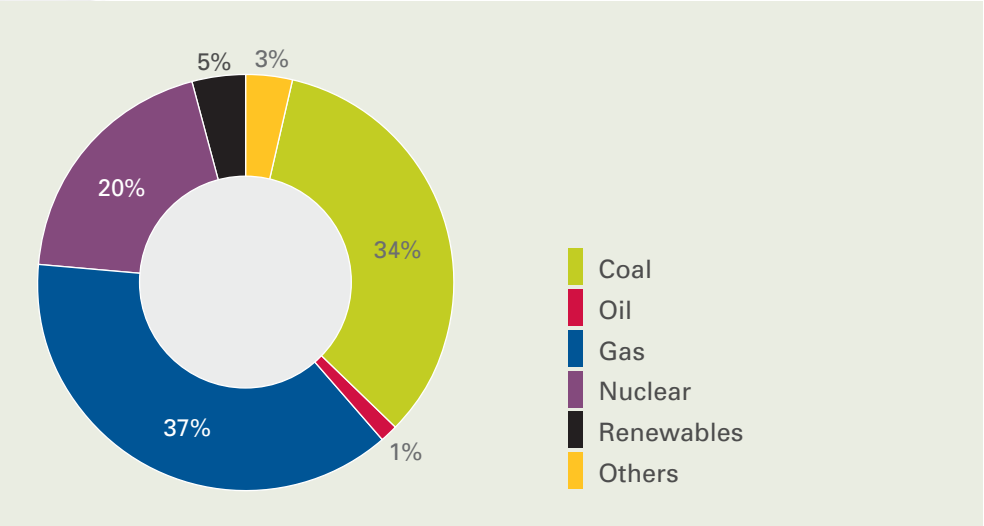
CHAPTER 5

Electricity Generation

The UK currently benefits from a diverse electricity generation mix; 37% is generated by gas-fired power stations, 34% from coal, 20% from nuclear, 5% from renewables and the remainder from other sources (chart 14). This diverse generation mix reduces the UK's dependency on a single fuel type and helps maintain a secure supply of electricity.

Over the next two decades, the UK will need substantial new investment in electricity generation capacity to replace closing coal, oil and nuclear power stations and to meet expected growth in electricity demand. Around 8GW (roughly a third of current capacity) of the UK's coal power stations must close no later than 2015 as a result of EU environmental legislation. And, based on published lifetimes, more than 10GW of the UK's nuclear power stations will close by 2023. In total, the UK is likely to need around 25GW of new electricity generation capacity by 2025, equivalent to more than 30% of today's existing capacity.

CHART 14. UK ELECTRICITY GENERATION MIX (2005)



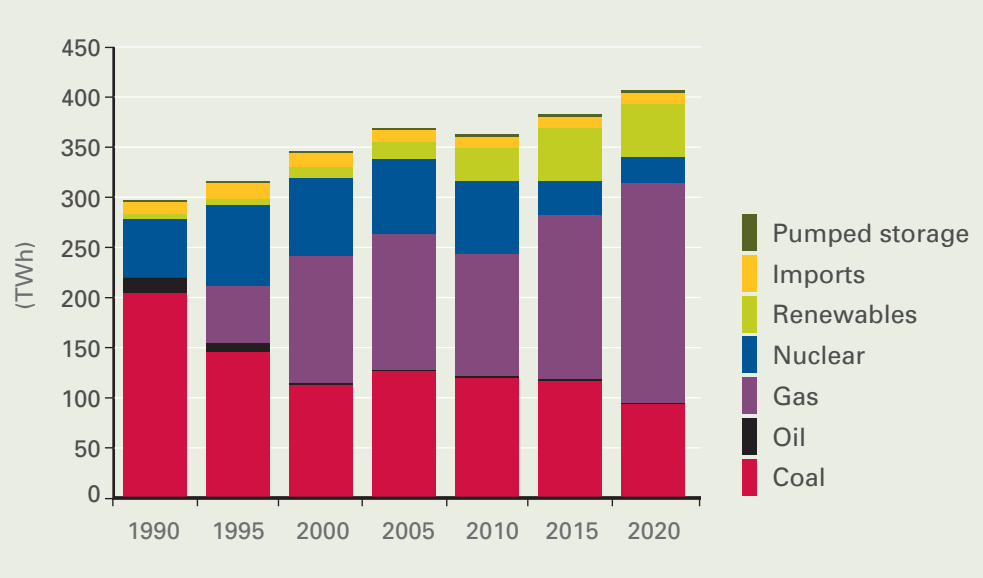
Source: DTI, 2006

5.1 It will be for private sector companies to make the necessary investment decisions within the regulatory framework set by the Government. We need to ensure that this framework provides the right incentives for adequate and

timely investment, consistent with our goal of moving to a low carbon economy. In this context, there are risks in the current outlook, but also opportunities.

5.2 Government's latest energy projections[39] based on a central set of assumptions show that, without changes to the current market framework, many of the closing coal and nuclear power stations would be replaced by gas-fired stations, along with some renewables (see chart 15). Under this scenario, the percentage of the UK's electricity supplied by gas-fired power stations could rise from 37% today to around 55% by 2020. This would reduce the diversity of the UK's generation mix, with more than half of the UK's electricity supply dependent on a single fuel type. This increased dependency on gas for electricity generation would also be happening at the very time the UK becomes increasingly reliant on imports for its gas supplies.

CHART 15. ELECTRICITY GENERATION MIX – PROJECTIONS TO 2020



Source: DTI, 2006

5.3 There are also implications for UK carbon emissions. Unless cost-effective technology to reduce carbon emissions in electricity generation comes forward, for every new fossil fuel-based station, there is a risk of locking in higher levels of carbon emissions for the 20-40 years that these power stations operate.

5.4 Finally, new investment must be timely. If new power stations do not come on stream in a pattern consistent with the expected closure rates of coal and nuclear power stations, the supply of electricity may only just able to meet demand during times of very high demand (e.g. at certain times of the day during winter). During these periods, businesses could face higher electricity prices. These periods of 'tightness' between supply and demand might result if new power stations are delayed in the planning system so that they do not begin operation as early as expected, potentially compromising security of supply. It could equally occur if existing power stations close

39 See Annex C.

earlier than is currently expected. However, our analysis indicates that based on existing UK capacity and the current expected pattern of power station closure, we are unlikely to face such risks before the middle of the next decade (see box 5.1). There is plenty of time for the market to respond to these developments with new investment. In addition, the proposals we make in this report to clarify the policy position on renewables and nuclear, and the commitment to a long term carbon market and to improve the planning regime should reduce uncertainty for investors and make it easier for companies to respond with new investment in a timely manner.

BOX 5.1: INVESTMENT IN NEW ELECTRICITY GENERATION CAPACITY

It is likely we will need up to 25GW of new generating capacity over the next two decades, to fill the 'generation gap' left by closing coal and nuclear stations and to meet future electricity demand. Given the scale of this challenge, the Review has undertaken detailed work to analyse the risks this could pose to our security of supply and to look at the cost-effectiveness of a number policy options[40]. The options investigated included different market-based mechanisms to encourage new build in a diverse set of generating technologies.

The analysis highlighted some risks around the market's ability to continue to deliver consistently the very high levels of security of supply UK consumers and businesses have been used to. The level of risk will depend on a number of factors including expected fossil fuel prices, the growth in electricity demand and the expected pattern of closure of existing coal power stations and nuclear power stations. The closure of coal stations will depend on individual company decisions, with stations that are not compliant with EU environmental legislation likely to close sometime after 2012 and certainly by 2015 when the EU legislation bites. The closure dates for nuclear stations will depend on whether some successfully achieve life extensions. The modelling suggests that if closure dates coincide, market participants may not be able to respond by developing and commissioning new power stations in a timely fashion. Under certain scenarios, this could lead to a reduction in the amount of spare capacity on the system to meet peak demand (e.g. demand at certain times of the day during winter). At the same time, it is important to recognise that this is a modelling exercise and as well as not being a perfect predictor of the future, the model does not take account of our proposals to clarify the Government's position on renewables and nuclear and to streamline planning, all of which should help ensure the market brings forward new investment in a timely manner.

However, the modelling also indicates that in most scenarios, the risk of having unserved electricity demand is unlikely to become substantively higher than today until around 2015. Even then, the amounts of 'shortfall' between demand and supply would likely be small and could therefore potentially be resolved by some companies voluntarily shifting their use from peak to off-peak times in response to price signals.

40 Redpoint Energy, Dynamics of UK Electricity Generation Investment, 2006.

Furthermore, the modelling showed that any intervention – such as a capacity mechanism – would impose significant costs and some risks on the system and, ultimately, the final consumer. The modelling indicates that while the policy options analysed can be effective in trying to address the issues identified around capacity shortfall, they can have unintended and often undesirable side-effects, such as further volatility in prices or higher carbon dioxide emissions. Such side-effects have indeed been one of the issues identified in markets elsewhere that have implemented capacity type mechanisms.

5.5 In analysing these risks and possible policy responses to address them we judge that, while recognising the risks associated with our existing market framework, the case for intervention on grounds of security of supply has not been made. This is especially true given our understanding that the system appears very robust to fluctuations in supply and demand under most scenarios at least until around 2015. We anticipate that, through the enhanced information provision arrangements for security of supply, the Government will be in a position to monitor the development of this market effectively to ensure that the framework continues to deliver. In addition, the proposals we make in this report to clarify the policy position on renewables and nuclear, the commitment to a long-term carbon market and to improve the planning regime should reduce uncertainty for investors and make it easier for companies to respond with new investment in a timely manner.

