



Innovation against Climate Change

The Climate Change Bill sets a statutory emissions target for the UK. To meet the challenge, the UK needs to make the transition to a low-carbon economy. However, it is currently locked-in to high-carbon technologies and ways of working, making the shift costly and difficult.

Disruptive innovations can help break this lock. These are cheaper, easier to use alternatives to existing products or services that often target new or under-served users. They can enable the rapid introduction of low-carbon technologies, or the carbon-conscious behavioural changes, that will make the transition easier.

But current environmental innovation policy is both too fragmented, and too narrowly focused on technological 'fixes' and 'radical innovation'. By consolidating and broadening environmental innovation policy, Government can enable individuals, firms and communities to create and utilise disruptive innovations. Communities, in particular, can often be the best groups to implement novel ways to reduce carbon emissions. NESTA's Big Green Challenge aims to enable communities to reduce their carbon footprint through innovation.

Climate change poses a major economic and social challenge

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

Scientists now almost universally recognise that human activity is having dramatic effects on the planet's climate. Average global temperatures could rise by up to 4C above 1990 levels by the end of the century.¹

The costs of unmitigated climate change, averaged across the whole world, could be equivalent to a loss in average world economic output of between five and 20 per cent per year.² The Stern Review described climate change as 'the greatest market failure ever seen'.³

Carbon emissions are rising

The UK's carbon output fell during the 1990s, largely as an unexpected bonus from a shift towards gas-fired power stations.⁴ This shift has helped the UK towards meeting its Kyoto obligations without needing to make hard policy choices.

Recent evidence suggests that carbon emissions are creeping up again, with one report even claiming that the rise has been substantial.⁵ The UK has not, as yet, broken the link between economic growth and carbon use.

The UK Government's response

The Climate Change Bill is currently making its way through the Houses of Parliament. It

sets out proposals, including a new target for the reduction of greenhouse gas emissions of 60 per cent by 2050,⁶ the establishment of a Committee on Climate Change, a system of carbon budgeting and powers to establish trading schemes to limit greenhouse gas emissions. This is in addition to the Energy Bill which will, if passed, make provisions for electricity generated from renewable sources.

New technology alone will not solve climate change

Most investors and policymakers are searching for a 'magic bullet'

Many innovative products are emerging that aim to either reduce the carbon output of existing processes, or to introduce new ways of living and working that will reduce carbon footprints.

Investment into so-called 'cleantech' – low-emission technology – is growing exponentially, with US venture capital investing \$2.7bn into the sector in the first three quarters of 2007 – up 44 per cent from the preceding year, and nearly five times as much as 2005.⁷

Policy focuses on invention and then adoption

Environmental innovation policy is also focused on the creation and diffusion of new-to-the-world technology. Alongside general schemes and policies promoting innovation, such as

1. 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.' Available at: <http://www.ipcc.ch/ipccreports/ar4-syr.htm> [Accessed 14 January 2008].
2. HM Treasury/Cabinet Office (2006) 'Stern Review of the Economics of Climate Change.' London: HM Treasury.
3. HM Treasury/Cabinet Office (2006) 'Stern Review of the Economics of Climate Change.' p. i. London: HM Treasury.
4. Inter-departmental Analysts Group (February 2002) 'Long-term reductions in greenhouse gas emissions in the UK.' Available at: <http://www.berr.gov.uk/files/file38187.pdf> [Accessed 15 January 2008].
5. One calculation, on a 'consumption basis' (taking into account all activities by UK citizens, and all their knock-on effects), finds that total emissions have risen by 19% from 1990 to 2003, driven principally by the importation of carbon-intensive goods. Helm, D. et al. (2007) 'Too Good to Be True? The UK's Carbon Record.' Available at: http://www.dieterhelm.co.uk/publications/Carbon_record_2007.pdf [Accessed 14 January 2008].
6. Against a 1990 baseline.
7. National Venture Capital Association (2007) 'Cleantech Venture Investments by US Firms Break Records in 2007.' Available at: <http://www.nvca.org/pdf/CleanTechInterimPR.pdf>. [Accessed 9 December 2008].

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8. BERR press release (2 January 2008) 'TSB to invest £10m in low carbon energy technology research.' Available at: <http://www.berr.gov.uk/innovation/technologystrategyboard/page43358.html> [Accessed 11 January 2008].

9. NESTA (2007) 'Hidden Innovation: how innovation happens in six 'low' innovation sectors.' London: NESTA.

10. Boardman, B. (2007) 'Home Truths: A low-carbon strategy to reduce UK housing emissions by 80% by 2050.' Available at: <http://www.eci.ox.ac.uk/research/energy/downloads/boardman07-hometruths.pdf> [Accessed 14 January 2008].

