Our Energy Challenge

Securing clean, affordable energy for the long-term

dti

ENERGY REVIEW

Consultation Document

JANUARY 2006

Our Energy Challenge

Securing clean, affordable energy for the long term

Why is the government conducting this consultation?

This consultation seeks views on the medium and long-term energy policy issues to be considered in the Energy Review.

In the 2003 Energy White Paper – 'Our energy future – creating a low carbon economy' – the government set out its goals and long-term framework for energy policy. The Energy Review will assess progress against these goals and the options for further steps to achieve them. The Review has a broad scope and will consider aspects of both energy supply and demand focussing on policy measures for the medium and long term.

Issued	23rd January 2006
Respond by	14th April 2006
Enquiries to	Department of Trade and Industry Response Centre 1 Victoria Street London SW1H 0ET Tel: 020 7215 5000 Email: EnergyReviewConsultation@dti.gsi.gov.uk

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Foreword by the Minister

Three years ago, we set out our energy strategy for the long term in our White Paper *"Our Energy Future – Creating a Low Carbon Economy"*. This brought together for the first time our goals for reducing carbon emissions, maintaining reliable energy supplies, promoting competitive markets, and making energy affordable for the poorest. It also reinforced our wider commitment to sustainable development.

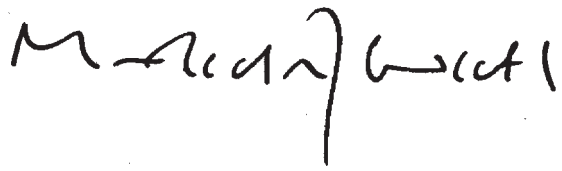
The government remains committed to those important public policy goals and to achieving them within a market framework. But the challenges we face in meeting them have been thrown into sharper relief:

- We have more evidence of the adverse impact of climate change, reinforcing the case for action to cut the emissions that cause it, here and across the world;
- The UK has become a net importer of gas sooner than expected, and is also becoming a net oil importer. Many other advanced industrial economies already import significant proportions of their energy needs, and producers have a strong incentive in providing reliable supplies. But with heightened concerns about energy security, we need to ask ourselves if we are doing enough to identify and manage potential risks in this new situation;
- Energy prices have risen sharply. This is reversing some of the excellent progress we have made in reducing fuel poverty. And for some big industrial consumers especially, high and volatile gas prices have caused real difficulties.

Against this background, now is the right time to look at whether we should take further measures to meet our goals. This does not mean pulling back from the key priorities we set out in the White Paper, notably on encouraging renewable energy and energy efficiency. But the Review will explore the further options open to us, within our market framework and our prudent approach to public finances.

There will be no single solution: we shall need to consider a range of options to influence the ways we both produce and use our energy. As the Prime Minister has said, this includes looking again at nuclear power as well as other sources of energy. We need too to ask whether we are doing enough to create the conditions for other low carbon technologies to come forward and to examine how carbon sequestration could ensure we can continue to have access to the world's ample coal reserves and other fossil fuels to meet our energy needs.

It is crucial that we have a wide-ranging and informed debate. Decisions to be made over the next few years by government and the private sector will have a big influence on our energy future for decades to come. I very much hope that all those with an interest in these important issues will contribute their views.



Malcolm Wicks MP
Minister of State for Energy

Executive Summary

The Government has set four goals for the country's energy policy:

- To put ourselves on a path to cut the UK's CO2 emissions by some 60% by about 2050, with real progress by 2020;
- To maintain the reliability of energy supplies;
- To promote competitive markets in the UK and beyond, helping to raise the rate of sustainable economic growth and to improve our productivity; and
- To ensure that every home is adequately and affordably heated.

In setting out the strategy for achieving those goals, the 2003 Energy White Paper said we would review and, if necessary, update our policies in the light of experience. There is much that has been positive in that experience. But with important decisions ahead for government and business, several recent developments make a review timely:

- Evidence about the adverse impact of climate change has continued to grow, reinforcing the need for international leadership and for multilateral action to address it;
- Fossil fuel prices have risen sharply, and projected prices are now much higher than at the time of the White Paper;
- The UK has become a net gas importer sooner than expected and is also becoming a net oil importer;
- Progress in introducing truly open energy markets in the EU has been slow over the last three years;
- There has been a general heightening of sensitivity around global energy issues, affecting perceptions of the security of supply from major exporter countries and contributing to higher price volatility.

Our energy policy goals: progress and prospects

The analysis in this paper shows that the UK's liberalised energy markets have delivered well against the four goals of energy policy:

- The UK remains one of the few European countries on track to meet its Kyoto commitment to address climate change – though considerably more remains to be done to secure effective multilateral action for the longer term;
- Our economy has become substantially more energy-efficient, with energy consumption increasing by just 2% since 1997 despite a 21% increase in GDP;
- There has been a leap forward in renewable generation, with over 500MW of wind capacity installed last year, double the amount in 2004;
- We have a strong record for the continuous physical supply of gas and electricity to end-users, with fewer unplanned interruptions to electricity supply than in any European country except the Netherlands;
- Retail prices for gas and electricity have consistently been lower in real terms than they were in 1985, despite sharp recent increases;
- The number of households in fuel poverty in the UK fell from around 6.5 million in 1996 to around two million in 2003 (the last available figures) through increases in income, reduced energy prices and new energy efficiency measures.

The period since the Energy White Paper has seen considerable advances on a number of fronts. For example, we:

- Intensified our leading role in highlighting and addressing the global climate change challenge, through the UK's presidency of the EU and G8 and our contribution to the Montreal Conference;
- Promoted the creation of a market price for carbon in Europe, through the mechanism of the EU Emissions Trading Scheme;
- Extended the UK's Renewables Obligation to 15.4% by 2015/16;
- Announced a new Renewable Transport Fuels Obligation, under which 5% of transport fuel sold in the UK will have to come from renewable sources by 2010;
- Extended earlier reforms of outdated electricity trading arrangements to create a competitive wholesale electricity market right across Britain, through the British Electricity Trading and Transmission Arrangements (BETTA);
- Attracted more interest in the 2005 licensing round for North Sea oil and gas production than any other round since gas production started in 1964, helping us to make the most of our indigenous resources;
- Attracted £10 billion of commitments to new investment in gas import infrastructure, giving us access in future to a range of source countries for gas;
- Extended winter fuel payments as announced in the 2005 Pre-Budget Review.

But trends discussed in this paper suggest there are risks that we may make only limited further progress against our energy policy goals in the medium and long term:

- Although we expect to meet our Kyoto targets to reduce greenhouse gas emissions as a whole, CO2 emissions have been rising in recent years. By 2020 (without taking account of any measures decided in the current Climate Change Programme Review) emissions are projected to be only slightly down on current levels;
- We will become more reliant on gas to meet our heating and electricity generation needs, and will continue to rely on oil for transport, despite likely gradual uptake of bio-fuels;
- By 2020 we are likely to be importing around three quarters of our primary energy, against the background that much of the world's proven oil and gas reserves are concentrated in Russia and the countries of the Former Soviet Union and in the Middle East and North Africa;
- Maintaining the reliability of electricity supplies will require very substantial levels of new investment as existing coal and nuclear capacity is retired and ageing distribution networks maintained and renewed;
- Increased energy efficiency is a central public policy goal, but the pace of efficiency improvements has been slower than needed;
- Higher global energy prices present macroeconomic risks, even though the impact of these relative to previous periods of high prices is mitigated by our more stable macroeconomic framework and lower energy intensity. Although these prices will incentivise reduced and more efficient consumption, policies designed to reduce emissions may prove unpopular if they add further to prices that are already high.

Over the coming months the Review will examine the potential impact of these trends on our energy goals in the medium and long term. That analysis will then inform an assessment of our future policy options.

In making its assessment the Review team will recognise that:

- The UK's energy sector has a framework that combines competition where it is desirable and regulation when it is necessary. Specific investment decisions under that framework are made by energy companies and by business more generally. Government's role is to ensure that the right framework is in place;
- Public policy needs to shape that framework so that decisions made by business properly reflect the country's goals on issues such as climate change;
- Policies need to avoid damaging our competitiveness and prosperity, and full account must be taken of their impact in terms of costs and contingent liabilities for government;
- To effectively tackle climate change, and in order to protect the competitiveness of UK industry, the UK's own actions need to be part of a wider international effort, which is why the government attaches great importance to making progress on international agreements within the UN Framework Convention on Climate Change (UNFCCC) and the EU;

- Work has already been initiated in a number of fora to co-ordinate international action in response to global challenges in energy markets, including producer/ consumer dialogues (through the International Forum and the EU/OPEC Energy Dialogue), ideas for reform (such as the G7 Finance Ministers' work on improving the functioning of oil markets) and the follow-up to the Hampton Court summit;
- The market framework must be sufficiently durable to ensure that companies make investments in the UK in a timely manner and in a way that reflects our public policy goals, particularly for the reduction of carbon;
- The complexity of the challenge facing us means that no single measure can deliver our goals.

The Review will assess options on both the supply and demand side for energy. It will look at the prospects both for existing and new low carbon technologies, and for more aggressive uptake of energy efficiency measures. It will examine the potential contribution of carbon sequestration to allowing continuing access to the world's coal and other fossil fuel resources. The Review will look at issues relating to innovation and skills in these areas, where required.

In this context the Review will look again at the role of nuclear electricity generation. Nuclear currently provides around 20% of the country's electricity needs, but most of our existing nuclear power stations are scheduled to close over the coming twenty years or so. The 2003 Energy White Paper recognised that replacement nuclear build might be necessary if we are to meet our carbon targets, but concluded that its then current economics made it unattractive and that there were also important issues of nuclear waste to be resolved. The Review will examine whether recent changes in energy prices have changed that assessment and at the other issues that would be raised by building new nuclear power stations. These other issues include all the characteristics of nuclear, including its creation of long-term liabilities such as nuclear waste; and how these liabilities should be managed and paid for.

The government is clear that, in making important decisions about energy policy including nuclear power, there should be the fullest public consultation. This consultation paper is part of that process. The government is not at this stage bringing forward policy proposals.

Key Questions for the Review

This consultation invites comments on the full range of issues it identifies, taking into account all the circumstances surrounding UK energy policy. These circumstances include the need to avoid damaging our competitiveness and prosperity and to take into account the impact of any proposals in terms of costs and contingent liabilities for government.

The key issues on which it may be useful to focus can be summarised as follows:

Q.1. What more could the government do on the demand or supply side for energy to ensure that the UK's long-term goal of reducing carbon emissions is met?

Q.2. With the UK becoming a net energy importer and with big investments to be made over the next twenty years in generating capacity and networks, what further steps, if any, should the government take to develop our market framework for delivering reliable energy supplies? In particular, we invite views on the implications of increased dependence on gas imports.

Q.3. The Energy White Paper left open the option of nuclear new build. Are there particular considerations that should apply to nuclear as the government re-examines the issues bearing on new build, including long-term liabilities and waste management? If so, what are these, and how should the government address them?

Q.4. Are there particular considerations that should apply to carbon abatement and other low-carbon technologies?

Q.5 What further steps should be taken towards meeting the government's goals for ensuring that every home is adequately and affordably heated?

Comments are also invited on the following issues, as described in the text:

i. The long term potential of energy efficiency measures in the transport, residential, business and public sectors, and how best to achieve that potential;

ii. Implications in the medium and long term for the transmission and distribution networks of significant new build in gas and electricity generation infrastructure;

iii. Opportunities for more joint working with other countries on our energy policy goals;

iv. Potential measures to help bring forward technologies to replace fossil fuels in transport and heat generation in the medium and long term.

How to respond

When responding please state whether you are responding as an individual or representing the views of an organisation. If responding on behalf of an organisation, please make it clear who the organisation represents and, where applicable, how the views of members were assembled.

A response can be submitted by email, by using the response forms on the DTI website or by letter to:

Energy Review Team
Department of Trade and Industry
1 Victoria Street
London SW1H 0ET

Email: EnergyReviewConsultation@dti.gsi.gov.uk
Website: www.dti.gov.uk/energy/review

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The Department will process your personal data in accordance with the DPA and in the majority of circumstances this will mean that your personal data will not be disclosed to third parties.

Help with queries

Questions about the policy issues raised in the document can be addressed to:

Department of Trade and Industry
Response Centre
1 Victoria Street
London SW1H 0ET

Tel: 020 7215 5000
Email: EnergyReviewConsultation@dti.gsi.gov.uk

If you have comments or complaints about the way this consultation has been conducted, these should be sent to:

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E-mail: Nick.vanbenschoten@dti.gsi.gov.uk
Tel: 020 7215 6206
Fax: 020 7215 8303

A copy of the Code of Practice on Consultation is in Annex D.

1 The 2006 Energy Review

The Energy White Paper published in 2003, *Our energy future – creating a low carbon economy*, set out four goals for UK energy policy:

- To put ourselves on a path to cut the UK's CO2 emissions by some 60% by about 2050, with real progress by 2020;
- To maintain the reliability of energy supplies;
- To promote competitive markets in the UK and beyond, helping to raise the rate of sustainable economic growth and to improve our productivity; and
- To ensure that every home is adequately and affordably heated.

The White Paper's most significant innovation was its explicit commitment to reducing carbon emissions as a goal of energy policy. The government accepted the recommendation of the Royal Commission on Environmental Pollution that the UK should put itself on a path to reduce carbon dioxide emissions by some 60% by about 2050. This was subsequently confirmed as a key element in the government's wider Sustainable Development Strategy published in March 2005. The White Paper was clear that, while there would be tensions from time to time between objectives, the four main goals could be achieved together.

The White Paper did not seek to define every detail of the policies we would need to pursue over the next 20 years and beyond. It said that we would need to be prepared to review the impact of policy changes and to update and amend policy measures in the light of experience.

The analysis in this paper shows that the UK's liberalised energy markets have delivered well against the four goals of energy policy:

- The UK remains one of the few European countries on track to meet our Kyoto commitments to address climate change – internationally there remains considerably more to be done to secure effective multilateral action;
- Our economy has become substantially more energy-efficient, with energy consumption increasing by just 2% since 1997 despite a 21% increase in GDP;
- There has been a leap forward in renewable generation, with over 500MW of wind capacity installed last year, double the amount in 2004;

- We have a strong record for the continuous physical supply of gas and electricity to end-users, with fewer unplanned interruptions to electricity supply than in any European country except the Netherlands;[1]
- Retail prices for gas and electricity have consistently been lower in real terms than they were in 1985, despite sharp recent increases;
- The number of households in fuel poverty in the UK fell from around 6.5 million in 1996 to around two million in 2003 (the last available figures) through increases in income, reduced energy prices and new energy efficiency measures.

The period since the Energy White Paper has seen considerable advances on a number of fronts. For example, we:

- Intensified our leading role in highlighting and addressing the global climate change challenge, through the UK's presidency of the EU and G8 and our contribution to the Montreal Conference;
- Promoted the creation of a market price for carbon in Europe, through the mechanism of the EU Emissions Trading Scheme;
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- Attracted £10 billion of commitments to new investment in gas import infrastructure, giving us access in future to a range of source countries for gas;
- Extended winter fuel payments as announced in the 2005 Pre-Budget Review.

The context in which energy policy operates has, however, changed significantly since the White Paper was published:

- Evidence about the adverse impact of climate change has continued to grow, reinforcing the need for international leadership and for multilateral action to address it. The Kyoto Protocol has entered into force, and the EU has begun to develop medium and long-term strategies for reducing emissions beyond the Kyoto 1st commitment period targets. The international community agreed at the Montreal UN Climate Conference in December 2005 to begin consideration of the further action needed beyond 2012 to stabilise greenhouse gases at a level that minimises the risk of the most serious climate impacts;

1 Second benchmarking report on quality of electricity supply, Council of European Regulators, (September 2003), which looked at the 1999-2001 triennium.

- Fossil fuel prices have risen sharply, and projected prices are now much higher than at the time of the White Paper, led in large part by higher than expected demand growth, notably from China and India. Oil prices have more than doubled. Gas prices globally are up, as are coal and uranium prices, and price expectations for the medium and long term have risen;
- The UK has become a net gas importer sooner than expected and is becoming a net oil importer;
- Progress in introducing truly open energy markets in the EU has been slow over the last three years;
- There has been a general heightening of sensitivity around global energy issues, affecting perceptions of the security of supply from major exporter countries and contributing to higher prices.

We are also three years closer to the period when substantial private sector investment will be needed to replace retiring generating plant. Further investment may be required in transmission and distribution networks as they adapt to the changing energy mix. Decisions made by companies and business as to the timing, nature and location of this investment will have significant long-term consequences for all our Energy White Paper goals.

In the context of these changing circumstances, it is appropriate to re-visit the policies and programmes put in place to meet the White Paper goals. The White Paper sought to strengthen the contribution of energy efficiency and renewables; the Review will examine what further measures, if any, might be desirable to foster both. Cleaner coal technologies and carbon sequestration may well enable us to continue to access the world's ample coal reserves and the Review will also examine whether and in what ways to encourage them. On nuclear power, the 2003 White Paper recognised that new nuclear build might be necessary if we are to meet our carbon targets, but concluded that its then current economics made it unattractive. The Review will examine the impact of recent energy price rises on the desirability or otherwise of new nuclear build, taking into account all the issues relating to nuclear including long-term costs such as de-commissioning and waste. Separately, the Committee on Radioactive Waste Management is assessing options for long term management of the UK's higher activity radioactive waste so as to be able to recommend the best way forward.

In assessing the UK's progress against the 2003 White Paper goals and the options for further steps to achieve them, the Review will take account of all short-term, medium-term and long-term costs and liabilities both to the taxpayer and to the energy user. The aim will be for the government, once it has assessed the conclusions of the Review, to bring forward proposals on energy policy later this year.

The Review is being conducted by an inter-departmental team of officials based in the DTI and working to the Energy Minister, Malcolm Wicks. In addition to DTI, a number of government departments in the Sustainable Energy Policy Network are represented, as is the Prime Minister's Strategy Unit. The relevant regulators,

including OFGEM, will be consulted. Through this consultation and through engagement with stakeholders, the team will also seek views widely outside government. The Review team will report to the Prime Minister and the Secretary of State for Trade and Industry in the early summer.

This consultation document addresses energy policy for the UK as a whole. Significant aspects of energy policy, however, are the responsibility of the Devolved Administrations in Scotland and Wales, so that decisions are made in the light of each country's particular circumstances. Following the suspension of the Northern Ireland Assembly and Executive in October 2002, devolved aspects of energy policy within Northern Ireland currently fall within the responsibility of the Secretary of State for Northern Ireland. We shall therefore be discussing with the Devolved Administrations, the Secretary of State for Northern Ireland and the Department for Enterprise, Trade and Investment in Northern Ireland the energy challenges that we face and their role in addressing them. We shall also be consulting regional interests in England, including the Regional Development Agencies.

The Review will take into account the work of a number of related exercises including but not limited to:

- The Stern Review. Sir Nick Stern, adviser to the Government on the economics of climate change and development, is leading a major review of the economics of climate change, to understand more comprehensively the nature of the economic challenges and how they can be met, in the UK and globally. This will report to the Prime Minister and Chancellor in Autumn 2006;
- The Climate Change Programme Review (CCPR). The CCPR is reviewing progress under the UK Climate Change Programme and is expected to report early in 2006. The UK Climate Change Programme was published in November 2000. It was focused on policies and measures to meet our Kyoto target and move towards our domestic goal of reducing carbon dioxide emissions to 20 per cent below 1990 levels by 2010;
- The Energy Efficiency Innovation Review (EEIR). Carried out by Defra, HM Treasury, Carbon Trust and the Energy Saving Trust, the conclusions of the EEIR were published alongside the 2005 Pre-Budget Report;
- The Chancellor announced in the 2005 Pre-Budget Report (PBR) a forthcoming consultation on the barriers to wide-scale commercial deployment of Carbon Capture and Storage in the UK and the potential role of economic incentives in addressing those barriers;
- The Barker Review of Land Use Planning. The Review will consider the planning system and how it affects potential developments in energy infrastructure whilst still providing the necessary democratic representation;
- The Committee on Radioactive Waste Management. In November, 2003 the UK Government set up this independent Committee to oversee the review of options for the long-term management of the UK's higher activity wastes and to recommend a strategy. The Committee is due to report in July 2006.

- Review of the Sustainability of Existing Buildings by the Office of the Deputy Prime Minister. Among other issues this review will consider measures that could reasonably be introduced to improve energy efficiency and reduce emissions from the existing building stock;
- DTI's preparation of a Micro-generation strategy as required by the Energy Act 2004;
- Defra's Review of its (non-nuclear) waste strategy, and similar reviews being undertaken by the Devolved Administrations;
- DTI consultation document, launched 30 December 2005, on policy options to address issues arising from potential differences between the quality of gas imports and the gas quality specifications set out in the 1996 Gas Safety (Management) Regulations.

As part of its role in monitoring health and safety in many areas of the energy sector, the Government will be calling on the Health and Safety Executive (HSE) to provide an expert report during the course of the Review. This is necessary for the Government to make informed decisions in bringing forward future proposals.

The Government have requested that the HSE report on some specific potential health and safety risks arising from recent and potential energy developments and on the HSE's approach to ensure that risks arising from these are sensibly managed by industry, including

- An increased need for gas storage in the UK;
- New demonstration projects for carbon capture and storage, and its potential in the UK;
- Increasing penetration of renewables and distributed generation in the UK;
- In the event of the building of new nuclear power stations, the potential role of pre-licensing assessments of candidate designs.