5.6 The opportunity is clear. Enabling an increase in new investment in low carbon electricity generation over the coming period, will lock-in lower levels of carbon emissions in our electricity sector for 20-40 years. Moreover, increasing the proportion of low carbon electricity generation will increase the diversity of the UK's electricity generation mix and could decrease the UK's dependency on imported gas.

Government sets the framework and companies make the investments

5.7 Government needs to ensure that the market framework enables companies to make timely investments consistent with the Government's policy goals on climate change and security of energy supplies.

5.8 Companies need a market and regulatory framework that provides clarity and helps reduce uncertainty. The policy proposals for electricity generation are aimed at reducing uncertainty, incentivising investment in low carbon technologies and improving market information.

Reducing policy uncertainty

5.9 Given the long-term nature of investments in electricity generation, policy uncertainty creates a barrier to new investment. Policy uncertainty affects the economics of all new power stations, by raising the cost of the capital companies need to borrow to make new investments. It can disproportionately affect technologies that require higher levels of upfront capital investment, such as low carbon technologies. Submissions to the Energy Review consultation particularly emphasised the need for clarity on the Government's future policy direction on renewables and on nuclear. Therefore, in the following sections of this report, we will:

- Confirm and strengthen our commitment to the Renewables Obligation; and
- Clarify our position on new nuclear build.

Reducing regulatory uncertainty

5.10 Another area of concern highlighted during the Energy Review consultation was the need to improve the planning process for all energy infrastructure. Uncertainties and delays caused by the existing planning process increase the likelihood that investments in new power stations (and other energy infrastructure such as gas storage) will not be timely. Proposals to improve the planning process for large-scale electricity generation are set out in a separate planning chapter. The proposed improvements should help in two ways:

- They should provide more certainty as to the timescales for any given planning inquiry; and
- They should shorten the overall timescales from application to a final decision on consent.

5.11 These proposals should help to incentivise investments in all forms of electricity generation, including low carbon technologies. More details can be found in chapter 7.

Sending a strong signal about the value of low carbon investment

5.12 In Chapter 1, we set out our aim to strengthen the EU Emissions Trading Scheme (EU ETS) post-2012 so that it provides a stable and transparent investment framework for business. The UK remains committed to a carbon price signal; a credible and continuing carbon price is crucial for sending a strong signal to companies about the need for low carbon generation. The EU ETS is here to stay beyond 2012 and will remain the key mechanism for providing this signal, and Government will continue to work with our international partners to strengthen the Scheme to make it more effective. We will keep open the option of further measures to reinforce the operation of the EU ETS in the UK if this should be necessary to provide greater certainty to investors

Improving the quality of forward looking market information

5.13 Companies will need to buy their electricity over the next 10-15 years against a background of many uncertainties in the electricity market. Companies wishing to invest in new power stations will face these same uncertainties. To mention just a few of these:

- it is likely that the long term average prices of fossil fuels will be higher in the UK than over the previous decade but neither companies nor Government can know how future prices might evolve. The future price of fossil fuels will affect the price of the electricity we buy;
- the exact pattern and timing of closures of coal and nuclear power stations is uncertain and as mentioned, the pattern of closure and new investment will affect electricity prices; and
- given the multilateral nature of the EU ETS, neither Government nor companies can be sure the pace at which this scheme will evolve.

5.14 Against this background of uncertainties, Government believes there is a strong case for improving the quality and dissemination of forward looking market information for companies and investors. There was strong support for improved information in the submissions to the Energy Review Consultation. As we have already set out for gas, Government will introduce new arrangements for the provision of forward-looking energy market information and analysis relating to security of supply. Led from the DTI and working with key energy market players, the objective will be to brigade in one place relevant data and analysis on the medium and long term adequacy of future energy supplies to help early identification of areas where policy may need to be reviewed and to assist energy market participants with their investment and purchasing decisions.

5.15 In the following sections, we set out our proposals on different forms of electricity generation: renewables, cleaner coal and carbon capture and storage and nuclear.

Summary of Proposals relating to Electricity Generation

Government will:

- **confirm and strengthen our commitment to the Renewables Obligation;**
- **clarify its position on new nuclear build;**
- **bring forward proposals to improve the planning process for large-scale electricity generation – these are set out in a separate planning chapter;**
- **set out our aim to strengthen the EU Emissions Trading Scheme (ETS) post-2012 so that it provides a stable and transparent investment framework for business. This is covered in more detail in chapter 1; and**
- **introduce new arrangements for the provision of forward-looking energy market information and analysis relating to security of supply.**

Electricity Generation – Renewables

Renewable energy, derived from sources such as the sun, the wind, waves, tides and biomass (including waste), is a vital and growing component of our diverse energy mix. If we could derive more of our energy from the renewable sources all around us, we could reduce our reliance on imported fossil fuels. And as renewable energy produces very little carbon or other greenhouse gases, it helps us cut emissions, and plays an important part in tackling climate change.

The Government therefore proposes to strengthen the framework that supports the development and deployment of renewable technologies. With this strategy, the Government believes that we can achieve 20% of our electricity coming from renewable sources by 2020.

Background

5.16 Energy flows all around us in the environment. The wind, waves and tides, driven by the power of the sun, or the gravitational effects of the sun and the moon, are essentially inexhaustible sources that we can harness to meet some of our energy needs. We can also use the crops that we grow and some of the waste that we generate.

5.17 Renewable energy is an integral part of the Government's long-term aim of reducing CO_2 emissions by 60% by 2050. As it produces very little carbon dioxide and other greenhouse gases, it plays an important part in tackling climate change.

5.18 Further, if we can increase the amount of energy we get from the renewable sources around us, we can reduce our dependence on imported fossil fuels. In this way, the extra diversity that renewables bring to the UK's energy infrastructure can make a significant contribution to the Government's goal of ensuring secure and reliable energy supplies.

5.19 The UK is naturally endowed with very favourable resources of renewable energy – especially onshore and offshore wind – and there is the potential for the UK to be a world-leader in emerging renewable technologies.

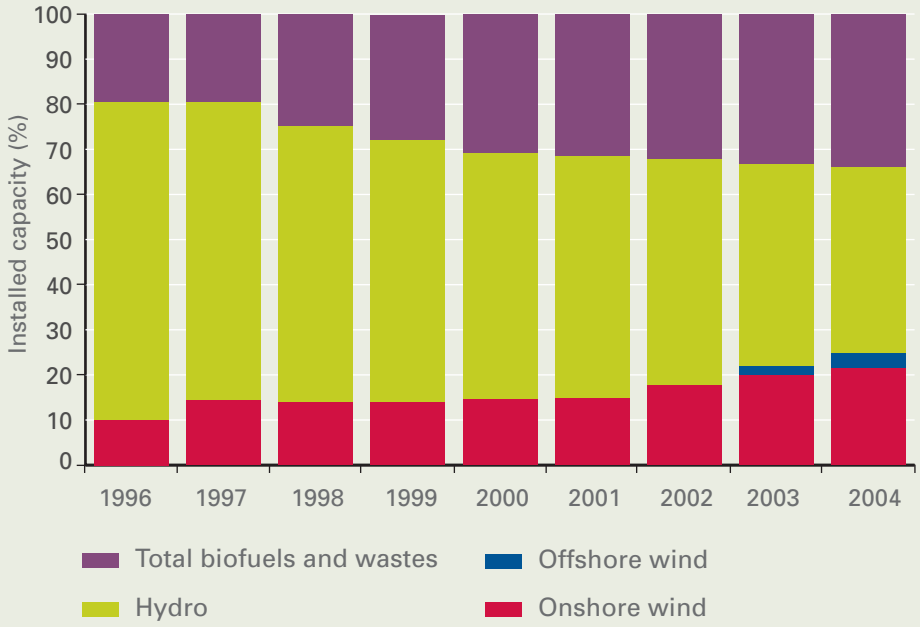
5.20 Recognising the important contribution that renewable forms of energy can make to our energy policy goals, in the 2003 Energy White Paper Government set a target of 10% of electricity supply from renewable energy by 2010, subject to the costs being acceptable to the consumer, with a further aspiration to derive 20% of our electricity from renewable sources by 2020.

5.21 To help achieve this, the Government has introduced a number of measures to incentivise the development and deployment of renewable sources of energy in the UK, including the Renewables Obligation (RO) and some £500m of public funding for various support programmes.

5.22 As a result, the amount of UK renewable electricity generation has increased substantially since 2002. Total generation from RO-eligible renewable sources was around 4% of total electricity supplied to UK consumers in 2005, up from 1.8% in 2002.

5.23 About 1.7 GW of wind power is now connected to the grid, enough to supply power to almost one million homes[41]. Chart 16 below indicates that energy from biofuels and waste and from onshore and offshore wind continue to provide a growing proportion of overall supplies of energy from renewable sources. There are also a significant number of projects currently in the planning pipeline, with over 11GW[42] of renewable projects in planning across the UK.

CHART 16. THE CONTRIBUTION OF DIFFERENT TECHNOLOGIES TO THE UK'S OVERALL ELECTRICITY GENERATION FROM RENEWABLE SOURCES



Source: DTI, 2005

5.24 However, without further action and greater long-term certainty for investors, the recent growth in renewables generation may slow between 2010 and 2020. This is because the growth in more established technologies is likely to be constrained – by scarcity of suitable sites in the case of hydroelectric power and landfill gas, and by planning requirements and delays in getting grid connections in the case of onshore wind. The growth of emerging technologies is currently constrained by their relative cost. For example, offshore wind, which was expected to make a substantial contribution to the Government's 10% target and 20% aspiration, is currently proving more expensive than anticipated. This is due, for example, to rising steel prices and increasing global demand for turbines.