11. The International Energy Agency claims Britain has 'perhaps one of the best wind resources in Europe.' IEA (2006) 'Wind Report 2006', p.233. Available at: http://www.ieawind.org/AnnualReports_PDF/2006%20AR%20IEA%20Wind/2006%20IEAWind%20AR.indd.pdf [Accessed 15 January 2008].

12. Ibid., p.233. British wind capacity took 14 years to exceed 1 Gigawatt.

13. Foxon, T. and Pearson, P. (2008) Overcoming barriers to innovation and diffusion of cleaner technologies: some features of a sustainable innovation policy regime. Submitted to 'Journal of Cleaner Production' special issue on 'Modelling, case studies and policy on cleaner technologies diffusion' (forthcoming).

14. See particularly the example of California, where, despite heavy state-led promotion in the early 1990s, electric car use failed to take off.

15. North, D. (1990) 'Institutions, Institutional Change and Economic Performance.' Cambridge: Cambridge University Press.

16. Unruh, G. (2000) Understanding carbon lock-in. 'Energy Policy.' Vol. 30, Issue 4, March 2002, pp.317-325.

17. Foxon, T. and Pearson, P. (2008) Overcoming barriers to innovation and diffusion of cleaner technologies: some features of a sustainable innovation policy regime, Submitted to 'Journal of Cleaner Production' special issue on 'Modelling, case studies and policy on cleaner technologies diffusion' (forthcoming).

18. Environmental Audit Committee (2007) 'Ninth Report of Session 2006-2007, The Structure of Government and the Challenge of Climate Change.' Available at: <http://www.publications.parliament.uk/pa/cm200607/cmselect/cmenvaud/740/740.pdf> [Accessed 14 January 2008]. Current initiatives include the Energy Technologies Institute, the Environmental Transformation Fund, the Carbon Trust, and the Environmental Innovation Advisory Board.

19. HM Treasury/Cabinet Office (2006) 'Stern Review of the Economics of Climate Change.' Ch.16. London: HM Treasury.

R&D Tax Credits, Collaborative R&D Grants, and the Knowledge Transfer Partnerships – most of which could, in practice, also support environmental innovation – there are a small number of specific schemes to promote environmental innovation.

Most recently, the Technology Strategy Board has announced a £10m investment in collaborative R&D to promote low-carbon energy technology.⁸

But policy is too heavily focused on large-scale, linear, high-technology innovation

Innovation policy has previously been considered a branch of science and technology policy, with the discovery and invention of new ideas and products as its overriding aim.

Much innovation, however, is based on the novel exploitation of existing technology, or other forms of change such as the implementation of new business models. These require a different set of policy responses from Government.⁹

Viable low-carbon technologies already exist

Technology already exists that can make a substantial reduction in greenhouse gas emissions. For example, Oxford University's Environmental Change Institute estimates that, with suitable modifications, emissions from the current stock of housing that will still be in use in 2050 can be reduced by 80 per cent, and that 'zero-carbon' new-build homes are a realistic possibility.¹⁰

But adoption and diffusion is too slow

Yet these technologies are being adopted very slowly. And even when new low-carbon technologies are generated, there are no guarantees that they will be taken up – regardless of their technical merits.

Reliable wind turbines have been available from the early 1980s, but Britain, perhaps the windiest country in Europe,¹¹ has been notably slow in utilising the technology.¹²

The UK is locked-in to high-carbon technologies

Existing technologies are in a privileged position

Existing technology has many inherent advantages over the new: familiarity amongst producers and consumers; an existing body of research and development makes further research easier; and network effects reduce the cost of additional units – for example, a new petrol car can rely on a huge network of existing petrol stations, making refuelling cheap and easy.¹³ By contrast, electric car use

has been hampered (to date) by the small number of accessible charging points.¹⁴

Institutions are also path dependent...

As a result, once a technology is established, it may be too costly to shift to another, making its use 'path dependent'. Where institutions have become established alongside a technology, mutually reinforcing each other, the costs of transition to a newer (and perhaps better) technology can become exceptionally high. Incumbent firms, for example, can rely on their market power to block new technologies.¹⁵

...with carbon lock-in as the result

The resulting strong attachment to high-emission technologies has been described as 'carbon lock-in'.¹⁶ Traditional theories of innovation would consider this lock hugely costly and disruptive to break. But if climate change is to be tackled successfully, it must be broken.

