1-key-findings](http://www.ukces.org.uk/reports/skills-for-jobs-today-and-tomorrow-the-national-strategic-skills-audit-for-england-2010-volume-1-key-findings)

<sup>40</sup> E.g. a need for individuals with skills equivalent to levels 4 and 5 in the following engineering disciplines: mechanical, design, civil and structural, electrical, aeronautical, marine and geotechnical

<p>services. Reporting requirements under Climate Change Act 2008 are a powerful stimulus for action across many organisations. The Infrastructure Planning Commission and Infrastructure UK should also help speed up adaptive capacity</p> <p><b>Strong standards:</b> Recognised globally for the thoroughness, accuracy and attention to detail used in producing standards which will help ensure consistency of approaches</p>	<p>Continual refinements to policy and regulation and greater certainty of future impacts (e.g. translation of UKCP09 projections for water companies) will help to incentivise and stimulate investment over the longer term</p> <p><b>Longer term adaptation integration into business planning:</b> Risk management, routine inspection and maintenance regimes, continuity planning etc. creates major opportunity for service providers</p>
<p><b>Weaknesses</b></p> <p><b>Nascent market:</b> Lack of consumer awareness of the long-term risks and impacts from climate change affects the uptake of measures</p> <p><b>Skills shortages:</b> Generic skills shortages in science and engineering and management (building adaptive capacity), as well as for installation (adaptive action)</p>	<p><b>Constraints</b></p> <p><b>Upfront costs of new adaptation technologies, products and services:</b> In some cases, the time-lag before benefits are realised can reduce investment in adaptation</p> <p><b>Insurance sector constraints:</b> Lack of information and failure to communicate risks plus high cost of insurance products hamper opportunities</p>

The latent strengths and international reach of UK supply chains across many of the sectors examined in this study, coupled with a research base that is at the leading edge of global adaptation research, are helping to draw innovations out into the wider market. Experience gained developing techniques and solutions in the UK will also strengthen skills and capabilities, and provide demonstration sites, which can be used to support a drive into global markets. UK firms and research institutes could also actively collaborate with countries already facing extreme climate challenges to jointly develop and exploit commercial ventures in the longer term.

There are already some very good examples of proactive strategic plans and actions being undertaken across the UK economy, which in many cases will require the skills and expertise of UK firms for their implementation.

The challenge, however, lies in building both resilience in the UK and the country's share of global adaptation markets. Investment obstacles include weaknesses and constraints in the UK market such as knowledge gaps, short term planning horizons within firms, the nascent state of the market and limited exemplar projects. Medium-term resolutions will help boost UK competitive advantage.

## ANNEX 1 AN OVERVIEW OF CLIMATE CHANGE IMPACTS

**The scale of climate change over the next few decades is, to a large extent, already 'programmed' into the climate system by greenhouse gas emissions that have already happened (due to a lag between emissions and impacts). The shape of emission trajectories over the next 40 years will therefore have some impact on physical impacts to 2050, but the differences are smaller than those projected later in the century.**

Modelling advances mean that future climate change is being predicted with increased resolution and confidence, while at the same time conveying uncertainties with more clarity. Currently, confidence in annual temperature projections is greater than for predictions of annual precipitation or extreme weather events.

### **Impacts in the UK**

In the UK, probabilistic projections are now available, which give a clearer sense of the uncertainties that need to be addressed in forward planning for adaptation<sup>41</sup>. Projections for 2050 suggest that the UK can expect to experience<sup>42</sup>:

- Higher mean annual temperatures;
- Drier summers (especially in the south of England);
- Wetter winters (especially in the west of the UK);
- Likelihood of more extreme weather events (e.g. concentrated rainfall that leads to flooding); and,
- Sea level rise of less than 25cm, with larger rises in the south than the north.

### **Impacts in Europe**

A number of trends are now visible across Europe:

- Europe has already warmed more than the global average, especially in the south-west, the north-east and mountain areas;
- Annual rainfall changes are already exacerbating differences between a wet north (an increase of 10 to 40% during the 20th century) and a dry south (a decrease of up to 20% in some parts of southern Europe)<sup>43</sup>. The intensity of precipitation extremes such as heavy rain events has increased in the past 50 years, and these events are projected to become more frequent. Dry periods are projected to increase in length and frequency, especially in southern Europe;
- Droughts and water stress will increase;
- Melting of glaciers is projected to continue and snow cover overall is projected to decline;
- No clear trend in the frequency and intensity of storms has yet been observed, but the strength of the heaviest storms is projected to increase, albeit with slightly lower frequency;
- Projections suggest that sea level and sea surface temperatures of some European seas could rise by more than the global average.

