



Alternatives to nuclear power

This annex looks at alternative futures for achieving our long-term energy goals. It uses updated analysis originally conducted for the Energy White Paper and the Nuclear Consultation Document to outline the implications for our energy goals if we ruled out the option of new nuclear power stations.

Introduction

- A1 Our two key energy challenges are to tackle climate change by reducing carbon dioxide emissions and to ensure secure, clean and affordable energy as we become increasingly dependent on imported fuel.
- A2 There is great uncertainty about future energy demand, the pace of technological change and the future availability and cost of energy supplies. In this context, the Government's view is that the policy environment should provide a framework that allows investors to consider a portfolio of different technology options that are consistent with our goals to reduce carbon dioxide emissions and to achieve security of supply. Reliance on single solutions on their own will not allow us to meet our goals under all circumstances. By having diverse options, the UK will be better placed to deal with the range of possible futures that could unfold.
- A3 This annex sets out our analysis of how the UK could deliver its goals for energy policy without new nuclear power stations and looks at the implications for our carbon emissions reductions targets, security of supply and costs. The analysis focuses on the implications for the medium to long-term energy mix since, given the lead times for new nuclear power stations, this is the period when new nuclear power stations could reasonably be expected to make a contribution to delivering Government's energy policy goals. It shows that to achieve our goals, without giving energy companies the option to build new nuclear power stations, would imply:
- Further need for significant improvements in energy efficiency across all sectors beyond what is set to be achieved through current policy
 - Higher cost emissions reductions in the electricity generation sector and greater effort to reduce emissions through more costly options outside the electricity generation sector, for example transport
 - A higher risk of not significantly reducing carbon emissions in the electricity generation sector, because of greater reliance on

low-carbon electricity generation technologies which are subject to greater risks in terms of their feasibility and deployability, e.g. wind and carbon capture and storage (CCS). This could also have implications for security of electricity supplies

- A mix of electricity generation technologies with less diverse characteristics than if new nuclear power stations were to be an option, with implications for ensuring energy security under the widest range of future scenarios.

A4 The Government's view is therefore that excluding nuclear power as an option would make it more challenging and expensive to meet our goal to reduce carbon emissions and could expose the UK to greater security of supply risks because our electricity supplies would be less diverse.

Carbon emissions

Contribution of nuclear power to reducing carbon emissions

A5 The Climate Change Bill²³⁴ commits the Government to legally binding targets to reduce carbon emissions by at least 60% from 1990 levels by 2050²³⁵. This is equivalent to a fall in annual carbon emissions of around 317 MtCO₂ from 2005 levels²³⁶. All sectors of the economy will need to contribute if we are to achieve such an ambitious target.

A6 The electricity sector is currently responsible for about a third of the UK's total CO₂ emissions, emitting around 172 MtCO₂ in 2005. To achieve our 2050 target at minimum cost, the electricity sector will need, over the long-term, to considerably, if not fully, 'decarbonise', since reducing emissions from the electricity sector is in general relatively less expensive than in some other sectors, such as transport. However, in the medium to longer term, the King review of low carbon cars concluded that electric or hydrogen-powered vehicles will contribute to decarbonisation of road transport. This will require major technological breakthroughs as well as substantial progress towards decarbonising the power sector²³⁷. This could be achieved on the demand side, through action to save energy, and on the supply side, through the development of low-carbon generation technologies, such as renewables, CCS and nuclear power.

234 <http://www.defra.gov.uk/environment/climatechange/uk/legislation/index.htm>

235 The evidence now suggests that as part of an international agreement developed countries may have to reduce their emissions by up to 80%. This evidence will be considered by the Committee on Climate Change, which will advise Government on whether our own domestic target should be tightened up to 80%.

236 Emissions in 2005 were 553 Mt CO₂, compared to a target for 60% by 2050 of 236Mt CO₂.

237 http://www.hm-treasury.gov.uk/media/9/5/pbr_csr07_king840.pdf



- A7 Nuclear power now provides approximately 19% of our electricity generation²³⁸, 7.5% of total UK energy supplies²³⁹ and 3.5% of total UK energy use²⁴⁰. As a low-carbon source of electricity, nuclear power makes an important contribution to lowering the carbon intensity of our energy supplies. Without our existing nuclear power stations, the UK's CO₂ emissions would currently be some 29 to 59 MtCO₂²⁴¹ higher than otherwise. However, most of the existing nuclear power stations are due to close in the next 15 years or so, based on published lifetimes. Over the same period, 12 GW of coal and oil-fired power plants are due to close as they reach the end of their lifetime and due to EU environmental legislation.
- A8 It will be for energy companies, taking account of the changes in energy and electricity use and the Government's policy framework, to decide on the type of capacity that will replace the power plants that close over the next 20 years and beyond. It is therefore difficult to predict how the energy system and the electricity mix will develop in the long-term, that is over the next 40 to 50 years. Investors face great uncertainties in planning future power station projects. For example, on top of uncertainties about likely future demand for electricity, it is very difficult to predict the cost and availability of fossil fuels, or the cost and feasibility of existing and emerging low-carbon technologies.
- A9 To understand the long-term implications of allowing or not allowing energy companies to invest in new nuclear power stations, we have used analysis conducted for the Energy White Paper 2007, the Nuclear Consultation document and the Climate Change Bill Impact Assessment. This analysis used a model of the UK energy system, the Markal-macro model, to analyse different long-term scenarios and how these affect the combination of technologies that could allow us to achieve our 2050 target for CO₂ emissions at least cost (see Box A1)²⁴².
- A10 The Markal-macro model indicates that, under a range of different assumptions, a diverse and very low-carbon electricity generation mix would be the best way to reduce CO₂ emissions across the economy as a whole²⁴³.

