Parliamentary Office of Science and Technology

postnote

December 2008 Number 318

THE TRANSITION TO A LOW CARBON ECONOMY

Fundamental changes to the UK economy will be required to meet the greenhouse gas emission targets of the Climate Change Act (2008). This POSTnote examines UK emission trends since 1990 and considers how the UK might achieve a technological and behavioural transition to meet the targets.

Background

Greenhouse gas emissions (GHGs) arise from activities which are central to everyday lives, contributing to shelter, heat, food and travel. Figure 1 shows that two thirds of UK GHGs come from energy services (electricity generation, heating in homes and offices, and transport).

Historically, energy use and carbon emissions have risen with population and economic growth. Since 1990:

- the UK population has increased by 6%, with a further 27% growth projected for 2050;[1]
- GDP has increased by 48%, with the government forecasting a further 170% growth by 2050;[2]
- electricity use has increased by 26%;
- transport energy use has increased by 11%.

UK territorial GHG emissions (those originating within the jurisdiction of the UK) have decreased by 1.1% per year since 1990 as explained overleaf. Cuts of 3.2% per year are needed from now to meet the 2050 target.

International reporting of UK territorial emission trends

The government estimates the UK territorial emissions of six greenhouse gases,[3] from all sources, under the UN Framework Convention on Climate Change (UNFCCC):

- carbon dioxide (CO_2), from combustion of fuels, industrial processes and land use;
- methane (CH_4), chiefly from agriculture and landfills;
- nitrous oxide (N_2O), from agriculture and transport;
- three fluorinated gases (HFCs, PFCs, SF_6), used in refrigeration, air conditioning and industry.

For easy comparison, emissions of the non-CO_2 gases are converted into equivalent CO_2 (CO_2eq). *International* aviation and shipping emissions do not contribute to the UK total because there is no internationally agreed process to split these between countries (Box 1).

UK GHG emission targets

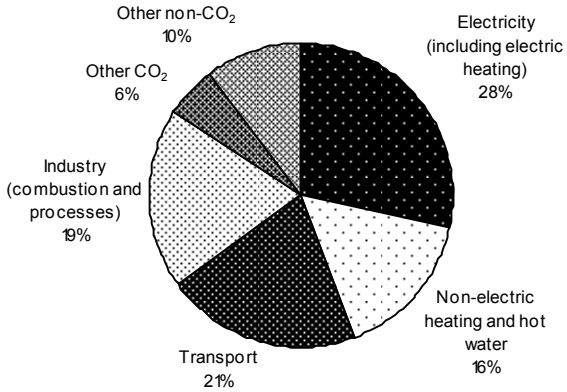
The UK has agreed to several legally binding emissions reduction targets relative to base year (1990) emissions:

- 12.5% GHGs by 2008–2012 (Kyoto Protocol);
- 26% CO_2 by 2020 (Climate Change Act 2008);
- 80% GHGs by 2050 (Climate Change Act 2008).

The *emission reductions per capita* in each case will increase with population; the projected 77 million by 2050 increases the *per capita* target from 80% to 85%.

Future international emission reduction targets will be negotiated at the UN Climate Change Conference in Copenhagen in December 2009. The independent Committee on Climate Change has recommended 5-year carbon budgets based on European targets, with a CO_2 reduction for the period 2018–2022 between 29% and 40% (depending on the Copenhagen outcome).[4]

Figure 1. Breakdown of UK territorial GHG emissions in 2006, excluding international aviation and shipping.



Box 1. Alternative methods to assess emissions

The territorial approach to reporting emissions may result in the 'export' of emissions, because energy-intensive industries can relocate overseas while the 'exporting' country still consumes the products that are produced. An alternative accounting method considers the emissions associated with the UK consumption of goods and services, or 'consumer emissions'. Between 1992 and 2004, while UK territorial emissions reduced by 5%, consumer emissions increased by 18%.[5] From a *consumption* perspective, CO_2 emissions have not been decoupled from GDP growth.

The government argues that it is unable to influence the emissions of a foreign country, in the absence of a shared emissions trading scheme, so using consumer emissions would require an international agreement.

The consumer emissions method could be used to split international aviation and shipping emissions between countries. Another approach would be to negotiate a separate international agreement for each of these sectors.

UK GHG emission trends since 1990

Total UK territorial GHG emissions in 2006 were 16% lower than in 1990. Specifically:

- CO_2 emissions have reduced by 6% (despite a 15% *increase* in UK transport emissions).
- Non-CO_2 emissions have reduced by 46%. Industrial N_2O emissions have reduced by 90%, primarily by fitting an abatement plant to a single factory. Agricultural emissions have reduced by 18%. 70% of landfill methane emissions are now captured.

