

## New types of innovation for a low-carbon society

In response to the challenge of climate change, the UK needs to make a transition to a low-carbon economy. This will require increased levels of innovation – in new technologies, but also new services, new forms of organisation and in the delivery of public services. But policies in the UK are currently only harnessing a narrow band of this possible innovation.<sup>1</sup>

Efforts to reduce carbon emissions could benefit from disruptive forms of innovation – cheaper, easier-to-use alternatives to existing products or services which are often developed by non-traditional players, and which target previously ignored customers. However, currently the UK is not set up to encourage these innovations and the entrepreneurs that drive them – in fact, they are frequently thwarted. With an innovation policy that allows them to flourish, a new breed of green innovator could make a vital contribution to the UK's strategy for carbon reduction.

### Climate change poses a major economic and social challenge

#### The Earth's climate is changing as a result of human action

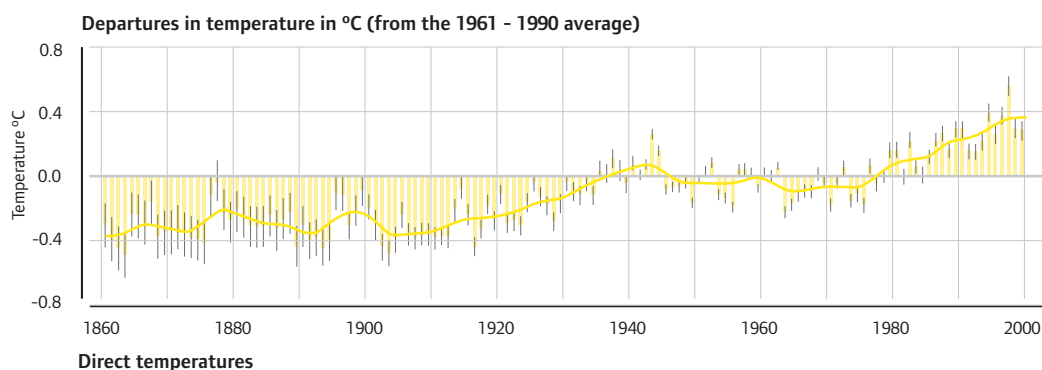
As a result of increases in greenhouse gases, especially carbon dioxide (CO<sub>2</sub>), the climate has warmed by 0.74°C over the last 100 years, with around 0.4°C of this occurring since the 1970s (see Figure 1). According to the latest report of the Intergovernmental Panel on Climate Change (IPCC), average global temperatures are likely to rise between 1.1 and 6.4°C above 1990 levels by the end of this century – a rise that is unprecedented in human history. They have estimated that 90 per cent of this variation will be due to human actions.<sup>2</sup>

#### The impact of climate change will be dramatic

According to the IPCC, this level of climate change will result in a further rise in sea levels of between 20cm and 60cm, continued melting of ice caps, glaciers and sea ice, changes in rainfall patterns and intensification of tropical cyclones. Food and water shortages will follow, resulting in the displacement of hundreds of millions of people and the loss of numerous species.<sup>4</sup>

In October 2006, the Stern Review suggested that the costs of climate change, averaged over time over the regions of the world, would be equivalent to a loss in average world consumption of between five and 20 per cent per year.<sup>5</sup> The Review emphasised the critical role of public policy, calling climate change 'the greatest market failure the world has seen.'<sup>6</sup>

**Figure 1: Variations of the Earth's surface temperature for the past 140 years**



Source: IPCC.<sup>3</sup>

1. This briefing is based on research commissioned by NESTA and conducted by Demos; see National Endowment for Science, Technology and the Arts (2007), *The Disrupters*, (NESTA, London).

2. Intergovernmental Panel on Climate Change (2007), *Climate Change 2007: The Physical Science Basis, Summary for Policymakers, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, (IPCC, Geneva).

3. Intergovernmental Panel on Climate Change (2001), *Global Temperature Change, 1861-2000 and 1000-2000*, (IPCC, Geneva).

4. Intergovernmental Panel on Climate Change (2007), *Climate Change 2007: The Physical Science Basis, Summary for Policymakers, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, (IPCC, Geneva).

5. HM Treasury/Cabinet Office (2007), *Stern Review on the Economics of Climate Change*, (HM Treasury, London).

6. p.1, HM Treasury (2007), *Stern Review on the Economics of Climate Change, Speaking Notes*, (HM Treasury, London).