238 The May 2007 consultation document stated that nuclear power accounted for around 18% of electricity, based on the latest energy statistics available at that time. The most recent published data now available, in the Digest of United Kingdom Energy Statistics 2007, shows that in 2006 nuclear power accounted for 19% of the electricity generated in the UK.

239 This figure is the total amount of fuel used to generate electricity taken as part of total energy supplies. This issue is discussed in Section 2 of this White Paper.

240 See the simplified flow diagram of UK energy supply and consumption 2006 showing the role of nuclear at <http://www.berr.gov.uk/files/file43008.pdf>.

241 Depending on the assumption made about the alternative capacity to replace nuclear.

242 For more details and the report on the work carried out for the Energy White Paper 2007 see <http://www.ukerc.ac.uk/TheMeetingPlace/Activities/Activities2007/0706MARKALMacroEWP.aspx>.

243 Full details of the assumptions and the methodology used in the Markal model are available on the UK Energy Research Council (UKERC) website <http://www.ukerc.ac.uk/ResearchProgrammes/EnergySystemsandModelling/ESMMARKALModelDocs.aspx>.

BOX A1 MODELLING APPROACH TO DEVELOP LONG-TERM SCENARIOS FOR THE ENERGY SECTOR

The UK MARKAL-macro model

MARKAL stands for MARKET ALlocation, since it mimics a market by always choosing the combination of technologies with the lowest cost. The MARKAL-macro model can be linked to a simple economic growth model, which represents the relationship between carbon, energy prices and energy demand. The combined MARKAL-macro (M-M) model gives estimates of future GDP, as well as the costs of carbon abatement in terms of a proportion of GDP. The M-M model covers the entire energy system, including electricity, heat and transport and is one of the few models that can explore the energy system in the long-term. We used the M-M model to explore different scenarios for the mix of technologies used to generate electricity in 2050, all of them consistent with achieving our goal of reducing CO₂ emissions by 60% by 2050 in the cheapest way. We conducted this analysis for a number of scenarios in order to capture the range of impacts on costs that might materialise under different assumptions about fuel prices and technology costs. The central scenarios used cost assumptions collected by the UK Energy Research Centre from a wide array of published sources and peer reviewed by a panel of experts. Other scenarios were developed using different ('DTI') assumptions based on numerous published market studies, reflecting estimates for typical projects being developed in the UK and published by DTI with the Energy Review Report, July 2006.

The MARKAL-MACRO model has both strengths and weaknesses. While its assumptions on data, technology pathways and constraints are transparent, not all factors can be captured fully. By optimising costs, in effect it represents a perfect energy market, and neglects barriers and other non-economic criteria that affect decisions. It also assumes that there is perfect foresight about the development of technologies and their costs so that at any point in time the model knows when and at what costs different technologies will become available. In addition, the model therefore does not capture the full range of uncertainty around the development of new technologies. In this way, it underestimates the full costs and risks of bringing less-developed technologies to market and the impact this could have on delivering our carbon goals while ensuring security of supply and affordability.

- A11 Our current approach to estimating savings in CO₂ emissions from Government policy measures is to assume that any new low-carbon generation plant that is built displaces new fossil fuel power stations, therefore saving the CO₂ emissions equivalent to that type of plant²⁴⁴. This is also the assumption made in the Markal model²⁴⁵. According to the model, nuclear power could, in 2050, deliver carbon emissions

²⁴⁴ The Nuclear Cost Benefit Analysis (<http://www.berr.gov.uk/files/file39525.pdf>) assumed that the alternative type of generation that would be displaced by new nuclear power would be gas-fired plants.

²⁴⁵ Under the base case and without any carbon emissions constraints, in the Markal model coal fired plants would be the preferred type of generation.



savings of up to 97 MtCO₂. If new nuclear power stations were not allowed, such savings would need to come from other options.

Achieving our CO₂ targets without new nuclear power stations

A12 We have analysed scenarios in which the Markal model is prevented from allowing new nuclear power stations to be built, while still enforcing the requirement to meet the UK's goal of reducing carbon emissions by 60% by 2050, and to do so at least cost to the UK economy (see Box A2). If there is no option to build new nuclear power stations, the model shows that, to meet our target, there would have to be even more effort to:

- Improve energy efficiency across all sectors
- Further invest to deploy alternative low-carbon electricity generation technologies, such as wind power and carbon capture and storage, and
- Further reduce carbon emissions in other sectors of the economy, for example transport.