41 British Wind Energy Association – www.bwea.com
42 Renewable Energy Statistics Database – http://www.restats.org.uk/2010_target.html

5.25 If we are to achieve 20% of electricity from renewable sources by 2020, then both onshore and offshore wind will need to make a significant contribution. We will also need to maximise the potential contribution from other technologies, established and emerging alike, such as landfill gas (including energy from waste – see box 5.3), biomass, hydroelectric power and wave and tidal stream (see box 5.2). Therefore, the Government has considered three main areas for further enabling the development and deployment of renewable energy in the UK:

- strengthening and modifying the Renewables Obligation to provide longer-term certainty and create a greater incentive for investment into those technologies that are further from the market;
- attempting to accelerate access to the electricity grid for renewable electricity generators; and
- tackling planning barriers to reduce delays and uncertainty for developers.

BOX 5.2: TIDAL IMPOUNDMENT SCHEMES

Tidal impoundment schemes – such as barrages and lagoons – and tidal current technologies have the potential to make a significant contribution to carbon reductions. In common with other power generation projects they could bring with them a number of external benefits, but generally are not competitive with other forms of low carbon generation.

During the course of consultation we have received a range of views on tidal generation, in particular on the plans for a Severn Barrage, which could provide around 5% of current UK electricity demand by 2020. This could cost in the region of £14 billion. It is clear that while attractive in terms of energy generation and associated benefits, plans for a Severn Barrage would raise strong environmental concerns in view of the designations that apply to the Severn Estuary.

We are however interested in improving our understanding of how to make best use of the potential tidal resource in UK waters. Together with the Welsh Assembly Government, we will therefore work with the Sustainable Development Commission, the South West Regional Development Agency and other key interested parties to explore the issues arising on the tidal resource in the UK, including the Severn Estuary, including potential costs and benefits of developments using the range of tidal technologies and their public acceptability.

Strengthening and Modifying the Renewables Obligation

5.26 The Renewables Obligation (RO) is the Government's main support mechanism for the expansion of renewable electricity in the UK. Introduced in 2002, the RO obliges electricity suppliers to source a rising percentage of electricity from renewable sources.

5.27 The level of the obligation is 6.7% in 2006/07. Under current policy, it would rise annually to 15.4% in 2015/16, then remain at that level until the obligation ceases in 2027.

5.28 In order to meet their obligation, energy suppliers must prove they have

purchased energy from renewable sources by presenting Renewables Obligation Certificates (ROCs), or, alternatively, by making a fixed financial payment (a "buyout price"), or some combination of the two. The "buyout price" rises in line with inflation each year. It caps the costs of the obligation to suppliers and, in turn, consumers.

5.29 The RO was designed to incentivise the most economic forms of renewable generation. Since its introduction, it has been effective in achieving this and has stimulated significant development of onshore wind, co-firing and landfill gas. However, more could be done to drive further innovation and bring forward significant growth in renewable microgeneration technologies. To achieve the step change we need in the share of our energy from renewables, these emerging technologies need to be strongly fostered.

5.30 We have identified the following three steps for strengthening and widening the impact of the RO:

- extending Obligation levels to 20% (when justified by growth in renewable generation);
- amending the RO to remove risk of unanticipated ROC oversupply; and
- adapting the RO to provide greater support to emerging technologies and less support for established technologies. The Government's preferred option for achieving this is through a "banding" system, ensuring that current ROC rights for existing projects and for those built prior to implementation of changes are preserved. Any changes would be introduced in 2010.

5.31 We shall consult fully on the second and third of these proposals and on the implementation of the first.

5.32 In introducing "banding", the Government would preserve current ROC rights for existing projects and for those built prior to implementation of changes. We envisage the change would be introduced in 2009 or 2010.

5.33 The Government announced in March 2006 that it would look again at the role of co-firing within the RO as part of the Energy Review. We believe that co-firing could play a greater role in contributing to our renewable energy and carbon reduction targets with reduced levels of support and we will be consulting on changes to the co-firing rules.

5.34 With this strategy, the Government believes that it is achievable to have 20% of electricity coming from renewable sources by 2020.

Obligation levels

5.35 In considering options for amending the RO to ensure it continues to meet our policy goals, the Government recognises that it is essential to maintain investor confidence. For this reason, the Government is committed to existing decisions on Obligation levels. The additional announcements detailed below aim to deliver long-term ROC price certainty beyond 2015/16 and through the remaining life of the Obligation to 2027.

5.36 The Government is also committed to ensuring the costs to consumers associated with the Obligation are acceptable. Therefore, the commitment to extend Obligation levels to 20% will be made cost neutral by freezing the ROC buyout price from 2015.

5.37 Overall, this measure involves the following elements:

- the Government commits to maintaining Obligation levels above the level of ROC-eligible renewable generation, to a maximum level of 20% of generation from renewable sources. Increases in Obligation levels above 15.4% will not occur at pre-determined stages, as with existing announcements, but will follow a "guaranteed headroom" model, where increases are contingent upon appropriate levels of growth in renewables generation;
- the Government will remove the automatic annual increase of the buyout price in line with inflation from 2015. The overall package of measures will be approximately cost-neutral to the consumer; and
- the Government will consult on measures to amend the RO such that any renewable generation exceeding the level of the Obligation would not have a precipitate impact on ROC prices, but rather taper gradually downwards.

Banding the Renewables Obligation

5.38 The Government has considered carefully a number of options proposed by respondents to the Energy Review consultation to modify the RO. Of these, we believe "banding" – whereby emerging technologies are awarded more ROCs per MWh of electricity generated than other technologies – would best deliver the Government's aims of:

- bringing forward emerging renewable technologies;
- improving the overall cost-effectiveness of the RO; and
- preserving investor confidence by applying changes only to new projects (i.e. "grandfathering" existing projects).

5.39 We therefore intend to consult on whether and how to move to banding the RO. If the Government decides to band the RO following the consultation, we will seek to introduce the necessary primary legislation in time for changes to be implemented to the Renewables Obligation Order in 2009 or 2010. This is subject to identification of a suitable legislative vehicle, passage of the legislation through Parliament and state aid approval from the European Commission.

5.40 Banding the RO would mean giving some technologies more ROCs and others less ROCs. In order to preserve ROC market stability, the Government will seek to balance these factors – so that the number of ROCs in the market does not significantly alter as a result of the change.

5.41 The DTI, the Scottish Executive and the Department of Enterprise, Trade and Investment in Northern Ireland are committed to maintaining a strong UK-wide ROC market, operating on a consistent basis, and will work together to ensure that this is delivered. This includes liaising with the Scottish Executive to promote complementarity with their current proposals for prioritising support to marine energy.

Reasonable notice and grandfathering

5.42 Changes to ROC eligibility rights will be introduced only after a reasonable notice period. The position of existing projects will be protected.

5.43 If the RO is banded, existing projects will be "grandfathered" – all projects operational now (i.e. that have been commissioned and are generating electricity) will continue to be entitled to one ROC per MWh for the remaining lifetime of the Obligation.

5.44 For projects which become operational after this announcement but prior to possible banding, the support they receive through the RO will depend on the technology used. Projects in more economic technologies that may have their number of ROCs reduced (such as landfill gas and potentially onshore wind) will remain entitled to one ROC per MWh for the remaining life of the Obligation. Projects in emerging technologies that may have their number of ROCs increased (such as offshore wind, marine and photovoltaics) will receive one ROC per MWh until the banding comes into effect, at which point they will, as appropriate, be moved up to the new band for their technology and receive the new (higher) number of ROCs. The one exception to this may be emerging technology projects that receive capital grants from the Government – as these projects are given grants on the basis of the current level of support.

5.45 If the RO is banded, projects that become operational after this change comes into effect will receive the number of ROCs determined by their band. This value would not be reduced for the lifetime of the project, irrespective of subsequent changes. The position of projects and investors will therefore be protected.

Co-firing

5.46 When the RO was introduced, co-firing – the burning of biomass alongside fossil fuels – was included as a transitional technology to encourage the establishment of biomass supply chains, particularly energy crops. Co-firing was permitted up to a specified cap and, from a specified date, co-firers would need to use a certain minimum amount of energy crops to be eligible for ROCs. Within the context of the Energy Review, the Government conducted a review of co-firing. This review led to a broad consensus that co-firing should be encouraged to play a long-term role in reducing carbon emissions. However, co-firing is one of the most economic forms of renewable energy and does not need full support of the RO. If the price of carbon were sufficiently high, it might be possible that co-firing would require no support from the RO – although this is an option for the long term.

5.47 At the moment, and probably for the next decade or so, co-firing is likely to continue to require the support of the RO. So, if the RO is banded, co-firing will be designated a band. This will be less than one ROC per MWh, but the cap on the total volume of co-firing will be removed. Unlike other technologies, however, there will be no grandfathering for co-firing – as it requires relatively little capital expenditure.

5.48 The Government believes there is a case to continue to support UK energy crops. One option under a banded RO would be to allocate energy crops a higher band. In order to ensure that the UK's energy crop market can continue to develop between this announcement and the possible introduction of banding, the Government will consult on an interim change to the co-firing rules – allowing the co-firing of energy crops outside the existing caps on co-firing.

5.49 If the RO is not banded, a cap on co-firing is likely to continue. The Government would consult as to whether the current cap and restrictions are still appropriate.

