

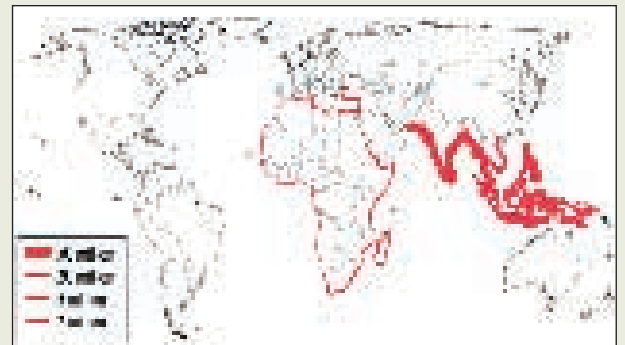
Chapter 2 The Environment

Climate change is happening...

- 2.1 There is now strong scientific evidence that climate change is happening and that it is being accelerated by human activity. The world is getting warmer. The earth's temperature rose by 0.6°C during the last century and is forecast to rise by between 1.4 and 5.8°C during this century. Globally the 1990s was the warmest decade and 2002 the second warmest year since records began.
- 2.2 There is increasing evidence that this is the result of an increase in atmospheric concentrations of greenhouse gases - notably carbon dioxide released by burning fossil fuels such as coal, oil and gas. By absorbing heat these gases keep the earth's temperature warmer than it otherwise would be. As greenhouse gas concentrations rise well above their natural levels, the additional warming that will occur could threaten human society.
- 2.3 Climate change research has looked at how far changes in temperature over the past century are due to human activities. Natural effects, such as variations in the sun's output and volcanoes, are insufficient to account for the observed warming, which can only be explained by greenhouse gases from human activities.
- 2.4 The rate at which the climate is changing will affect the world in extreme and unpredictable ways. Its impacts could include:
 - many millions more people being exposed to the risks of hunger, water stress, flooding and diseases like malaria. Poor people in developing countries are likely to be most vulnerable;

- low-lying areas, wetlands and small islands will be especially at risk from sea-level rise. Globally, an extra 80 million people could be exposed to flood risk by the 2080s, 60% of whom are likely to be in the poorest parts of South East Asia. In one of the most vulnerable areas, Bangladesh, a 45cm rise in sea level could result in 10% of the total land area being lost and 5½ million people being put at risk;

Chart 2.1
Number of additional people at risk of flooding each year by the 2080s, assuming no action to cut green house gas emissions¹



- irreversible losses of biodiversity could be accelerated. Expected impacts include bleaching of coral reefs, loss of mangrove swamps and impacts on fish populations. Changes in the polar regions are expected to be the largest and most rapid, leading to thawing of permafrost, melting of ice sheets and changes in species distribution; and
- the UK will also be affected. Rising sea levels could threaten our coastal communities and environment. Storms and extreme events could have the most costly impacts - the autumn 2000 floods cost the UK £1bn.

1 Source: Defra

The costs of climate change

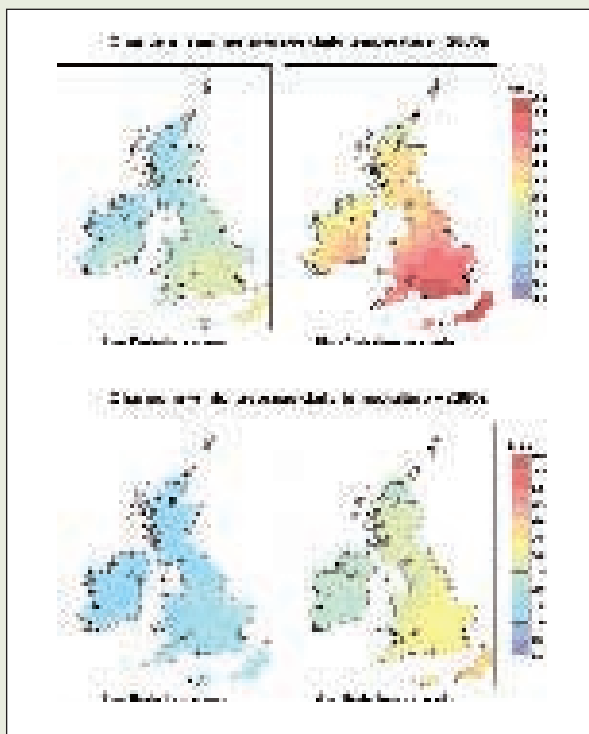
A Government Economic Service working paper² has suggested £70/tC (within a range of £35 to £140/tC) as an illustrative estimate for the damage cost of carbon emissions. It also suggested that this figure should be raised in real terms by £1/tC per year as the costs of climate change are likely to increase over time.