Revised Projections and Assumptions

DTI will publish revised emissions projections for the UK shortly together with updated assumptions for future fossil fuel prices (see Annex B for a summary). Comments will be invited on these projections and assumptions, which have been used to inform this consultation document.

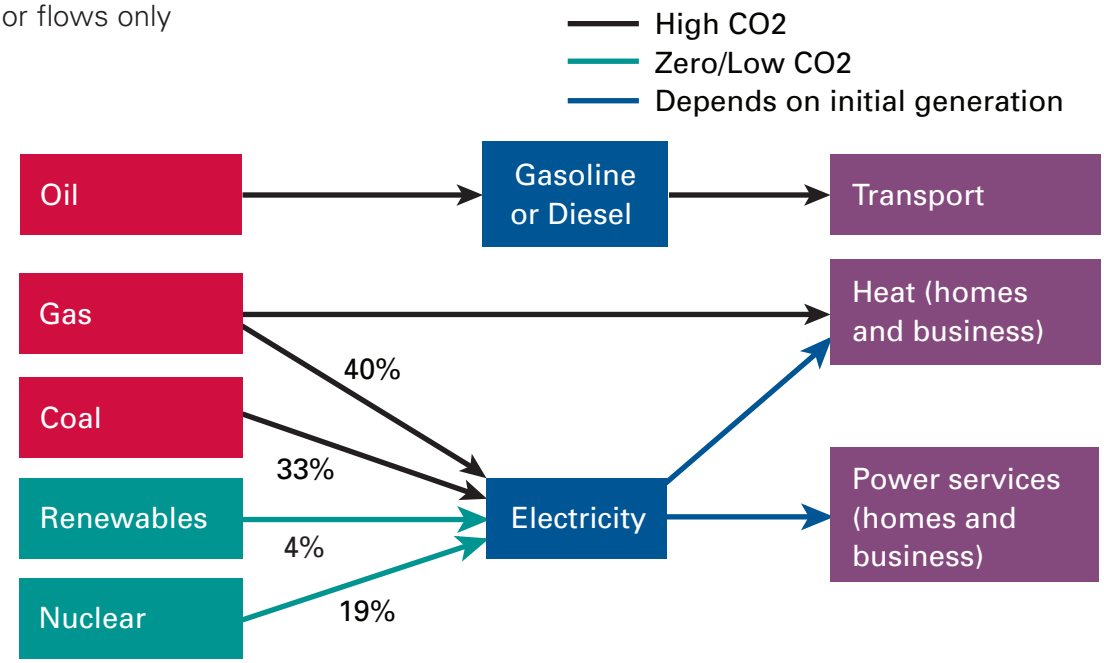
2 Our Four Energy Goals: Progress So Far

2.1 THE UK ENERGY SYSTEM

Energy is essential to nearly everything we do. We use it in transport, to generate the heat that we use in homes and businesses and to power our lights and other appliances. Increasingly we are learning how to use natural and renewable sources of energy such as sunlight, water, wind and crops to meet these needs. We remain however heavily reliant on fossil fuels which, when burnt, release greenhouse gases.

For transport we currently rely almost entirely on oil – nearly all of our transport relies on it, in the form of petrol or diesel for road transport and kerosene for aeroplanes. Indeed oil and transport are intimately linked, with around 70% of our oil going to transport. Heat is generated mainly from gas, but we also use electric heaters and burn small amounts of oil, coal and other natural substances. For lighting and the powering of appliances, we use electricity. Capturing only the major flows from raw fuel through to end use, we might think of our energy system in simple diagram form:

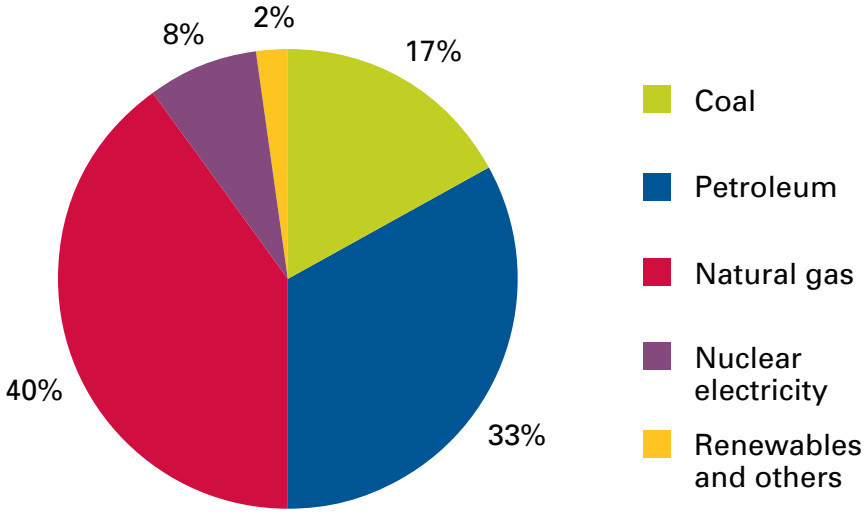
Chart 1: The UK energy system
Major flows only



Source: Prime Minister's Strategy Unit, DUKES 2005

Electricity plays a key role in this system. It is not a fuel, but rather a conduit of energy generated from a mixture of coal (33%), gas (40%), nuclear (19%) and renewables (4%).[2] When the use of fossil fuels to generate electricity is added to their uses in transport and providing heat, we get a full picture of our reliance on fossil fuels:

Chart 2: Breakdown of UK energy supply
Mtoe, %, 2005



Source: DTI, DUKES 2005

We rely on a series of transmission and distribution networks to get gas and electricity to the homes and businesses where it is used. Electricity flows from the high-voltage transmission network into fourteen lower-voltage distribution networks and in turn to homes and businesses. Gas transfers from the high-pressure transmission network into a series of low-pressure pipes for distribution to buildings. These networks are sometimes referred to as the 'electricity grid' and the 'gas grid'.

The UK's energy sector has a framework that combines competition where it is desirable and regulation when it is necessary. Consumers, business and households are able to choose between competing suppliers of electricity and gas, and a number of companies operate in the electricity generation market. The electricity and gas networks are privately owned and operated, but regulated in Great Britain by the independent Office for Gas and Electricity Markets (Ofgem) and in Northern Ireland by the Office for Regulation of Electricity and Gas (Ofreg).

A range of public policy interventions impacts on the sector, most significantly the EU Emissions Trading Scheme (EU ETS) and the Renewables Obligation (RO).[5] These policies have a significant impact on the way the sector operates, in particular on investment in generating capacity. The EU ETS is a cap-and-trade scheme to reduce carbon emissions. Companies that own high-emission plant are set annual emissions reduction targets that can be met either by lowering emissions or by buying 'allowances' from other companies. The RO incentivises the supply of renewable energy by requiring electricity suppliers to

2 DTI DUKES 2005. The remaining 4% consists mainly of electricity imports and oil.

source a minimum amount of their electricity from renewables. The higher costs of renewable energy compared to other sources are passed through to consumers. It is estimated that, along with exemption from the Climate Change Levy, the RO will be worth £1 billion per year in 2010 to the UK renewables sector. Environmental regulations such as the Large Combustion Plant Directive and planning policy also have a significant impact on the sector, as do building and other regulations on energy efficiency and energy use. The government's investment in science and its support for R&D can impact on the pace of technological development.

In the UK energy sector, specific investment decisions (including choices about which technologies to use) are made by energy companies and by business more generally. Public policy shapes the framework in which those investment decisions are made so that they properly reflect the country's goals on issues such as the reduction of carbon emissions. Policies to achieve that influence need to take full account of affordability and avoid damaging our competitiveness, public finances and prosperity.

2.2 PROGRESS TOWARDS OUR ENERGY GOALS, AND EMERGING CHALLENGES

In this Chapter we make a preliminary assessment of the UK's progress against each of the four goals of energy policy, and of emerging challenges.

2.2.1 Reducing carbon emissions

1. The global Climate Change challenge

The Earth's climate is changing. Over the past century global temperatures have risen by some 0.7 deg C on average, and all the evidence points to the primary cause being an increase in greenhouse gases in the atmosphere due to human activities, with carbon dioxide having the major impact[3]. The effects of recent warming are already evident, such as an increased incidence of heat-waves[4] and the retreat of mountain glaciers.

Without actions to curb emissions, globally averaged temperatures are expected to rise by some 1.4 to 5.8 deg C and sea levels by between 9 and 88 cm during this century, with increasingly severe impacts on the natural world and society. As temperatures rise the risk of more major climate disruption over the longer term will increase, such as melting of the Greenland ice-sheet or changes to the North Atlantic Ocean Circulation that gives the UK its mild climate.

Some of the effects of climate change might be mitigated through adaptation measures such as improvement of coastal defences, but these will become increasingly expensive. Ultimately the concentration of greenhouse gas in the atmosphere must be halted at a level

3 IPCC, 2001: Climate Change 2001: Synthesis Report. Cambridge University Press, Cambridge, UK and New York, NY, USA.
4 P. A. Stott, D. A. Stone & M. R. Allen200. Human contribution to the European heat-wave of 2003, Nature, 3089

that minimises the risk of major disruption and reduces the risk of the most dangerous impacts.

There is no international consensus on the level at which greenhouse gases should be stabilised. In 1997 EU Member States agreed that we should be aiming for a global average temperature increase of no more than 2 deg C above pre-industrial levels and therefore, as estimated at the time, a concentration below 550 parts per million of CO2 to prevent the most damaging effects of climate change. More recent scientific evidence suggests that this assessment of the stabilisation level required to stay below the 2 deg C limit was probably optimistic. This reinforces the case for urgent and committed multilateral international action. Stabilisation at 550 parts per million of CO2 will itself represent an enormous global challenge.

2. Progress in the international response to climate change

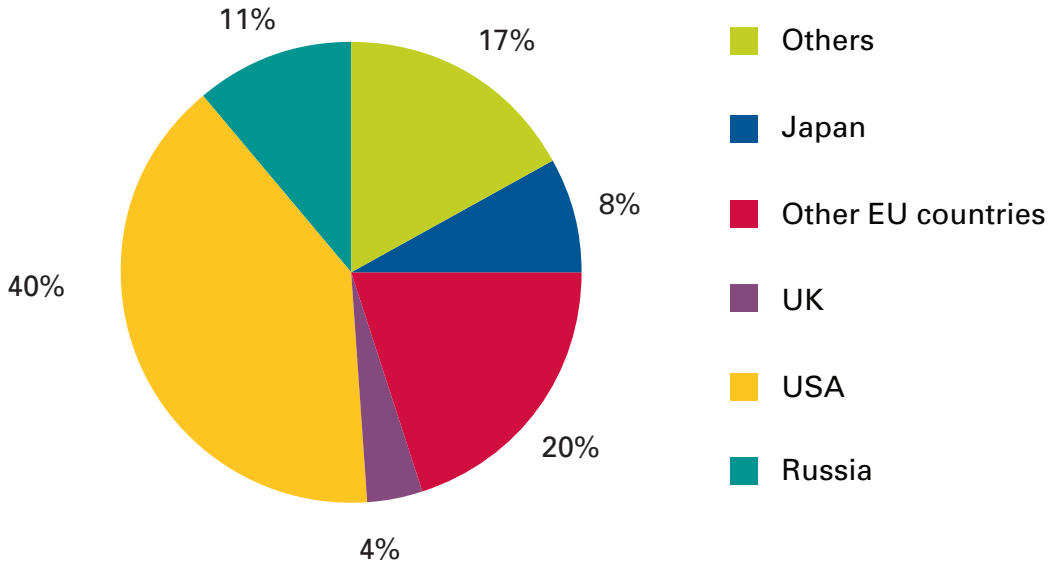
UK emissions are only about 2% of total global emissions. Tackling climate change, to be successful, therefore has to be an international effort. This is why the government has been giving such high priority to leading and influencing international negotiations to tackle climate change.

The UN Framework Convention on Climate Change (UNFCCC) aims to prevent dangerous man-made climate change and commits developed countries to taking the lead in tackling climate change. The Kyoto Protocol to the Convention entered into force on 16 February 2005. As of end 2005, 157 countries had ratified the Protocol, with the USA and Australia the only significant energy-using countries not having done so. The Protocol set legally binding targets for participating developed countries to reduce greenhouse gas emissions by around 5% of the 1990 level in the period 2008-2012.

However, global emissions have continued to increase. Between 1990 and 2003, emissions in Annex I countries[5] grew by 5.2%. The International Energy Agency projects that, on the basis of current policies, global energy demand will be more than 50% higher in 2030 than today, with greenhouse gas emissions about 60% higher.[6] This underlines the scale of the challenge faced by the international community and the importance of the further agreements reached during 2005 under both the UNFCC and the G8 process.

5 Annex I countries include European and other G7 countries, Australia and New Zealand
6 IEA, 2005 World Energy Outlook.

Chart 3: Greenhouse Gas emissions in Annex I countries
Million tonnes of carbon equivalent, %



Source: Greenhouse Gas Emissions Data for 1990 – 2003 submitted to the United Nations Framework Convention on Climate Change, 2004

At the UN Climate Conference in Montreal in December 2005, the Kyoto Parties adopted the detailed rules and procedures implementing the Protocol, including the Compliance regime which lays down penalties for failure to meet emission reduction targets for the period 2008-2012. The Parties also agreed to begin considering further emission reduction targets for developed country parties for the period beyond 2012. They agreed to prepare for a broader review of the Protocol starting in December 2006 and to submit views on the procedure by which countries not currently included in Annex I could adopt a target on a voluntary basis.

In addition to discussing further action within the context of the Kyoto Protocol, all Parties to the parent UN Framework agreed to launch a Dialogue on long-term co-operative action to address climate change (the so-called Montreal Action Plan). The dialogue will focus in particular on supporting and facilitating actions by developing countries to mitigate climate change.

The UK government also made climate change a priority of its G8 Presidency. At the Gleneagles Summit in July 2005, attention was focussed on the importance of urgent action to tackle climate change and on the linked challenges of clean energy and sustainable development. The G8 countries agreed on the nature of the problem and on the need to take urgent action, and agreed to make substantial reductions in greenhouse gases. They also decided a Plan of Action to address the major strategic challenges presented by climate change.[7] The plan is being taken forward under the guidance of the Dialogue on Climate Change, Clean Energy and Sustainable Development established at Gleneagles,

7 This covered energy efficiency, cleaner energy, research and development, financing the transition to cleaner energy, the impacts of climate change and illegal logging

which brings together 20 developed and developing countries with significant energy needs. The Dialogue will continue through the Russian and German G8 Presidencies and report back to Heads of Government during Japan's Presidency of the G8 in 2008.

Addressing climate change has also risen up the EU internal agenda. The most recent report on progress in meeting the EU's Kyoto commitments estimates that as a result of current and planned actions by the EU and its member states, the EU15[8] are on track to reduce greenhouse gas emissions by 9.3% by 2012, against the EU's collective 8% Kyoto target. The EU has also begun to consider strategies for reducing emissions beyond the 2012 timeframe. EU Heads of Government agreed in March 2005 to explore with other parties strategies for emission reduction pathways for developed countries of 15-30% by 2020 and 60-80% by 2050. They will consider this further in 2006 in light of the Commission's current work on the next phase of the European Climate Change Programme. Meanwhile EU member states, including the UK, France and Germany, have begun to consider national strategies for achieving substantial emissions reductions beyond 2012.

Establishment of the EU Emissions Trading Scheme in January 2005 was a major step forward in EU action to reduce emissions. The EU ETS promotes investment in low-carbon plant by setting annual emissions reduction targets for over 1000 installations in the UK. These targets can be met either by lowering emissions or by buying 'allowances' from other companies. The first phase of the scheme covers 2005-2007. Phase II covers 2008-2012 and allocations for this phase will be agreed in 2006. The Commission is carrying out a review of the scheme with a view to reporting by 30 June 2006 as a precursor to Phase III of the scheme.

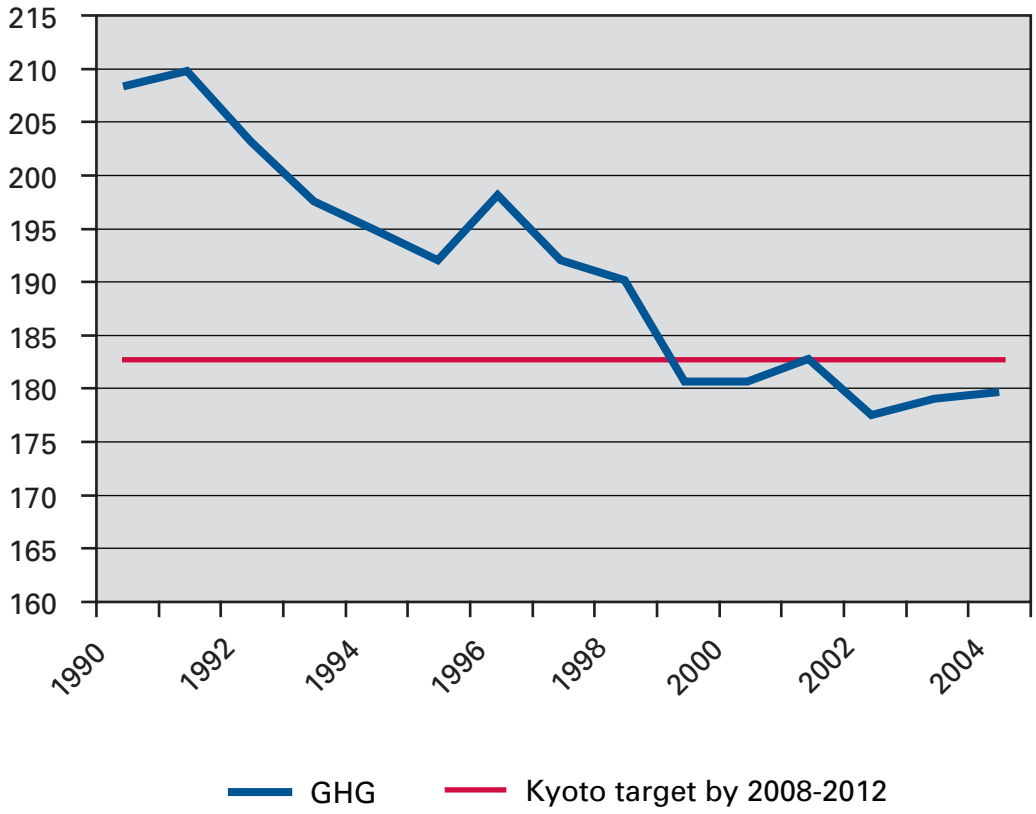
3. UK progress on reducing carbon emissions

The government committed itself in the 2003 Energy White Paper to putting the UK on a path to cut CO2 emissions by some 60% by about 2050, as recommended by the Royal Commission on Environmental Pollution, and to achieving 'real progress' by 2020.

In the shorter term, the UK has two goals. The first arises from the EU's obligations under the Kyoto Protocol, under which the UK's contribution is to reduce greenhouse gas emissions by 12.5% below base year levels by 2008-12. The UK is on track to deliver this. Latest estimates show that total UK greenhouse gas emissions in 2004 had fallen 14.6 per cent below 1990 levels (see Chart 4). Current projections show that they should be about 20 per cent below by 2010.