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<sup>41</sup> *Climate change projections*. Murphy *et al.* UK Climate Projections (UKCIP). 2009

<sup>42</sup> These summarise outputs from the UK Climate Projections user interface at <http://ukclimateprojections-ui.defra.gov.uk/ui/start/start.php>

<sup>43</sup> *Impacts of Europe's changing climate – 2008 indicator-based assessment*.

## **Global Impacts (to 2050)**

### Africa:

- Land areas may warm by as much as 1.6°C over the Sahara and semi-arid regions of southern Africa<sup>44</sup>.
- In southern Africa and parts of the Horn, rainfall will fall by about 10%;
- Climate variability and the frequency and intensity of severe weather events will increase<sup>45</sup>.

### Latin America and the Caribbean<sup>46</sup>:

- Hurricanes and tropical storms will increase in intensity;
- Sea level rise is likely to hit coastal areas, leading to loss of coastal land, infrastructure, and biodiversity, as well as the intrusion of soil-contaminating saltwater.

### Asia<sup>47</sup>:

- By the 2050s, freshwater availability will decrease in Central, South, East and South-East Asia, particularly in large river basins<sup>48</sup>;
- Rainfall will become more variable during the Indian summer monsoon. The timing and intensity of rainfall will become more erratic;
- Heavy rainfall and tropical cyclone intensity may increase due to disruption of the El Nino cycle and increasing sea surface temperature. A 1°C increase in sea surface temperatures in the Bay of Bengal could increase tropical cyclone intensity by 10%;
- Other extreme events such as heat waves are also likely to increase as the climate becomes unstable through climate change.

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<sup>44</sup> Africa - *Up in Smoke? The Second Report from the Working Group on Climate Change and Development*. <http://www.iied.org/pubs/display.php?o=9560IIED>

<sup>45</sup> Department for International Development.

<sup>46</sup> *Up in Smoke? - Latin America and the Caribbean: The Third Report from the Working Group on Climate Change and Development*. <http://www.iied.org/pubs/pdfs/10017IIED.pdf>

<sup>47</sup> Department for International Development;

<sup>48</sup> IPCC synthesis report. 2007

## ANNEX 2 CONSULTTEES

### Built Environment

1. Philip Charles, Delivery Manager, Modern Built Environment Knowledge Transfer Network
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6. Nicola Taylor, Director, Eco Coverage Technologies
7. Malcolm Baxter, Owner, Floodology Ltd
8. Tony Carlton, Technical Manager, Marley Plumbing & Drainage
9. Shaun Fitzgerald, Managing Director, E-Stack Ltd
10. Jeremy Richardson, Scott Wilson
11. Jon Robinson, Associate Director, Water, Scott Wilson

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19. Kerry Thomas, Associate Director for Research and Training, Environmental, KTN
20. Victor Aguilera, Water quality, Defra
21. Conrad Bishop, Water quality, Defra
22. Anthony Williams, Director, Biwater
23. Gerald Jones, Founder, Corinium Innovation
24. Stephen Hill, Manager, Energy and Carbon Management, Severn Trent
25. Keith Simons, innovation consultant
26. Mike Keil, Head of Climate Change Policy, Ofwat

### Energy

27. Rob Harrison, Principal Consultant, Met Office Hadley Centre
28. Fiona Hewer, Consultant, Fiona's Red Kite Environmental Consultancy
29. Bob Bish, Deputy Director (Power Sector), UKTI
30. Rufus Ford, Public Affairs, Scottish & Southern Energy
31. Anne Stuart, Energy National Policy Statements, Planning Reform, DECC

### Transport

32. Black & Veatch
33. Colin Loveday, Director of Technology, Tarmac
34. Dean Kerwick-Chrisp, Head of Sustainable Development & Climate Change, Highways Agency
35. Matthew Lugg, Leicestershire County Council
36. Climate change team, Network Rail
37. Scott Wilson
38. Stephen Cook, Associate Director (Planning), Arup

### Agriculture & Natural Resources

39. ADAS (various consultees on pigs, poultry, dairy)
40. Alison Austin, ex-Sainsbury's
41. Carl Atkin, Bidwells
42. Dr Penny Maplestone, British Society of Plant Breeders
43. William Frazer, Farming Futures
44. Food & Drink Federation
45. Tara Garnett, Food Climate Research Network

46. Patricia Thornley, Sustainable Consumption Institute
47. Phil Sketchley, National Office of Animal Health
48. Dr Ceris Jones, National Farmers Union

**Insurance services**

49. Andrew Voysey, Climate Wise
50. Swenja Surminski, ABI
51. Sharlene Leurig, CERES
52. Andreas Spiegel, Swiss Re

**General**

53. Jane Kirby, Head of Low Carbon and Environment/Water teams, UKTI
54. Neil Golborne, Adaptation Subcommittee, Committee on Climate Change
55. Matthew Sheldon, Climate Change Adaptation representative, CBI
56. Francis Wood, Policy lead on energy, environment and climate change FSB