These values are under review in light of developments in the academic literature and in the Government's economic appraisal guidance. Currently the estimate only represents a subset of damage costs, and the review will also consider issues of coverage. While the suggested range covers impacts such as effects on agriculture, wildlife and health, sea level rise and some extreme weather effects, it does not include the possible impacts of 'climate catastrophes' (e.g. melting of the West Antarctic ice sheet or

changes to the Gulf Stream), of social impacts such as famine or mass migration, or of impacts after 2100. Nor does it include other benefits of reducing emissions, such as improved air quality. These could increase the social cost of carbon considerably. Impacts will also vary significantly across sectors and regions.

These values do not set a limit on the acceptable costs of reducing emissions. Wider impacts on other energy policy objectives are also relevant. Costs which initially look high may also be reduced by economies of scale and innovation. Nevertheless, in looking at measures to reduce carbon it is important to consider abatement costs. Most of the carbon savings we are looking at pre-2020 can, we believe, be delivered at costs lower than, or in line with, the illustrative range for damage costs.

Chart 2.2
Changes in summer and winter temperatures³



2.5 We will have to adapt to some degree of climate change. Greenhouse gases that have already built up in the atmosphere mean that some temperature rise is inevitable. In the UK, we are already taking steps to adapt the way we manage flood risk, water and other natural resources, but there is still more to do, and there will be challenges for the transport, construction and business sectors too. For developing countries, climate change increases the urgency of finding more sustainable pathways to development.

² *Estimating the Social Cost of Carbon Emissions*, Government Economic Service Working Paper 140, www.hm-treasury.gov.uk

³ Changes in average summer and winter temperatures (with respect to Hadley Centre model - simulated 1961-1990 baseline climate) for a 30-year period centred on 2080 for high and low greenhouse gas emissions scenarios. UK *Climate Impacts Programme*, 2002.

Action to limit emissions is under way...

- 2.6 But the worst effects of climate change can be avoided if concentrations of greenhouse gases in the atmosphere are stabilised, rather than increasing as they are now. There is as yet no international consensus on the level at which concentrations of greenhouse gases should be stabilised. But in 1997 the EU member states agreed that we should be aiming for a global average temperature increase of no more than 2°C above the pre-industrial level and therefore a concentration below 550 parts per million (ppm) of carbon dioxide - about twice the pre-industrial concentration - to prevent the most damaging effects of climate change.
- 2.7 Even at this level, there will be negative impacts⁴. The majority of the world's population is likely to experience some consequences. At the upper end of the possible temperature rises there would be severe impacts on natural systems and on all sectors of society, a significant increase in extreme climatic events and a high risk of major geographical changes in ice sheets or in ocean currents. Higher concentrations would be likely to pose even greater and more unpredictable risks.
- 2.8. Against this background we take the view that the potential consequences of climate change are so severe that, within a policy framework that keeps costs to a minimum, we should take steps ourselves and work closely with other countries to reduce our greenhouse gas emissions. If we are to stabilise carbon dioxide concentrations in

the atmosphere at no more than 550ppm, global emissions will need to drop well below current levels.

- 2.9 Already policy-makers around the world have begun to respond to these challenges. The UN Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol are the starting point for international efforts to cut emissions.