BOX 5.3: ENERGY FROM WASTE

The Government's waste policy prioritises prevention, reuse and recycling over the recovery of energy from residual wastes. But where prevention, reuse and recycling are not possible, recovering energy from waste could contribute to our energy policy goal as a source of low carbon energy where the energy so generated comes from the biomass fraction of the waste (e.g. waste food), which is renewable; does not displace recycling, which is even more beneficial; and does displace fossil generation.

Strong opposition from some sections of the public has hindered the development of energy from waste technologies in the UK. This opposition is motivated primarily by fears over supposed impacts on human health, as well as by concerns that excessive investment in incineration, in particular, might "lock in" wastes which could otherwise have been recycled. The Government believes that the first of these concerns is not supported by the available evidence, whilst the second can be addressed through the careful design of local waste strategies. These issues are being addressed in the Government's revision of its waste strategy for England, which will be published towards the end of this year.

Next steps and timetable

5.50 The Government will launch a consultation on if and how the RO should be banded by this autumn. This will include consultation on how bands are set, how frequently bands are to be reviewed, the operation of the headroom approach to setting Obligation levels, the ROC price tapering mechanism, and changes to the co-firing rules.

Action on Grid Issues

5.51 Growth in future renewables requires connection to the electricity network. The anticipated geographical location of much of the new renewable generation that will be coming on stream, and of wind generation in particular, will require the development of new transmission infrastructure in parts of England, Wales and Scotland. Without the investment to link these renewables to the grid, we will not see the levels of renewables delivered that we want. Annex E discusses potential investment requirements to accommodate different amounts of generation.

5.52 The Government is aware of a number of significant and pressing issues that need resolution. These include current Final Sums Liability (FSL) arrangements and the "queue" created by the confluence of the Government's renewable targets, the Renewable Incentive Scheme and transitional arrangements for BETTA. Annex E discusses these in depth as well as a number of longer-term technical and regulatory issues.

5.53 It is vital to resolve these issues in order to maximise the potential of renewables and to achieve targets for their use. Ofgem and National Grid are working to resolve these issues through the Transmission Price Control Review and Access reform working groups. The Government will monitor these processes closely; it is crucial that they progress to a satisfactory conclusion.

5.54 The Government is also taking the following steps to promote electricity network access for renewables generators, explained and elaborated in Annex E. First, work sponsored by the DTI suggests that renewable generation may drive the need for transmission reinforcement to a lesser degree than conventional generation. In a cost-reflective pricing system such as ours, this would imply that transmission charges should be lowered for variable generating plant, such as wind.

5.55 We will work with Ofgem and National Grid, and in consultation with industry and relevant experts, to determine whether variable generation, particularly wind, drives network investment to a different degree than conventional generation and, if so, whether changes to the Security and Quality of Supply Standards for renewables as well as relevant investment and transmission charging methodologies are required.

5.56 The Government is concerned to ensure that current rules under BETTA relating to system security are not leading to unnecessary delays in the connection of renewable generation. We welcome Ofgem and National Grid working together with industry to consider the options for shared, temporary and limited access to the transmission system with a view to giving renewable generation priority.

5.57 The Government is also working with Ofgem and industry to develop an offshore transmission regime to connect offshore wind and future wave and tidal projects to the onshore grid. This is critical enabler for the development of the marine renewable sector. The aim is to have the regime in place by 2008.

Planning

5.58 The Government has identified a number of issues relating to the planning system for large energy infrastructure as a whole, and a set of proposals for addressing them. These are outlined in chapter 7.

5.59 The Government also recognises that there are specific issues relating to planning and renewable energy generation. For example, securing planning permission for renewables, and in particular onshore wind, can be an especially difficult process, with developers facing much uncertainty and a significant risk of delays. The Government proposes to tackle these planning issues with a view to reducing delays and uncertainties for developers and others. These proposals are outlined in more detail in chapter 7.

5.60 The Scottish Executive will implement an ambitious strategy for the deployment of renewables in Scotland and speeding up the consenting process, which has the potential to boost significantly the level of renewable generation by 2020.

Conclusions

5.61 The Government has also recently announced extra funding for renewables and other low carbon technologies from the Environmental Transformation Fund and further investments that will accelerate the contribution from microgeneration and distributed renewable generation. Taking all of these measures together, the Government believes that we can achieve 20% of our electricity coming from renewable sources by 2020.

Measures on Renewable Energy

In order to support the development and deployment of renewable technologies, the Government proposes to:

- **Strengthen and modify the Renewables Obligation (RO) to provide longer-term certainty and create a greater incentive for investment into those technologies that are further from the market.**

This will include:

- **extending Obligation levels to 20% (when justified by growth in renewable generation) – this will be made cost-neutral to the consumer by freezing the buyout price from 2015;**
- **consulting on amending the RO to remove risk of oversupply of ROCs;**
- **consulting on possible adjustments to the RO ("banding") to provide greater support to emerging technologies and reduced support for more established technologies;**
- **providing new funding for renewables through the Environmental Transformation Fund;**
- **working with industry, Ofgem and the National Grid to accelerate access to the electricity grid for renewable electricity generators; and**
- **working with the Devolved Administrations to ensure that across the UK, planning systems for renewables projects can reduce delays and uncertainty for developers and others, while maintaining the openness, fairness and accountability of the current system.**

Electricity – Cleaner Coal and Carbon Capture and Storage

5.62 For many decades electricity generated from coal-fired power stations has played a major part in meeting the UK's electricity needs. Even with the growing importance of gas in the generation mix, coal-fired generation continues to meet around a third of electricity demand on average and during the winter of 2005/2006, in response to high gas prices, it met about half of demand. This illustrates the important contribution made by coal fired generation to the UK's energy security and the flexibility of its energy system.

5.63 Generators have recognised the importance of coal in their generating portfolios and have committed significant investment to enable 20GW, or about two thirds, of existing coal-fired capacity to comply with the Large Combustion Plant Directives (LCPD), which restricts emissions of sulphur dioxide and nitrogen oxides.

5.64 Coal-fired generation will therefore continue to play an important role in the UK's energy system, provided that its environmental impact can be managed effectively. As Table 5.1 below shows, coal-fired generation is the most carbon intensive of the major forms of electricity generation, emitting, for example, considerably more carbon than gas-fired generation. This underlines the importance and urgency of reducing the environmental impact from coal-fired generation.

5.65 There are at present three main means of reducing the carbon emissions from coal-fired generation – improving the efficiency of power stations, co-firing coal with biomass, and carbon capture and storage. These technologies are sometimes known collectively as "cleaner coal". The Government is taking action in each of these areas.

Table 5.1: Illustrative annual carbon emissions from 500MW electricity generation plant[43]

Plant type	Carbon emissions (millions tonnes / year)
Conventional coal	0.90
Efficient coal	0.69-0.74
Efficient coal with biomass	0.60-65
Natural gas	0.36
Natural gas or efficient coal with carbon capture and storage	<0.10

5.66 There has been and continues to be significant improvement in the efficiency, and therefore the carbon emissions intensity, of coal-fired generation technology. Advanced boilers, improved turbines and gasifiers can increase efficiency of coal plant and reduce emissions by about 20%.

43 Source: DTI, 2006.

5.67 There is the potential to increase further the efficiency of coal-fired generation and thereby improve its environmental performance. This is an important component of the Carbon Abatement Technology (CAT) strategy,[44] which sets out the Government's approach to supporting the development of low carbon technologies for power generation. £25 million was initially allocated to support technology demonstration within the CAT strategy and this was supplemented by an additional £10 million in the 2005 Pre-Budget Report.

5.68 This CAT strategy demonstration programme will formally launch its first call for proposals in September 2006. The first call is worth £10 million and will focus on the pre-commercial demonstration of key components and systems to support carbon abatement technologies. Subject to state aid approval, later calls in the scheme for the remaining £25 million will focus on projects which involve the demonstration of carbon abatement technologies in operating power stations.

5.69 More efficient coal plant can also be combined with co-firing of biomass to decrease emissions by about 10%. Co-firing has been incentivised through the Renewables Obligation. The Government has looked again at the co-firing rules and more detail is set out in the renewables section of this chapter.

Carbon capture and storage (CCS)

5.70 Carbon capture and storage (CCS) involves capturing carbon from a process that produces carbon, such as the burning of fossil fuels, and transporting it to a site where it is stored underground in geological formations and thereby prevented from entering the atmosphere.

5.71 CCS might reduce the carbon emissions from the combustion of fossil fuels in electricity generation and industry by 80 to 90% relative to the same plant without CCS. CCS in conjunction with electricity generation offers particular promise. The world still is and will continue to be highly dependent on electricity generation from fossil fuels. In the UK, for example, fossil-fuel based generation accounts for about 70% of UK electricity supply and about 30% of the UK's carbon emissions. Further, rapidly developing economies such as China and India are meeting much of their increasing demand for electricity through coal-fired generation. So if CCS were economic and technically feasible on a large scale, it could have a major impact on global carbon emissions.

5.72 Each of the component parts of the CCS process is already in use in various places around the world, including in commercial settings, although the whole CCS process in conjunction with electricity generation has not yet been demonstrated on a commercial scale. For instance, at the Great Plains Synfuels Plant in North Dakota, carbon dioxide is captured in a commercial setting and transported by pipeline to Weyburn in Canada where it is used to increase the recovery of oil from an oil field. A project at the Sleipner gas field in the Norwegian North Sea stores about one million tonnes of carbon dioxide per annum in a deep saline aquifer. But neither of these projects involves electricity generation. Indeed, because the whole CCS process in conjunction with electricity generation has not yet been demonstrated on a commercial

44 *A Strategy for Developing Carbon Abatement Technologies for Fossil Fuel Use*, DTI, 2005.

scale, there remain uncertainties about some of the technical, environmental and economic aspects of CCS in such a setting.