8 The EU15 refers to the member states of the European Union before the accession of ten new states in 2005.

Chart 4: UK greenhouse gas emissions vs the Kyoto target

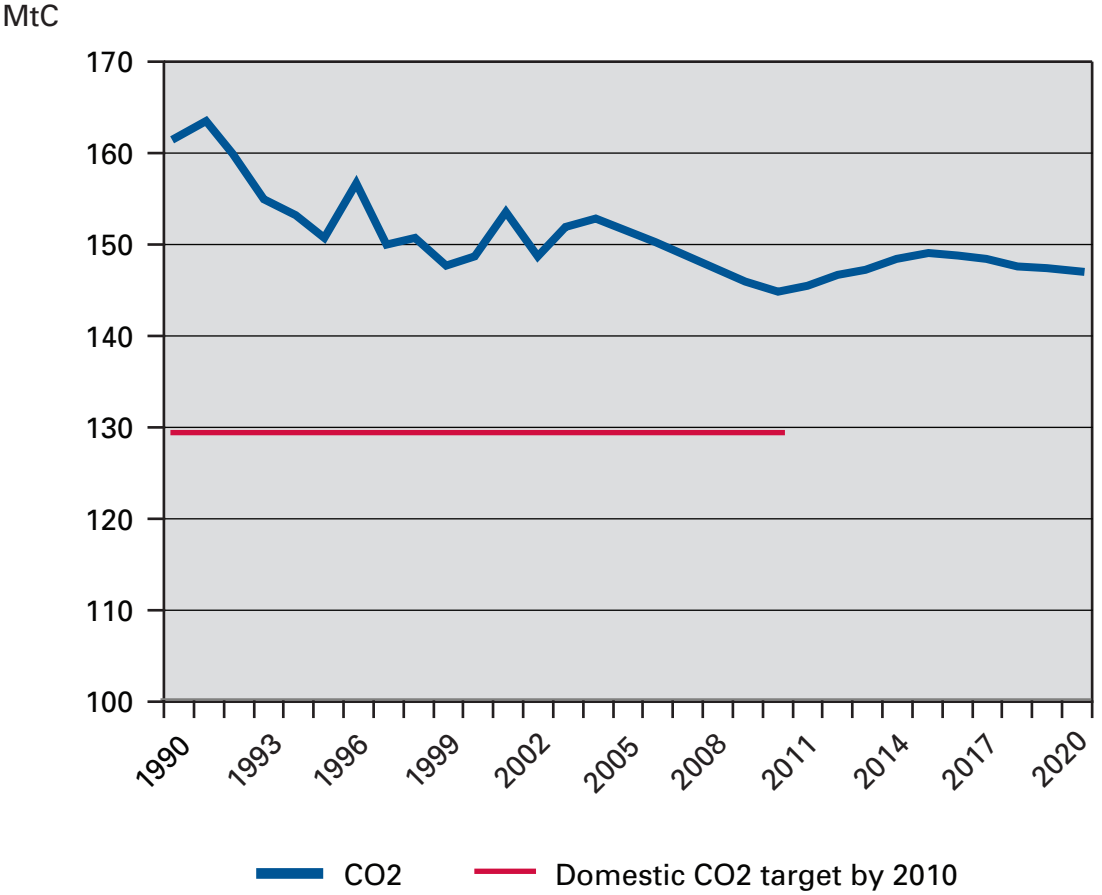


Source: DEFRA, 2005

Our second goal in the shorter term is to reduce CO2 emissions by 20% on the 1990 level by 2010. Meeting this aim is proving to be challenging. Our latest projections suggest that the UK will have reduced CO2 emissions to around 10% below 1990 levels by 2010. These projections are based on current measures only, and do not take account of any new measures which will be introduced as part of the revised Climate Change Programme.[9]

9 For example, setting of the cap for Phase II of the EU Emission Trading Scheme is not included.

Chart 5: UK carbon emissions vs 2010 domestic target



Source: DTI, 2005

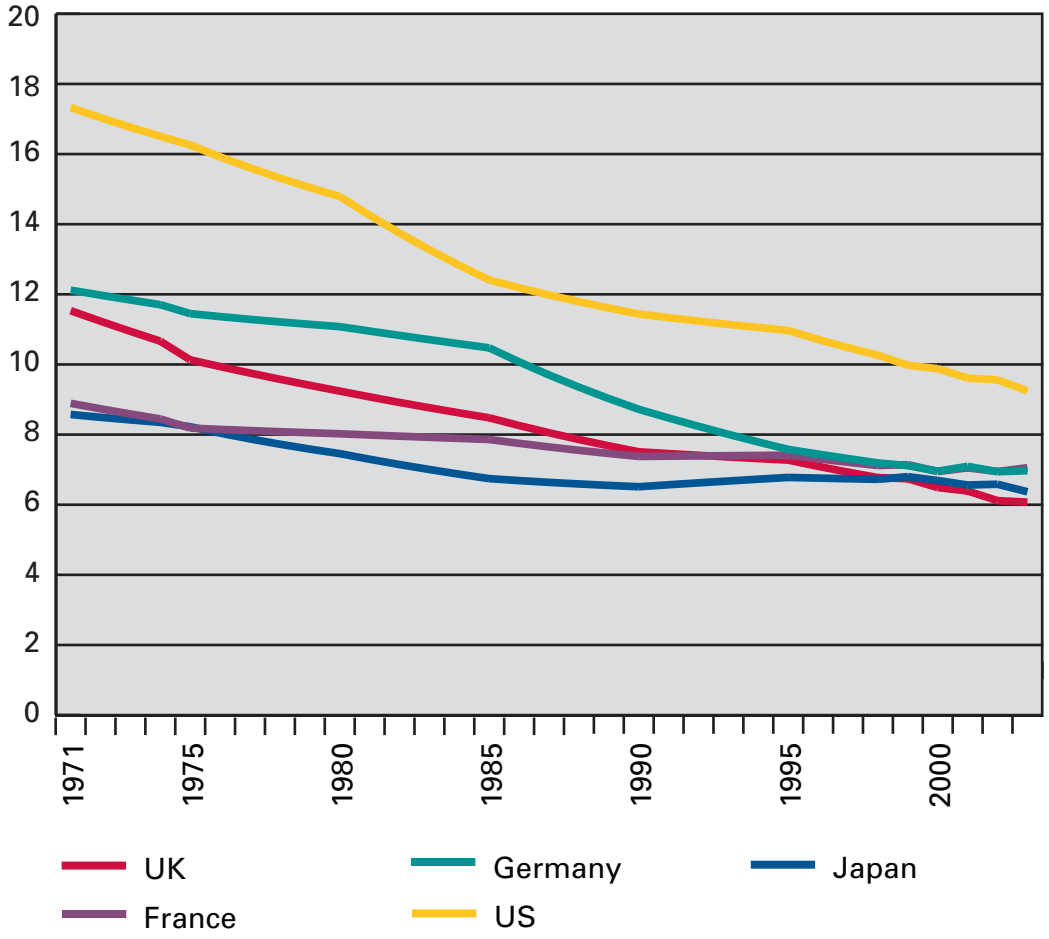
Progress against these short-term goals is not the subject of this Review. The latest projections do, however, highlight the size of the challenge represented by our longer-term carbon goals. By 2020, again before allowing for any new measures arising from the Climate Change Programme Review, emissions are projected to be in a range of 144MtC to 148MtC depending on assumptions made on fossil fuel prices. This is some 30MtC above the level indicated in the Energy White Paper as representing 'real progress' towards our 2050 goal.

4. Emissions Relative to GDP

As the level of activity in the economy grows, demand for energy and hence the risk of increased emissions grows. A key indicator of progress therefore is *energy intensity* i.e. total energy used divided by Gross Domestic Product (GDP). A way of illustrating the size of our carbon challenge for 2050 is to measure the level of carbon emissions against GDP. The term used to describe this relationship is *carbon intensity*.

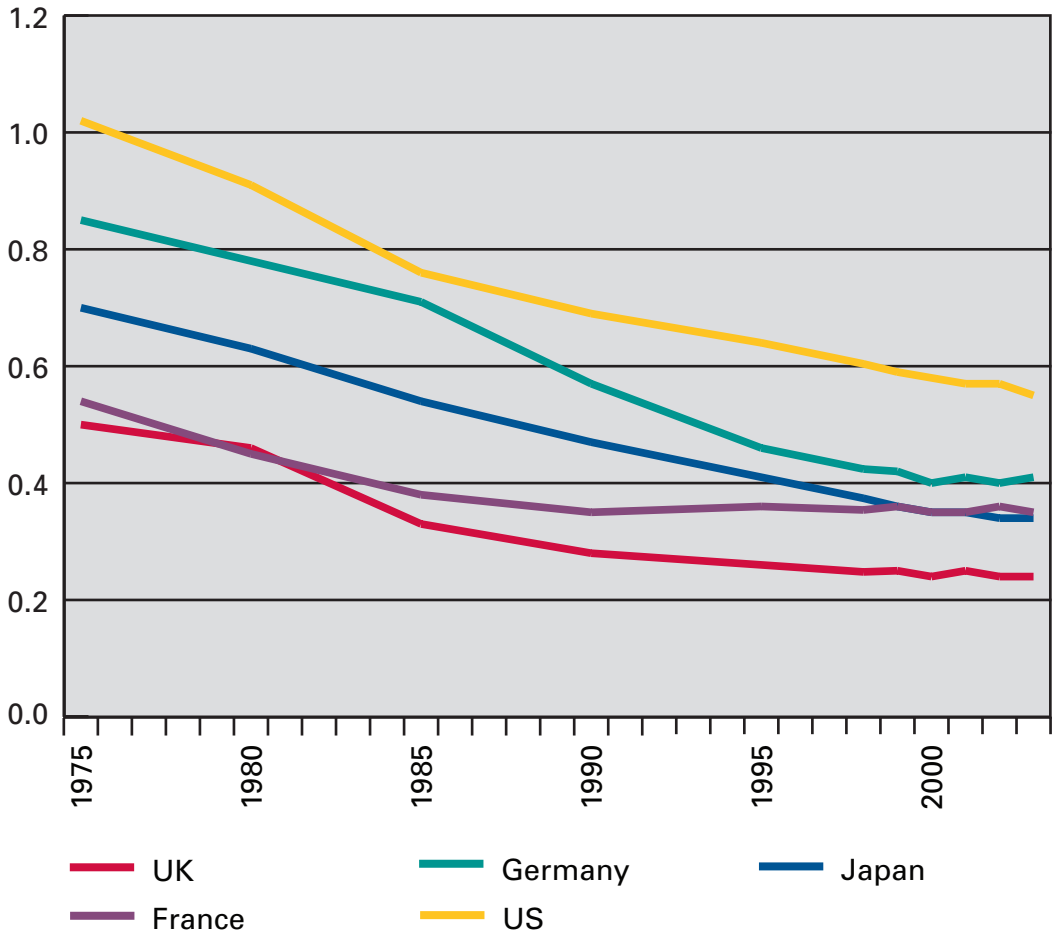
The UK has improved considerably on both counts. Carbon intensity has improved by 55% since the early 1970s, a rate of almost 2% per annum. Energy intensity has improved by 40% in that period, largely as a result of energy efficiency improvements, the trend away from coal to gas plant for electricity generation, and the shift in our economy from heavy industrial towards commercial and services sectors. There has been a similar trend in other countries.

Chart 6: Energy Intensity – final energy consumption/GDP ratio
Petajoules per billion dollars using PPP, US$ 2000



Source: IEA CO2 emissions from combustion 1971-2003, 2005

Chart 7: Carbon intensity – energy related CO2 emissions/GDP
Mt CO2/GDP (PPP US$ 2000)



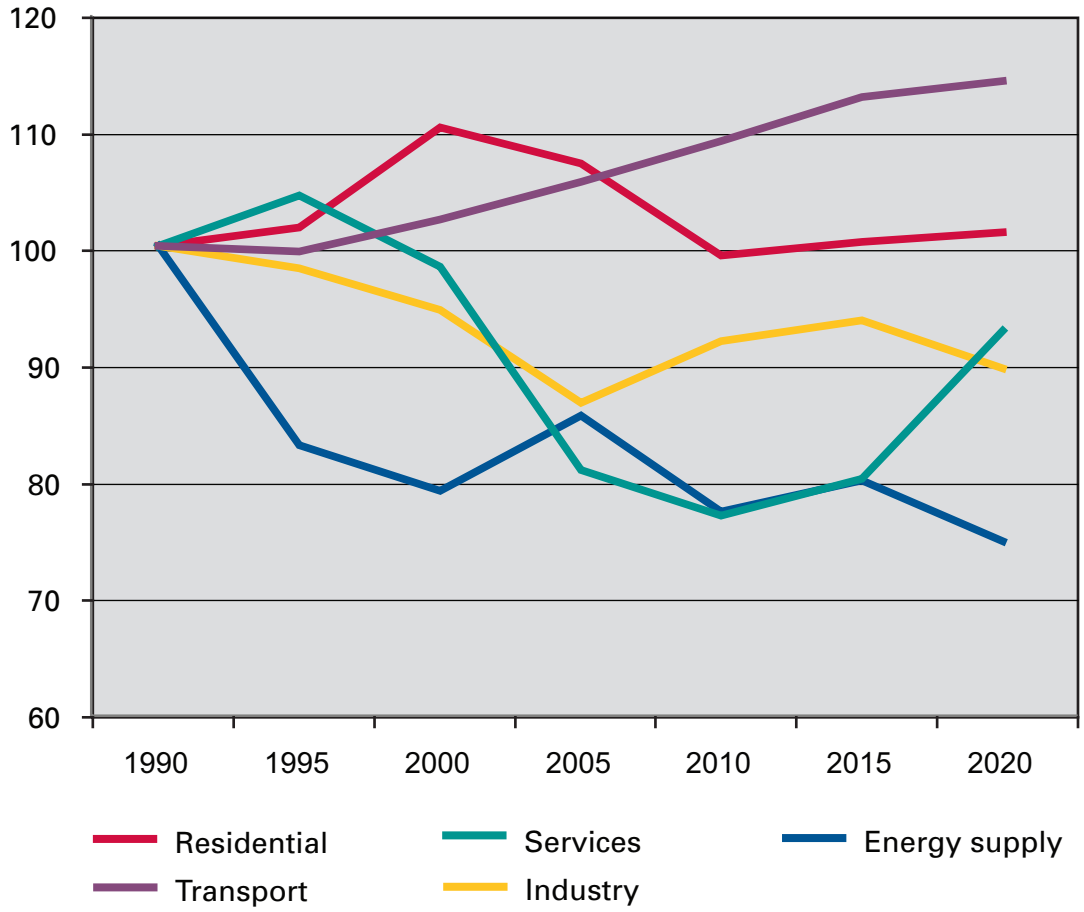
Source: IEA CO2 emissions from combustion 1971-2003, 2005

If we assume that UK GDP will grow on average by 2.5% per annum in the years to 2050, then carbon intensity in the UK would need to reduce to around 10% of what it currently is today in order for us to meet our 2050 target. This is a hugely demanding goal.

5. Emissions by sector

A sectoral analysis helps to understand where emissions are coming from in our economy, and what is driving them. The energy supply sector currently accounts for around 35% of emissions; transport for 24%; industry 22%; services 4% and the residential sector 15%. This profile is likely to change over time, as the structure of the economy changes, as progress is made on energy efficiency and as people become wealthier. Chart 8 shows the rise in transport emissions that will likely result. Emissions from the services sector are also expected to rise, while emissions in other sectors are expected to be flat or declining.

Chart 8: UK emissions by sector
1990-2020, Index (1990=100)



Source: DTI, 2005

Within each sector there are many different government interventions that might help to reduce carbon emissions, each with its own cost and potential benefits. Because cost-effectiveness varies significantly according to the instrument or programme being used, a sector-by-sector analysis does not necessarily tell us the most cost-effective way to reduce emissions. An important input for the Review will be work currently being done on the comparative costs of emissions reduction by the Climate Change Programme Review and the Stern Review, both due this year.

a. Emissions from the energy supply sector

The energy supply sector, which includes oil refining and electricity generation, is the biggest single contributor to carbon emissions. It is, however, the sector that contributed most to the fall in emissions since 1990, reducing the amount of carbon emitted by almost 8MtC or 12%. A large driver of this reduction was the 'dash for gas' which saw coal-fired stations replaced by lower-emission gas-fired plants, though recent price rises for gas have made coal stations more competitive, pushing emissions upward again.

The sector might see further reductions over the next ten to fifteen years as coal plants are retired and the share of gas and renewables in the generation mix increases, but the scale of any reduction will be significantly offset by the impact of nuclear plant closures. If retired capacity were replaced by gas plant, for example, the effect would be to add some 5 to 6 Mtc to emissions by 2020.[10]

One source of uncertainty in our projections is that we do not know when new technologies might begin to make a material contribution to our generation mix. For example, energy companies are looking at a number of possibilities for carbon capture and storage, including construction of a gas plant at Peterhead in Scotland, from which carbon would be pumped into the Miller field in the North Sea. Similar uncertainty surrounds the speed of technological development in other low carbon technologies.

However, even if we had a completely carbon-free generation mix but took no measures in other sectors, we would fall far short of our 2050 target. To make real progress towards it by 2020, we will need lower emissions from generation but we will also need continued improvement in the efficiency with which we use energy in our travel, our homes and in business.

b. Transport emissions

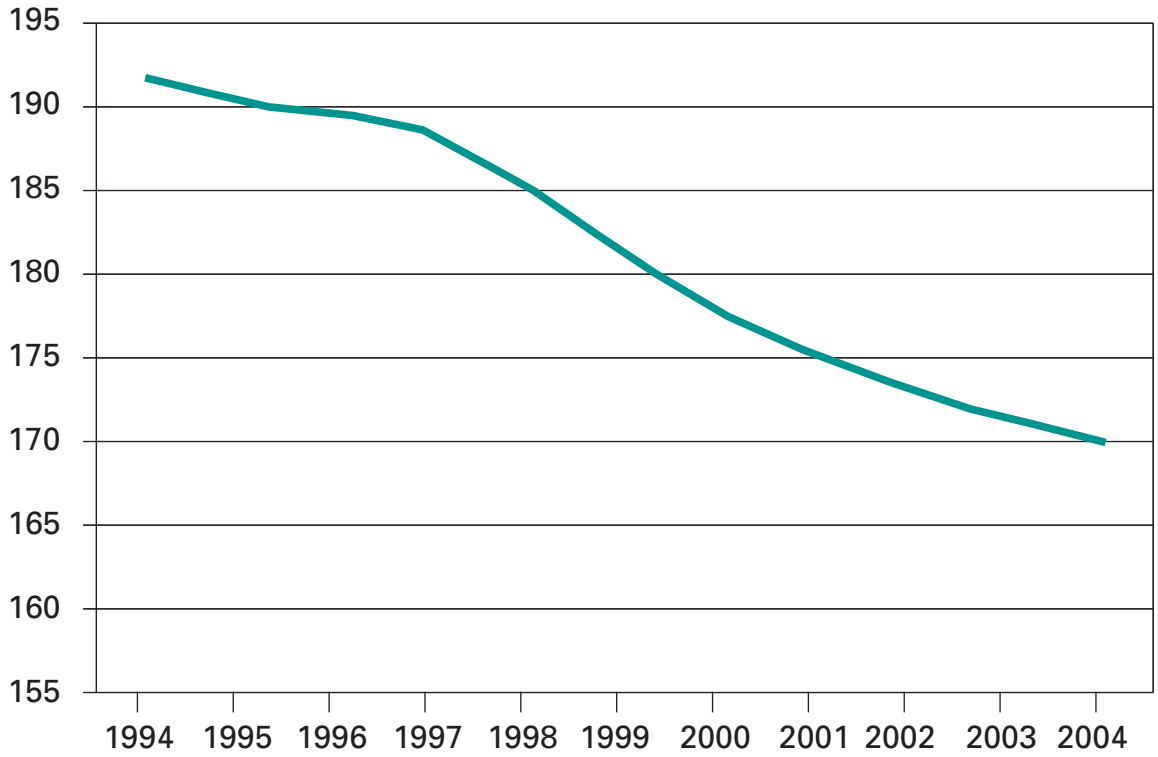
In a growing economy, the demand for transport fuel grows. As people become more prosperous they tend to choose to travel more and, in many cases, to travel in a way that emits more carbon – for example, to drive rather than take public transport. This is why road transport CO2 emissions grew by 8% between 1990 and 2000 even though average fuel efficiency from new cars has improved by 10% since 1997. Forecasts indicate that road transport emissions will grow by another 8% between 2000 and 2010 (See Chart 8).

The Government has a long term strategy to tackle emissions from transport by:

- **Reducing the fossil carbon content of transport fuel.** A range of policies are in place to support the use of clean, low carbon fuels. Key to this is the Renewable Transport Fuels Obligation, under which 5 per cent of transport fuel sold in the UK will have to come from renewable sources by 2010. This will lead to an estimated 1 MtC reduction in emissions, equivalent to taking one million cars off the road, without limiting travel;
- **Increasing the fuel efficiency of vehicles.** Better fuel efficiency is largely responsible for the fact that between 1990 and 2003 GDP grew by 35%, road traffic grew by 20% and transport emissions only went up by 9%. In the UK, both Vehicle Excise Duty and the Company Car Tax system reward motorists for choosing more fuel-efficient cars. At an EU-level, the Voluntary Agreements on new car fuel efficiency with European, Japanese and Korean Manufacturers have also encouraged the development of more fuel-efficient cars. Average emissions from new cars in the UK went from 192 grams of CO2 per kilometre in 1995 to 172 in 2004. The rate of improvement has, however, slowed in recent years (See Chart 9);

10 See Chart 16 on page 41 and acccompanying text. This shows a possible scenario for the make-up of our generating capacity, on the assumption that nuclear plants close as now scheduled and that no new nuclear plant is in operation by 2020

Chart 9: Average CO2 emissions from new cars in the UK
Grams per kilometre, 1994-2004

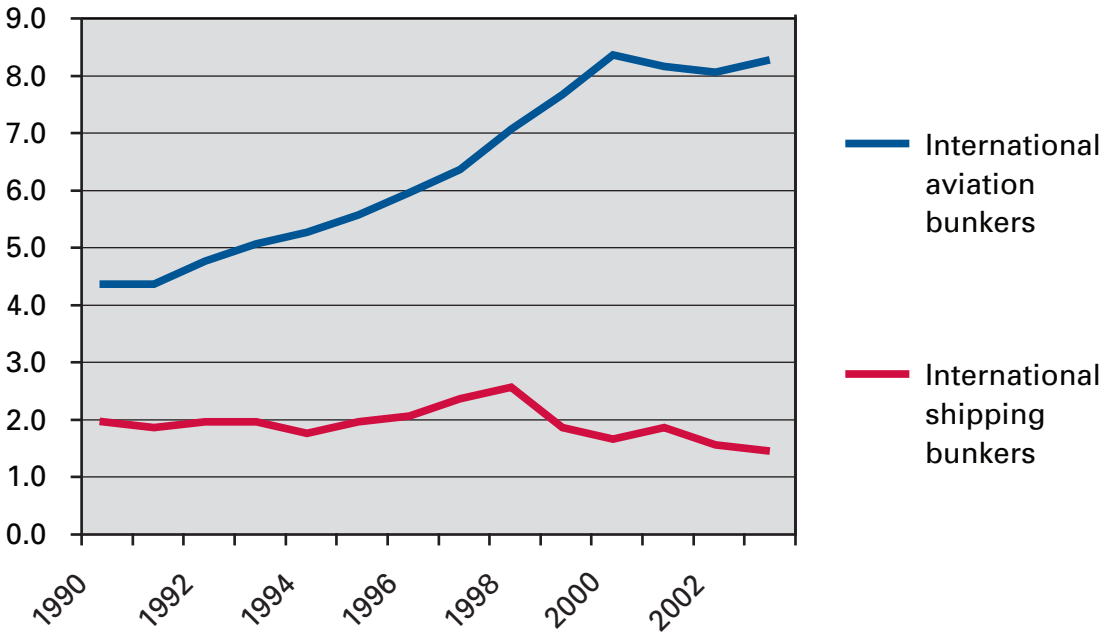


Source: HM Treasury: Pre-Budget Report 2005

- **Encouraging a move towards more environmentally friendly forms of transport.** We are putting record investment into public transport to give people a real alternative to travelling by car – the UK now has the fastest growing railway in Europe ("Ten year European Rail Growth Trends" by The Association of Train Operating Companies);
- **Working towards the inclusion of transport in emissions trading.** There is no international agreement on how to allocate the emissions from international aviation or international shipping. These are, therefore, not included in either the Kyoto targets or the Energy White Paper's domestic targets. But it is clear that aviation in particular is making a growing contribution to climate change. The Air Transport White Paper forecast in December 2003 that by 2030 CO2 emissions from UK aviation could amount to about a quarter of the UK's total contribution to global warming[11]. In December 2005 the EU Environment Council called on the Commission to bring forward a legislative proposal on including aviation in the EU emissions trading scheme. The government supports this, because we believe that the best way of ensuring that aviation contributes towards climate stabilisation is through a well-designed emissions trading regime in which emissions reductions can be made in the most cost-effective way.