## Government has recognised the importance of innovation in meeting this challenge

### The UK has set targets to reduce emissions

In 2003, the UK Government set a long-term goal of reducing CO<sub>2</sub> levels by 60 per cent (from 1990 levels) by 2050.<sup>7</sup> If passed, the Climate Bill that is currently before Parliament will make this target legally binding through a succession of five-yearly carbon budgets.<sup>8</sup> However, if the UK is to meet its targets, it will need to develop different ways of building, travelling, shopping and even eating, and it will need innovators who can respond to these needs by developing new and successful products, services and business models.

### A small number of specific initiatives have been introduced to encourage invention and adoption

Innovation has been defined as the 'successful exploitation of new ideas'.<sup>9</sup> Historically, this has been most closely associated with the development of science and technology-based inventions. Consequently, this approach is reflected in current UK environmental innovation policy.

#### *Boosting invention*

Although designed primarily with other purposes in mind, existing governmental initiatives such as the R&D Tax Credit, Collaborative R&D Grants, Knowledge Transfer Partnerships and Knowledge Transfer Networks could equally be used to support environmental innovation.

The UK Government has also funded research centres, such as the Hadley Centre for Climate Prediction and Research. Similarly, the Scottish Executive has set up the Scottish Energy Environment Foundation as a centre of excellence in energy and related environmental technologies with funding from three Scottish electricity companies and support from Strathclyde and Edinburgh Universities.

#### *Promoting adoption*

The Renewables Obligation has been specifically designed to promote the adoption of 'newer' sources of renewable energy. It requires power suppliers to derive a specified proportion of the electricity they supply from renewable sources. Further, under the Energy Efficiency Commitment, electricity and gas suppliers have a statutory obligation to achieve targets for the promotion of improvements in domestic energy efficiency.

#### *Encouraging behaviour change*

The UK Government's latest awareness campaign, Act On CO<sub>2</sub>, proffers a list of climate-friendly chores such as walking a short

distance rather than driving, drying clothes outside rather than in a machine, and only part-filling a kettle. In Scotland, the Executive has developed a website called Climate Change in Scotland which contains resource materials and games designed to raise awareness of climate change.

#### *Developing markets and incentives*

Building on academic models and the example of the European Trading Scheme for companies, the Department for Environment, Food and Rural Affairs (Defra) is currently engaged in a consultation process on domestic carbon trading. The RSA's new online carbon trading scheme for individuals, CarbonDAQ, allows people to calculate their carbon emissions and compare them to others.<sup>10</sup> Similarly, the Climate Group's new initiative, We're in this Together, provides a forum for individuals to pledge carbon reductions, offers help with meeting the pledges, and accumulates pledges to provide overall carbon saving figures.<sup>11</sup> Big companies such as Tesco, Marks & Spencer and BP also now have sophisticated carbon reduction strategies.

### But despite these initiatives, UK carbon emissions are rising

The UK's carbon emissions fell in the 1990s more by accident than design, when a large proportion of electricity generation switched from coal to lower-carbon North Sea gas. Indeed, the UK will meet its Kyoto target largely because of this. However, since then, overall reductions have tapered off, and emissions from the energy sector have been increasing steadily.<sup>12</sup>

## Adequately responding to climate change will necessitate disruptive innovation

### Current initiatives place a priority on large-scale, linear, high-technology innovation

Currently, there exists an 'innovation gap' between policy and practice. Policy has largely remained focused on the discovery and invention of new-to-the-world science and technology and their subsequent commercialisation – the so-called 'linear model' of innovation.<sup>13</sup> This has placed an emphasis on science-based invention, the role of universities, and subsequent knowledge transfer from universities into businesses. However, much innovation is actually based on the adoption and exploitation of technology, or other forms of change such as new business models and organisational forms, and therefore requires a different set of policies from government.<sup>14</sup>

7. The Kyoto Protocol, agreed in 1997, was designed to lead to the cuts in emissions needed to prevent serious climate change. The UK agreed to reduce its emissions by 12.5 per cent. UK emissions in 2010 are predicted to be 23.6 per cent below base year levels, 11.1 per cent lower than required by Kyoto. See 'International Action - The UN and the Kyoto Protocol', [www.defra.gov.uk/environment/climatechange/international/kyoto.htm](http://www.defra.gov.uk/environment/climatechange/international/kyoto.htm)

8. HM Government (2007), Draft Climate Change Bill, (HM Government, London).

9. See Department of Trade and Industry (2003), Innovation Report, Competing in the Global Economy: The Innovation Challenge, (DTI, London).

10. See [www.rscarbonlimited.org](http://www.rscarbonlimited.org)

11. See [www.together.com](http://www.together.com)

12. Department for Environment, Food and Rural Affairs (2007), 2005 UK Climate Change Sustainable Development Indicator and Greenhouse Gas Emissions Final Figures, (Defra, London).