BOX A2 THE ELECTRICITY MIX IN 2050 – A MODELLING PERSPECTIVE

Most of the scenarios explored in the work with the Markal model included nuclear power as an option, while some explicitly excluded the option of investing in new nuclear power stations. It also covered scenarios on different economic growth rates, fossil fuel prices and technological developments. Significant improvements in energy efficiency are common across all scenarios. To meet our carbon reduction goals, energy demand would need to be lower than today despite the economy being much larger (UK GDP is expected to grow from around 1.2 trillion pounds today to around 2.8 trillion in 2050 in real terms). If new nuclear power stations were allowed as an option for investors, under all scenarios the model shows that new nuclear power stations would be part of the mix of technologies that delivers our carbon goal at least cost to the economy²⁴⁶.

In the absence of nuclear power, according to the model renewable energy sources would account for around 41% of the 2050 electricity generation mix, with coal with CCS also making up 41%. Most of the renewables would come from wind technology, both onshore and offshore, with the remaining electricity generated through biomass or hydro. Some gas-fired power stations would still remain in the mix, mainly to provide flexibility to the system. Excluding CCS would result in the electricity mix being dominated by offshore wind power (around 60% of generation), supplemented by higher cost renewables, including marine (bringing the total share of renewables to over 80% of the mix), with natural gas and bio-gas CCGT plants meeting requirements for seasonal minimum electricity demand.

As part of further work for the Climate Change Bill, Defra commissioned a further study using the MARKAL-Macro model to consider the additional impacts (economic and technological) of reducing UK CO₂ emissions by 70 per cent and 80 per cent by 2050, beyond the current UK goal of a 60% reduction²⁴⁷. Similarly to the previous work, the model was tested under different scenarios, some of them explicitly excluding the option of investing in new nuclear power stations. This analysis shows that increasingly stringent carbon constraints force even more radical change on the energy system, in terms of energy mix and technology take-up, than seen in the previous 60% constraint runs. For example, limits on new nuclear power stations result in an increase in wind generation to meet demand beyond 60% of the mix, but also in the take up of further expensive abatement measures. The marginal abatement cost in 2050 could also increase from around £800/tC in the base case to around £1450/tC when both nuclear and CCS are not available. An 80% reduction scenario using central fossil fuel assumptions with the option of new nuclear power stations would reduce GDP in 2050 by 1.6%. Placing a constraint on new nuclear power stations would increase the costs to 1.7% of GDP in 2050.

246 See UKERC, *Final Report on DTI-Defra Scenarios and Sensitivities using the UK Markal and Markal-Macro Energy System Models*, May 2007.

247 MARKAL *Macro analysis of long run costs of climate change mitigation targets*, November 2007.



Energy efficiency

- A13 According to the results from the UK Markal-macro model, by 2050, with no carbon constraint, electricity demand is expected to increase by around 30% compared to today's levels. Energy efficiency can make a significant contribution to achieving our policy goals cost effectively. When all options, including new nuclear power stations, are available, the model shows that improvements in the efficiency and the way we use energy could reduce demand by around 30% compared to what it would otherwise be. Total electricity demand would therefore remain at roughly today's levels despite the UK's GDP being three times larger than it is today.
- A14 If new nuclear power stations were to be excluded from the generation mix, efforts to improve energy efficiency would need to go even further. The UK Markal-macro model shows that electricity demand would need to fall by around 6% compared to today's levels to meet our long-term carbon reduction target in this scenario. Such a reduction, which is equivalent to all the electricity currently consumed in private offices, would have to occur in the context of continued economic growth. A substantial additional improvement in the energy intensity of the economy would therefore be required. In other words, according to the model we would need to produce each unit of economic output with less and less energy, around 48 tonnes of oil equivalent per million pounds compared to 211 tonnes of oil equivalent per million pounds today²⁴⁸.
- A15 Without such improvements in the energy efficiency and intensity of our economy, the only other way to keep energy demand at current levels or even to reduce it, would be to forego economic growth. Such an option is not directly considered in the model but would imply a considerable change in consumer behaviour, with impacts on standards of living.
- A16 Energy efficiency measures (such as improved billing for businesses and improved insulation in homes) are amongst the most cost effective ways of reducing energy demand and hence carbon emissions (as illustrated by the Marginal Abatement Curve in Section 2 of this White Paper). However, evidence also points to the fact that despite the benefits most consumers fail to take up the opportunities available to them, even if policy can be effectively designed to overcome these. There are limitations to the potential contribution that energy efficiency measures can make in delivering our energy goals. For example, households may use the financial rewards from improving energy efficiency to increase their use of energy – a phenomenon described as the "rebound effect" – either to improve their level of comfort, by increasing the temperature at which they heat their home, or by purchasing more energy-consuming products, thereby increasing carbon emissions. So we need to factor in the overall impact on

248 When nuclear is available as an option the ratio would be 61 tonnes of oil equivalent per million pounds.

reducing carbon emissions that result from action to improve energy efficiency²⁴⁹.

- A17 Therefore, even if we achieve the reductions in future electricity use as estimated in the UK Markal-macro model, the UK is still likely to need a substantial amount of new electricity generation capacity in the coming decades, which will need to be low-carbon if we are to meet our climate change goals.