The UN Framework Convention on Climate Change and Kyoto Protocol

The UNFCCC aims to prevent dangerous man-made climate change and commits developed countries to taking the lead in tackling climate change. The Kyoto Protocol set legal targets for them to reduce greenhouse gas emissions by around 5% of 1990 levels in the period 2008-2012. The US and Australia have withdrawn from the Protocol, though Australia has said that it still intends to limit its emissions as if it had decided to ratify. It seems likely that the effect of the Protocol in the period 2008-2012 will be a reduction in projected global emissions of at best 2%. To help meet targets, countries can use international emissions trading or receive credits for reductions achieved by supporting projects in other countries. Discussions on action beyond 2008-12 must begin by 2005. In the long term, developing countries are most at risk from climate change and need to be helped to become a part of the global response to it. Developing countries currently account for around 40% of global CO₂ emissions from fossil fuels, and their emissions may exceed those of developed countries by 2020, although per capita emissions in most developing countries are still relatively low.

⁴ Based on conclusions of the *Third Assessment Report of the Intergovernmental Panel on Climate Change, 2001*.

But more needs to be done...

2.10 Climate change is a global problem. It has to be tackled globally. The UK will continue to show leadership but it cannot solve this problem alone. The UNFCCC and its Kyoto Protocol demonstrate that it is possible to reach global agreement on action, but far more needs to be done. UK emissions of carbon dioxide currently account for only about 2% of the global total. Our own actions will have no impact on climate change unless they are part of a concerted international effort. A wider effort is also necessary, for example in bringing forward technological changes, to keep down costs to the UK and to avoid compromising our competitiveness.

We will therefore continue to work with other countries to establish both a consensus around the need for change and firm commitments to take action to reduce carbon emissions world-wide within the framework of the UNFCCC.

2.11 Some countries, including some of our European partners, are already moving in this direction. We need, with them, to lead others internationally. It is clear that substantial cuts are needed in the longer term. Delay will only compound the problem. We therefore believe that the time is now right to reinforce our commitment to the achievement of significant long-term cuts in emissions in the UK.

2.12 Our ambition is for the world's developed economies to cut emissions of greenhouse gases by 60% by around 2050. **We therefore accept the RCEP's recommendation that the UK should put itself on a path to a reduction in carbon dioxide emissions of some 60% from current levels by about 2050⁵.** In this white paper, we therefore set out the first steps to achieving this goal.

And we set as a key objective of the UK's foreign policy securing international commitment to this ambition.

2.13 We can get to a 60% cut in emissions by 2050 in a number of ways. But leaving action until the last minute is not a serious option. If we do not begin now, more dramatic and more disruptive change will be needed later on. We need early, well-planned action to provide a framework within which businesses and the economy generally can adjust to the need for change. This will for example allow business to plan to act in the course of normal capital replacement cycles. It will also encourage new technologies to come forward to meet the challenges we face.

2.14 The UK already has a Kyoto Protocol commitment to reduce greenhouse gas emissions by 12.5% below 1990 levels by 2008-12 and a national goal to move towards a 20% reduction in carbon dioxide emissions below 1990 levels by 2010. The measures in this white paper keep us on track for both goals⁶, and represent a significant departure from the level that emissions would otherwise be under 'business as usual'.

5 A reduction in carbon dioxide emissions of 60% by 2050 is consistent with the level of reduction likely to be needed by developed countries in order to move towards stabilisation of carbon dioxide concentrations in the atmosphere at no more than 550 ppm, taking account of a realistic assessment of emissions growth in developing countries. This is set out in more detail in the Defra paper *The scientific case for setting a long term emission reduction target*, available at www.defra.gov.uk/environment/climatechange. RCEP's recommendation of putting the UK on a path to 'reducing carbon dioxide emissions by some 60% from current levels by about 2050' was based on a more detailed calculation of 58% reductions from 1997 levels. This would lead to 2050 emissions of 64 MtC. The Kyoto Protocol, and the UK's current domestic targets, use 1990 as a baseline. A precise reduction of 60% in emissions from 1990 would result in emissions of 65.8 MtC in 2050. As the RCEP recommendation implies, absolute precision five decades before 2050 is not possible. This white paper uses 'around 65 million tonnes' to describe the level of carbon emissions which a 60% cut would deliver by 2050.