11 UK aviation in this context is defined as all domestic services plus all international departures from the UK.

Chart 10: Greenhouse gases from UK based international aviation and shipping[19]
MtC



Source: National Statistics, Sustainable Development Indicators 2005

c. Residential emissions

As a result of economic growth we now have more numerous and wealthier households with many more appliances than 15 years ago. Energy services demand has increased by 40%; that is, homes in total enjoy the benefit of 40% more light, heat and powered appliances than they did in 1990. Residential emissions, however, remain broadly the same as they did in 1990, at 40MtC.[12] This has been achieved largely as a result of improvements in energy efficiency helped by a number of government programmes, such as stepped improvements in building standards, an obligation on energy suppliers to promote energy efficiency (EEC), improved product labeling and minimum standards for appliances.

It was recently calculated that there exists in the residential sector a further cost effective carbon saving potential of some 9MtC by 2020. Most of this would come from improvements in space and water heating and in insulation (7.5MtC) and from improvements to the energy efficiency of appliances (1.5MtC).[13] Improvements in energy efficiency (including efforts to reduce energy wasted because of poorly insulated buildings or poor control of heating, lighting, ventilation and appliances) represent potentially the most cost-effective way of delivering our energy policy objectives.

Given the scale of the emissions challenge for 2050, however, we need to do more than stem the speed of growth in emissions; we need to make actual carbon reductions on a significant scale. Defra estimates that in the household sector, a 50% increase in the historic rate of energy efficiency improvements would meet the increases in demand for

12 This figure represents the share of emissions after emissions from energy supply are allocated to end users.
13 Energy Savings Trust, Energy Efficiency Innovation review: Report on the Household Sector (2005)

energy services and stabilise energy consumption. The higher rates of improvement in energy efficiency expected from current policies should reduce consumption.

The work undertaken in the current Climate Change Programme Review shows that progress in achieving energy efficiency savings has been slower than was expected in the 2003 White Paper. The recent Energy Efficiency Innovation Review (EEIR)[14] examined the strengths and weaknesses of specific programmes, and identified some broad barriers to the uptake of energy efficiency measures. These included:

- **Users unaware of the potential savings inherent in energy efficiency.** For residential consumers and many businesses, energy costs are a small proportion of total costs and payback on an efficiency investment might take years. The absence in many buildings of accurate meters also makes it difficult to measure energy usage;
- **Users not taking into account the full economic savings available from investments in energy efficiency,** the so-called cost-perception gap. Sometimes this is due to a lack of understanding or a lifestyle preference, but it is often rational. Landlords bear the cost of an investment for example but tenants enjoy the lower bills. There is little evidence that such investments raise property values or rents. A similar dynamic exists between developers and buyers;
- **Distrust of suppliers and installers.** A major impediment to residential investments is distrust of suppliers and installers of boilers, insulation and other efficiency measures, combined with the hassle of getting these jobs done and the relatively small size of the potential savings.
- **The 'rebound' effect.** Energy users who invest in efficiency tend to spend at least some of their savings on more energy rather than on lower bills, e.g. they make their homes warmer rather than lower their heating bill (referred to as 'comfort taking'). This in part explains why improvements in the technical efficiency of many households and their appliances have not delivered reduced emissions.

The better understanding of these barriers afforded by the EEIR will inform our assessment of the long term potential of energy efficiency measures and of how best to achieve that potential.

d. Emissions from business

Carbon emissions for the business sector accounted for 48MtC in 2002, demonstrating considerable improvement since 1990[15]. Part of this was due to the shift in the UK economy away from energy-intensive businesses like steel towards the services and commercial sector, but part of it has been due to efficiency measures. For example an independent evaluation published at Budget 2005 concluded that the Climate Change Levy (CCL)[16] should save over 3.4 million tonnes of carbon (MtC) per annum by 2010, well above the estimates made at its introduction.[17]

14 The summary report can be found at: http://www.hm-treasury.gov.uk/media/FB4/AE/pbr05_energy_675.pdf
15 This figure represents the share of emissions after emissions from energy supply are allocated to end-users.
16 The Climate Change Levy is a tax on energy use that typically adds around 15% to businesses' energy bills.
17 Cambridge Econometrics, Modelling the initial effects of the Climate Change Levy.

Further reductions in the energy intensive sector in the medium term are likely. The Carbon Trust report to the Climate Change Programme Review[18] calculates that there exists, based on existing technologies, a cost effective carbon abatement opportunity to 2020 of 3.3 MtC, not including future savings under extension of the EU ETS.

In the commercial and public sectors it is predicted that the CCL, in combination with price effects, will have reduced energy demand by 14.6 per cent by 2010.[19] There appears to be potential for further reductions. The UK ETS, a voluntary precursor to the EU ETS that runs from 2002 to 2006 and which applies to commercial sector companies, is estimated to have saved 1.4MtC in 2004[20] despite a very limited number of participants. The Carbon Trust[21] calculates that there exists, based on existing technologies, a cost effective carbon abatement opportunity to 2020 of 3.9 MtC across all non-energy intensive sectors. The largest saving (some 2.9 MtC) would come from improvements in buildings.

Significant barriers to the uptake of energy efficiency measures in business remain, however. Many of them are similar to the barriers identified for households above. There is also some debate about the relationship between energy efficiency and actual carbon reduction. In particular, because increased energy efficiency effectively makes energy cheaper, it allows some businesses to more competitively price their products, potentially leading to greater demand and hence to extra output.[22]

e. The public sector

Carbon emissions within the public sector account for some 6MtC. The Carbon Trust report to the CCPR estimated that there exists a cost effective carbon saving potential of 0.8MtC, mainly through improved energy efficiency in public buildings. Within the Energy Efficiency Action Plan[23] government set out its commitment to ensure that the public sector leads by example in managing its carbon emissions, defining emissions reduction targets and a procurement policy for buildings in the government estate. The Government has set itself a series of goals and targets to achieve this.[24] Progress to date has been slow. However, the recent PBR announced £20M for a revolving fund to support increased investment in energy efficiency across the public sector, which is expected to help make significant improvements. The Government also has in place a number of targets to reduce emissions from its own vehicle fleet.[25]

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18 The Carbon Trust (2005), The UK Climate Change Programme: Potential evolution for business and the public sector.
19 Cambridge Econometrics, Modelling the initial effects of climate change levy.
20 HM Treasury: Budget 2005, p171
21 The Carbon Trust (2005), The UK Climate Change Programme: Potential evolution for business and the public sector.
22 One school of economists suggests that, while energy efficiency measures raise productivity levels, and help control growth in demand, they will not deliver significant actual reductions in carbon emissions on an economy-wide level because the increased energy productivity will be used to produce more output rather than to save on energy use: see for example Herring, Energy efficiency – a critical view, Energy 31 (2006). This theory has been neither confirmed nor disproved empirically, and the UK Energy Research Centre has commissioned work to assess it in full.
23 Defra (2004) Energy Efficiency: The Government's Plan for Action. (April 2004)
24 It has a goal to procure only buildings in the top quartile of energy performance for the central Government estate. It has set itself targets to reduce absolute carbon emissions from government buildings; to increase energy efficiency in its buildings; to source at least 10% of its electricity from renewable sources by 31 March 2008; and to source at least 15% of electricity from good quality CHP by 2010.
25 These include commitments from all Departments to reduce by March 2006 their road vehicle carbon dioxide emissions by at least 10%, to ensure that at least 10% of their fleet cars are alternatively fuelled, and to reduce single occupancy car commuting by 5%. The Secretary of State for Transport has also asked the Chief Executive of the Government Car and Despatch to consider options for increasing the proportion of clean, low carbon vehicles in the Government Car Service fleet.

2.2.2 Reliable energy supplies

In order to ensure reliable energy supplies in the long term, we need a dependable system of physical distribution networks and access to sufficient and affordable energy. The UK has generally performed well over the last few years on both dimensions. There have been fewer unplanned interruptions to electricity supply than in any European country except the Netherlands,[26] and only a small number of threats to oil and gas supply.[27] Protecting this record in the changing circumstances of the next decade is a priority of UK energy policy.

The Energy White Paper set out our strategy for maintaining energy reliability, basing it on the following principles:

- The regulatory framework must give high priority to reliability;
- Diverse sources, fuel types and trading routes should be promoted to avoid the UK being too reliant on too few international sources of oil and gas;
- Liberalised markets, a cornerstone of our policy, must incentivise suppliers to achieve reliability;
- We need robust information on supply and demand, and market responses to it.

This winter's experience with gas supplies and prices has raised concerns, especially for some industrial consumers, about the UK's links to European and other international gas markets. Reliability of supply issues are also raised by our increasing reliance on oil and gas imports, high projected fossil fuel prices and the retirement of large amounts of electricity generation capacity. In this context, we provide information for the consultation process on five specific issues:

- Making the most of UK oil and gas reserves;
- Increasing reliance on imported oil;
- Increasing reliance on imported gas;
- The changing electricity generation mix;
- Maintenance and development of transmission and distribution grids.

26 Second benchmarking report on quality of electricity supply, Council of European Regulators, September 2003, which looked at the 1999-2001 triennium.

27 For motorists during the fuel protests in 2000, for example, and for energy-intensive gas users this winter who have been subject to high and volatile prices

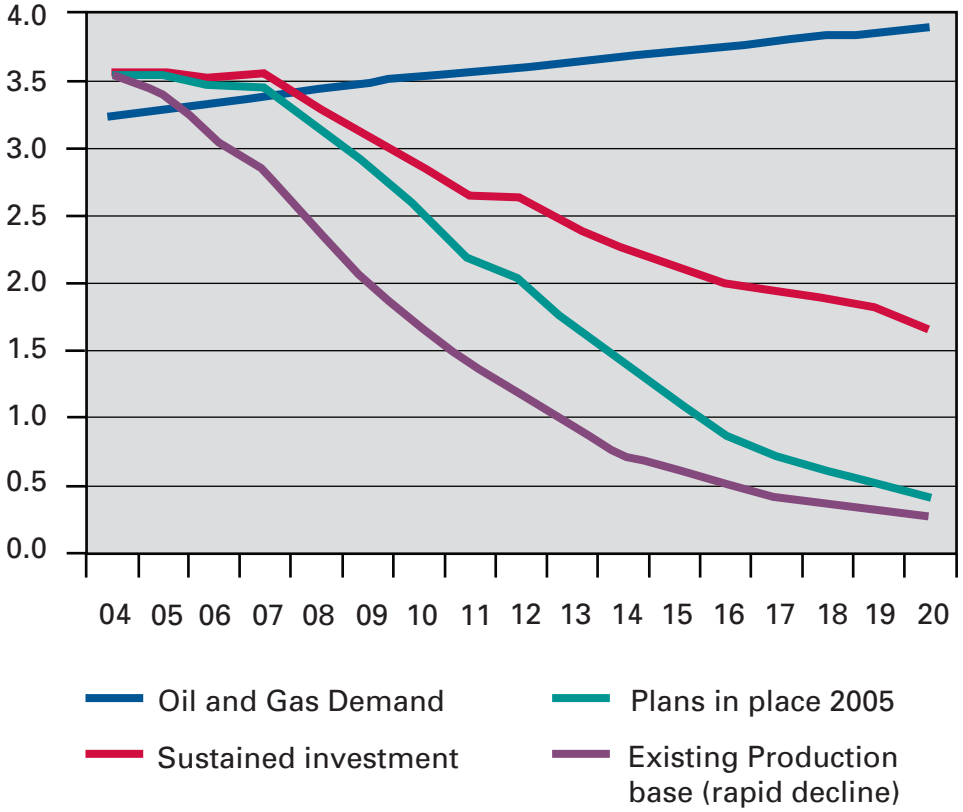
1. Making the most of UK oil and gas reserves

Large-scale extraction of oil and gas from the UK Continental Shelf began in the late 1970s. Production of both however, has been declining and on current trends we will become a regular net importer of oil by around 2010.[28] The UK was a net importer of gas on an annual basis in 2004 and 2005.

The UK is still, however, one of the global top 10 producers of oil and gas and will remain a major player for many years. 34 billion barrels of oil equivalent (bboe) have been produced so far; remaining reserves are likely to amount to between 21 and 27 bboe. Maintaining investment in the exploration and development required to find and recover these reserves remains a priority. If we make the most of these resources, maintaining indigenous production as far as possible, production is likely to decline at an average rate of around 7% per annum. If, on the other hand, the UKCS fails to attract continued investment, the decline in production could be significantly more rapid; studies suggest up to 14% pa. This would be the difference between meeting half of the UK's oil and gas needs by 2020 instead of just 10%:

Chart 11: UK continental shelf oil and gas production

Million barrels of oil equivalent per day



Source: UKOOA Economic Update November 2005

28 For the first time in many years, the UK is likely to have been a net importer of oil (crude, NGLs and refined products) in 2005, partly due to the shutdown of the large Schiehallion Field because of a fire in the second half of the year. However, with the large Buzzard field due on-stream in late 2006, the UK should return to being a net exporter of oil by 2007 before becoming a net importer on a sustained annual basis by around 2010

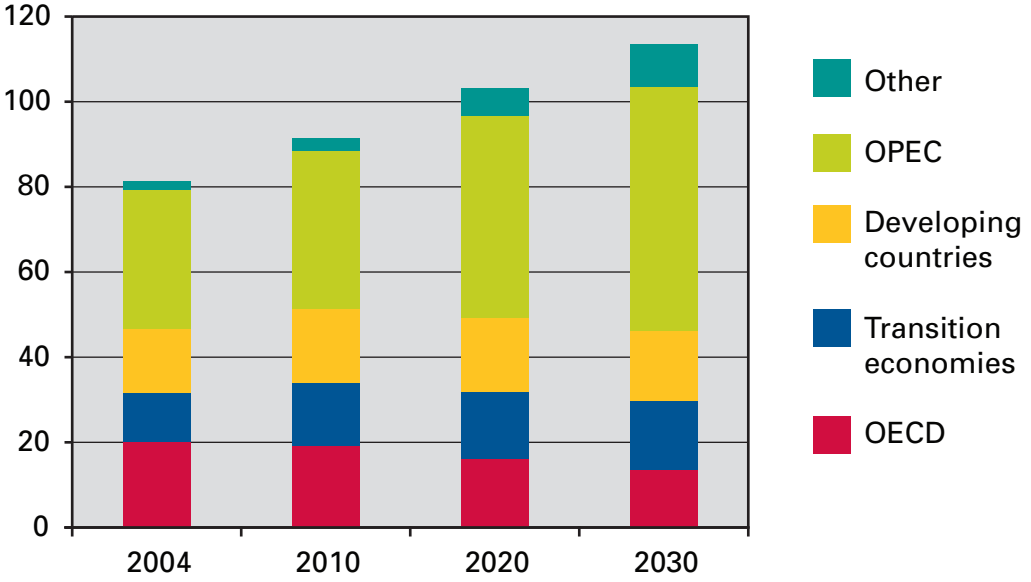
In recent years Government and industry have been committed to a number of initiatives to help increase investment in long-term offshore projects, from improving access to pipelines and other infrastructure to ensuring activity in all areas under licence. These are proving successful. For example, the 2005 licensing round had more interest than any other round since gas production started in 1964. The review will therefore seek to determine whether there is more that Government, working with industry, can do to build on the success of PILOT[29] to ensure that the UKCS remains attractive to long term investors and to maximise economic recovery of its oil and gas resources.

2. Reliance on imported oil

As the UK becomes increasingly reliant on imported oil, the efforts of the UK and other governments to ensure a stable and transparent international oil market will increase in importance. The bulk of the world's conventional oil reserves are found in OPEC countries, particularly in the Middle East; OPEC produces 40% of global output and holds approximately 75% of proved reserves.[30]

Chart 12: Global sources of oil production

Million bpd



Source: IEA, 2005

More transparent, stable and open investment climates are needed in producer and transit countries if the world's future energy needs are to be met in a way that is consistent with sustainable and healthy economic growth. Through our presidency of the G8, G7 and EU, the UK has been promoting international efforts to increase the transparency of oil market data, to improve dialogue between producers and consumers and to promote investment in alternative and cleaner energies. An example is the UK's championing of the Extractive Industries Transparency Initiative (EITI), designed to encourage the full publication of company payments and government revenues from oil, gas and mining.

29 High level Government industry oil and gas forum, chaired by the Energy Minister.

30 OPEC sets a production limit for its crude production and uses changes in the quota limit to send signals to the market regarding its production policies and in turn to influence prices.

Stability and transparency in producer countries constitute just one of the factors that influence the oil price, however. Increasing demand (especially from China and other emerging markets), tight extraction capacity and higher costs of production (partly due to increases in the costs of raw materials such as steel) have caused prices to rise considerably in recent years. Most forecasters predict prices in the range $35-45/bbl in 2010 (real 2005 prices). While this is significantly less than current prices (over $60/bbl), it is higher than foreseen at the time of the 2003 Energy White Paper when medium and long term projections were in the mid $20s per barrel.

Another factor in recent price rises has been concern over global refining capacity. Crude oil for use in the UK is processed in the UK's nine oil refineries into fuel and other products.[31] These refineries and the distribution networks which depend on them are an essential part of the supply network, especially of transport fuels, and also make essential contributions to maintaining supplies in the event of disruption, both in the UK and, through export, in the global market. Changes in the demand for oil products in the UK and globally will require major investment in the refining sector if it is to remain profitable. The extent to which this investment is made in UK refineries rather than elsewhere will depend on the competitive advantage of doing so from the point of view of the global oil companies.

Higher international oil prices, if sustained, would have two notable impacts on the UK. First, by raising the cost of oil-based products like petrol and diesel, higher prices should make it more attractive to invest in and use oil substitutes and non-conventional oil supplies. Substitution will be limited in the short term: the prospects for cars that run on bio-fuel, electricity or hydrogen are discussed in more detail in Chapter 3.2. However investment in substitutes such as these will become increasingly attractive if international oil prices remain high. Bringing forward these different transport technologies is a key R&D priority for all countries, including the UK. For the medium term at least, though, oil will continue to fuel most of our transport.

High oil prices will also impact indirectly on UK consumers through the gas price. In the UK's liberalized system, markets for gas and oil are independent, and large amounts of both are bought and sold on short-term 'spot' markets. In Europe, however, gas is bought mainly on long-term contracts that tie the price of gas to the price of oil products.[32] And as the UK relies more and more on imported gas, our exposure to European gas markets will increase.