Generation sector

- A18 To almost fully decarbonise our electricity supply will require us to replace all existing generation capacity with low-carbon technologies by 2050. There are a number of low-carbon technologies that energy companies could invest in, some are already available, e.g. nuclear or wind power; others are in development, the primary example being CCS. To meet the UK's carbon reduction goal, the Markal-macro model shows a diverse generation mix in 2050, with nuclear between 5% and around 60% of the electricity mix by 2050 (depending on assumptions), and renewables and CCS making up most of the remaining capacity.
- A19 When nuclear power is excluded from the electricity generation mix, in order to reduce emissions from the generation sector and meet our carbon emissions goals, more investment would need to go towards other low-carbon generation technologies. The total contribution of renewable technologies and CCS would have to increase substantially in such a scenario (see Box A2). This is even more significant if we were to have higher targets for emissions reductions in 2050²⁵⁰.
- A20 According to the Markal Macro model, when new nuclear power stations are excluded, electricity generated from renewable sources would have to play a significant role in electricity generation, constituting over 40% of the generation mix by 2050. The proportion of supplies generated through wind power would need to rise from around 1 to 2% of electricity output today to around 30%. In the context of the EU 2020 renewables target, we will next year set out a renewable energy strategy to significantly increase the proportion of UK electricity generated from renewables by 2020. Achieving this will mean resolving the challenges associated with higher penetrations of renewables.
- A21 Beyond 2020, however, further cost effective reductions in emissions from the electricity generation sector will require a complementary effort to deploy non-renewable low-carbon technologies. Without new nuclear power stations, the main low-carbon non-renewable electricity generation technology which could be deployed would be CCS, but this will only be possible if this technology can be successfully demonstrated in the next decade. The runs in the Markal-macro model which excluded new nuclear power stations show coal plants with CCS

249 The UK Energy Research Council estimates that rebound effects in the energy market can be significant when both direct and indirect consequences are taken into account.

250 Our target is to put ourselves on a path to cutting the UK's carbon dioxide emissions by at least 60% by about 2050, with real progress by 2020. There is provision in the Climate Change Bill for the targets to be amended in light of significant developments in climate science or in international law or policy.



making a significant contribution to reducing emissions in the electricity generation sector, providing up to 41% of electricity supplied, which is roughly equivalent to the amount of electricity provided today by all gas-fired plants.

- A22 However, large-scale CCS represents a significant technological challenge. No commercial scale power station using CCS technology has yet been developed anywhere in the world, although all the elements of the individual stages of the process have been demonstrated. Given the huge potential of CCS to abate carbon emissions in the UK and abroad, a number of governments, including the UK, are in the process of supporting commercial scale demonstrators of the technology on power generation²⁵¹.
- A23 To reflect the uncertainties over CCS, we have, therefore, also examined a scenario where new nuclear power is excluded as an option, and safe, reliable CCS with power generation fails to develop on a sufficient scale in the timeframe available. This scenario could, for example, result if the overall costs of a large-scale roll-out of CCS, including the required infrastructure, turn out to be substantially higher than projected. Such a scenario would require us to further reduce the amount of energy we use by 2050 and substantially affect the means of producing it:
- Electricity demand would have to fall by around 9% relative to today's levels, compared to essentially no change in demand if new nuclear power stations and CCS were included in the mix. Again, this would need to be delivered against a background of the UK economy in 2050 being almost three times as large as today
 - Renewables generation would have to provide up to 80% of electricity supplies, with wind generation providing around 60% of the UK's electricity generation mix. This would require further renewables deployment beyond our commitment to the EU 2020 renewables target, which would bring further challenges in terms of finding appropriate locations, grid connections and to overcome local objections
 - Further increasing generation capacity from intermittent renewable sources such as wind would require additional investment in conventional generation plant to provide 'back-up' for the inevitable hours when intermittent renewable energy resources would not be available²⁵².

²⁵¹ Currently three governments worldwide are supporting commercial scale demonstrations plants.

²⁵² The Markal model does take into account the need for back-up generation capacity, but its representation is simplified and therefore does not capture the full implications of changes in the system needed to accommodate intermittent generation technologies.

BOX A3 ADDITIONAL EFFORT FROM OTHER SECTORS WHEN NEW NUCLEAR POWER IS NOT AVAILABLE

Analysis from the UK Markal-Macro model showed that when nuclear power is excluded as an option, minimising the costs of meeting the 2050 carbon reduction goal would require other non-electricity sectors to further reduce carbon emissions. By excluding new nuclear power stations and therefore reducing the low-carbon options in the electricity generation sector, carbon emissions from electricity generation are likely to be higher than under the scenario where new nuclear power stations are allowed.

Excluding the option of new nuclear power stations could have broader energy policy implications, as we would have to consider options that are more expensive than new nuclear power stations both within and outside the electricity generation sector (see Marginal Abatement Curve in chapter 10 of the Energy White Paper and Section 2 of this White Paper). In other words, we would have to make even greater reductions in emissions from transport and the use of heat. For example, when we exclude nuclear power from the mix, the model shows that CO₂ emissions from the transport sector will need to be around 10% lower. This would have to come primarily through demand reduction and increased efficiency, thus reducing car fuel demand by approximately 13%. Some increase in hydrogen use in transport might also be required.