There is potential to reduce non-CO_2 further but it is difficult to realise without, for example, reducing livestock numbers or field fertilisation. Only CO_2 emissions are considered in this POSTnote, concentrating on the electricity, heat and transport sectors.

Transition scenarios for the UK

Scenarios have been produced by several organisations to assess how UK emissions could be reduced.[6] Transitions are generally characterised by:

- whether energy demand significantly reduces in the future or continues to increase;
- whether the aviation sector peaks at current levels or continues to grow;
- expectations of the performance of new technologies.

Box 2 lists some of the technological and behavioural options that will contribute to meeting the CO_2 targets.

The time required for emission cuts depends on the economic cost, the capacity of the economy to deploy new technologies, and the rate at which the population adopts more environmentally sensitive behaviour. Most scenarios suggest that significant political interventions are necessary to facilitate a transition.

Economic cost of a transition to a low carbon economy

The cost of a transition is difficult to assess because the potential of new innovations and behavioural change is difficult to estimate. Another important unknown is the price of fossil fuels relative to low carbon technologies.

Box 2. Options to meet emission reduction targets

Both technological and behavioural options are considered. In each sector, currently used technologies are listed first.

Electricity sector

See POSTnote 280 for a description of the electricity sector in the UK. Options for the future include:

- nuclear power (Pn 317);
- fossil fuels with carbon capture and storage (CCS) (Pn 238 and the forthcoming update);
- renewables, including wind, solar and marine technologies (Pn 164, 315), perhaps in conjunction with electricity storage systems (Pn 306);
- biofuels, including domestic and agricultural waste;
- electrical appliance energy efficiency improvements;
- reducing peoples energy use where economic; smart meters (Pn 301) would facilitate this strategy.

Buildings – space and water heating

Improving the energy efficiency of buildings is likely to be the most effective short term measure to reduce heat use (POSTnote 249). Only 8% of English housing is rated in bands A–C for energy efficiency, while 62% is rated in bands E–G (there are 7 bands, A–G, where A is most efficient).[7] Other options for the future include:

- providing heating through district heating schemes;
- widespread use of electric or biomass boilers;
- microscale renewable heating using heat pumps.

Road Transport

Experts consider emissions from transport to be the most difficult to reduce. Road vehicles are responsible for 92% of domestic transport emissions; options for reducing these are discussed in POSTnotes 255 and 293. Options include:

- improving the energy efficiency of vehicles;
- using hybrids, battery power, biofuels or hydrogen;
- persuading people to adapt their lifestyles and habits to travel more efficiently and reduce emissions.

Air Transport

Demand for air travel is projected to grow from 228 million in 2005 to 490 million passengers passing through UK airports each year by 2030, limited only by airport capacity.[8] Aviation is the most difficult sector to decarbonise. Demand reduction measures may be necessary to control CO_2 emissions, for example by changing working patterns to encourage people to take fewer but longer foreign holidays. Aviation will be included in the EU Emission Trading Scheme from 2012.

The Committee on Climate Change estimates a cost to 2020 of less than 1% of UK GDP.[4] This should be compared with the impact of climate change and the cost of adaptation if no action is taken. Costs escalate if infrastructure (for example, power plants) is closed early so long-term planning is important. Taking early action avoids the need for large, expensive cuts in the future.

Rolling out energy efficiency measures will have positive economic benefits in the short term. But in the longer term, as emission reduction targets are tightened, each successive round of CO_2 reductions will become more expensive (the marginal cost will increase).

Current technologies, lifestyles and UK infrastructure were developed for a high carbon economy. To achieve an 80% emissions cut at an acceptable cost, all of these will have to be adapted significantly. The UK will have to undergo a technological transition.

Technological transitions

Technology and behaviour cannot be considered as separate concepts because they co-evolve together. For example, the growth of motor car use changed lifestyles by giving new freedoms and flexibility to owners. Over several decades, a new road network was developed and new land use patterns emerged because people could live remotely from their workplace. Similarly, building new runways creates a larger aviation market which encourages the adoption of international lifestyle choices, for example by taking weekend breaks or buying overseas property.