Carbon lock-in imposes great challenges for environmental innovation policy

There remains a substantial gap between innovation and environmental policies

Innovation and environmental policymakers have historically sat in separate silos, based on different research agendas and policy goals, with little direct communication between the two.¹⁷ Currently, BERR oversees electricity regulation, Defra emissions control, and DIUS has an overview role in promoting innovation. The Environmental Audit Committee has criticised the multiplicity of separate UK Government initiatives on climate change, noting that this reduces the effectiveness of intervention.¹⁸

Market intervention alone is not the answer

Carbon lock-in means that attempting to alter incentives directly, through market mechanisms like taxation and subsidies cannot alone be enough to shift behaviour: no price instrument will be strong enough to break the lock.

The Stern Review argued that innovation to tackle climate change will require more than just tweaking prices: a 'portfolio' of policies was needed, covering the different, interlinked aspects of climate change.¹⁹

Market mechanisms may stimulate only those technologies that are already closest to the market. For instance, the Renewables Obligation has promoted the use of wind power by creating a guaranteed market for renewable energy.²⁰ But this is promoting only the nearest-available technologies, rather than advancing innovation across the range of potential technologies.²¹

In response, the Commission on Environmental Markets and Economic Performance has recommended the use of innovation policy measures alongside environmental policy to drive innovation in low-carbon technology.²² This is the most developed set of recent UK policy proposals on environmental innovation, to which the UK Government is now preparing a reply, and includes some direct price instruments alongside broader institutional changes.

Government policy needs to actively promote disruptive innovations

Disruptive innovations are typically cheaper, easier-to-use versions of, or alternatives to, existing products and services that target new customers.

Disruptive innovations are often confused with 'radical innovations'. A radical innovation is one that utilises a significant technical advance; a disruptive innovation is one that causes a shift in behaviour. For example, low-cost airlines were a disruptive innovation, using old technology with a new business model; Concorde was a radical innovation, using advanced technology (but in an old business model). Of the two, low-cost airlines have had the most significant impact on people's lives, despite not utilising new technical knowledge.²³

Moreover, a reliance on discovering magic bullets, and technological fixes, is both dangerous (since hoped-for technologies may not emerge) and potentially counter-productive, weakening incentives to change behaviour. Policymakers can be drawn to them, however, because they appear to offer a way to avoid hard decisions about incumbent industries, and behaviour change.

Disruptive innovations are already making a difference

Challenging established business models

Electricity is typically generated through large power stations attached to a centralised grid. But this imposes its own carbon costs, including the relative inefficiency of transmission, and the mismatch between generating capacity and typical demands.²⁴

Decentralised generation, based on smaller-scale generators closely matched to their users' needs, offers a solution to this problem. Funding and installing such schemes, however, imposes its own challenges where the large power generating companies may be uninterested in relatively marginal developments, and lack the local knowledge to make such schemes work.

The Baywind example

Baywind, based at Harlock Hill, Cumbria, was the UK's first community-owned wind farm. Based originally on a Swedish example, Baywind was established in 1997 and now has 1,350 individual shareholders, each of whom receives a dividend from the company's profits.²⁵

The co-operative's structure, with locally-held shares, also enabled a difficult planning process to run more smoothly, with local residents able to see tangible benefits from the scheme's operation.²⁶

The success of the Baywind co-operative led to its expansion to a further site at Haverigg in Cumbria. Government support for renewable electricity generation has been vital in guaranteeing a market for the co-operative's output, and ensuring electricity can be economically generated.

Wind farm co-operatives elsewhere

In Denmark, such co-operatives are well-established, with half of the country's privately-owned wind farms being owned by community co-ops. The success of co-operative ownership has been attributed to three main ingredients: first, a stable pricing mechanism for wind power, credibly guaranteeing a high price for wind energy fed into the national grid; second, a planning system that actively encouraged the development of wind farms; and, third, a strong tradition of co-operative ownership.²⁷

Replication of such schemes can enable significant reductions in carbon emissions to be achieved. But successfully reproducing the model will require continuing Government support for renewable electricity, and a legal environment that can support non-traditional forms of business ownership.

Tackling a global problem

The UK's carbon emissions, whilst significant, represent a fraction of global emissions. Because disruptive innovations can be easily replicated, they can play an important part in reducing globally emissions. By supporting disruptive innovations, the UK can provide a lead globally in combating climate change, and potentially reap the economic rewards from doing so.

Government policy can support disruptive low-carbon innovation

The Climate Change Bill is only part of the battle

While the Climate Change Bill is welcome, it is only a step. Among the next steps are for the governments to support individuals and

20. It requires generating companies to produce a steadily-increasing proportion of the electricity they sell from renewable sources. For more information, please refer to <http://www.berr.gov.uk/files/file10719.pdf>

21. Smith, A. and Watson, J. (2002) 'The Renewables Obligation: can it deliver?' Available at: http://www.tyndall.ac.uk/publications/briefing_notes/note04.pdf [Accessed 16 January 2008].