- A24 The changes we could see in electricity generation are not limited to conventional generation. Distributed Generation (DG) – generation of electricity and production of heat close to its point of use – could play a significant part in our future energy mix. Currently around 5% of our electricity comes from DG, primarily through gas-fired Combined Heat and Power (CHP) plants. The Markal model under the different scenarios estimates that up to 25% of our electricity could come from DG in the future, mostly from CHP but also from newer technologies including microgeneration. As with other low-carbon options, the penetration of Distributed Generation in the future mix will depend on the level of ambition in reducing carbon emissions and on the availability of other technologies.
- A25 The Energy White Paper made it clear that the Government sees potential advantages from more use of DG alongside the traditional centralised system. DG can contribute to meeting carbon emission reduction targets in a variety of ways: making use of the waste heat produced through electricity generation to heat and cool buildings; reducing electricity losses by moving generation much closer to where electricity is used; reducing the need for transmission and distribution infrastructure; facilitating the use of local renewable energy sources; and encouraging behavioural change through increased awareness of energy consumption²⁵³.



- A26 Preliminary findings of the analysis conducted for the Energy White Paper suggest that the costs of some DG technologies may be competitive with costs of centralised technologies. However, overall systems costs and risks to our energy security are likely to be lower if we retain a framework where DG is a complement to rather than an alternative to centralised electricity generation.
- A27 We recognise that there is a large degree of centralisation in the UK energy system and that this may disadvantage smaller players. More use of DG will bring new and smaller players into contact with the system and it is important that the costs and complexities of this interaction are not prohibitive. The Energy White Paper committed us to level the playing field, tackling the barriers to help more distributed solutions come to market and become cost-competitive. On 18 December 2007 we published a joint consultation with Ofgem²⁵⁴ which aims to make the regulatory arrangements “fit-for-purpose” for DG, reducing costs and burdens and making it significantly easier for projects to work with the regulated electricity system, in terms of paying a fair price for use of the network, being rewarded for the benefits they can bring and reducing the risks of participating in the electricity markets.
- A28 The scale of the challenge to achieve a higher penetration of DG in the future generation mix in a cost-effective way is nevertheless significant but we believe the changes to the policy framework we have set out will make DG a significant part of our future energy mix. However, the pull through and benefits of each policy cannot and should not be taken in isolation, or assumed to mean that DG would develop such that it would replace the need for conventional centralised sources of energy.
- A29 Therefore, as also demonstrated by results from the Markal model, we believe that in the future there will be continued need for a considerable amount of centralised generation capacity, and that this will need to be low-carbon and cost-effective. In this context, we believe that new nuclear power stations would not constrain the potential from DG.

Security of supply

- A30 In the absence of nuclear power, as outlined above, the UK generation mix would need to be more reliant on other forms of low-carbon generation such as coal with CCS and renewable technologies, though potentially some gas power plants could still be part of the electricity mix²⁵⁵. Whilst lower than when all options are available, a degree of diversity could therefore remain a feature of the electricity system. As we outlined in Chapter 3 of the nuclear consultation document and in this White Paper, a mix of technologies with diverse characteristics is

²⁵⁴ *Distributed Energy – Initial Proposals for More Flexible Market and Licensing Arrangements* <http://www.ofgem.gov.uk/Networks/ElecDist/Policy/DistGen/Documents/1/DE%20con%20doc%20-%20complete%20draft%20v3%20141207.pdf>.

²⁵⁵ As shown in Box A3 above, when nuclear power is not available, other sectors have to make more efforts as abatement options are relatively cheaper than further reducing emissions from the electricity sector. We will need still some conventional gas plants to ensure sufficient flexibility in meeting demand in the electricity sector.

key to the security of the electricity system, as it avoids being overly dependent on any one technology so that the whole system is less exposed to any technology specific risk. The actual level of security of supply will then be determined by the reliability of those technologies in the energy mix.

- A31 Coal and some renewable energy technologies rely on relatively reliable supply chains. Coal is the most abundant fossil fuel in terms of proven remaining reserves. The IEA estimates that at current rates of consumption, coal reserves would last for more than 150 years. Coal is also traded in global markets and responsive to changes in demand and supply over reasonable time horizons. In addition, it is comparatively easy to transport and store. Some biomass used in the electricity sector is likely to come from domestic sources, though as consumption increases we will have to import more and more. The market for biomass fuels is still relatively underdeveloped, though it is expected to grow considerably over the next decade. Renewable technologies such as wind, marine and solar are domestic by nature, and therefore do not rely on a long supply chain for fuel, even though they do rely on complex supply chains for the resources and skills needed to build them. In comparison nuclear power fuel supply is a stable and mature industry. Based on the levels of global nuclear generation in 2004, the known available reserves of uranium would last for the next 85 years. Uranium imports also come from a range of countries that are not necessarily the same as those that supply other energy sources. Uranium is currently mined in 19 different countries and resources of economic interest have been identified in at least 25 other countries.
- A32 There are, however, potential risks of relying on a mix of electricity generation technologies with less diverse characteristics. Different technologies bring different characteristics and therefore play different roles in the energy market. As outlined in Chapter 3 of this White Paper, the characteristics of nuclear power enhance security of supply by (i) providing reliable low-carbon baseload electricity generation, (ii) increasing the diversity of supply sources, and (iii) reducing the vulnerability to volatility in fossil fuel prices. Excluding a technology with a different set of characteristics like nuclear magnifies the risks and uncertainties around the remaining set of technologies so that the overall electricity generation system is less flexible. This is especially true where these technologies are either yet unproven or not deployed on a large-scale, as is the case with CCS and some renewable technologies²⁵⁶.
- A33 Some technologies have potential limitations which need to be taken into account as the electricity system becomes more reliant on them.