Past technological transitions (for example, the motor car, mobile phones and the internet) were successful because people received immediate tangible benefits and voluntarily changed their behaviour to fit their new lifestyles. Making a transition to a low carbon economy is more difficult because the benefit is long-term and intangible, and comes at the cost of reduced energy use and hence lifestyle changes. People may be more willing to adopt a transition if:

- there are adequate alternatives to meet their needs;
- they believe that the transition is necessary (for example, to benefit their grandchildren);
- they understand how particular measures contribute to the transition.

Unless these conditions are met, public information campaigns are unlikely to engender low-carbon lifestyles and fiscal instruments are likely to be unpopular. For example, the fuel tax escalator has attracted sustained protests, and subsequent fiscal policies have targeted industry and commerce rather than individuals, with costs being passed on to consumers indirectly.

Government policies

Policy instruments generally fall into one of four groups:

- *command and control regulation* (for example, by regulating for minimum energy efficiency standards);
- *economic instruments* (eco-taxes, emission trading);
- *information-based approaches* (eco-labelling);
- *negotiated agreements and voluntary approaches* to agree emission reductions.

EU Emissions Trading Scheme

The primary policy instrument appears to be the EU Emissions Trading Scheme (ETS), which requires energy intensive industries to obtain permits for their emissions in a market. Permits are granted to industry sectors where there are concerns over competitiveness (for example, if the industry could relocate outside Europe, so-called 'carbon leakage') and auctioned to others. The total emissions from each country are capped, with a gradual reduction, to initiate emission cuts. Around half of UK CO_2 emissions are included in the ETS.

The ETS allows emitters to buy spare emission credits instead of cutting their emissions. When bought from abroad, they count towards the UK targets; for example, in 2006, emission credits purchased by the UK were equivalent to a 5% cut in emissions under the Kyoto Protocol, so the total emissions account for that year showed a 21% reduction. The Committee on Climate Change has recommended that:[4]

- 70% of UK emission reductions come from sectors within the EU ETS;
- there should be no limit on the number of emissions credits that are used to meet this target;
- the remaining 30% cut, from non-ETS sectors, should be achieved entirely by in-country reductions (depending on the outcome of the post-Kyoto talks).

Command and control regulations

Mandatory regulations are generally introduced by the EU, with the UK preferring to limit unilateral action to voluntary agreements. For example, there is voluntary agreement with major retailers to phase out the sale of incandescent light bulbs, although these will still be available from smaller retailers. Some voluntary agreements have been ignored: CO_2 emissions from new European cars are currently ~156 g/km despite manufacturers having an achievable target of lower than 140 g/km by 2008 (new *mandatory* regulations have been proposed by the EU of 130 g/km by 2012).

Economic instruments

Current economic instruments include:

- *industrial tariffs* (for example, the Climate Change Levy and the Renewables Obligation);
- the *Carbon Reduction Commitment*, from 2010, encouraging large UK organisations outside the EU ETS to reduce emissions using monetary incentives;
- *transport taxes*, including fuel duty, vehicle excise duty and air passenger duty.

Several alternative policies are being planned by departments or have been advocated by experts:

- *Progressive energy use tariffs* for domestic customers, where the cost of energy increases with consumption to encourage frugal behaviour.
- *Feed-in tariffs*, where a guaranteed minimum price is paid for low carbon generation for a set period of time. These have underpinned rapid renewable deployment in several countries and were introduced in the Energy Act (2008), but only for small-scale low-carbon generators (<5 MW).
- *Dedicating the revenues from fiscal policies to environmental purposes* (hypothecation). Research suggests that fiscal policies are more acceptable to the public when revenue is invested in the same sector.[9]

Information-based policies

Studies suggest that giving information alone increases awareness but does not necessarily lead to behavioural change. Tailoring advice, giving feedback and promoting community interactions are generally more effective.[10] Several independent community initiatives which engage people directly have appeared in recent years; for example, there are now 87 'Transition Towns' within the UK. Such initiatives may promote community cohesion.

Issues for the government

The EU has set the UK a target of supplying 15% of energy from renewables by 2020, but the House of Lords EU Committee concluded that this will not be achieved within the existing policy environment.[11] The government will announce how it intends to meet the various climate change targets in 2009. The last government strategy, published in 2006, contained several new initiatives which aimed at a 23% cut in UK CO_2 emissions by 2010.[12] Only a 6% cut was achieved by 2006.

Coordinating policy goals across government

The Dutch Environment Plan is notable for aiming to integrate environmental concerns and policies across government (Box 3). In the UK, the new Department of Energy and Climate Change (DECC) has overall responsibility for climate change across government, but other departments are responsible for particular aspects:

- DECC is responsible for energy industries.
- The Department for Environment, Food and Rural Affairs deals with land use issues such as biomass.
- The Department for Communities and Local Government is responsible for planning policy.
- The Department for Transport covers transport issues.