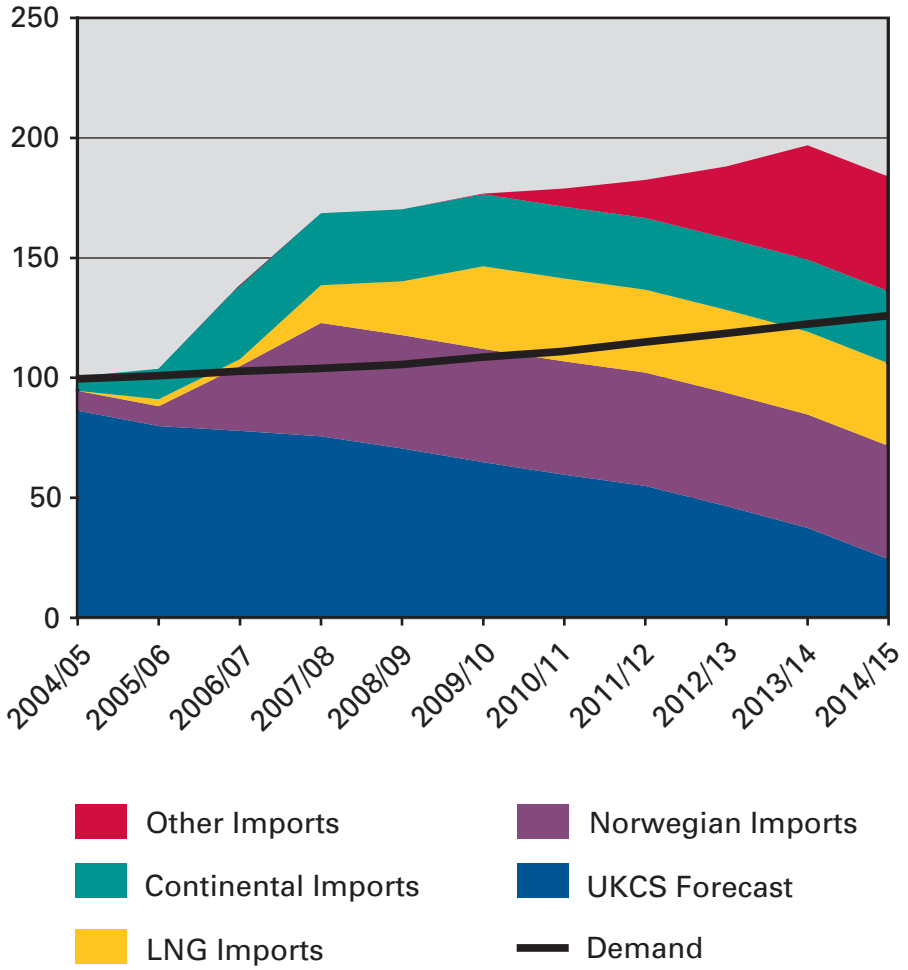
3. Reliance on imported gas

The UK is on the most recent available figures a net importer of around 7% of our gas. This percentage varies throughout the year and is higher at times of peak winter demand.[33] Gross imports, that is the amount of gas imported without balancing against UK gas exports, accounted for 12.7% of our total demand for gas in 2004.[34] Import reliance will increase over the coming years as output from the UKCS declines. Imports could be meeting up to 40% of total gas demand by 2010 and 90% by 2020.

31 Primarily products and feedstocks for the lubricant and petrochemical industries
32 See fuller discussion at pages 43-47
33 Using annualised net import figures up to October 2005, the UK is currently a net importer of 6.6% of its gas. DTI Dukes 2005
34 DTI Dukes 2005

In this context we need to ensure that our sources of supply are sufficiently diverse and reliable and that the necessary import facilities are in place.

Chart 13: UK gas supply and demand balance
Bcm per annum



Source: NGT, Ten Year Statement, 2005

Gas is currently imported into the UK in three ways. Around 70% of imports come direct from Norway. Most of the remainder arrives through the inter-connector that links the UK to Europe via Belgium. A very small amount currently comes in the form of Liquefied Natural Gas shipped into the Isle of Grain terminal and re-gasified before distribution around the UK. Gas from Norway should meet much of the UK's needs in the coming decades from 2010, though will eventually decline. The rest will come via pipeline through Europe or as LNG. New infrastructure to the value of around £10 billion is planned or under construction to accommodate increases in the amount imported via these routes.[35]

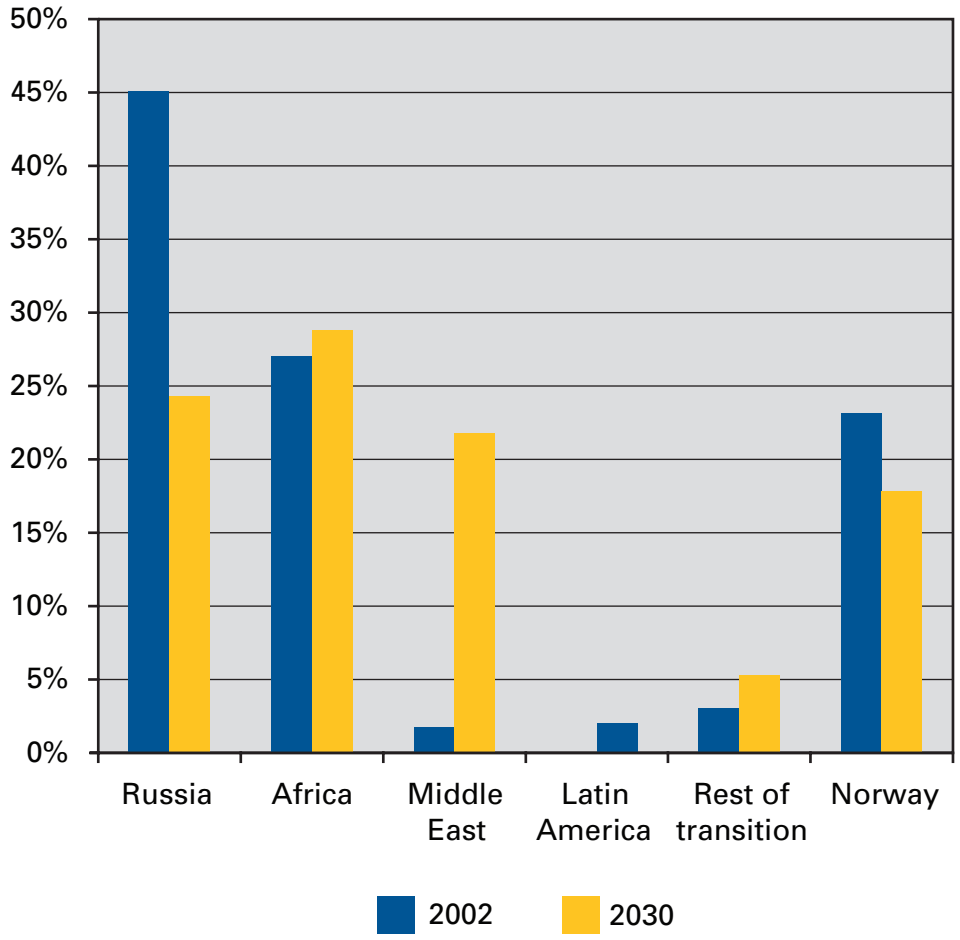
35 A new pipeline from Norway – the Langeled pipeline – is due to open in 2006 and contracts are in place to ensure supply for at least another ten years. The UK-Belgium inter-connector is being further upgraded to accommodate increased supply from other European countries and a second pipeline from the Continent – this time through the Netherlands – is also due to open in late 2006. Further LNG terminals are planned, for example at Milford Haven (two) and Canvey Island, and a project is also under consideration for Anglesey.

One of the key areas for consideration in the Review will be whether the resulting diversity of source countries and import infrastructure, combined with active diplomacy with European and source countries, will be sufficient to deliver reliable gas supplies for the UK over the medium and long term. Key factors for consideration will include:

- **Sufficiency of import infrastructure.** The government has played an important part in creating the conditions for the significant investment already planned or underway in the UK.[36] On current projections planned new infrastructure will meet our import needs for the next decade. It is crucial, however, that sufficient of the currently planned projects be followed through to completion, and that further timely investments be made when required. We need to consider whether existing commercial incentives are sufficient and whether there are any significant non–commercial barriers to infrastructure development or operation that need to be removed;
- **Sufficiency of storage facilities.** Storage can play an important strategic role as a defence against import or production shortages in periods of interrupted supply or particularly high demand. The UK's total storage capacity is considerably lower than for other major European countries, due partly to our recent history of self-sufficiency. Current storage capacity represents around 4% of UK gas demand, compared to 25% in France, 21% in Germany and 18% in Italy.[37] A number of gas storage facilities are being planned or under active development.[38] If they all went ahead, these new facilities would increase UK storage capacity to around 9% of annual UK gas demand by 2010;
- **Progress in EU gas market liberalisation.** This will be crucial to ensuring fair, transparent and competitive access to the European transit and storage infrastructure required to bring gas into the UK. In an environment of higher oil prices than we have experienced on average over the last twenty years, the creation of independent gas markets with a spectrum of short, medium and long-term contracts independent of the oil price will also be important to the UK. Recognising this, we continue to work with the EU Commission for the development of properly functioning, competitive and transparent gas markets in Europe;[39]
- **Diversity of source countries.** Most European countries rely heavily on imported gas, with the result that the ultimate source of gas imported into the UK via the inter-connectors will include Russia, Africa and the Middle East (see chart). Major suppliers of LNG will include countries in the Middle East, North Africa and West Africa.

36 Notably through agreement on new Treaties with Norway and the Netherlands and in providing a conducive regulatory environment
37 IEA 2004
38 For example, Aldbrough and Byley storage facilities are under construction and are expected to be operational by 2008/9 at the latest.
39 EU markets issues are discussed in more length at page 43-47

Chart 14: Current and predicted suppliers of imported EU gas, 2002 and 2030
Share of imports



Source: IEA, 2005

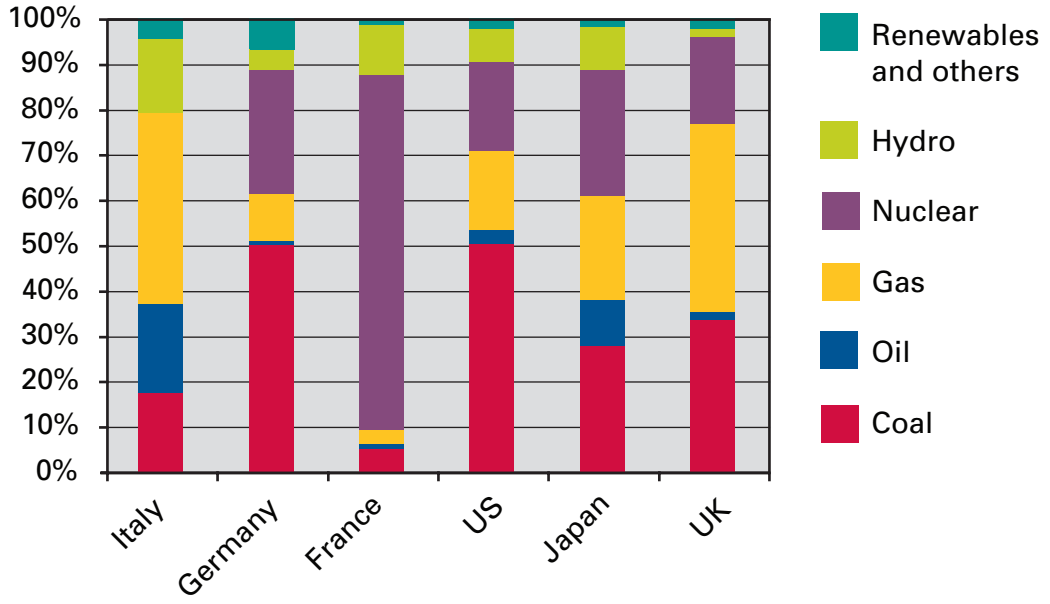
- **Reliability of source countries.** Source countries generally have a strong record in supplying gas to Europe; supply from Russia for example was uninterrupted throughout the Cold War. This reflects to some extent the mutual importance of the supply relationship. Large exporter countries are generally heavily dependent on their export receipts: income from oil and gas, for example, accounts for around 40% of Algeria's GDP. The UK government continues to be in active dialogue with exporting countries both bilaterally and within the framework of EU dialogues. The importance of the EU-Russia Dialogue was emphasised by the temporary suspension of Russian gas supply to the Ukraine on 1 January 2006, when the pressure exerted by the European Union helped to bring a quick resolution to the dispute.

4. The electricity generation mix

The Energy White Paper made clear that it is not the role of government to decide the fuel mix for generating electricity. Our policy is for the market to make these decisions within the right regulatory framework. But the White Paper also said that diverse sources, fuel types and trading routes should be promoted to avoid the UK being too reliant on too few international sources of oil and gas.

The UK currently enjoys considerable diversity in the type of fuel used for generating electricity, with a mix of gas, coal, nuclear and renewables. However in the last ten years most new build has been in gas-fired generation, reflecting its relative cost advantage. Other major economies also have fairly diverse patterns of electricity generation, except for France which relies heavily on nuclear power, (Chart 15).

Chart 15: Electricity generation in major IEA countries
Share of generation by fuel 2004



Source: IEA, 2005

Much of our nuclear and coal generating capacity faces closure over the next two decades. In the case of coal-fired generating plant, this is in part because of the implementation of the Large Combustion Plants Directive aimed at reducing emissions in the EU of substances such as sulphur dioxide. In many cases the plant concerned is already reaching the end of its working life. Coal currently meets around 32% of the UK's electricity requirements. According to current projections, this could shrink to perhaps around 15% to 20% over the next 10-15 years.

The share of nuclear in generation might fall from its current level of around 19% to 7% by 2020. Plant refurbishment projects and the scope for potential lifetime extensions could serve to extend the period over which closures of nuclear plants take place. However, if there were no further extensions beyond the one already announced for Dungeness B, the profile of nuclear plant closures would be as follows:

Table 1: Closures of nuclear plants by date

	Capacity MW	Published Lifetime
Sizewell A	420	2006
Dungeness A	450	2006
Oldbury	434	2008
Dungeness B	1110	2018
Wylfa	980	2010
Hinkley Point B	1220	2011
Hunterston B	1190	2011
Hartlepool	1210	2014
Heysham 1	1150	2014
Heysham 2	1250	2023
Torness	1250	2023
Sizewell B	1188	2035

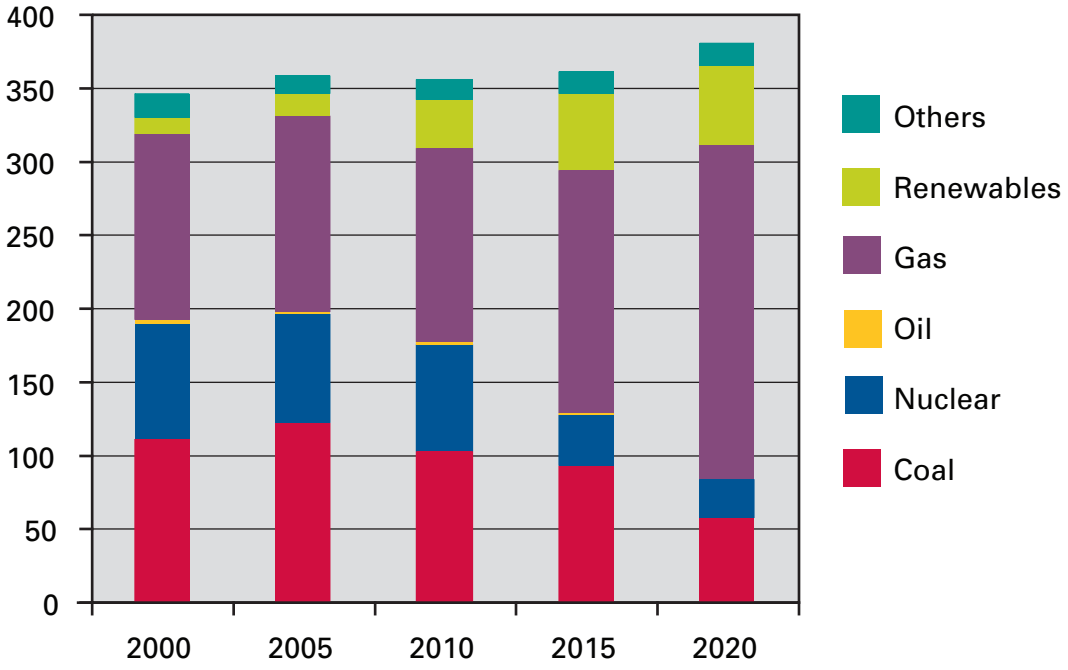
20GW or more of generation capacity may be required to replace retiring coal and nuclear plant (up to about 30% of current electricity demand). The exact amount of new investment required will depend in part on trends in electricity demand. It will also depend on the mix of generating capacity that evolves over time. The plant margin, the level of electricity generation capacity above estimated peak demand, has historically been at or above 20%, The level required in future will vary depending on how much back-up is required for the different technologies in the generating mix and on how much of the available capacity is capable of being flexible in response to changing demand. Decisions on the timing, type and level of investment are for market participants.

Projecting the make-up of our generating capacity fifteen or twenty years forward is inevitably difficult. A range of outcomes is possible. Decisions on new capacity will be made by the companies concerned based on a number of considerations, including expectations about relative costs (such as carbon and fossil fuel prices) and the regulatory environment. However, in the absence of new nuclear build or extensions to existing nuclear plant, the fuel mix for electricity generation by 2020 might be as shown in Chart 16[40].

This scenario projects a large increase in gas and renewables, as coal and nuclear decline. (The renewables share increases to around 15%, broadly in line with the level of the Renewables Obligation for 2015/16 of 15.4%). But another scenario is that the decline in coal's share of total capacity will be smaller, whether as a result of new coal plant being built or existing plant being kept on longer; the shares of gas and renewables would then be correspondingly less.

40 The data represents gross supply by MPPs, plus other renewable supply. Generation from other sources is excluded from this chart.

Chart 16: Electricity generation fuel mix
TeraWatt hour



Source: DTI, 2005

A major objective of this consultation is to ask what further steps, if any, the government should take to develop the market framework for delivering reliable energy supplies. With the UK becoming a net importer of gas and with the prospect of large investments to be made over the next twenty years in generating capacity, a key consideration in assessing potential new measures will be their impact on electricity generation. Decisions on generation could in turn have implications for the transmission and distribution networks.

5. Reliability of transmission and distribution grids

The UK has one of the most reliable electricity systems in Europe,[41] with only 0.8 interruptions per customer in 2003, compared to Italy's 3.5 and France's 4.7. UK grid performance has improved since the introduction of an incentive scheme in 2002. An important element of the Review will be to evaluate how far electricity and gas grids might contribute to, or act as a constraint on, reaching our broader energy goals. The UK's enviable record of reliability will need to be protected while addressing two sets of challenges.

a. Investing in the necessary replacement of the ageing network infrastructure

National Grid forecasts that replacement capital expenditure for gas transmission networks will be £458m for the period 2007/8-11/12. This is an increase of around 165% on the allowance in the previous price control period.

41 In 2004/05 on average in Great Britain there were 0.78 interruptions longer than three minutes per customer with customers without power for an average of 94 minutes in the year. In addition there were 103 short interruptions per 100 customers (Ofgem 2004/5

There are four electricity transmission systems in the UK covering over 25 000km[42] with an estimated asset value of £6 bn. These high-voltage systems are integrated, but only limited amounts of electricity can be moved between them. The electricity distribution networks are much larger at 810 000km and have an estimated asset value of £13bn.[43] The national gas transmission system consists of 6 400km of high-pressure pipelines. These feed over 250 000km of distribution pipelines at lower pressures across eight networks.

The regulator, Ofgem[44], sets price controls for Great Britain which limit the amounts network operators can charge customers and include incentives for improving performance. Price controls are based on assessments of the operating costs and investments that network operators require in order to meet obligations and targets, including the costs of connecting new network users and delivering reliable supplies. The costs of transmission and distribution currently add 3% and 20% respectively to electricity bills. Additional obligations that require increased capital investment in the networks – for higher than usual maintenance or to upgrade or extend them – will feed through to customers' bills.

The renewal requirement in electricity will also grow as assets in poorer condition (often, but not always, older assets). Most plant was built during the 1960s and 1970s with lifetimes between 40 to 50 years. The transmission companies in Great Britain have forecast that expenditure could be almost £3 bn for the period 2007-12, representing an increase of more than 200 per cent over the allowances provided for 2005 to 2011. Total capital investment in the electricity transmission system will be £1.88bn over the period 2000-2006/07. Ofgem estimates the capital investment requirement of the distribution grid at £5.7bn for the period 2005-10. This represents a 48% increase over the previous control period.

42 One for England and Wales owned by National Grid; two in Scotland, in the south owned by Scottish Power, in the north by Scottish and Southern Energy; and one in Northern Ireland by Northern Ireland Electricity
43 Ofgem, excludes Northern Ireland
44 The Office for regulation of electricity and gas (Ofreg) is the regulator for Northern Ireland

b. Upgrading and extending capacity for new gas import facilities and accommodating a wave of new and varied electricity generating capacity.

As well as being renewed and maintained, networks need to be upgraded to meet the changing needs of users. The gas transmission system will require investment to link new import infrastructure to the grid. Implications for the electricity transmission system will differ according to the decisions made about generation. Replacing nuclear power stations even on current sites would likely require upgrades to accommodate higher generation capacities. Increases in large and geographically remote power generation plant, such as offshore wind, will require new connection to the grid. This is a lengthy and costly procedure, and the current planning and consents regime can add substantially to the time taken to complete investments and add to their cost.

Adding intermittent generation from renewables to the national electricity grid will increase the complexity of balancing supply with demand as the proportion of intermittent sources grows. Other challenges will come from the loading on major grid lines, particularly those from Scotland to England and from the midlands to the south, which have potential to become bottlenecks if investment is delayed (for example, due to the time taken to secure planning consents).