²⁵⁶ We recognise that concerns were raised in the responses to the consultation about safety risks related to accidents or the threat of terrorist attacks. Some argued that these types of risks made nuclear power fundamentally different from other types of energy. The models we used in our analysis did not attempt to monetise all costs and benefits, for example a monetary value associated with potential accidents was not estimated. Evidence suggests that the likelihood of such accidents is negligible, particularly in the UK context. Though accident risk should not be dismissed, the assumption is that this can be managed through design of regulatory and corporate governance arrangements for the nuclear industry. This assumption is similar to the position of the Sustainable Development Commission, see *The role of nuclear power in a low carbon economy*, SDC position paper, March 2006. See Nuclear Cost Benefit Analysis (available at: <http://www.berr.gov.uk/files/file39525.pdf>) for more details.



Many forms of renewable generation are intermittent, and depend on external forces that are not always available (for example tides or wind). Some types of renewables, such as wind, are variable but their output is not very predictable while others, such as tidal power, are variable though predictable. Their contribution to the UK's electricity system will therefore be different²⁵⁷. Nevertheless, the system operator will have to take into account the intermittency of renewable energy when calculating how much reliable generation will need to be available at peak times. The system operator will also need to take into consideration that such generation may be limited in its ability to respond to short-term market signals. As a result, back-up generation would be required to maintain an adequate supply of electricity at all times. This would increase the amount of generation capacity required and the investment needed to strengthen networks to accommodate such new capacity.

- A34 Without appropriate back up, the greater the percentage of intermittent renewables in the generating mix, the greater the risk to security of supply in the absence of increased demand-side response and/or expensive bulk storage of electricity. In particular, very high proportions of wind or marine generation could create difficulties for system operation and load balancing. The generation costs could therefore be higher because of the greater costs of system balancing resulting from the intermittent nature of renewable energy, and the costs of retaining or building thermal plant to maintain the same level of security of supply where renewables make up a very large proportion of the mix.
- A35 If the low-carbon benefits of adding renewable capacity are not to be eroded, then this back-up capacity also needs to be low-carbon. This back-up could be biomass or coal with CCS, though it is likely that cheaper high-carbon options such as gas-fired generation would be used²⁵⁸.
- A36 There are also uncertainties over the speed with which some of the new and less developed technologies such as wave and tidal power but also CCS will develop. These uncertainties affect estimates of the likely timing, cost and feasibility of their deployment on a much larger scale. Important considerations of local acceptability, e.g. associated with alternative land use or wider environmental impacts, could also significantly hinder the deployment of such technologies and limit the number of available sites even further²⁵⁹.
- A37 Similarly, CCS represents a significant technological challenge. No commercial scale power station using CCS technology has yet been demonstrated anywhere in the world, although all the key elements of the individual stages of the process have been demonstrated. There

²⁵⁷ Tidal generation is predictable and can provide consistent electricity twice a day, similar to 'baseload' plant. It cannot, however, provide flexibility at times of peak demand.

²⁵⁸ According to the Redpoint model in fact, in the absence of nuclear power, carbon emissions from the generation sector could increase by up to 29Mt CO₂ in 2030.

²⁵⁹ A study of the potential for tidal power in the UK carried out by the Sustainable Development Commission suggests that around 90% of the UK's (practical) tidal range resource exists within the Severn Estuary and that a Severn Barrage could provide up to 5% of our electricity demand. Opposition to such a project would therefore limit considerably the potential capacity from tidal resources in the UK.

are technical uncertainties related to the construction of a system to transport and store carbon dioxide. There are also practical uncertainties related to applying the technology to electricity generation and to ensuring and monitoring the long-term integrity of the storage site, after injection has ceased. Based on the current status of CCS, there is therefore a high risk attached to placing too much future reliance on the ability of CCS to reduce carbon emissions, whilst retaining secure electricity supplies.