Climate change is only one of several priorities; for example, transport priorities include the environment, quality of life, economic growth, safety and security. If climate change policies conflict with other departmental aspirations then prioritisation becomes necessary.

Box 3. Dutch Transitions Approach

The Dutch approach combines local community based experimentation with a top-down view of the transition.[13] The vision is long-term, with strategic intermediate goals en route and learning from numerous small experiments.

The Ministry of Economic Affairs, which is responsible for energy and innovation policy, manages the Energy Transition Programme. The plan has been praised for encouraging long-term thinking in energy policy and the energy sector and for placing local experiments within a larger process. It has been criticised for being dominated by the incumbent energy providers who have narrowed the innovation focus to their interests; for example, there are no experiments in low energy lifestyles.[14]

Technological and behavioural issues

It is not possible accurately to predict the makeup of the UK economy in 2050 because both technologies and lifestyles will evolve over the next 40 years. A diverse portfolio of low-carbon technologies and a flexible approach would allow solutions to evolve which fulfil peoples' needs and ambitions.

Supporting innovation

Carbon capture and storage technology is currently unproven for power stations and needs to be tested on a commercial scale.

The Stern Review recommends that the government promotes innovation in low-carbon technologies to make emission cuts more cost effective in the long run.[15]

Infrastructure and technology lock-in

Transition options are restricted by current land use and infrastructure patterns. The built environment changes very slowly, with the housing stock growing by only 0.7% a year, so the majority of the homes will continue to be used in 2050. Similarly, generating electricity off-shore or using micro-renewables on buildings requires significant investment in the National Grid.

Government structures and regulations have evolved around the current technologies, a situation called 'technology lock-in'. A new coal power station can generate electricity for 60 years; a new aeroplane has a similar lifespan. Technologies which have not previously had large-scale use, such as some renewables, will compete only if environmental, innovation, infrastructure, planning and fiscal policies are coordinated.

Overview

- UK *territorial* greenhouse gas emissions have fallen by 16% since 1990.
- Emissions and GDP growth have *not* been absolutely decoupled when measured by emissions associated with products and services (UK *consumer* emissions).
- A technological transition will be required to meet the 2050 target in the Climate Change Act (2008).
- Behaviour and technology co-evolve over the long-term and cannot be considered separately.
- The EU Emissions Trading Scheme appears to be the primary UK policy instrument to cut emissions.

Endnotes

1 Office for National Statistics, 2006 to 2051.
2 Assumes an annual GDP growth rate of 2.25% from 2006.
3 NAEI, *Annual Report*, AEAT/ENV/R/2582, Apr 2008
4 Committee on Climate Change, *Building a low-carbon economy - the UK's contribution to tackling climate change*, Dec 2008
5 DEFRA, *Development of an … Emissions Indicator*, Jul 2008
6 UK Energy Research Centre, Tyndall Centre, BERR, Committee on Climate Change and Greenpeace have all produced scenarios.
7 DCLG, *English House Condition Survey 2006*, Jan 2008
8 DfT, *UK Air Passenger Demand and CO_2 Forecasts*, Nov 2007
9 Schuitema et al., The role of revenue use in the acceptability of transport pricing policies, *Trans. Res. Part F*, vol 11 (2008), p221
10 Abrahamse et al., A review of intervention studies aimed at household energy conservation, *J. Env. Psy.*, vol 25 (2005), p273
11 HL Paper 175–I, *The EU's Target for Renewable Energy*, Oct 2008
12 DEFRA, *Climate Change: The UK Programme 2006*, Mar 2006
13 *4th Dutch Environmental Policy Plan*, 2001
14 Kern et al., Restructuring energy systems for sustainability?, *Energy Policy,* vol 36 (2008), p4093
15 HM Government, *The Stern Review*, Oct 2006

POST is an office of both Houses of Parliament, charged with providing independent and balanced analysis of public policy issues that have a basis in science and technology.

POST is grateful to Paul Dodds for researching this briefing. to the ESRC for funding his parliamentary fellowship, and to all contributors and reviewers. For further information on this subject, please contact Dr Jonathan Wentworth, at POST.

The Parliamentary Office of Science and Technology, 7 Millbank, London, SW1P 3JA; Tel: 020 7219 2840; email: post@parliament.uk

www.parliament.uk/parliamentary_offices/post/pubs2008.cfm