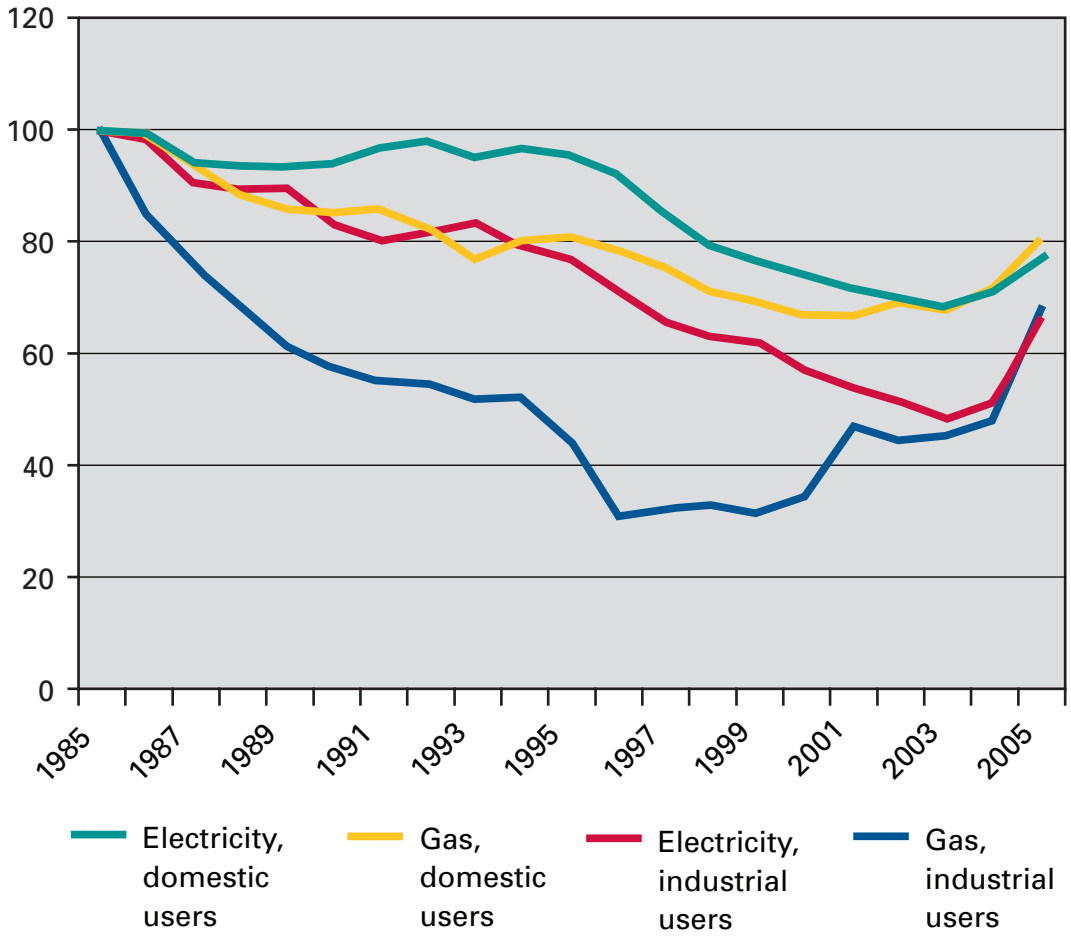
2.2.3 Competitive markets delivering affordable energy

Liberalisation of the UK energy sector has increased transparency of costs at each stage in the energy supply chain, eradicated the monopoly profits of the old State-run companies and rewarded those companies best able to serve their customers. Recent EU-wide evidence suggests a clear causal link between liberalisation, increased diversity, higher productivity and lower energy prices.[45] The UK has the most competitive gas and electricity markets in the EU and G7, according to a recent independent study.[46] Consumers in the UK benefit from a range of products and customer services not known 15 years ago, including the ability to switch suppliers.

One important impact of market arrangements has been on price. Since energy market liberalisation, prices in the UK have decreased substantially. Despite recent increases, the gas and electricity prices paid by UK consumers are still lower than they were in 1985, in real terms (see Chart 17).

45 Source: The Case for Liberalisation, Ernst & Young, 2006 (publication forthcoming)
46 Source: Energy Market Competition in the EU and G7, OXERA 2005

Chart 17: Historical gas and electricity prices in the UK
Index of real prices, 100=1985 (2005 is an estimate)

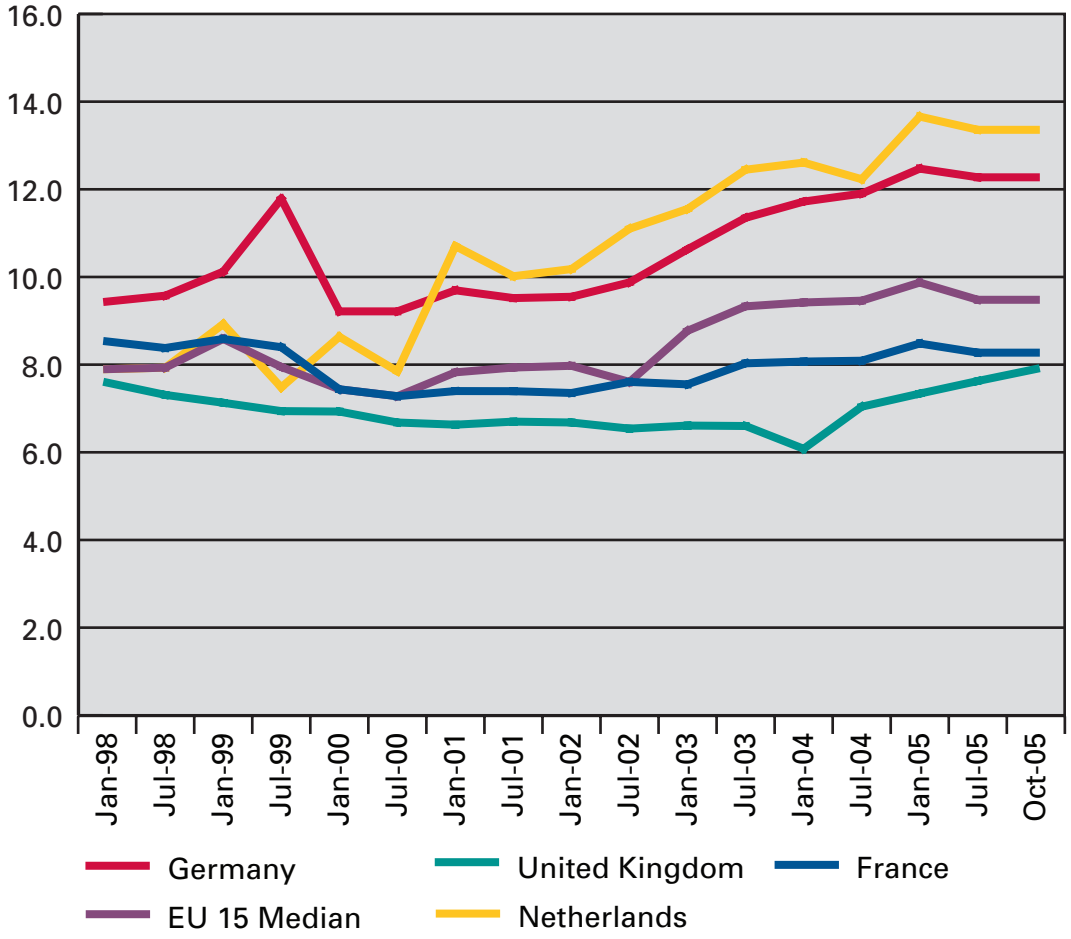


Source: DTI Energy Statistics 2005

UK gas and electricity prices for households (including taxes) have been consistently lower since 1998 than in other major European countries, and in October 2005 remained below the EU15 average.[47] (see Chart 18)

47 For details on comparative domestic gas prices, see DTI Quarterly Energy Prices (December 2005)

Chart 18: Average European domestic electricity prices
P/kWh, 1998-2005 average

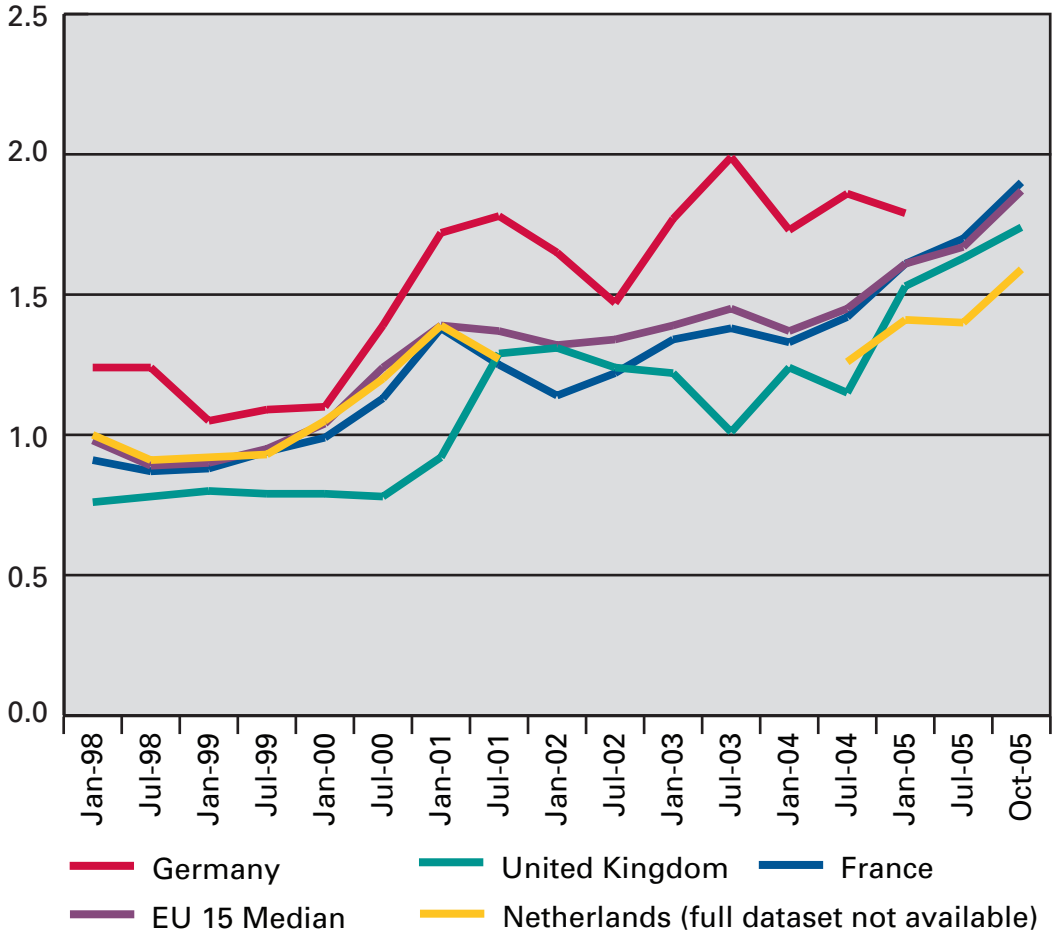


Source: DTI Quarterly Energy Prices December 2005

Electricity prices for industrial end-users have been around the EU average in the same period,[48] while industrial gas prices have been consistently lower:

48 For details on comparative industrial electricity prices see DTI Quarterly Energy Prices (December 2005)

Chart 19: European industrial gas prices for medium-sized customers
P/kWh, 1998-2005, average



Source: DTI Quarterly Energy Prices December 2005

However, wholesale prices in the UK have been rising since 2002 in both gas and electricity, and in 2005 they were for the first time materially above prices in Germany. At the end of 2005, forward gas prices for calendar year 2006 were 31% higher in the UK than on the Continent, though forward prices for years further out show increasing convergence. These recent increases, and the need to take into account the impact on prices of government interventions, are an important part of the context of the Review.

One factor in recent price rises, alongside higher global fossil fuel prices and tightness in the UK gas market, has been our interaction with Europe.[49] Recent reports from the European Commission[50] into European energy markets identified 'serious malfunctions' and called on Member States to 'quickly and fully implement the gas and electricity directives not only in letter but also in spirit'. Gas and electricity markets in many European countries remain heavily influenced by dominant incumbent companies, and there are significant barriers to entry by new players. Long-term gas import contracts, which tie the price of gas to the global price of oil products, remain the rule.

49 The introduction early in 2005 of the EU Emissions Trading Scheme probably also had an upward impact on prices
50 Commission of the European Communities, Report on progress in creating the internal gas and electricity market (2005) and European Commission, Energy sector inquiry: issues paper (2005)

Lack of liberalisation in Europe also has implications for the UK's reliability of supply. The traded gas market remains small and it is not easy for willing gas traders to get access to the pipelines and storage facilities needed to deliver gas to the UK. The prevalence of oil price-indexed long term contracts means that market participants in European countries do not always react to price signals as they would with market-based pricing. These are contributing factors in the failure of gas to flow in greater volumes to the UK this winter despite very high spot prices here compared to those on the Continent.

It will remain a priority for us to continue to encourage our European partners to take the action required to achieve well functioning EU energy markets. Good progress was made during our recent Presidency of the EU. A thorough debate at the Energy Council enabled the Presidency to conclude that full implementation of the existing directives is required. It was also concluded that further action is needed in a number of areas, including: non-discriminatory access to networks; incentives for investment in cross-border infrastructure; development of coordinated regional markets; and full cooperation between regulators.

Energy policy was discussed as a key issue at the Hampton Court informal Heads of Government meeting in October, where Heads agreed to consider how the EU can work together on a European Energy policy. The UK will input into the Commission's forthcoming Green Paper to be developed during 2006. Ofgem has also taken a leading role in Europe.[51]

2.2.4 Reducing fuel poverty

The Government's overall target set out in *The UK Fuel Poverty Strategy* and reiterated in the 2003 Energy White Paper is to seek an end to the problem of fuel poverty. In particular, it aims to end fuel poverty in vulnerable households in England and Northern Ireland by 2010. A vulnerable household is deemed to be one containing children or the elderly, or someone who is sick or disabled. The overall aim is to ensure, as far as reasonably practicable, that, by 2018, no household in the UK should live in fuel poverty.

Substantial progress has already been made. The number of households in fuel poverty in the UK has fallen from around 6.5 million in 1996 to around 2 million in 2003 (the latest year for which figures are available). The number of vulnerable households in fuel poverty in England has fallen from 5.1 million in 1996 to around 1.0 million in 2003.

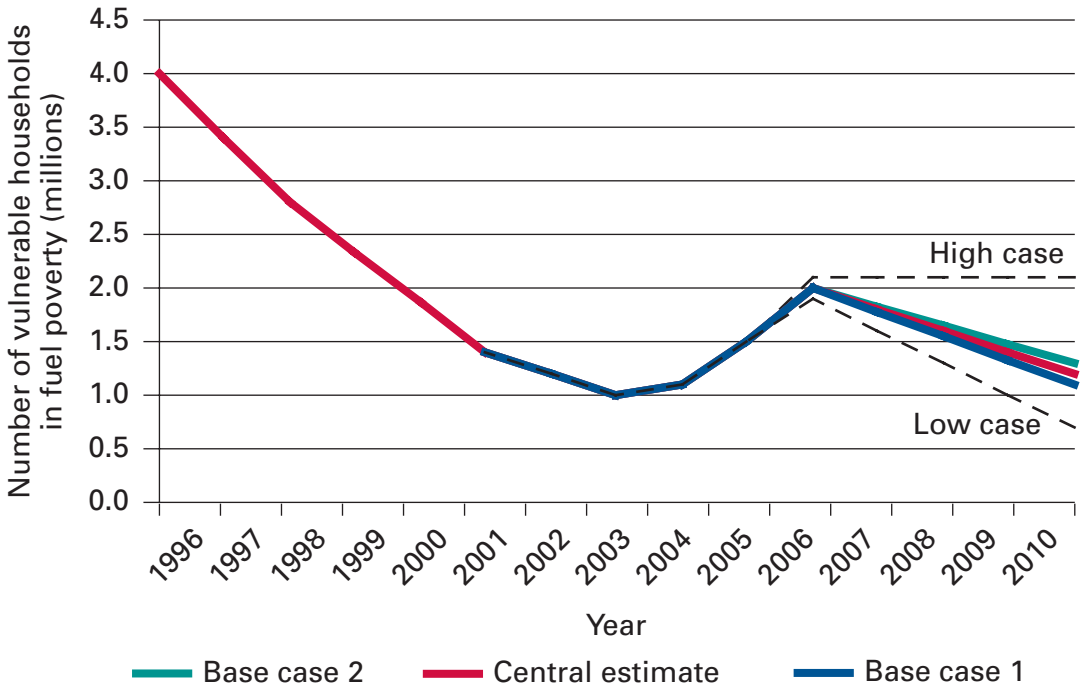
These falls will have been due to a number of factors, including more competitive energy prices in the early stages (and a greater degree of choice in energy supplier); improvements in incomes, and improvements in household energy efficiency. The greatest influence, however, accounting for around 60 per cent of the reduction, has been improvement in income, especially among vulnerable groups. Measures such as the Pension Credit, Winter Fuel Payments and the Child Tax Credit have helped to raise the net incomes of vulnerable and low-income households. Winter Fuel Payments alone took 100,000 households out of fuel poverty in 2003.

51 Ofgem's Chairman, Sir John Mogg, is the President of the Council of European regulators (CEER) and the Chairman of the European regulators Group for Electricity and Gas (ERGEG) which advises the European Commission on regulatory matters. Recent regulatory developments pursued through CEER and ERGEG have included the publication of guidelines on the operation of gas storage facilities and a report on compliance with those guidelines, proposals on gas balancing, and advice to the Commission on electricity congestion management.

Analysis of the overall effects of changes in fuel prices and incomes, excluding consideration of energy efficiency improvements, suggests that the total number of vulnerable households in fuel poverty is likely to rise substantially in the short-term, before falling back towards 2010, as energy prices stabilise and incomes continue to grow. Chart 20 below shows the impact of energy prices and income changes on levels of fuel poverty in vulnerable households in England to 2010. (It does not include the impact of improved energy efficiency of dwellings, achieved through schemes such as Warm Front and the Energy Efficiency Commitment.)

To meet our fuel poverty targets, 1.1 million households will need to be removed from fuel poverty through a policy intervention by 2010. This is because the central estimate of energy price and income movements under the base case scenarios suggest that around 1.2 million vulnerable households will still be in fuel poverty in 2010. Assuming that around 10 per cent of those households will refuse assistance,[52] the lowest level of fuel poverty achievable is 100,000 households.

Chart 20: Number of vulnerable households in fuel poverty in England after economic effects
Millions



Source: DTI 2005

52 This is similar to the assumption made in 'Fuel Poverty in England: The Government's Plan for Action' (2004)

As prices rise, the focus will increasingly be on energy efficiency and income improvements. In England, the Warm Front Scheme has already helped over one million vulnerable households with the provision of a range of insulation and heating measures since its inception in 2000. Recent enhancements to the Scheme, launched in June last year, are designed to improve its impact on fuel poverty in a sustainable way. In Scotland, the Central Heating Programme has to date installed central heating systems in over 60,000 homes and Warm Deal has insulated over 200,000 homes (nearly 10 per cent of Scotland's housing stock).[53] The Welsh Assembly run the Home Energy Efficiency Scheme (HEES) which met the Fuel Poverty Commitment for Wales' target of assisting 38,000 households in Wales by March 2004. The Warm Homes Scheme is run in Northern Ireland, which is on track to meet its target of assisting at least 40,000 households in fuel poverty by 2006.

53 These two programmes are run by the Scottish Executive

3 Looking Ahead

In this Chapter we summarise the risks to achieving our energy policy in the medium and long term that flow from some of the trends and developments identified in Chapter 2. We then discuss what policies, initiatives or further developments might improve the prospects for us meeting those goals.

3.1 IMPLICATIONS OF THE CONTINUATION OF CURRENT TRENDS

Trends and developments identified in Chapter 2 include:

- Although we expect to meet our Kyoto targets to reduce greenhouse gas emissions as a whole, CO2 emissions have been rising in recent years. By 2020 (without taking account of any measures decided in the current Climate Change Programme Review) emissions are projected to be only slightly down on current levels;
- We will become more reliant on gas to meet our heating and electricity generation needs, and will continue to rely on oil for transport, despite likely gradual uptake of bio-fuels;
- By 2020 we are likely to be importing around three quarters of our primary energy, against the background that much of the world's proven oil and gas reserves are concentrated in Russia and the countries of the Former Soviet Union and in the Middle East and North Africa;
- Maintaining the reliability of electricity supplies will require very substantial levels of new investment as existing coal and nuclear capacity is retired and ageing distribution networks maintained and renewed;
- Increased energy efficiency is a central public policy goal, but the pace of efficiency improvements has been slower than needed;
- Higher global energy prices present macroeconomic risks, even though the impact of these relative to previous periods of high prices is mitigated by our more stable macroeconomic framework and lower energy intensity. Although these prices will incentivise reduced and more efficient consumption, policies designed to reduce emissions may prove unpopular if they add further to prices that are already high.

These trends are the background against which our energy companies will make important decisions in the coming years about investments to replace retiring coal and nuclear plant.