- A38 An increase in the amount of Distributed Generation (DG) on the system would also represent a major challenge as it would require significant changes to how the system currently operates. DG potentially adds to the complexity of the role undertaken by the system operator (National Grid) in ensuring that electricity supply and demand remains in balance minute to minute²⁶⁰. Higher penetration of DG would significantly increase the number of generators bringing electricity onto the grid, requiring improved coordination between the system operator (National Grid), Distribution Network Operators and suppliers.
- A39 Increasing DG capacity that is effectively invisible to the system operator (National Grid), therefore, could increase the level of uncertainty that has to be managed to ensure supply security. However, National Grid already copes with the vast numbers of customers whose demand is continually fluctuating throughout the day. A wider range of generators is essentially little different. Equally, the provision of electricity by a much wider range of producers reduces the importance of any one generator, and potentially makes the system much more robust to equipment failure and other temporary outages.
- A40 Overall, therefore, without the option of nuclear power, we will be reliant on a less diverse mix of technologies to insure us against the future developments that could undermine security of supply, for example higher fossil fuel prices or disruption in the fuel supply chain. Some of these technologies, such as CCS and renewables, may not be deployable on a large scale to timely meet demand when needed. This would expose us, in some scenarios, to a higher risk of interruptions to electricity supply or to higher costs for delivering a given level of security of supply.

Costs

- A41 Achieving our long-term targets to reduce carbon emissions will require a considerable change in our energy and electricity system. We will have to make these changes whilst maintaining secure and reliable energy supplies. This will require significant new investment, both in the development of new low-carbon technologies and in the deployment of new electricity generation capacity, based on existing and new technologies. The costs for the economy will therefore be considerable. On the other hand, there is scope to improve the

²⁶⁰ See Ofgem's website for details on transmission and distribution networks: <http://www.ofgem.gov.uk/Pages/OfgemHome.aspx>.



productivity of the economy, both by improved energy efficiency but also from the use of new and more advanced technologies.

- A42 Some of the costs to be incurred will not necessarily be financial, but will arise from the changes we will need to make to our own lifestyle and from some of the opportunities we will have to forego to achieve our objective to move to a low-carbon economy. Such costs will occur regardless of which technologies become available, but they are likely to be even higher if we exclude some technology options, as this then limits our opportunities to balance the different types of risks.
- A43 In particular, modelling for the Energy White Paper shows the range of economic costs that the UK will incur to achieve its 2050 targets for reductions in carbon emissions, under different scenarios, including those scenarios where new nuclear is not available. The Markal model estimates that delivering the 60% goal for CO₂ reduction in the scenario where we exclude new nuclear power stations, and all other technologies become available and are successfully deployed by 2050 at the cost assumed in the modelling, would by 2050 imply an additional annual cost to the UK economy of £1 billion compared to a scenario where nuclear power is available.
- A44 If, in addition, the application of CCS on power generation were not to prove feasible, the model estimates that the cost in 2050 of achieving the 60% goal is likely to be at least an additional £5 billion per annum, compared to a scenario where all options were available²⁶¹. As part of the impact assessment for the Climate Change Bill further analysis was conducted on achieving targets of 70% and 80% CO₂ emissions reduction by 2050. The costs of not allowing nuclear as an option would then rise to £3 to £5 billion per annum in the case of a 70% reduction or £3 to £11 billion per annum in the case of an 80% reduction target by 2050²⁶².
- A45 However, as we mentioned above, any analysis, and particularly an analysis that makes use of models, cannot fully capture the full financial and social implications, especially in scenarios that exclude a particular technology²⁶³. This is particularly important because so long as their characteristics are distinct, widening the range of low-carbon electricity generation technologies will mean we are better able to meet our carbon and energy security objectives under the widest range of future circumstances. As their characteristics are distinct, widening the range of low-carbon electricity generation technologies will mean we are better able to meet our carbon and energy security objectives under the widest range of future circumstances. Moreover, as we reduce the number of options available to meet our objectives, the range of uncertainties around the remaining technologies becomes much more significant. In these scenarios we lose flexibility in the system. In other words, if a technology fails we have fewer alternatives. The Markal

²⁶¹ By 2050, the total cost of achieving the 60% goal would be £21 billion (compared to no action to reduce emissions) with all options available, £22 billion when nuclear is not available and £26 billion absent both CCS and nuclear.

²⁶² Final impact assessment for the Climate Change Bill is available at: <http://www.defra.gov.uk/environment/climatechange/uk/legislation/pdf/cc-impact-assessment-final.pdf>.

²⁶³ See Box A1 for an explanation of the limitations of the modelling work.

model, in addition, does not take account of the security of supply considerations of relying on a set of technologies with less diverse characteristics. For example it does not consider our exposure to a greater risk of technological failure or exposure to the risk of a fuel supply interruption, for example in gas supply. The Markal model is also limited in its ability to capture the costs of maintaining the reliability of the electricity system as the share of intermittent generation in the mix increases²⁶⁴.

- A46 Nor does the model capture some of the risks inherent in the modelling assumptions. For example, it cannot model the risk that the costs of alternative low-carbon technologies do not fall as much as projected or the risk that we fail to see the behavioural change required to deliver the improvements in energy efficiency necessary to meet our 2050 goal. For this reason, we believe the cost estimates that the Markal model provides are likely to be at the lower end of estimates of the expected costs. The model is, however, very useful in illustrating the broad economic and structural impact of achieving our long-term targets for carbon emissions.