5.73 CCS nevertheless has great potential as a means of reducing global carbon emissions. Further, the UK has a number of natural and commercial advantages in developing CCS, because of the skills to be found within its well established oil and gas industries, and the role that oil and gas fields in the North Sea might play in CCS storage. Before CCS can play a significant role in reducing carbon emissions, however, there are a number of challenging regulatory issues that need to be resolved, both at home and abroad. CCS also presents real and new challenges in terms of its economic feasibility.

5.74 In the UK and elsewhere a number of specific proposals for large-scale CCS projects in conjunction with electricity generation have been brought forward by potential operators. While many of these proposals are only at an early stage in their development, they reflect a growing interest in CCS technology on the part of potential generators.

Developing a regulatory framework for CCS

5.75 Before CCS can happen in the UK, a legal and regulatory framework needs to be established which would enable operators to bring forward CCS projects that are safe, that minimise potential environmental risks and that assign responsibilities appropriately between the public and private sectors.

5.76 The Government will continue to work with international partners to amend international legal frameworks to provide the legal basis for CCS. Storage beneath the seabed is particularly important to the UK because of the available capacity associated with depleted oil and gas reservoirs as well as deep saline aquifers. Such storage falls under the international agreement called the London Convention which exists to protect the marine environment through preventing the dumping of wastes in oceans and seas world-wide. While this prevents marine pollution, it creates uncertainty over what types of CCS projects with carbon dioxide storage in the marine area are legally allowed. The Government has pushed strongly to clarify these rules, and in April 2006 a draft amendment was prepared which would allow geological storage of carbon dioxide beneath the seabed. A separate international agreement, the OSPAR Convention, exists to provide further protection of the marine environment in the North East Atlantic. Signatories to the Convention have agreed to start work to clarify and if appropriate amend the Convention to facilitate subsea geological storage of carbon dioxide, and the Government is supporting this initiative.

5.77 There are also a range of complex regulatory issues at the domestic level that the Government is working to resolve. In 2006 a CCS Regulatory Task Force was established with membership from across the Government. The Task Force will clarify existing UK regulation and its application, identify the need for new regulation, and develop proposals for new regulation as required in the following areas:

- the licensing of carbon dioxide storage sites and activities offshore;
- decommissioning and long-term liabilities associated with storage facilities; and
- licensing and regulation of onshore facilities, including carbon capture, transport and storage and "capture-ready" plant.

5.78 The work of the CCS Regulatory Task Force will continue in consultation with industry and other stakeholders in order to clarify and develop proposals on appropriate regulations both to facilitate CCS and to ensure the environmental integrity of CCS activities. This should include an assessment of the issues relating to liability for carbon dioxide in geological storage, including in the longer-term. The Government will consider the best ways to consult as the Task Force's work progresses, including the option of a formal consultation covering all aspects of CCS regulation. Formal consultation on carbon dioxide storage in the marine environment already forms part of the Marine Bill consultation.

International cooperation

5.79 The UK has joined together with international partners to facilitate the adoption of CCS and to encourage its development in countries with rapidly growing energy needs.

5.80 The UK is working in partnership with Norway through the North Sea Basin Taskforce to develop, where appropriate, common principles for the regulation and management of carbon dioxide transport, injection and storage in the North Sea. The Taskforce is comprised of public and private organisations from both countries and will be reporting its conclusions to the UK and Norwegian Energy Ministers by 2007. As announced in the 2005 Pre-Budget report, the UK and Norway have also been working collaboratively on the issues surrounding the costs of CCS.

5.81 The development of CCS in the North Sea is likely to require a new infrastructure enabling the transport and storage of carbon dioxide. This is a big challenge and there will clearly be benefits in the coordinated international development of each element of CCS.

5.82 The Chancellor and the Norwegian Prime Minister announced in June 2006 a joint project on enabling CCS in the North Sea. This will include an examination of the likely future need for a physical infrastructure of pipelines, the advantages of and barriers to the development of such a potential network, and ways in which the benefits of CCS could be realised in the most efficient and cost-effective way. The project will also examine aspects of the international regulatory regime including the rules for CCS in the EU Emissions Trading Scheme (see below).

5.83 The UK is also working to encourage the development of CCS in countries with rapidly growing energy needs. As part of the UK's Presidency of the EU during 2005, the Government announced it was to take the lead in setting up an EU-China collaboration on CCS with China through the Near Zero Emissions Coal (NZEC) project which aims to demonstrate coal fired power generation with carbon capture and storage technology in China by 2020. The UK has funded and is leading on the first phase of the NZEC project. The UK is also actively exploring the potential for collaboration on CCS with the Government of India, which also has a rapidly expanding power generation sector highly dependent on coal.

Economics of CCS

5.84 While creating the legal and regulatory framework which would allow CCS projects to come forward is a necessary step in making CCS a reality, it is not in itself sufficient. CCS will only realise its potential if it is also technically feasible, environmentally sound and economically viable. The evidence available, including experience from existing projects involving the capture, transportation and storage of carbon, suggests that CCS is both technically feasible and, with suitable safeguards and appropriate choice of storage sites, involves an acceptable level of environmental risk. Further, studies[45] suggest that shortage of suitable sites for carbon storage is unlikely to be a significant constraint on CCS's potential to deliver carbon emissions reductions on a large scale. In the long run the most crucial issue for CCS may therefore be its economic and commercial feasibility.

5.85 The costs of CCS consist of both the costs of the capture technology and transport and storage infrastructure, and the process of capturing, transporting and storing carbon. Further, carbon capture imposes a significant reduction in the efficiency of the underlying electricity generation process. There remains significant uncertainty about the scale of some of these costs, in part because CCS has not yet been demonstrated on a commercial scale in conjunction with electricity generation. For CCS to be commercially feasible, where these costs are incurred by the owners of plant with CCS they must be offset by some benefits to the owners.

5.86 Depleted oil and gas fields in the North Sea are potential storage sites for carbon dioxide, and carbon dioxide can also be used to enhance oil recovery from oil fields that are still active. There may be scope for reuse of some of the oil and gas infrastructure in the North Sea for CCS. Following an announcement in the 2005 Pre-Budget Report, the Government has opened discussions with industry to examine structural issues for the North Sea fiscal regime. The discussions provide a useful vehicle for HM Treasury and HMRC to work with industry to consider ways in which greater certainty can be provided on how existing tax rules impact on the use of assets involved in energy production, in particular where assets have previously been used in oil and gas exploration and production activities.

5.87 A crucial step in bringing CCS closer to economic and commercial feasibility is ensuring that the environmental benefits that it secures are recognised and rewarded under schemes and policies designed to encourage carbon emissions reductions. This will help ensure that the environmental benefits of CCS are taken into account by generators when they make investment decisions.

5.88 Before this year it was not possible to include the impact of CCS on the quantity of emissions countries reported to the United Nations Framework Convention on Climate Change (UNFCCC). This meant that countries could not use CCS to help them meet their Kyoto targets. Through its work with the International Panel on Climate Change (IPCC) the Government has made a major contribution to the development of new guidelines on accounting for greenhouse gas emissions, which now allow emissions from CCS projects

45 For example the *IPCC Special Report on Carbon Dioxide Capture and Storage*, IPCC, 2005.

to be reflected in emissions reporting. This means that CCS projects will in principle be able to help countries to meet their targets for the first Kyoto commitment period, 2008-2012.

5.89 The development of these guidelines is a crucial step towards such projects being counted as Clean Development Mechanism (CDM) projects, which allow developed nations to achieve part of their emissions reduction obligations under the Kyoto Protocol through projects in developing countries. There are still outstanding issues preventing CCS projects from being recognised as CDM projects at present, but the Government is working hard with EU partners to reach agreement on this within the UNFCCC.

5.90 These new guidelines, and potentially the recognition of CCS as a valid source of emissions reduction under the CDM, should serve to incentivise investment in CCS projects in both the developed and developing world.

5.91 Further, the Government will continue to push for the recognition of CCS within the EU ETS. This issue has been considered by the European Commission through the European Climate Change Programme's Working Group on CCS, and a communication from the European Commission is expected in autumn 2007 on this and other issues relating to CCS.

Next steps

5.92 In the light of the significant cooperation that the UK is undertaking with Norway, the Carbon Abatement Technology Strategy's £10 million call for demonstration and the recent announcement of the Environmental Transformation Fund, the next step would be a commercial demonstration of CCS, if it proved to be cost-effective. Following HM Treasury's recent consultation on CCS, we will do more work on the potential costs of such demonstration projects. A further statement will be made at the Pre-Budget Report.

- **The Carbon Abatement Technology demonstration programme will formally launch its first call for proposals in September 2006, with a first call worth £10 million which will focus on the pre-commercial demonstration of key components and systems to support carbon abatement technologies.**
- **The Government will continue to work with international partners to amend international legal frameworks to provide the legal basis for CCS.**
- **The work of the CCS Regulatory Task Force will continue in consultation with industry and other stakeholders in order to clarify and develop proposals on appropriate regulations both to facilitate CCS and to ensure the environmental integrity of CCS activities.**
- **The Government will continue working with international partners to develop CCS's potential, including through the recently announced joint UK-Norway project on enabling CCS in the North Sea and the EU-China Near-Zero Emissions Coal initiative.**
- **The Government will continue to push for the recognition of CCS within the EU ETS.**
- **The Government believes that the next stage would be a commercial demonstration of CCS, if it proved to be cost-effective. More work on the costs of such demonstration projects will be undertaken, and a further statement will be made at the Pre-Budget Report.**

Electricity – Nuclear

Introduction

5.93 Nuclear power is a source of low carbon generation which contributes to the diversity of our energy supplies. Under likely scenarios for gas and carbon prices, new nuclear power stations would yield economic benefits in terms of carbon reduction and security of supply. Government believes that nuclear has a role to play in the future UK generating mix alongside other low carbon generating options. Evidence gathered during the Energy Review consultation supports this view.