6 The UK's carbon dioxide emissions increased for the second year running in 2001 and were some 5.2% below the 1990 level, having been 8.1% below in 1999 and 7.3% below in 2000. This upward trend is expected to have been reversed in 2002 when emissions are likely to have decreased slightly. The measures in this white paper should allow the domestic goal to be achieved. We are also committed to reviewing the Climate Change Programme in 2004. This will provide an opportunity to review progress and to strengthen measures if it is thought necessary to keep us on track towards the domestic goal.

2.15 Discussions under the UNFCCC to tackle climate change beyond 2008-12 will start soon. On the basis of our current policies, including the full impact of the Climate Change Programme, our carbon dioxide emissions might amount to some 135 MtC in 2020⁷. To be consistent with demonstrating leadership in the international process, we will aim for cuts in carbon of 15-25 MtC below that by 2020. This would also put us on course to reduce our carbon dioxide emissions by some 60% by about 2050.

2.16 If we are to cut emissions this much we will need to achieve a fundamental long-term shift in the way energy is supplied and used. Already we have decoupled economic growth from energy use and carbon emissions. Overall energy consumption in the UK has risen by around 15% since 1970, while the economy has doubled.

2.17 In order to achieve our aims we must accelerate this trend. If the UK economy were to grow at an average of 2.25% a year between now and 2050 it would be three times as large then as it is now. Reducing carbon emissions to around 65MtC (see footnote 5) in the same period would require an improvement in the ratio between emissions and economic output of around seven-fold. We will achieve this by raising the resource productivity of our economy - producing more with less pollution.

2.18 The table below illustrates how cuts of 15-25 MtC could be achieved by 2020. The exact target figure will be determined in the light of international negotiations, and the actual mix of measures needed to reach it will be shaped by economic and technological developments. **We will put in hand measures now to ensure we are well placed to deliver on our commitments.**

Chart 2.1
GDP, primary energy consumption and emissions

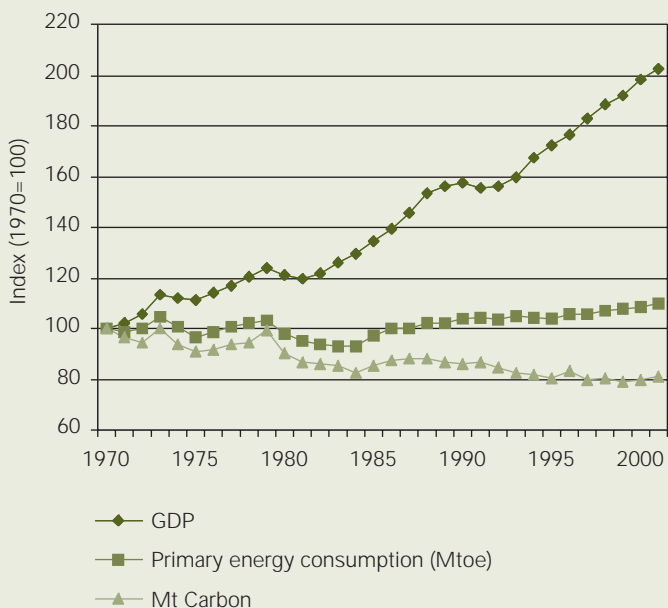


Table 2.1
How cuts of 15-25MtC could be achieved by 2020

	Estimated MtC reductions ⁸
Energy efficiency in households	4-6
Energy efficiency in industry, commerce and the public sector	4-6
Transport: continuing voluntary agreements on vehicles; use of biofuels for road transport	2-4
Increasing renewables	3-5
EU carbon trading scheme	2-4