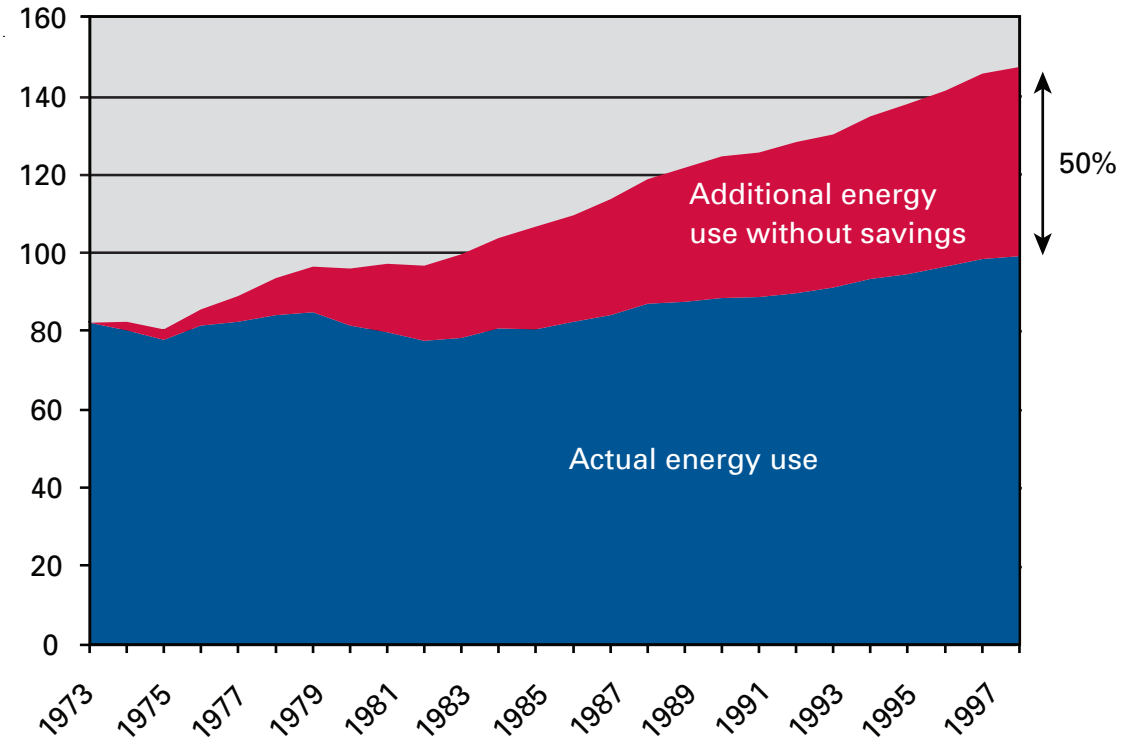
3.2 CONSTRAINTS AND OPPORTUNITIES

3.2.1 Energy Saving

One of our options for better meeting our energy policy goals lies in encouraging the use of less energy, both in total and at times of peak demand. By using less energy, we serve many of our goals simultaneously – in particular, emissions are reduced and users of energy have lower bills.

We have seen in Chapter 2.2 the enormous improvements in energy intensity achieved in the UK over the last thirty or so years. The same is true at a global level. International Energy Agency (IEA) data suggests that, without energy savings achieved since 1973, energy demand across eleven IEA countries would have been 50% higher in 1998.

Chart 21: Energy Demand and Saving
Exajoules



Source: IEA (2004), Oil Crises and Climate Change Challenges: 30 years of energy use in IEA countries

This improvement in energy intensity in developed economies has been driven in part by the shift away from manufacturing towards services sectors and by the increased use of gas to replace coal and oil in electricity generation. It is also partly due to improvements in the efficiency of businesses, buildings, appliances and cars. For example some new homes require only half as much heating fuel as the average stock and new fridges use less than 50% as much electricity as a typical 10-year old model. A key attraction of investing in energy efficiency alternatives such as fuel-efficient cars, modern boilers or home insulation is that many of them pay for themselves over time through lower energy bills.

Absolute demand for energy however continues to rise despite these increases in efficiency. This is partly due to changing social trends, such as increased levels of house building and people living on their own. It is also because greater wealth is leading to greater consumption of energy intensive consumer goods and services, such as digital set top boxes, plasma TVs and mobile phones.

The 2003 White Paper made energy efficiency a central plank of our energy policy and said that different instruments would be designed to reinforce each other in pursuing this goal. These included emissions trading; the Energy Efficiency Commitment (EEC); tax incentives; and a greater emphasis on energy services, building and product regulations and advice and information. The recent work of the Energy Efficiency Innovation Review (EEIR) suggests the opportunity represented by energy efficiency remains very significant. The issue for the Review is to identify how we can encourage more household and businesses to take up those opportunities. In particular the Review will look at tackling the barriers to uptake of energy efficiency measures that were described in Chapter 2.2, including lack of awareness of the cost savings to be made from greater energy efficiency.

3.2.2 Mobility and transport

Vehicle efficiency has improved greatly in the UK and in Europe over the last ten years. The recent surge in diesel cars[54] has also done much to contain emissions growth, as diesel vehicles emit on average 10-15% less carbon than their petrol equivalents.

A number of other fuels have the potential to make far greater cuts in transport emissions. The greatest long-term potential lies in:

- **Bio-fuels.** Moving from oil to bio-fuels can cut fossil carbon emissions, help protect air quality and increase diversity and the reliability of supply. In the short to medium term, however, bio-fuels are likely to cost more before tax than petrol and diesel. And their mass production would require a massive increase in energy crops, which may have an environmental downside;
- **Hydrogen.** The potential for carbon savings from hydrogen is immense, because hydrogen vehicles do not emit carbon locally; in the long term, hydrogen could reduce transport emissions to near zero. But hydrogen does not exist naturally in the forms

54 32% of new cars bought in the UK in 2004 ran on diesel, compared to 16% in 1997. Source: Society of Motor Manufacturers and Traders Ltd (2005)

needed for commercial use and more energy is consumed in making it than is released when it is used. Unless there is a great increase in the amount of carbon-free energy available to produce hydrogen in the UK, its main benefits will be to reduce demand for oil rather than to reduce carbon emissions. Much work also needs to be done on fuel cell technology, hydrogen storage technology and hydrogen distribution before hydrogen cars can compete with conventional vehicles on performance, cost and convenience. The Department for Transport is looking at what steps would need to be taken to develop a hydrogen transport economy;

- **Hybrid and Electric Cars.** Electric cars have been widely available for some time, but their popularity has been limited, largely because of a relative lack of performance and the fact that the batteries need to be re-charged frequently. Hybrid cars, which use energy more efficiently than conventional cars because they rely on batteries running the car at peak efficiency and reabsorbing the energy produced when braking, have recently enjoyed very promising sales. In the long run, they save consumers money, but it can take around 7 years for an average motorist to recoup the extra cost in fuel savings.

Government intervention can play a part in encouraging the take up of such fuels. At a national level, the duty on oil-based fuels and the Renewable Transport Fuel Obligation both have this effect. At a local level, initiatives such as the exemption of electric and hybrid cars from the London congestion charge also send a clear signal to motorists.

The Review will look at whether there are further cost-effective steps which might be taken to develop the long term potential of low carbon fuels for transport.

3.2.3 Heat

Heat accounts for over a third of primary energy consumption in the UK. Most of it is generated from gas, though some use is made of oil and coal, and slightly less than 1% comes from renewable sources.[55] Electricity currently provides small amounts of space heating, but is a much less efficient option for this purpose than gas.

The longer-term low-carbon options for mass generation of heat are relatively limited. A recent report concluded that biomass could potentially provide up to 7% of our heating needs by 2015.[56] Because most biomass for heating would likely need to be transported by road, however, its greatest potential lies in residences and businesses located near to a supply source.

For a large-scale shift away from gas, the long-term possibilities appear to be hydrogen and electricity, but widespread adoption of either is well into the future. We would need far greater amounts of hydrogen or electricity than we currently produce, and these would need to be manufactured or generated by low-carbon technologies in order to meet our carbon goals. The uptake of hydrogen as a heating source will also require costly new infrastructure, in this case a hydrogen distribution system to buildings. Finally, it is likely that the most cost-effective use of hydrogen in the initial stages of its development will be for transport rather than for heat.

55 Biomass Task Force report to government, (October 2005)
56 Biomass Task Force report

In the meantime, the best opportunities for reducing the UK's reliance on gas for heating would seem to rest in energy efficiency. The opportunity for demand-side measures such as insulation was highlighted earlier. On the supply side, there is some potential in the more efficient use of heat generated by power stations or other large plant. Thermal generating plant loses, in the form of heat, 60% or more of the primary energy typically generated. Combined Heat and Power (CHP) plants collect this heat and use it in place of gas or other heating in nearby buildings or industrial processes. Large-scale CHP investments have the potential to save around 3 MtC by 2020.[57] But progress has been slower than expected and the cost of CHP remains relatively high. In the long term, the significant potential of CHP will probably be limited ultimately by the difficulty of transporting heat: its potential is limited to customers geographically close to the heat source.

Small scale and micro-CHP have the potential to make a significant contribution to our energy goals. If we moved towards more distributed generation of electricity,[58] one of the advantages would be that heat generated by a micro-generation facility in a building could be captured and used, for no extra cost, to provide heat. For example, a mini-CHP plant might replace a boiler in the home, generating small amounts of electricity as well as heat.

The Review will look at the potential of micro-CHP and micro-heat technologies such as solar thermal, ground source heat pumps and biomass heating. It will ask whether there are further cost-effective measures that could be taken to encourage more efficient use of heat or encourage development of the longer-term low carbon options for generating it.

3.2.4 Electricity generation

Approximately 30% of the UK's existing capacity is scheduled to retire over the next twenty years. Given the long life-times of new plant – around forty years for nuclear and for conventional fossil fuel plants[59] – large-scale investment decisions made in the near term will have an impact on our energy system for decades to come.

Decisions to invest in new generating capacity are complex and affected by a range of factors. In addition to long lifetimes, for example, new generating assets are typically capital intensive and can take a number of years to complete. As a result, investors are looking for clarity and consistency in the regulatory framework within which those decisions are made. Some of this framework, for example the Renewables Obligation, is the responsibility of the UK government. Other parts of the regulatory framework, such as the EU Emissions Trading Scheme (EU ETS), are the responsibility of the EU. Investors will be concerned about arrangements after Phase II ends in 2012: the European Commission is carrying out a review of the scheme with a view to reporting by 30 June 2006.

57 PIU Report (2001)
58 See Annex A, heading 3
59 The PIU Report made the following estimates of life-times, which can vary substantially by installation: wind power stations 20 years; combined cycle power stations 30; conventional fossil fuel stations 40; nuclear power stations 40; hydro-electric power stations 100

It was explained in Chapter 2 that, on one scenario, based on current costs estimates (see summary of estimates at Annex B), the investment decisions made by generating companies would tend to replace retiring nuclear and coal plant with renewables and gas.[60] The renewables share is assumed to rise in line with the aspiration in the Energy White Paper to around 20%, compared with around 4% today. The share of gas would rise to around 60% of capacity from approximately 40% today. Under other scenarios, for example sustained high gas prices, some of the lost capacity would be replaced by new coal plant instead of gas.

The Review will assess the implications of such scenarios. In particular, it will look at implications for emissions, reliability of supplies and networks.

Emissions

Replacement of retiring coal and nuclear plant will have a potentially significant impact on emissions. The replacement of coal by gas or renewables would be benign in terms of emissions, as would replacement by renewables alone if this proved economically and technically feasible. Replacement of nuclear by coal or gas would put upward pressure on emissions. The Review will look at various scenarios for the future UK generating mix that might emerge from the investment decisions made by energy companies, and the potential impact of those decisions on the level of carbon emissions in the UK.

Reliability of supplies

If gas were to have a 60% share of generation by 2020, this would increase gas demand for electricity by 50% compared with today. With the decline in North Sea production, this extra amount would need to be imported. Taking account of all our gas needs, including heat, by 2020 we would be importing 80% or more of our gas.

Many other advanced industrial economies already import significant proportions of their energy needs, and many producers have a strong interest in providing reliable supplies. But with heightened concerns about energy security, and in line with the Energy White Paper's commitment to monitor carefully the UK's increased import dependence, the Review will consider whether we are doing enough to manage the potential risks in this new situation. It will review the prospective diversity of our sources of supply and the outlook for import infrastructure and storage. It will also review progress in the achievement of market liberalisation across the EU and its implications for the UK; and take into account discussions on development of a European energy policy.

Networks

The Review will look at how different patterns of generating capacity would affect our transmission and distribution networks over the medium and long term. The integrity of the grid depends on predictable base-load generation of the type offered by large coal, gas, hydro, biomass and nuclear plants. The grid also requires substantial amounts of electricity from sources such as coal and hydro (but unlike nuclear and some gas turbines) that can be economically powered on and off to match fluctuations in demand. In the absence of

60 See chart 16, and accompanying text

significant breakthroughs in the electricity storage technologies, grid constraints and intermittency set the upper bound for wind, wave and tidal power in the generation mix. The need for flexibility does the same for nuclear.

Decisions on new capacity are a matter for the generating companies, within the market framework established by government. The Review will consider, in the light of its assessment of the implications of different scenarios for our emissions and supply goals, whether there is a case for any changes to that framework.

Many of the potential sources of low carbon electricity generation remain the subject of technological uncertainty or face other barriers. Renewable and micro-generation technologies continue to offer great promise, but remain expensive compared to fossil fuels. Carbon capture and storage, if viable, would deliver carbon reductions from fossil fuel plant here and globally, and could allow the UK to make use of the world's ample coal reserves. Technical uncertainties surrounding carbon storage need to be addressed, and a regulatory regime for CO2 storage introduced. The 2003 Energy White Paper recognised that nuclear is an important source of carbon-free electricity and did not rule out the possibility that at some point in the future new nuclear build might be necessary if we are to meet our carbon targets. But the economics at that point made it unattractive and there were also important issues of nuclear waste to resolve.

Annex A contains information about these low carbon technologies, including the particular issues that arise in the context of possible nuclear new build. Annex B provides a summary, prepared last year by DTI in consultation with Defra, of the various estimates that have been made of the cost of different generating technologies.

3.2.5 Reducing fuel poverty

Chapter 2 explained that, on central projections for energy prices and incomes, around one million vulnerable households in England would remain in fuel poverty in 2010 after energy price and income effects. This is still a massive reduction on the 1996 figure of around 5 million. Existing Government energy efficiency programmes will reduce this number further, but fuel poverty is a complex mixture of circumstances relating to housing conditions, incomes and energy prices. The Review will consider whether there are any further steps that the government, working with the energy supply industry and other stakeholders, could take to accelerate our progress towards meeting our 2010 targets and the UK goal of eradicating fuel poverty by 2016-18.

3.2.6 The international dimension

Many of the constraints and pressures facing the United Kingdom's energy policy are shared by other nations. Crucially climate change is a global problem that will only be solved by a global approach. This international dimension creates both issues and opportunities.

For instance, the UK emits just 2% of global carbon emissions. The ultimate goal of addressing global warming will only be met by a co-ordinated international effort that includes the nations responsible for the other 98%. To achieve that international effort, there will be times where it is appropriate for the UK to show leadership in order to galvanize international action; making domestic progress on carbon reduction is important to our international credibility. But our own actions will have no impact on climate change unless they are part of a wider intermediate effort.

The Stern Review[61] will increase our understanding of the size and nature of the costs to society of climate change and to consumers and participants of the instruments available to prevent it. The economic modelling carried out for the Energy White Paper suggested that the cost impact of effectively tackling climate change would be very small, on a number of assumptions including that the world's leading industrial nations act together.

One of the questions for the Energy Review is whether there is more we could do by way of joint international action to share this cost. Could we for example share our own technologies; join with other countries on R&D efforts or reliability of supply measures; or find joint ways of incentivising investment in energy efficiency or low carbon generating technologies?

SUMMARY OF QUESTIONS

This consultation invites comments on the full range of issues it identifies, taking into account all the circumstances surrounding UK energy policy. These circumstances include the need to avoid damaging our competitiveness and prosperity and to take into account the impact of any proposals in terms of costs and contingent liabilities for government.

The key issues on which it may be useful to focus can be summarised as follows:

Q.1. What more could the government do on the demand or supply side for energy to ensure that the UK's long-term goal of reducing carbon emissions is met?

Q.2. With the UK becoming a net energy importer and with big investments to be made over the next twenty years in generating capacity and networks, what further steps, if any, should the government take to develop our market framework for delivering reliable energy supplies? In particular, we invite views on the implications of increased dependence on gas imports.

Q.3. The Energy White Paper left open the option of nuclear new build. Are there particular considerations that should apply to nuclear as the government re-examines the issues bearing on new build, including long-term liabilities and waste management? If so, what are these, and how should the government address them?

61 The Stern Review is described in Chapter 1

Q.4. Are there particular considerations that should apply to carbon abatement and other low-carbon technologies?

Q.5 What further steps should be taken towards meeting the government's goals for ensuring that every home is adequately and affordably heated?

Comments are also invited on the following issues, as described in the text:

i. The long term potential of energy efficiency measures in the transport, residential, business and public sectors, and how best to achieve that potential;

ii. Implications in the medium and long term for the transmission and distribution networks of significant new build in gas and electricity generation infrastructure;

iii. Opportunities for more joint working with other countries on our energy policy goals;

iv. Potential measures to help bring forward technologies to replace fossil fuels in transport and heat generation in the medium and long term.

Annex A: Overview of Generating Technologies

Many technologies are capable now or potentially in the future of generating significant amounts of electricity. A wide range of information on specific technologies has been published or commissioned by the UK government in recent years. An overview of all the different options was provided in the Performance and Innovation Unit's 2001 Energy Review. More recent and detailed papers that impact on electricity generation technologies include:

- The Carbon Abatement Technology Strategy for Fossil Fuels (DTI, 2005) – includes discussion of carbon capture and storage
- Renewables Innovation Review (DTI, 2004)
- Wind Power in the UK (Sustainable Development Commission, revised 2005)
- Biomass Task Force Report (October 2005)
- Potential for micro-generation: study and analysis (Energy Saving Trust, December 2005))
- Strategy for Combined Heat and Power (Defra, 2004)

Other major government publications with material on energy technologies include the Energy Efficiency Innovation Review (Defra/HMT, 2005) and the DfT report, Liquid Bio-fuels and Renewable Hydrogen to 2050 (2004).

The following pages provide an overview of those technologies that have a proven capability to generate significant amounts of electricity. It does not include technologies that are still in the early stages of Research and Development, such as nuclear fusion.

1. Carbon Abatement Technologies

The UK would benefit substantially if coal and gas power plant emitted less carbon. The low price of gas over the last decade has been a key factor in low electricity prices and, because it has largely replaced coal plant, has contributed to the effort to reduce our carbon emissions. Both coal and gas can provide continuous 'base-load' output or, if required, intermittent output to meet daily fluctuations in demand. Coal fired plant is particularly flexible in this respect.

Coal-fired generation, however, is projected to decline sharply in the UK, from around a third to approximately 16% of capacity by 2020. A major driver is the Large Combustion Plant Directive, which requires upgrading of plant to reduce other pollutants, particularly sulphur. Around half our coal stations may opt out of LCPD and therefore have to close by 2015. Many are nearing the end of their lives in any case.

Production from UK coal mines will decrease over coming years as a result of the increasingly difficult geological conditions in UK pits and the availability of competitively priced coal imports from countries such as Australia and South Africa. The government has, however, made available some £60 million in investment aid to help existing pits in the UK to develop new reserves, where they are economically viable and can help to safeguard jobs.

For both gas and coal the greatest long-term potential to reduce emissions lies in Carbon Capture and Storage (CCS). This process captures the carbon emitted during the generation process and stores it in geological formations (e.g. depleted gas fields or deep saline aquifers). Successfully applied to gas or coal power stations, CCS could reduce the amount of carbon emitted into the atmosphere by up to 85%. Components of CCS have been implemented in a number of projects, although none of these involve electricity generation. None are in the UK, although the feasibility of a project near Peterhead in Scotland deploying the full CCS cycle with gas–fired electricity generation is being assessed.[62] E.ON is examining the possibility of a similar CCS project based on coal.

In June 2005, the Government announced its Carbon Abatement Technology (CAT) Strategy setting out the path for developing these technologies up to 2020 and beyond. As part of the Strategy £35 million has been made available for demonstrating CAT technologies. Key challenges that remain to be addressed include:

- Optimising the integration of CCS technologies to make them competitive on cost with existing mainstream technologies;
- Proving the integrity of long-term CO2 geological storage (evidence to date suggests that geologically stored carbon does stay underground);[63]
- Establishing a regulatory regime for accountability in the event of leakage and for the management of carbon storage;
- Clarifying the two international treaties on dumping CO2 storage beneath the sea.[64] These are currently under review.

In addition to CCS, a number of new technologies offer promise for reducing carbon emissions from coal-fired plant:

- Modern pulverised coal plants use efficient supercritical boilers that emit around 20% less carbon than existing conventional plant;

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62 BP, ConocoPhillips, Shell and Scottish and Southern Energy (SSE)

63 The Sleipner Project in the North Sea has been running for some nine years successfully storing some 1 million tonnes of Carbon per year.

64 These two treaties (London, 1972 and OSPAR, 1992) are aimed at protecting the marine environment from waste dumping. Because the treaties were not drafted with a view to carbon capture and storage they are not consistent in their treatment of the technology. For example EOR projects are permitted, but injection from an existing offshore production platform for storage only is not, while direct injection from a pipeline from shore may not be prohibited.