5.94 Consultation evidence highlighted regulatory barriers which are faced by many energy projects, including nuclear. In response to this, the Government is setting out a proposed framework for the consideration of the relevant issues and the context in which planning inquiries should be held. This framework would be set out in a White Paper to be published around the turn of the year. To support preparation of this White Paper, Government is consulting on the proposals outlined in Annex A of this document. Under this framework, Government will assess planning applications on their merits, taking into account the policy set out in the previous paragraph.

5.95 Planning is a devolved matter and powers to grant consent for the construction of large power stations in Scotland have been executively devolved, therefore it will be for Scottish Ministers to take such decisions.

5.96 Any new nuclear power stations would be proposed, developed, constructed and operated by the private sector, who would also meet full decommissioning costs and their full share of long-term waste management costs. The Government does not take a view on the future relative costs of different generating technologies. It is for the private sector to make these judgements, within the market framework established by Government. The actual costs and economics of new nuclear will depend on, amongst other things, the contracts into which developers enter, and their cost of capital for financing the project.

5.97 However, for the purposes of this report, the Government has carried out a cost-benefit analysis of nuclear new build in order to inform its conclusions on the potential role of nuclear power and whether the Government should take facilitative measures to enable new build to come forward as a generating option[46]. This analysis is based on a number of gas prices, carbon prices and nuclear costs, rather than a single projection.

Nuclear is a potentially economic source of electricity generation

5.98 The economics of new nuclear build depend on expectations about future gas and carbon prices, as well as expected costs of building, operating, decommissioning and dealing with the waste of a new nuclear plant. Based on a range of plausible scenarios, the economics of nuclear now look more positive than at the time of the 2003 Energy White Paper. However, it will be for the private sector to make commercial decisions on investment in nuclear.

46 A summary of this cost-benefit analysis, together with other background information, is available on the DTI website www.dti.gov.uk/energy/review

5.99 The following table sets out a number of scenarios:[47]

Table 5.2: Nuclear generation welfare balance under alternative gas price, carbon price and nuclear cost scenarios, £m/GW

	Low gas price	Central gas, high nuclear	Central gas price	Central gas, low nuclear	High gas price
Carbon price = €0/tCO2	-2100	-1400	-400	900	1400
Carbon price = €15/tCO2	-1500	-900	200	1400	2000
Carbon price = €25/tCO2	-1100	-500	600	1800	2400
Carbon price = €36/tCO2	-700	0	1000	2300	2800

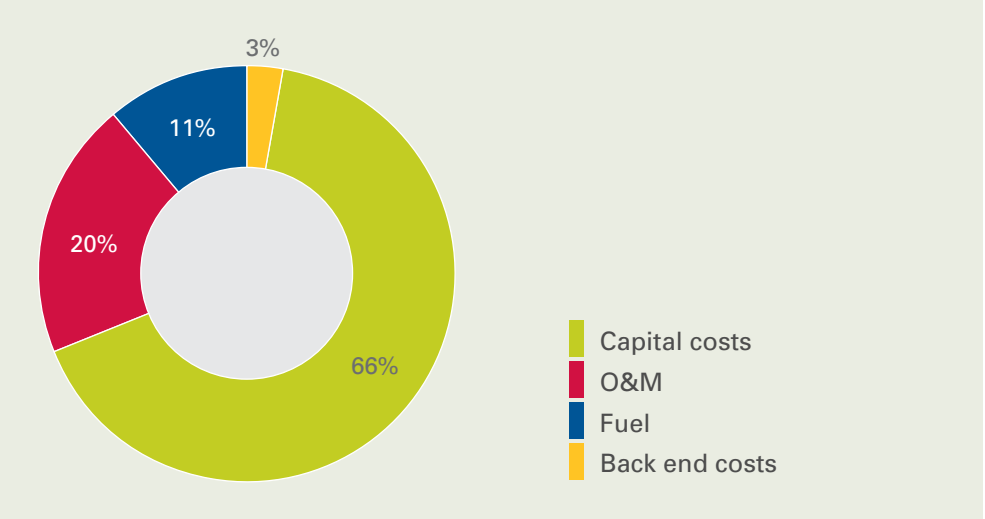
5.100 The central gas price scenario (37p/therm) reflects the current market situation. While the gas price has been around 20 pence/therm on average over the last decade, the average price in 2005 was 42 pence/therm. Going forward the central gas price is expected to remain high by historical standards, in line with expectations on the oil price. Sustained commitment to tackling climate change makes the positive carbon price scenarios more likely.

5.101 The cost of new nuclear power generation is assumed to be around £38/MWh, as a central case. However, we have also considered a high case of (£44/MWh) and a low case of (£30/MWh). For the central gas price scenario (37p/therm) and a carbon price of €36/tCO_2 the economics of nuclear remain robust for generating costs up to £43/MWh. This is well above the forecast cost of power generated from the Finnish nuclear project currently under construction, by a margin that far exceeds any historical cost overruns associated with nuclear projects, e.g. Sizewell B.

5.102 The cost profile of nuclear power is different from that of most other generating technologies. Chart 17 below shows findings for the proportion of the levelised cost of nuclear power (i.e. average cost per megawatt hour over the life of the power station) that may be attributed to each stage of a station's life. The majority of nuclear costs are capital, reflecting the complexity of the construction of the plant. By contrast, the fuel cost represents a small proportion of the overall cost.

47 The table shows monetarised environmental and security of supply benefits net of cost penalties in £m/GW, NPV over 40 years.

CHART 17. NUCLEAR COSTS BY STAGE



Source: DTI, 2006.

5.103 Increases in the price of fuel will have a relatively minor effect on the economics of nuclear, because fuel costs represent only approximately 11% of the levelised cost[48]. The doubling of uranium prices since 2000 has had only a minor impact on final fuel costs and overall generation costs[49]. By contrast, gas-fired generation is vulnerable to changes in the cost of fuel because this makes up 71% of its levelised cost[50].

Nuclear plays an important role in reducing carbon emissions

5.104 The full lifecycle release of CO_2 from nuclear power is similar to wind power, and much less than fossil fuel plant[51]. As an illustration of the many studies which have been conducted, the Organisation for Economic Development and Co-operation (OECD) Nuclear Energy Agency (NEA) has published a table (see table 5.3) giving the full lifecycle carbon emissions of a range of generating technologies.

48 DTI analysis 2006.
49 IAEA Red Book 2005.
50 DTI analysis 2006 – this assumes gas costs of 36.6p/therm, as per DTI assumptions set out in annex B.
51 Sustainable Development Commission, The Role of Nuclear Power in a Low Carbon Economy, Paper 2: Reducing CO_2 Emissions – Nuclear and the Alternatives, March 2006.

Table 5.3: Total Lifetime Releases From Selected Technologies		
Technology (2005-2010)	GC/kWh*	1.Equivalent to GCOÇ/kWh**
Lignite	228	836
Coal	206	755
Natural Gas	105	385
Biomass	8-17	29-62
Wind	3-10	11-37
Nuclear	3-6	11-22

*Grams of Carbon per kilowatt hour of electricity produced.
** Grams of Carbon Dioxide per kilowatt hour of electricity produced.
Source: OECD Nuclear Energy Agency.

5.105 Some respondents to the Energy Review consultation questioned nuclear's credentials as a net producer of low carbon energy, particularly in relation to the availability of high quality uranium ore. Lower grade ores will require more energy to make fuel for nuclear power stations, which could increase the lifecycle carbon emissions from nuclear power. However, it is not expected that high-grade resources will be depleted in the foreseeable future[52]. This view is endorsed by the International Atomic Energy Agency (IAEA) and NEA; none of the planned new mining projects are of significantly lower grade ores than that currently mined[53]. As such, we can have confidence that the estimates of the lifecycle emissions from nuclear will remain comparable with wind power, a view highlighted by the Sustainable Development Commission[54].

Nuclear contributes to increased diversity of energy supplies

5.106 Nuclear currently provides around 20% of the country's electricity needs and a significant proportion of its baseload capacity. However, most of our existing nuclear power stations are scheduled to close over the coming two decades. In the absence of new nuclear build or life extensions to existing nuclear plant, the nuclear share of generation will decline sharply by the 2020s. Much of our coal generating capacity is also likely to face closure over this period. We expect a substantial increase in renewable capacity by then. However, central projections indicate that based on the existing market framework, many of the closing power stations would be replaced with gas-fired power stations. This would increase our dependence on imported gas. By 2020, electricity generated by gas would probably be around 55%.

5.107 There is a possibility of extensions to the scheduled lives of some existing nuclear plant. However, this is uncertain, and will remain so for some years. Any life extensions would help mitigate the decline in low carbon generation in the period towards the end of the next decade. However, it is less clear and certain that life extensions would have a significant impact on the amount of nuclear capacity operating in the 2020s.

52 Sustainable Development Commission The Role of Nuclear in a Low Carbon Economy – "Paper 8 Uranium Resource Availability".
53 Information from IAEA member states submitted to IAEA/NEA for "*Uranium 2005: Resources, Production and Demand*", aka "Red Book".
54 Sustainable Development Commission The Role of Nuclear in a Low Carbon Economy – "Paper 2 Reducing CO2 Emissions – Nuclear and the Alternatives".