7 See material referred to in paragraph 1.49.

8 The figures represent reductions below the baseline of 135 MtC discussed in paragraph 2.15.

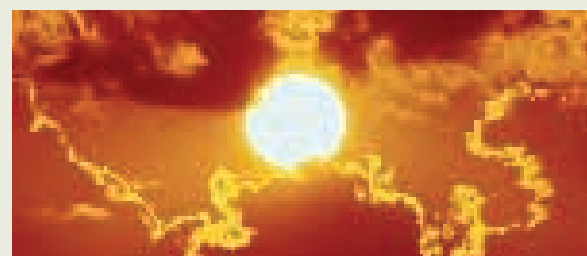
2.19 The Kyoto Protocol's project mechanisms provide for credits from international emissions trading, including from projects under the Clean Development Mechanism and Joint Implementation, to contribute towards emission reduction commitments. They will provide another possible route to savings, although it is not yet possible to judge the scale of any contribution that they may make.

Maintaining our competitiveness at the same time...

2.20 We have analysed carefully the likely impacts on the UK economy of cutting emissions by 60% by 2050. A good deal of caution is needed in looking at economic changes over such a long period and given the sensitivity to the assumptions made. But analysis of data assessed by the Intergovernmental Panel on Climate Change suggests that action aimed at stabilising carbon dioxide atmospheric concentrations at no more than 550ppm would lead to a loss of around 1% in projected GDP⁹. The outcome of our UK analysis is consistent with that review, assuming that the world's leading nations all act together. It suggests that the cost impact of effectively tackling climate change would be very small - equivalent in 2050 to just a small fraction (0.5 - 2%) of the nation's wealth, as measured by GDP, which by then will have tripled as compared to now. And this figure takes no account of the costs avoided by tackling climate change.

2.21 Modelling work shows that higher transition costs would occur if there were very tight reduction targets in too short a time scale, if policies such as emissions trading or other economic instruments were not used or if energy efficiency was not exploited. In the medium term, transition costs would also increase if other countries did not take action to reduce emissions. But the more other countries commit to move in the same direction, the less direct impact there will be on the UK. These impacts need to be monitored and managed, both across the economy and sector by sector. And there will also be some economic benefits, for example through increasing energy efficiency or through enabling UK firms to benefit from new opportunities in manufacturing, servicing and exporting lower-carbon and renewable energy technologies. **We will ensure that we continue to work closely with businesses to develop strategies to enable them to adapt to these changes and exploit them as appropriate.**

⁹ Report of Working Group III of Intergovernmental Panel in Climate Change, Mitigation, 2001.



Analysis and modelling work

A wide range of analytical work has supported the white paper. This included work by the Government's interdepartmental analysts group on long-term reductions in greenhouse gas emissions, following which the DTI commissioned Future Energy Solutions to use the MARKAL modelling approach to look at the costs and options for a substantial CO₂ reduction by 2050¹⁰. MARKAL uses a 'bottom-up' model of the UK energy system, which selects the least cost technologies to meet specified energy demands, subject to constraints imposed on emissions.

The results depend on the assumptions - on technology availability and costs - that are made in the model. However, the assumptions used reflected expert opinion, informed by workshops with industry experts.

The work was not intended to create a single view or forecast. Instead a wide range of sensitivity analyses was carried out to assess which technologies and measures might be crucial to minimising the costs of emissions

reduction and to assess how costs change if assumptions are varied. The analyses covered business as usual cases as well as reductions in CO₂ of 45%, 60% and 70% by 2050.

The analysis suggests that for many of the assumptions tested the cost of reducing CO₂ emissions by 60% by 2050 was in the range £200-300 per tonne of carbon. GDP in 2050 was reduced by 0.5-2.0%, equivalent to an average annual reduction of between 0.01 and 0.02 percentage points from a business as usual GDP growth rate of 2.25% per annum.