22. Defra, BERR and DIUS (2007) 'Report of the Commission on Environmental Markets and Economic Performance.' Available at: <http://www.defra.gov.uk/environment/business/commission/pdf/cemep-report.pdf> [Accessed 15 January 2008].

23. Willis, R., Webb, M. and Wilsdon, J. (2007), 'The Disrupters: lessons for low-carbon innovation from the new wave of environmental pioneers.' NESTA: London.

24. Patterson, W. (2007) 'Keeping the lights on: towards sustainable electricity.' London: Earthscan.

25. The estimated carbon savings are approximately 4,200 tonnes of CO2 equivalent every year.

26. Willis, R., Webb, M. and Wilsdon, J. (2007) 'The Disrupters: lessons for low-carbon innovation from the new wave of environmental pioneers.' NESTA: London.

27. Details in Renewable Energy Investment Club, presentation to IIR (March 2002) 'Developing successful community energy schemes to engage in your renewables project.' Available at: <http://www.reic.co.uk/communityincentiveschemes.ppt> [Accessed 9 January 2008].

organisations developing innovative ideas to reduce emissions, and to support the scaling up and replication of these ideas.

The emphasis in the discussions around the Bill is that if government can frame a new broad market context for carbon (through trading or taxation) then business and society will make the appropriate choices for a low carbon transition. But this neglects the fundamental issue of whether actual organisations and communities have the capacity and will to innovate.

The Bill does, however, establish a challenging target, and a framework in which it could be met. Because it is not prescriptive, it allows the scope for a variety of different approaches to be taken in meeting the UK's carbon emissions target.

A lead from the devolved administrations

The Scottish Government has set itself the ambitious aim of an 80 per cent reduction in Scottish emissions by 2050, in line with recent scientific evidence.

Consequently, it is introducing policies to promote renewable heat and increased micro-generation; the establishment of an expert panel on building energy efficiency; and plans to introduce a 'one-stop-shop' for domestic consumers across Scotland offering sustainable energy advice.

The Welsh Assembly Government has established a Climate Change Commission, drawing on the expertise of key sectors with an interest in climate change and providing policy advice. In addition they have set an aspiration for all new buildings to be zero carbon from 2011 and are ensuring that the public sector procurement sets an example in this area.

The Northern Ireland Assembly has given its legislative consent to the extension of the Climate Change Bill to Northern Ireland. Northern Ireland is already committed, on a non-statutory basis, to a 25 per cent reduction in greenhouse gas emissions by 2025.

Offer better support and advice

As part of the ongoing Business Support Simplification Programme, Government should consider better integrating advice on establishing small businesses into its environmental information campaign, alongside improved advice on establishing environmental co-operatives.

Develop bank-approved packs for community ownership

Working with the financial sector, Government can develop models of community ownership

that will simplify the current legal and technical complications in setting up community-owned projects, encouraging greater participation and providing a more secure base for investment.

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

The UK Government should consider making flexible funding available for non-technological innovations, like Baywind. Funding could help with the costs of developing and trialling new business models.

The Committee on Climate Change should support environmental innovation

The creation of the Committee presents an ideal opportunity to cut through the thicket of separate schemes and initiatives to deliver effective policy interventions. In addition, it can help ensure a better match between innovation and environmental policy. As part of its remit, it should ensure that low-carbon innovations are being effectively supported, and that Government departments and agencies are collaborating effectively.

The NESTA Big Green Challenge

Reducing carbon emissions through carbon literacy and community involvement

The Climate Change Bill sets a clear target for the whole of the UK. Meeting that target will, however, be the task of firms, individuals and communities. This will mean developing 'carbon literacy', where the carbon impact of actions is understood, alongside targeted interventions. Local communities could be the ideal level at which to aim, since they can be self-regulating and self-monitoring, but also capable of more significant changes than individuals alone.

Empowering local communities

Building on its work on both disruptive innovation, and the importance of user-led innovation, NESTA is running a new scheme to incentivise local communities into creating innovative new ways to reduce their carbon output.

The Big Green Challenge is a £1m prize fund aimed at communities who innovate to reduce their carbon use. It is deliberately designed to impose very few restrictions on the kinds of 'communities' that might apply – whether they are parish councils, community interest companies, or even just a group of concerned neighbours. The community must not exist to make a profit, and must come up with an innovative means to reduce its carbon footprint.²⁸

28. The competition will be run in three stages over the next year. In September 2009, the ten finalists will report on their progress, as measured by their carbon saving, their use of innovative ideas, their community engagement, and how easily their scheme can be copied elsewhere. The winning communities will share £1m to further develop their idea. For further details see <http://www.nesta.org.uk>