5.108 Investment in new nuclear capacity would help to sustain a diverse electricity generation mix, by reducing the level of total UK gas consumption and gas imports. For every gigawatt of nuclear capacity displacing gas-fired generation, gas demand is expected to be approximately 1.3bcm lower than otherwise (representing roughly 1% of projected gas demand in 2020). This could make an important contribution to the diversity of our energy supplies, particularly in light of the decline in indigenous gas supplies from the North Sea.

Availability of fuel

5.109 Realising the potential benefits of new nuclear build would naturally be dependent on the availability of fuel. The range of assessments of future prospects for uranium supplies reflects the difficulty of making exact predictions, in exactly the same way as predictions of future oil and gas reserves are complex.

5.110 Predictions on how long uranium deposits will last in any given country are dependent on a number of variables:

- the number of new mines and the rate at which they come on stream;
- the price of uranium ore. The price affects the mining market and may make mining of certain deposits more viable;
- new nuclear reactor technology may use less uranium thereby extending the lifetime of available uranium deposits;
- more nuclear reactors may be built globally, thereby increasing the demand on available uranium deposits; and
- increased use of reprocessing to recycle used fuel and create MOX (Mixed Oxide) fuel (a mix of uranium and plutonium) will require less uranium.

5.111 Every two years, the IAEA and NEA undertake a comprehensive assessment of the availability of uranium, taking into account expected production and demand levels. Their most recent report[55] estimates the identified amount of conventional uranium resources that can be mined for less than USD 130/kg (just above the current spot price) to be about 4.7 million tonnes. Based on the 2004 nuclear electricity generation rate this amount is sufficient for 85 years. Deposits of uranium ore are distributed across a range of countries, including those on whom we are not currently dependent for fossil fuels. Using IAEA figures it is possible to make a rough, high-level estimate that reserves in Australia alone will last another 150 years, with reserves in Canada lasting 45 years, based on current estimated resource and production levels[56].

5.112 The demand for uranium has increased in recent years, resulting in higher prices for uranium ore. However, the IAEA expect future increases to be modest, even with further increasing global demand. Prices are expected to remain substantially below historically high levels of the 1970s. At the same time the increases we have seen are expected to encourage further exploration of uranium resources, as can be seen from the new mines expected to open across the world and from the increasing exploration.

55 IAEA/NEA Red Book 2005.
56 IAEA/NEA Red Book 2003, updated 1 June 2006.

Nuclear Waste

5.113 The 2003 Energy White Paper noted that there are "important issues for nuclear waste to be resolved". Work is underway to tackle the legacy of nuclear waste. The Nuclear Decommissioning Authority (NDA) is setting a UK-wide strategy for more effective decommissioning and clean up of its sites. The Committee on Radioactive Waste Management (CoRWM) was established in the second half of 2003 to make recommendations on the best options for the long-term management of the UK's higher activity radioactive waste. It has evaluated the options in an open and inclusive manner and Government believes the approach they have taken will provide a sound basis for building future consensus.

5.114 CoRWM produced interim recommendations in April. In these, CoRWM concluded that deep geological disposal in a repository is the best available approach for the long-term management of waste, and that a programme of interim storage (already planned by the NDA as part of its strategy) is required. While CoRWM has no position on the desirability or otherwise of nuclear new build, CoRWM has however said that "in principle" new build wastes could be incorporated within in their options, although this would raise practical issues about the size, number and location of facilities, which would need to be properly assessed[57]. CoRWM's final report will be published at the end of July. The Government will respond in a formal statement to parliament as will the Devolved Administrations, setting out how work to manage long-term waste will be taken forward.

5.115 The UK has a historic legacy of nuclear waste that it is estimated will total 475,000m^3 (high and intermediate level). Similar to France, the UK's legacy nuclear wastes include a complex mix of waste forms from both the civil and military programmes which increases the technical challenges in conditioning them for ultimate disposal. Through the NDA, and the nature of the ownership of the current civil nuclear industry, the public sector is ultimately responsible for delivering and paying for a long term waste management solution. The private sector would pay its full share of the costs of long term waste management arising from any new nuclear build.

5.116 Modern nuclear plants produce significantly less waste than early generations of nuclear reactors by volume. CoRWM's inventory study suggests that if the current level of nuclear capacity were replaced with new build, existing waste stocks would increase by about 10% by volume.

Regulatory Protection

5.117 The UK already has in place a mature regulatory framework to ensure the safety, security and environmental risks of nuclear are managed effectively. Before any developer is allowed to begin construction of a nuclear power station, they must have a site licence from the Nuclear Installations Inspectorate (NII), part of the Health and Safety Executive (HSE). This licence certifies that the design can be operated safely with risks "as low as reasonably practicable".

57 CoRWM draft recommendations www.corwm.org.uk

Regulatory Protection – Safety

5.118 Nuclear power stations in the UK must be designed and operated to stringent standards which demand that all reasonably practicable steps are taken to avoid accidents, as well as requiring multiple barriers to mitigate the consequences of any that might occur. Safety standards have advanced over the years and the IAEA has developed a suite of international safety standards that reflect worldwide good practice. The recent revision of HSE's Safety Assessment Principles has been benchmarked against those international standards.

5.119 Nuclear power stations are designed so that there are a number of different safety systems, with multiple back-ups, resulting in a robust system for responding to abnormal operation and fault conditions. The current safety assessment principles state that safety equipment should be actuated automatically, and that no human action should be necessary for at least 30 minutes.

5.120 The risks of a nuclear accident with significant offsite impacts are very small. Globally, in the history of civil nuclear power there have been ten incidents that have resulted in offsite impacts, as classified by the IAEA/OECD International Nuclear Event Scale[58]. While some of these incidents were extremely serious, the majority had only minor consequences. The Sustainable Development Commission has described the UK's civil nuclear power stations have having an "excellent safety record". In the UK, there have been no major incidents relating to a civil nuclear power station and there have been no events recorded either with off-site consequences or where all safety barriers had been exhausted. The most serious incident, the 1957 Windscale accident, where there was an off-site release but no loss of life or long-term environmental damage[59], occurred at a reactor of a very early design, designed solely for military purposes[60].

5.121 Modern reactor designs are expected to reduce the very small accident risks still further[61]. Modern designs have multiple layers of protection to guard against faults and wherever possible employ safety systems which operate passively and require no operator intervention. Passive safety systems further reduce the human error factor, which in the past has been a factor in some of the more serious nuclear incidents.

Regulatory Protection – Radiation

5.122 Radiological protection of employees and the general public in the UK is covered by a structured legal framework. Any discharge of radioactivity to the environment from a nuclear site is only permitted under an authorisation from the relevant environmental regulator[62]. Doses to the public as a result of authorised discharges are kept as low as reasonably achievable by the regulators' requirement that operators use best practicable means to minimise the activity of waste discharged.

58 Sustainable Development Commission The Role of Nuclear in a Low Carbon Economy – "Paper 6 Safety and Security", March 2006.
59 cited in Sustainable Development Commission Report "Paper 6 Safety and Security", March 2006.
60 In response, the Government of the day set up an independent nuclear regulator, HM Nuclear Installations Inspectorate, which is now part of HSE.
61 Sustainable Development Commission Report "Paper 6: Safety and Security", March 2006.
62 The Environment Agency in England and Wales and the Scottish Environment Protection Agency in Scotland.

5.123 Permitted dose levels to the public, as a result of nuclear industry operations, are only a small fraction of natural background radiation, which makes up 80% of the average annual dose. The average dose to a member of the public, due to radioactive discharges, is 0.015% of the annual average dose from all sources[63]. The largest source of manmade radiation relates to medical exposures, accounting for 14% of the average annual dose[64].

Regulatory Protection – Security and Non-Proliferation

5.124 Although the international security situation is expected to remain at current levels in the medium to long term, the Office for Civil Nuclear Security (the UK security regulator) considers that new nuclear build would be unlikely to increase risks to the UK. Any new plant would be built taking the current threat environment into account, with robustness and security built-in, rather than retro-fitted as with the existing plant.

5.125 An international mechanism for keeping track of nuclear material, referred to as Safeguards, is operated by the International Atomic Energy Agency (IAEA) and the European Commission to detect and prevent diversion of this material from peaceful use. The UK, as a nuclear weapons state, has a voluntary agreement with the IAEA and is a signatory of the EURATOM Treaty, both of which cover all our civil nuclear installations, as part of this regime. Any new nuclear reactors would be covered by these agreements. The proliferation risks from an increase in the number of modern reactors in the UK are small; all of the plants that industry have highlighted as potential candidate designs for new build in the UK can be considered as low-proliferation risk. To further international non-proliferation objectives, the UK is working with US, France, Russia, Germany and other states, as well as the IAEA, to establish international assurance of supply for nuclear fuel which is aimed at avoiding widespread investment in sensitive enrichment and reprocessing plants, which can have a greater proliferation risk.

Where might new nuclear plant be built?

5.126 Any new nuclear stations would be proposed, constructed and operated by the private sector. Industry has indicated that the most viable sites for new build are likely to be adjacent to existing nuclear power plants. It will be up the potential participants of new build to discuss with the owners appropriate access to suitable sites. We will undertake a further assessment which will help developers in identifying the most suitable sites. Government will monitor whether an appropriate market in suitable sites is developing.