Higher costs were indicated if innovation in low-carbon technologies was limited, if energy efficiency improved only in line with past trends, or if both new nuclear build and carbon capture and storage were completely excluded in the longer term.

To be on track for the 15-25 MtC reduction beyond current baselines that we are aiming at, MARKAL indicates costs of reducing carbon in 2020 in the range £10-80 per tonne of carbon.

A clear long-term policy framework...

2.22 To deliver these outcomes, our aim will be to provide industry and investors with a clear and stable policy framework. In practice, we need a mix of measures in order to shape the market to achieve our goals, including economic instruments and regulation. But we are seeking a framework which, as far as possible, simplifies the mix of measures and takes account of the cost of environmental damage from carbon emissions. We will also

aim to use the price mechanism as far as we can to give clear signals about these costs. This will give the market the flexibility to determine the best way to reduce carbon emissions, and drive action on both the demand and supply sides of the economy. It will also give business a dynamic incentive to find new and innovative ways to reduce emissions. Environmental taxes and tradable permit schemes can both help to achieve these objectives.

2.23 The UK has already made significant progress through the climate change levy and the voluntary UK emissions trading scheme.

¹⁰ Full details of this work are at www.dti.gov.uk/energy/greenhousegas/index.shtml

The levy is a tax which applies to business and public sector use of gas, coal, electricity and liquefied petroleum gas (LPG). It gives those sectors an incentive to improve energy efficiency and thereby to reduce greenhouse gas emissions. It also involves 80% discounts for energy-intensive sectors which enter into climate change agreements to improve energy efficiency or meet emissions targets. Following the recommendations of Lord Marshall, the levy was designed as a 'downstream' energy tax,¹¹ which makes it possible to avoid impacting on domestic energy users, and therefore avoid adding to the problem of fuel poverty.

2.24 The first phase of the UK emissions trading scheme has involved a range of organisations from the private and public sectors agreeing to meet emissions caps in return for a share of a financial incentive. Emissions trading has expanded recently through the participation of firms covered by climate change agreements, seeking to deliver their targets.

2.25 The development of emissions trading in the next few years will primarily be dependent on developments at EU level. On 9 December 2002, the European Union Council of Ministers reached initial agreement on a new European carbon emissions trading scheme. This is expected to begin in 2005.¹² Installations which are covered by other equivalent arrangements may not need to join the scheme until 2008. In the scheme, each participant will be set a cap - a target level of emissions. Each will then receive

tradable allowances equal to its cap. To comply with the scheme, each participant must hold allowances at least equal to its emissions. Participants will therefore have three choices:

- meet their cap by reducing their own emissions;
- reduce emissions below their cap and sell or bank the excess allowances; or
- let their emissions remain above their cap and buy allowances from other participants.

2.26 The best strategy for each participant will depend on the price of allowances in the market compared to the costs of reducing their own emissions. In this way, emission reductions from the participating sectors will be achieved at minimum cost across the European Union.

2.27 **We will make the new trading scheme a central plank of our future emissions reduction policies, through which the traded carbon market can set a signal for the value of carbon reductions in the economy. It will be a mechanism for delivering part of the carbon savings we need to make, helping to save around a further 2-4MtC by 2020. We will continue to work proactively with the European Commission, European Parliament and other member states to secure detailed plans for the implementation of the scheme to help deliver this aim. We will also work with them to extend, where appropriate, the coverage of the EU scheme in due course.**

2.28 The inclusion of the electricity industry within the scope of the EU emissions trading scheme will further change the incentives on electricity generators and suppliers, as it will begin to give a direct incentive to electricity

11 In report *Economic Instruments and the Business Use of Energy*, November 1998 <http://archive.treasury.gov.uk/pub/html/prebudgetNOV98/marshall.pdf>

12 From the outset, it is proposed that it should cover CO₂ emissions from combustion installations exceeding 20MW, oil refineries, coke ovens, and ferrous metal industries, mineral industries and pulp and paper plants (over certain size thresholds).

generators to reduce emissions. To the extent that the scheme leads to an increase in electricity prices, this will add to costs for electricity users. The scale of such impacts is currently uncertain, but will be driven by the price of carbon in the European market.