13. National Endowment for Science, Technology and the Arts (2006), The Innovation Gap, (NESTA, London).

14. National Endowment for Science, Technology and the Arts (2007), Hidden Innovation, (NESTA, London).

## Responding to climate change will require changes across many dimensions

Reducing the UK's carbon emissions by over 60 per cent is an immense innovation challenge which has understandably encouraged policymakers to think primarily in terms of radical ('discontinuous') innovation – typically associated with large technological leaps based on new scientific knowledge. This is politically comfortable: it is associated with the inherent excitement of ground-breaking science and it holds out the prospect that new technologies will allow us to continue living much as we have in the past while allowing us to enjoy a low-carbon future.

However, this implicit reliance on scientific invention as a 'silver bullet' is not only dangerous (the hoped-for technologies may not be invented), but may be counter-productive in under-cutting efforts at behaviour change. In reality, no single solution will suffice: responding effectively to climate change will require economic, social and political transformation as well as technological change.<sup>15</sup>

## We need to develop and adopt more 'disruptive innovations'

Instead, the UK also needs to think in terms of disruptive innovations that may have enormous impact, but are more often the result of lateral thinking and smaller technological developments combined with appropriate behaviour change.<sup>16</sup> Disruptive innovations are typically cheaper, easier-to-use versions of, or alternatives to, existing products or services that target 'low-end' or new (previously ignored) customers. They transform established business models and user expectations, and often come from non-traditional players.

## The UK is developing disruptive innovations, but many face resistance

### Cheaper, easier alternatives

Barnsley Council has taken an old technology – wood-burning stoves – and updated it to run municipal buildings on wood waste (a form of biomass).<sup>17</sup> The Digital Media Centre is the latest in a string of biomass-heated buildings – blocks of flats, the civic headquarters, libraries and schools. Biomass also has the benefit of being home grown: much of the wood that Barnsley uses comes from within the borough.

### Reaching out to new consumers

GREENhomes is a London-based company that provides a concierge service to householders who want to cut their carbon.<sup>18</sup> The service

starts with a home visit and a detailed energy audit, which forms the basis of advice on home energy generation as well as efficiency. There is then help with finding suppliers and implementing any changes. Crucially, the service is personalised according to people's outlook, budget and aspirations, as well as to the conditions of their house.

## Challenging established business models

Baywind, based in Cumbria, is the UK's first community-owned wind farm. Typically, electricity is generated through large power stations attached to a centralised grid, but Baywind is run as a 600-person co-operative, powering 1,300 homes.<sup>19</sup> Experience from Denmark and Germany suggests that community ownership can work on a larger scale. Both countries have significant quantities of wind power, with around 80–90 per cent owned by small investors.

## But disruptive innovations are often locked out of existing markets

By its very nature, disruptive innovation doesn't fit neatly into existing policy boxes. For example, regulations covering energy generation can prevent greater innovation. In the UK, local, small-scale electricity generators find it extremely hard to sell their surplus electricity to the grid. Suppliers are not obliged to buy power back, and if they do, the rate is likely to be very low. They also have problems connecting to the electricity distribution system, as network operators are not incentivised to draw upon small-scale power generators.

Dynamic Demand is an organisation that promotes a technology which could change the way that the National Grid works.<sup>20</sup> Its device allows appliances like fridges to 'talk' to the Grid, and switch themselves off at peak times. If introduced across the network, this could smooth out spikes in demand for electricity, or supply from renewables, leading to huge efficiency savings, and reducing the number of power stations needed for back-up power. However, no-one in the current market is in a position to pay for this public good: consumers and appliance manufacturers have no incentive to fit the device, while the National Grid has no way of asking them to.

## Many disruptive innovations fall outside of the definition of innovation policy and are consequently unsupported

20C is a company that suffers from innovation policy's traditionally narrow definitions. It aims to help organisations harness the pressure contained within the UK's gas pipelines to generate renewable electricity (geo-pressure).

15. Disruptive innovation is often confused with radical innovation. The source of this confusion is that disruptive innovations can have a radical impact when widely adopted, but are not necessarily radical in themselves. An example of disruptive innovation is low-cost airlines, whereas an example of radical innovation is the Concorde supersonic passenger airplane.

16. The term 'disruptive technology' was introduced by Clayton M. Christensen and Joseph Bower in 1995, see Bower, J. L., and Christensen, C. M. (1995), 'Disruptive Technologies: Catching the Wave', Harvard Business Review, January–February. The concept was developed further in Christensen, C. M. (1997), *The Innovator's Dilemma*, (Harvard Business School Press, Watertown MA), and replaced with 'disruptive innovation' in Christensen, C. M., and Raynor, M. E. (2003), *The Innovator's Solution*, (Harvard Business School Press, Watertown MA).