Networks

5.127 The Government has examined whether the transmission network could be a potential barrier to new nuclear generation. The costs of accommodating new nuclear build at existing sites vary considerably. This is because the existing capacity at some sites is lower than others. Some sites will therefore require extensive upgrading or new overhead lines, many requiring new planning approval. Such costs are likely to be a factor in the private sector's site selection process. There could also be costs incurred from needing to upgrade the system further away from the site to accommodate increased flows of energy.

63 Sustainable Development Commission Report "Paper 6: Safety and Security", March 2006.
64 Sustainable Development Commission Report "Paper 6: Safety and Security", March 2006.

Supply Chain and Skills

5.128 One issue which was raised during the Energy Review consultation was the potential for shortages in the supply chain for all types of new power station. This is due to increased global demand for limited resources and a shrinking skills/company base. Addressing some of the regulatory barriers associated with civil nuclear power (as set out below) should enable industry to undertake long-term planning, allowing pre-positioning of resources, orders and manufacturing slots. It would also enable industry to secure the engineering design resource from the technology provider.

5.129 The Nuclear Industry Association believes that nuclear skills are available for new nuclear build and that potential skills pinch points can be managed through long-term planning and training programmes. The Cogent Sector Skills Council was licensed in March 2004 to take a strategic view of the nuclear sector; a Cogent Labour Market Study completed in September 2005 was generally positive, with few shortages in specialist areas and reported that the industry is making a high commitment to training. The Engineering Construction Industry Training Board is working with its client companies to resource a significant increase in UK investment over the coming decade. The Energy and Utility Skills Sector Skills Council has taken steps to ensure that the skills to support the expansion of the transmission system will be in place.

5.130 UK Research and Development capability will be critical to the nuclear clean-up programme going forward and may also become important to support other strategic initiatives such as new nuclear build in the future. While the market should provide much of the nuclear R&D that will be needed, Government will want to ensure in any transitional period that current key R&D capabilities are preserved and developed, potentially as part of a National Nuclear Laboratory. We will be carrying out some detailed work over the coming months to establish the way forward on this.

Proposals

5.131 Within the UK's market-based framework, it is for companies to make investments in new power stations, including investments in any new nuclear stations. However, interested parties have made clear as part of the Energy Review consultation that if new nuclear is to play a role in the future of UK electricity generation, the Government needs to address a number of regulatory barriers. Some of these barriers are common to all large energy projects, while others are specific to nuclear. The current planning systems creates delays and uncertainties for all energy infrastructure projects (see chapter 7 for more detail). The inquiry for Sizewell B (the most recent nuclear plant to be built in the UK) took 73 months, with the direct inquiry costs reaching £30m. Our proposals to tackle the regulatory barriers facing nuclear are set out below.

Pre-Licensing

5.132 Government welcomed the recent independent expert report published in June by the HSE/NII that, among other things, set out the potential role of pre-licensing assessments of candidate reactor designs. Government also welcomes a similar report by the Environment Agency on the potential to provide their own pre-authorisation statements in relation to radioactive discharges. Based on these expert reports, Government has asked HSE/NII to

take forward proposals to introduce a pre-licensing, design authorisation procedure, and the Environment Agency to introduce a similar system of pre-authorisation. We expect the regulators to work closely together to introduce an integrated regulatory framework.

5.133 The new framework would allow potential developers to apply for pre-licensing approval for a generic reactor design before committing significant sums of capital to planning and construction. Providing the subsequent development and construction followed this "pre-licensed" standard design, potential developers should be confident that their site licence application would be approved by HSE/NII without significant (and potentially costly) design modifications to address unresolved issues.

5.134 The Office for Civil Nuclear Security (OCNS) and the Environment Agency expect to contribute to the HSE/NII's pre-licensing process to avoid the need to add measures to the design after the safety case has been made. A staged approach to licensing was one of the recommendations of a recent IAEA review as a sensible way to manage any new build. HSE will develop guidance for this new process to be in place by the start of 2007. The Government has asked HSE/NII to develop more detailed guidance for this process to be in place by the start of 2007.

Planning – Setting the Policy Framework for New Nuclear Build

5.135 The recommendations on streamlining the planning process for all large electricity infrastructure projects are outlined in detail in chapter 7. Any nuclear projects in England and Wales would also benefit from these changes. As is discussed in chapter 7, Scotland has its own planning system and is taking forward work to make it more efficient. Scottish Ministers will also take any planning permission decisions for any new nuclear power stations in Scotland.

5.136 In addition, Government is setting out a proposed framework for the consideration of the issues relevant to new nuclear build and the context in which public inquiries, as part of the planning process, should be held. This framework would be set out in a White Paper to be published around the turn of the year. To support preparation of this White Paper, Government is consulting on the proposals outlined in annex A of this publication.

5.137 We are seeking views on a policy framework in which national strategic and regulatory issues are most appropriately discussed through processes other than the public inquiry. The inquiry should focus on the relationship between the proposal, the local plans and local environmental impacts. The inquiry should weigh up these issues against the national strategic or regulatory material considerations, which will have already been established. The inquiry should also examine the local benefits of the development and how specific local impacts of the construction and operation of the plant can be minimised.

Waste and Decommissioning

5.138 Satisfactory arrangements will need to be established for dealing with the costs of decommissioning and waste from nuclear new build. Government will need to be satisfied an appropriate structure is in place to ensure that participants in nuclear new build deal with these costs. It is important that arrangements are sufficiently robust, particularly given that in order to comply with its international obligations for nuclear safety Government must bear the ultimate responsibility for the management (or disposal) of radioactive waste and spent fuel in the event that no other party is able to discharge those obligations.

5.139 Government will engage with industry and other experts to develop arrangements for managing these costs based on the principles set out below. The first step will be for Government (with the support of the NDA) and industry to have a common understanding of the likely costs of decommissioning and waste management. Industry participants will need to meet the financial requirements established by the Government's decommissioning and waste frameworks even in challenging downside scenarios.

5.140 In the case of waste disposal costs it is recognised there will need to be a mechanism that shares the burden between the existing legacy wastes and the cost arising from nuclear new build.

5.141 Government intends to appoint an individual with senior management or financial experience of major capital investment projects to lead the development of arrangements for the costs associated with new build decommissioning and waste management. This individual, who will be supported by officials from the DTI, will lead discussions with industry on these topics and make proposals, based on the principles set out below. Further details on the work programme and timetable will be published by the time of the White Paper.

5.142 **Principles: The Risk Management Framework – Decommissioning**

- There should be an upfront assessment of decommissioning costs.
- Full responsibility for decommissioning costs to be retained by the private sector operator(s).
- Protection will be given to the public sector regarding credit risk and reduced reactor life.
- The framework should be robust and transparent through time.
- These principles will form the basis of arrangements which will apply consistently to all new build operators and reactor types.

5.143 **Principles: The Risk Management Framework – Waste**

- Delivering and paying for a long term waste management solution for legacy waste is a responsibility that falls to the public sector. Any long-term waste management solution developed by Government will factor in waste from new build.
- There will be an assessment of how new build affects the cost of delivering the national waste management solution.

- The private sector will pay a charge covering the full and equitable costs of managing the waste generated over the expected life of each new power station.
- The level of this charge will be informed by work on the Government's long term waste management solution.
- The commercial nature of the arrangements in relation to waste disposal will incentivise participants to operate power stations in a way that seeks the optimal balance between performance and waste generation.
- Protection will be given to the public sector regarding changes in reactor life and other factors.
- Provision of interim storage over the life of the plant will be the responsibility of the operator.
- The framework should be robust and transparent through time.
- These principles will form the basis of arrangements which will apply consistently to all new nuclear build operators and reactor types.

Nuclear Proposals

- **The Government believes that nuclear has a role to play in the future UK generating mix alongside other low carbon generation options.**
- **Any new nuclear power station would be proposed, developed, constructed and operated by the private sector who would also meet decommissioning and their full share of long-term waste management costs.**
- **We will undertake further assessment which will help developers in identifying the most suitable sites. It will be up to the potential participants of new build to discuss with the owners appropriate access to suitable sites. Government will monitor whether an appropriate market in suitable sites is developing.**
- **Government has asked HSE to take forward proposals to introduce a pre-licensing, design authorisation procedure, and the Environment Agency to introduce a similar system of pre-authorisation.**
- **Government is setting out a proposed framework for the consideration of the issues relevant to new nuclear build and the context in which planning inquiries should be held. This framework would be set out in a White Paper to be published around the turn of the year. To support preparation of this White Paper, Government is consulting on the proposals outlined in annex A of this publication.**
- **We are seeking views on a policy framework in which national strategic and regulatory issues are most appropriately discussed through processes other than the public inquiry. The inquiry should focus on the relationship between the proposal, the local plans and local environmental impacts. The inquiry should weigh up these issues against the national strategic or regulatory material considerations, which will have already been established. The inquiry should also examine the local benefits of the development and how specific local impacts of the construction and operation of the plant can be minimised.**

- **As is proposed for the more contentious onshore wind projects, Government will appoint a high-powered inspector whose role will be to ensure that planning inquiries are run to clearly defined timescales, and maximum use is made of the powers and efficiencies set out in the major infrastructure projects rules.**
- **Government will engage with industry and other experts to develop arrangements for managing the costs of decommissioning and long term waste management based on the principles set out in this text.**
- **Government intends to appoint an individual with senior management or financial experience of major capital investment projects to lead the development of arrangements for the costs associated with new build decommissioning and waste management. This individual, who will be supported by officials from the DTI, will lead discussions with industry on these topics and make proposals, based on the principles set out below. Further details on the work programme and timetable will be published by the time of the White Paper.**