2.29 We aim to have a coherent approach to carbon valuation and energy use, so that environmental costs can be internalised as efficiently as possible, irrespective of whether the instruments are international or domestic. The linkages between tax and tradable permit schemes will be carefully considered in the light of the emerging EU emissions trading scheme. As the box below shows, emissions trading is unlikely to cover all emissions from all sectors of business for the foreseeable future, and there will continue to be a role for a tax if a price signal is to be given to other areas of business.

2.30 The issues involved in linking the two mechanisms are not entirely new. The UK has already made links between the sectors covered by the climate change agreements and the voluntary emissions trading scheme. Some changes might be needed, for example, to ensure that the sectors of manufacturing industry which are covered by the EU emissions trading scheme are not subject to unnecessary burdens. The views of manufacturers would be welcome. We will now consider the impact of the proposed EU emissions trading scheme on the climate change levy, while bearing in mind that this will ultimately depend on the precise nature of the future emissions trading scheme which has yet to be agreed. Any tax changes will be a matter for future Budgets.

Emissions trading - potential development

The political agreement on the proposed EU trading scheme outlines its design, together with procedures for expansion. How the scheme will develop in the UK will depend on further work on proposals to manage the transition from the current UK policy mix to the new EU scheme, as well as on decisions by the European Commission and member states. But a possible scenario might be:

January 2005 - First phase of the EU scheme starts, covering CO₂ from electricity generation, oil refineries and some other sectors of heavy industry. Temporary exclusions allowed for heavy industry during this first phase, with caps on generator emissions adjusted to take account of measures for renewables and energy efficiency.

January 2007 - Current phase of UK emissions trading scheme for 'direct participants' ends. All of the direct participants in the UK scheme that are covered by the EU scheme transfer their CO₂ emissions to the EU scheme.

January 2008 - Second phase of EU scheme starts. Scheme covers CO₂ emissions from other sectors of industry as required by the directive and relevant changes made as necessary to the arrangements for the climate change agreements.

Coverage could be extended by unilaterally opting in other activities and greenhouse gases, or by harmonised EU-wide expansion. The EU scheme might expand to include other energy intensive sectors of industry or other industrial and commercial sectors where the size of installation makes this cost-effective.

2.31 The European Union is also close to agreeing a directive on the taxation of energy products. This would require all member states to introduce taxes on the business use of energy to encourage energy efficiency, such as the climate change levy. Once agreement on the emissions trading directive has been reached, the Commission is planning to bring forward proposals to modify the rules on taxation of energy products in the light of the agreement on community-wide emissions trading, to ensure that the two schemes are complementary. We will consider these proposals as part of our own approach to linking the two measures.

2.32 Wherever possible, we will also link the other measures described in this white paper to the carbon emissions trading scheme. This will help enable a common Europe-wide value to emerge for carbon savings, enabling business and consumers to choose themselves how best to achieve their economic and commercial aims against that background. We will now be taking forward work to consider how best to make such linkages and will come forward with appropriate proposals when the relevant policy positions are more firmly established.

also has binding international commitments to meet targets for emissions of air pollution and for local and regional air quality, including cuts of 50% in sulphur dioxide and 20% in oxides of nitrogen from current levels by 2010. Meeting these will require significant reductions in emissions from electricity generation, in particular current coal fired generation. Energy infrastructure, including renewable energy, has effects on the environment. Future analysis of energy policy choices will continue to bear all these impacts in mind.

Considering other environmental impacts too...

2.33 There are other important environmental issues to be borne in mind as well as climate change. Measures to reduce carbon emissions can also have other benefits, such as improved air quality.¹³ For example, the UK

¹³ Air quality is set out in *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland*, Cm4548, January 2000. www.defra.gov.uk/environment/airquality