17. Barnsley Metropolitan Borough Council (2006), 'Biomass Heats Up Barnsley - Heating from Tree Waste', press release, undated, (BMBC, Barnsley).

18. See [www.greenhomeslondon.co.uk](http://www.greenhomeslondon.co.uk)

19. See [www.baywind.co.uk](http://www.baywind.co.uk)

20. See [www.dynamicdemand.co.uk](http://www.dynamicdemand.co.uk)

By 2014, they could be generating enough energy to remove one million tonnes of carbon from the system.<sup>21</sup> However, geo-pressure does not fit into existing support for low-carbon innovation. As geo-pressure had been used elsewhere in Europe, it was classified as an existing technology and so was ineligible for R&D funding. Since it isn't about the efficient end-use of energy, it could not benefit from funding or support schemes for energy efficiency.

### **Government policy should do more to encourage disruptive low-carbon innovation**

While defining innovation as the 'successful exploitation of new ideas' is inclusive, most policy is directed towards the research and development of new-to-the-world technologies. To maximise low-carbon innovation, these examples suggest that government policy should focus more on helping solutions with potentially high-impact, whether high-technology or not. Further, policy should concentrate more on the dissemination and adoption of technologies rather than simply on their invention.

### **The supply and demand sides of energy policy should be closely linked**

At present, supply-side policies aim to reduce the unit cost of electricity; demand-side policies ask people to value and conserve power. The more that we can link supply of energy to demand for energy, the more likely we are to find ways of using it well. The creation of the new Department for Business, Enterprise and Regulatory Reform, with responsibility for energy, offers an opportunity to reconsider how to link supply-side and demand-side policies for energy.

### **The TSB should develop a UK-wide Innovation Platform for disruptive low-carbon innovation**

The Technology Strategy Board's (TSB) Innovation Platforms bring together stakeholders to focus on a societal challenge, enabling 'the integration of a range of technologies and better coordination of policy and procurement, resulting in a step change in UK performance.'<sup>22</sup> If these are to be one of the UK's main instruments of innovation policy, the newly-reconstituted TSB should establish a low-carbon Innovation Platform as a focal point for efforts to integrate innovation policy with energy and climate change policy, and to develop practical solutions.

### **The UK should create a number of 'low-carbon innovation zones'**

Given the size of the low-carbon challenge and the identified constraints on disruptive innovation, the UK needs more space for

experimentation. Low-carbon innovation zones could combine different forms of technological, service, behavioural and organisational innovation in creative ways. Local and regional decision-makers could pledge ambitious carbon cuts, and set a framework to achieve them. In return, they would be given greater autonomy and scope for regulatory experimentation (and a larger share of funding) to find ways to involve local households, communities, businesses and the public sector in carbon reduction.

### **Ofgem should be set the objective of encouraging low-carbon innovation**

The mandate and duties of Ofgem, the energy regulator, should be reconsidered. Rather than being focused around narrow consumer protection issues, its objectives should be broadened to include specific references to reducing emissions and encouraging low-carbon innovation. Through its role as regulator, it could prioritise investment in electricity networks to accommodate distributed generation; encourage smart metering and time-of-day pricing for electricity; and open markets to a wider variety of participants.

### **Funding streams should be introduced or extended to non-technological innovation**

Often, innovation is seen as synonymous with the invention of new technologies. But some of the most significant low-carbon innovations instead introduce new services or business models. The UK Government should therefore consider making flexible funding available for non-technological innovation, like GREENhomes or Baywind; or for companies working with existing technologies that have not yet been deployed successfully in this country, like Barnsley's biomass or 20C's geo-pressure. While not spent on the pure development of new technology, funding could help with the costs of developing and trialing new business models.

### **NESTA is developing a prize to stimulate innovation in response to climate change**

NESTA's Innovation Challenges programme runs a series of experimental, high-impact projects designed to create opportunities for innovation in response to major social issues. The programme is focussed on testing incentives for innovation, with a particular emphasis on social innovation and citizen-led innovation. As part of this programme, NESTA is developing a Climate Change Prize with the aim of stimulating and studying diverse forms of innovation in response to climate change.

For more information see [www.nesta.org.uk/challenges](http://www.nesta.org.uk/challenges)

21. See [www.20c.co.uk](http://www.20c.co.uk)

22. See [www.dberr.gov.uk/innovation/technologystrategy/innovation\\_platforms/index.html](http://www.dberr.gov.uk/innovation/technologystrategy/innovation_platforms/index.html)