- The efficiency of IGCCs[65] is comparable to new pulverized fuel plants, but they can also be used for co-generation of electricity and hydrogen. They also make it easier to capture the carbon produced in the generation process. Uptake so far has been limited by the cost advantage of gas fired plant and the reluctance of power plant operators to move away from conventional coal technology.
- Co-firing a mixture of coal and up to 20% bio-mass also reduces emissions;[66]

2. Renewable Technologies

3.6% of the UK's electricity came from renewable energy sources in 2004, mostly from hydro, wind, biomass and landfill gas. Over time, other renewable technologies such as solar, wave and tidal power are also expected to contribute. The Renewables Obligation makes it a duty for electricity suppliers to source a minimum amount of their electricity from sources such as these. Combined with other government incentives,[67] it is estimated that the RO will be worth around £1 billion per year in 2010 to the UK renewables sector. We remain committed to the RO and to our target for 10% of our electricity to be generated from renewables by 2010 with an aspiration to double that by 2020.

Different renewable technologies have some common and some divergent characteristics:

Carbon profile. Once built, all renewables are at least carbon neutral. As with any energy generating plant, the construction, operation and dismantling of stations gives rise to some CO2 emissions. However, total 'lifetime' emissions from renewable electricity generation are generally lower than for other generating technologies.

Reliability and Flexibility. Unlike coal, gas and nuclear, the source of energy for most renewables occurs naturally at the site of the plant. This is a benefit from the point of view of security of supply; the fuel is free and will never run out or need to be imported. However as many renewables are intermittent,[68] much larger proportions of renewables in the generating mix could in the longer term increase the amount of flexible back-up capacity required for the electricity network. With large proportions of renewables on the system, additional back-up (likely from coal, oil or gas) would tend to add to the cost and technical complexity of system management. The electricity system as a whole also requires a consistent 'base-load' of electricity. Because the potential for further large-scale hydro in the UK is limited, coal, gas and nuclear power are currently the major options for base-load in the UK.

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65 Integrated gasification combined-cycle (IGCC) systems combine a coal gasification unit with a gas fired combined cycle power generation unit. The coal is turned into gas and burnt, producing electricity and steam. The steam is then used to power additional turbines and create more electricity. As a result more electricity is generated with the same amount of coal: IGCC systems are around 45% efficient. They are also inherently cleaner than conventional coal plant in terms of sulphur, nitrogen oxide and particulate emissions.

66 Anything beyond 20% co-firing would involve substantial transportation distances which would add to the cost of the biomass and involve significant energy use.

67 Renewables also get financial support from the government through exemption from the Climate Change Levy and various capital grants and R&D support programmes

68 Excepting large hydro and bio-mass

Potential and cost. Renewables have the potential to generate very large amounts of power in the future, if technological breakthroughs allow us to harness them more effectively and cheaply. Solar power alone, for example, might have the potential in the long term to generate more electricity than we currently use. Costs for most renewables need to come down, though (see Annex B). In the medium term, the most cost-competitive source of new large-scale renewable generating capacity, made competitive on price by the Renewables Obligation, is wind. Around 3 GW of new wind capacity (~ 2% of total electricity demand) exists or has planning permission onshore, and another 1 GW offshore.

The planning consents process and the electricity grid. Like all infrastructure, large-scale renewables projects often face opposition during the planning process. This might be from local communities, interested industries (eg fisheries or the aviation industry) and/or on environmental grounds (such as visual impact or possible effects of the developments on local habitats). Renewables, like other new plant, may also require additional grid capacity or reinforcement, which in itself may be subject to planning objections in some cases.

Other factors. A wide range of technology-specific factors are also relevant. Bio-mass, for example, has the advantage that it can be used as a co-firing agent in coal plants, thus reducing emissions. On the other hand, while there is potential to secure additional generation from municipal and commercial wastes, the contribution from landfill gas is unlikely to grow due to EU regulations that require increasing proportions of waste to be diverted from landfill.

3. Micro-Generation

Micro-generation refers to small-scale electricity generating units of capacity <50-100 kW, located in buildings. There are currently ~2,000 micro electricity generation units in the UK, generating ~9 MW, or less than 0.1% of total UK capacity.[69] The Energy Savings Trust (EST) estimates that, as costs decrease, micro electricity generation technologies (including micro-CHP) could potentially provide up to ~30 to 40% of UK electricity demand by 2050 given the right market conditions[70].

Three technologies show particular potential:

- **Solar Photovoltaics (PV).** The UK currently has a small installed solar PV base of ~8.2 MW. Germany and Japan are the world's leading users of PV: Germany generates ~800 MW (~0.6% of total capacity) and Japan ~1100 MW (~0.5% of total capacity). The potential of solar PV to generate large amounts of electricity is very high, if costs can be brought down. The Renewables Innovation Review recently estimated that PV would likely not be competitive with residential retail prices before 2020;

69 Energy Savings Trust, 2005, Potential for Microgeneration: study and analysis
70 Ibid

- **Micro-wind.** There are currently only 200 kW of installed micro-wind power in the UK, compared to a figure of 30 MW for the global leader, the United States.[71] A recent paper by the Energy Savings Trust estimated that micro-wind could potentially provide ~15 GW of capacity in 2050. This assumed a rapid decline in the cost of micro-wind – currently at ~25 p/kWh;
- **Micro-hydro.** The installed capacity of this technology in the UK is only 1 MW (less than 0.1% of the UK total). The IEA estimates that roughly 5% of total global hydroelectric power, or 1% of global electricity generating capacity, is provided by micro-hydro[72]. The Energy Savings Trust estimates that micro-hydro plants have the potential to provide up to 100 MW in 2050. Costs (currently at ~5 –7 p/kWh) would have to fall, and the need for suitable sites is also an impediment. Micro-hydro sites are, however, a promising source of low-carbon technology in areas local to appropriate sites.

Common to all the micro-electricity technologies is relatively high cost. Part of this cost arises from technical and regulatory challenges generic to all 'distributed' generation. For example, to maximise the potential of micro-generation, excess power generated by a household or business (e.g. from wind power at night) would be exported back to the local and national grid, but tracking these flows requires new metering technology and is likely to bring challenges to distribution networks designed for the one-way flows of a centralised power system. There are also regulatory issues to resolve, for example, should income from exported electricity be treated as income for tax purposes?

The government is committed under the 2004 Energy Act to producing a micro-generation strategy by April 2006. This strategy will be taking a holistic approach to micro-generation, looking at measures that might remove barriers preventing the development of sustainable markets in both micro-heat and micro-electricity technologies. Work towards this strategy will provide an important input into our Review.

4. Nuclear Power Generation

Nuclear fission plants have contributed to electricity generation in the UK for the last 50 years. In 2004, nuclear plants generated 80 TWh of electricity, or 19% of the UK total. This is forecast to fall to 7% by 2020 as existing plants are retired.[73] The world's most intensive user of nuclear electricity is France, where more than 70% of electricity is nuclear-generated. Other major users include Ukraine (45%), South Korea (36%) and Japan (27%). Sweden (46%) and Germany (29%) are currently committed to phasing out nuclear power generation.

Increases in projected UK nuclear capacity could come from extensions to the current lifetimes of existing plant or from new build. British Energy recently announced a planned ten year extension to the life of its Dungeness B plant. It is uncertain whether it will be economically attractive or technically possible for British Energy to extend the lifetimes of

71 American Wind Energy Association, 2004, Small Wind Industry Market Study
72 http://www.ieahydro.org/Bur-Recl-web/questions/smallpro.htm
73 Refer to list of currently expected closing dates provided in Table 1 at page 40

its other reactors.[74] It will not be possible to extend significantly the lifetimes of older Magnox reactors now owned by the Nuclear Decommissioning Authority.

After a general global slowdown over the last 15 years, many countries are considering new nuclear build. Over 20 new plants are under construction globally, primarily in Japan, China, India and South Korea. A new plant is under construction in Finland. The last nuclear fission plant built in the UK was Sizewell B, which became operational in 1995. Planning permission was first sought in 1981. Like all UK nuclear plants, it was built by the public sector. We would expect any future plant to be built and run by the private sector, within the regulatory framework set by the government.

Among the considerations bearing on the issue of new nuclear build in the UK are:

Carbon profile. Nuclear power plants emit almost zero carbon, and could therefore contribute to the government's goal of reducing emissions. However the mining, refining and enriching of uranium, and plant construction and decommissioning, are carbon-intensive processes, especially when low quality uranium ore is being processed.

Reliable access to fuel. Uranium is typically refined in source countries but enrichment is conducted at Capenhurst, near Chester. The UK has no commercial uranium resource but it could draw on its stockpile of separated plutonium to supply Mixed Oxide (MOX) fuel, enough for the lifetimes of two large reactors. The world's major exporters of uranium ore are Australia and Canada, and deposits are known to exist elsewhere.[75] Known recoverable uranium reserves would last around 50 years at current levels of demand and a further ~30 years is available from decommissioned plants and weapons.[76] A global expansion of nuclear power stations would reduce this, but there has been little exploration for uranium since the mid-1980s and it is likely that further deposits exist. Today, mine expansions and new mines are planned in Australia, Canada, Kazakhstan, Russia, Brazil and Namibia.

Flexibility. Nuclear power provides a significant share of the UK's base-load generating capacity. But it has the disadvantage that it cannot easily follow peaks and troughs in energy demand. Were it to provide more than around 30% of the UK's electricity, issues of overcapacity may arise at periods of low demand. The UK has only one electricity connection to Europe and so (unlike France) has very low scope to export surplus electricity in periods of low demand.

Safety and security. An independent safety regulator, the Nuclear Installations Inspectorate, has the authority to shut down a nuclear power station if it is not completely satisfied with standards of safety. However the potential consequences of a significant release of radiation, or of the theft of nuclear material, make the security of nuclear plants a very high priority. The security regulator, the Office for Civil Nuclear Security, is responsible for approving security arrangements within the industry and enforcing compliance. Before the construction of any new nuclear plant could start, the independent safety and security

74 There is precedent in the USA (where the regulatory regime is different) for regulatory approval to extend the lifetimes of some PWRs up to a total lifetime of 60 years
75 Kazakhstan, South Africa, Namibia, USA, Russian Federation and Uzbekistan
76 World Nuclear Association, July 2005: Supply of Uranium issues brief

regulators would need to be completely satisfied that any proposed nuclear plant was safe and secure.

Proliferation risk. Current nuclear designs, operated within an effective security and safeguards framework such as the UK's, should create very little risk of proliferation. Safeguards are applied to civil nuclear material and activities in the UK according to the Treaty establishing the European Atomic Energy Community (Euratom), the UK's safeguards agreement with Euratom and the International Atomic Energy Agency (IAEA), and the Additional Protocol to that agreement. Such arrangements are put in place to provide assurance that any diversion from the UK's civil programme would be detected.[77]

Waste. The Committee on Radioactive Waste Management (CORWM) has been set up to examine options for the long-term storage of radioactive waste. The UK has a historic legacy from its military and civil nuclear programmes; the government has created the Nuclear Decommissioning Authority as the body with responsibility for dealing with this legacy safely and efficiently. CORWM has confirmed that waste from a new build programme could be technically accommodated by the options it is considering. The issue of waste will be one of the important considerations relating to nuclear power in this Review.

Cost. Market investors would make their own calculations about the viability of new nuclear investment. As the analysis shows in Annex B, cost estimates for new nuclear build vary significantly. One reason for this is that, because of the large capital investment required, a change in the discount rate can have a significant impact on the total cost of construction. Further uncertainty is created by the planning and licensing process, which can take five years or more. Subsequent reactors are likely to cost less than the first of a kind in a series.[78]

Decommissioning and long-term waste management. Taken together these can add up to around 15% of the lifetime cost of a nuclear plant. Decommissioning and long-term waste management are also significant issues for the public. A report on the latter by the Committee on Radioactive Waste Management, is expected in July 2006.

Skills. The Government has established a Sector Skills Council to represent the needs of the nuclear industry. Cogent Sector Skills Council was launched on 2nd March 2004 and is taking a strategic view of the nuclear sector to ensure that the education and training base can meet current and future employment needs in the nuclear industry.

77 Proliferation concerns arise most acutely in the context of countries without an Additional Protocol (AP) agreed with the IAEA. An AP allows the IAEA rights of inspection which significantly reduce the risk of those countries being able to use domestic energy programmes as a means of helping them to develop materials which can be used in nuclear weapons. The UK continues to play a strong role, with the IAEA and in other contexts, in seeking to limit the spread of nuclear weapons technologies.

78 For example, a 2004 University of Chicago study suggests a range of 3–10% cost reduction per doubling of units built.

Annex B: A Selection of Studies on The Comparative Economics of Different Forms of Generation

This document was produced by DTI in 2005, in consultation with Defra.

This annex summaries the results of a number of studies in the comparative economics of different generating technologies. It is not an exhaustive list and only briefly presents key findings. Government studies have included:

- Performance and Innovation Unit (PIT) Energy Review (2001);
- Interdepartmental Analysts Group (IAG) Report (2002);
- Analysis published with the Energy White Paper (2003);
- The Renewables Innovation Review (2003).

Other organisations have also published studies including

- The University of Chicago (2004);
- Royal Academy of Engineering (2004);
- David Hume Institute (2004);
- The Massachusetts Institute of Technology (2003).

The Government does not endorse the conclusions of studies published by other organisations. The studies all show a wide range of numbers from different sources and there is also some overlap between the ranges for different technologies. It is impossible to say unequivocally that one technology is cheaper than another because different assumptions about capital costs, fossil fuel prices and carbon prices all affect the relative competitiveness of different generating technologies.

Government Studies

1. PIU estimates

The following table shows the PIU estimates for new plant in 2020 for offshore and onshore wind, nuclear and gas-fired generation. The costs shown for onshore and offshore wind did not include system intermittency costs. These were estimated to add up to 0.1p/kWh for a 10% contribution from intermittent sources of generation and up to 0.2p/kWh for a 20% contribution.

Technology	P/kWh
Onshore wind	1.5-2.5
Offshore wind	2.0-3.0
Nuclear	2.5-4.0
Gas	2.0-2.3

2. Interdepartmental Analysts' Group estimates

The IAG comprises analysts from DTI, DEFRA, DfT, Treasury, Carbon Trust and Energy Saving Trust. It was established in January 2001 to address the recommendation by the Royal Commission on Environmental Pollution that the Government should commit itself to a 60% reduction in carbon emissions by 2050. The Group looked at a similar range of low carbon generation options as the PIU and reached the estimates in the table below. The estimates for onshore and offshore wind, as with the PIU, did not include the costs associated with intermittency.

Technology	P/kWh
Onshore wind	2.0-2.5
Offshore wind	2.0-3.0
Nuclear	2.6-4.0
Gas	2.3-2.9

3. White Paper modelling work

For the Energy White Paper the Government commissioned additional external modelling work from Future Energy Solutions (FES) using the MARKAL model. Assumptions made included the costs of both gas- and coal-fired generation (with and without carbon capture and storage). These estimates were based on the experience of the modelling team but were also discussed at a workshop with representatives from all the key generation technologies.

Technology	P/kWh
Gas 2000	2.2-2.4
Gas 2020	2.1-2.2
Coal 2000	3.6-3.9
Gas (capture and storage) 2000	3.5-3.7
Gas (capture and storage) 2020	3.0-3.2
Coal (capture and storage) 2000	5.7-6.1
Coal (capture and storage) 2020	4.5-4.9
Nuclear 2010	3.4-3.7
Nuclear 2020	2.7-3.0

Note: 2000 means plants built in the decades 2000-2010 etc.

Since the publication of the Energy White Paper, assumptions for fossil fuel prices would now be higher and this would affect the future cost of gas-fired generation.

4. Renewables Innovation Review

This review was undertaken in 2003 after publication of the Energy White Paper. As part of the review, OXERA were commissioned to undertake modelling work on the costs and potential for renewable generation technologies as part of the review. Assumptions about capital costs, discount rates and other factors affecting generation costs were agreed with the Department. The modelling work included cost estimates for additional investment in the transmission system to handle an increased share of offshore wind generation as well as the costs of providing back up capacity for intermittent sources of generation such as wind. For onshore and offshore wind turbines constructed in the years shown, the model suggested the costs in the following table.

P/kWh

	2005	2010	2015	2020
Onshore wind	3.1-4.0	2.7-3.6	2.6-3.4	2.5-3.2
Offshore wind	6.0-7.6	4.4-5.5	3.9-4.9	3.0-4.6

5. Studies by other organisations

The economic Future of Nuclear Power (University of Chicago): This study compared the costs of nuclear generation with those for coal and gas generation. It concluded that in the absence of federal financial assistance, new nuclear plants in the next decade would have a levelised cost of $47-71/MWh compared with $33-41 for coal and $35-45 for gas.

Can we afford to keep the lights on? (Royal Academy of Engineering): This report estimated that electricity from offshore wind farms would cost at least twice as much as that from conventional sources. The study attempted to put all energy sources on a level playing field by comparing the costs of generating electricity from new plants using a range of different technologies and energy sources. It concluded that the cheapest electricity would come from gas turbines and nuclear stations, costing just 2.3 p/kWh, compared with 3.7 p/kWh for onshore wind and 5.5p/kWh for offshore wind farms.

Titling at Windmills: The Economics of Nuclear power (David Hume Institute): This report questioned whether the economic analysis of wind energy justified its increasing use. It stated that the cost of generating electricity from wind power was approximately twice that of the cheapest alternative source and that the cost of subsidising renewables by 2010 would be around £1bn per year.

The Future of Nuclear Power (Massachusetts Institute of Technology): Key conclusions were that nuclear power was not currently economically competitive. If in the future carbon dioxide emissions carried a significant price, nuclear energy could become an important option for generating electricity. The conclusions were based on a model to evaluate the real cost of electricity from nuclear power versus pulverised coal plants and natural gas combined cycle plants (at various levels of real lifetime prices for natural gas), over their economic lives.

Annex C: DTI emissions projections and fossil fuel prices assumptions

Table A.1 below shows the current DTI projections for carbon dioxide emissions up to 2020. These projections are based on current measures only. They do not take account of any new measures that will be introduced as part of the revised Climate Change Programme, including the level of cap for Phase II of the EU emission trading scheme.

C.1 UK Carbon dioxide emissions projections 2010-2020

	2010	2015	2020
Major power stations and refineries	46.9	48.5	45.3
Residential	20.7	20.9	21.1
Industry	32.4	33.1	31.6
Services	6.4	6.7	7.7
Transport	38.3	39.7	40.2
Land Use Change	-0.6	-0.1	0.4
Total	**144.2**	**148.7**	**146.3**

Current projections for energy demand and associated CO_2 emissions are estimated for four scenarios depending on different assumptions for fossil fuel prices: a high prices case, a low prices case and two central prices cases (one with higher gas prices that the other). The use of scenarios for fossil fuel prices reflects the uncertainty around such prices going forward, and the potential sensitivity of results to these assumptions.[79] Table A.2 to A.5 below show the fossil fuel price assumptions for the four scenarios (in 2004 real prices).

C.2 High sensitivity scenario

	Oil ($/bbl)	Gas (p/therm)	Coal ($/GJ)
2010	50	38	1.70
2015	50	38	1.70
2020	50	38	1.70

79 In the main text and in table C.1 we use for simplicity an average of the two central cases.

C.3 Central scenario (favourable to coal)

	Oil ($/bbl)	Gas (p/therm)	Coal ($/GJ)
2010	35	28	1.50
2015	35	28	1.43
2020	35	28	1.35

C.4 Central scenario (favourable to gas)

	Oil ($/bbl)	Gas (p/therm)	Coal ($/GJ)
2010	35	23	1.50
2015	35	23	1.43
2020	35	23	1.35

C.5 Low sensitivity scenario

	Oil ($/bbl)	Gas (p/therm)	Coal ($/GJ)
2010	20	18	1.30
2015	20	18	1.15
2020	20	18	1.00

It must be noted that these figures should not be considered as DTI fossil fuel price forecasts. The uncertainties are considerable. For a variety of purposes, however, there are requirements to consider what may happen to prices going forward – generally through considering ranges of assumption, or sensitivities to different assumption. These are published price assumptions currently used in the DTI UK Energy Model, which constitutes the basis for the UK CO2 projections.

A more complete presentation of and consultation on DTI projections, including fossil fuel prices assumptions, will be published shortly.

Annex D: DTI Consultation Criteria

The Consultation Process

The formal consultation period runs from 23rd January 2006 to 14th April 2006

Those wishing to respond to some or all of the issues for consultation should do so in writing before 14th April 2006. Responses are welcome by e-mail, through the response form on the DTI website or in hard-copy. A programme of stakeholder events will be announced in January to support the written consultation process.

In providing your written response please let us know of any issues of confidentiality explained at page 9.

All responses that are not subject to a confidentiality provision will be published on the DTI website together with a summary of the responses.

Consultation Criteria

1 Consult widely throughout the process, allowing a minimum of 12 weeks for written consultation at least once during the development of the policy.

2 Be clear about what your proposals are, who may be affected, what questions are being asked and the timescale for responses.

3 Ensure that your consultation is clear concise and widely accessible.

4 Give feedback regarding the responses received and how the consultation process influenced the policy.

5 Monitor your department's effectiveness at consultation, including through the use of a designated consultation co-ordinator.

6 Ensure your consultation follows better regulation best practice, including carrying out a Regulatory Impact Assessment if appropriate.

The complete code is available on the Cabinet Office's web site, address http://www.cabinet-office.gov.uk/servicefirst/index/consultation

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