Conclusion

- A47 It is very difficult to predict how energy supply and demand and the electricity generation mix will develop over the very long-term. The factors which contribute to this uncertainty include: the cost and availability of fossil fuels, the cost and availability of emerging low-carbon technologies, and growth in energy demand.
- A48 Our analysis indicates that narrowing the range of available low-carbon technologies make it more difficult for us to meet our energy policy goals under all circumstances. The Government believes that by having a diverse range of options, the UK will be better placed to deal with the range of possible futures that could unfold.
- A49 The analysis shows that to achieve our target to reduce CO₂ emissions at least cost:
- All sectors of the economy will need to contribute in the effort to reduce CO₂ emissions
 - The electricity sector will need, over the long-term, to considerably (if not fully) decarbonise, since reducing emissions from the generation sector is relatively less expensive than reducing carbon emissions in other sectors (for example transport). Low-carbon technologies will have to replace virtually all existing generation capacity by 2050
 - Large changes will be needed in the electricity system in terms of the scale of new capacity needed: the EU 2020 Renewables targets will mean rapid deployment of renewable technologies in the medium-term while learning how to maintain security of supply with large penetrations of wind and other intermittent renewable

²⁶⁴ For an analysis of the potential costs from intermittency, see a report from UKERC on the estimated costs of integrating intermittent generation into the electricity system – available at: <http://www.ukerc.ac.uk/ResearchProgrammes/TechnologyandPolicyAssessment/TPAIntermittencyReport.aspx>.



technologies, most likely through considerable investment in backup capacity

- The overall challenges of delivering secure electricity supplies while making the transition to a low-carbon economy will be magnified over the long-term in the absence of a dependable low-carbon technology such as nuclear power
- This will be particularly significant should safe and reliable CCS for power generation not be proven or deployed at scale at reasonable costs
- Without nuclear power as an option, it would take a greater effort to reduce emissions through more costly options both within and outside of the electricity generation sector, and we would have to rely on generation technologies which together have a less diverse set of characteristics. This would expose the UK to greater risks of supply interruption and high prices, because our electricity system would not have access to a relatively low-cost, dependable low-carbon source of generation
- Our analysis suggests that excluding nuclear power as an option would therefore increase the risks and make it more expensive to meet our goal to reduce carbon dioxide emissions and to maintain secure energy supplies.

A50 In this context, Government's view is that our energy policy should promote, and be open to, all the technology options that are consistent with our goals for reducing carbon emissions and for achieving security of supply.

Justification and Strategic Siting Assessment processes

- B1 Alongside the Government's consultation on the future of nuclear power, the Government also consulted on proposed Justification and Strategic Siting Assessment processes²⁶⁵. This Annex provides an assessment of the key arguments submitted to the technical consultation and the Government's response.

Justification

Overview

- B2 The concept of Justification is based on the internationally accepted principle of radiological protection that no practice involving exposure to ionising radiation should be adopted unless it produces sufficient benefits to offset the health detriment it may cause. This principle has been incorporated into European Community law by article 6(1) and (2) of Directive 96/29/Euratom. These articles were implemented in the UK by the Justification of Practices Involving Ionising Radiation Regulations 2004²⁶⁶. The process the Government has put in place for assessing applications for Justification is based around the Justification Regulations.
- B3 A number of the responses to the Government's technical consultation suggested changes to the proposed Justification process that would require applicants to provide information that went beyond the scope of Justification as defined by the regulations or would be inappropriate for a high-level assessment. For example, some respondents made comments on how Justification would apply to specific sites. As Justification is a generic process, and site assessments are dealt with in detail at other parts of the regulatory process, it would not be appropriate to consider them here. Likewise, the Justification Regulations do not require a comparison with other forms of electricity generation and it would therefore be inappropriate to require applicants to do so. In such situations, the Government has not been able to accept the suggestions put forward.
- B4 An assessment of the key arguments submitted to the technical consultation and the Government's response is as follows.

²⁶⁵ The Future of Nuclear Power, *Consultations on the proposed processes for Justification and Strategic Siting Assessment*, URN 07/972, May 2007.

²⁶⁶ Justification of Practices Involving Ionising Radiation Regulation 2004 (S.I.2004/1769).



1a. Are Government plans to structure the proposed Justification process by making a time-limited “call for applications” helpful?

Key arguments and issues presented in responses

- B5 There was broad support from those responding to the technical consultation for the Government’s proposed Justification process. Many felt that the time limited call for applications would help create an impetus to the process for building new nuclear power stations and help focus resources and some suggested that the time limit should be no longer than two months. Some noted that the time limited call for applications did not preclude applications at any other point, however some felt that applications submitted during the window should be given priority.
- B6 Some respondents felt that the time limited call for applications would encourage a number of applications to be submitted at the same time, which would allow the Justifying Authority to consider them together where appropriate. In this context, some respondents felt that it should be possible for a single application to be made covering a range of reactor designs, providing the health detriment and benefits were similar. This point is picked up in greater detail under Question 1b.

Government response

- B7 The Government can confirm that it will be issuing a time limited call for applications in February/March 2008. While this will not preclude applications being submitted at any other time, applications submitted during the call for applications will be processed as a priority.

1b. Is the proposed application, assessment and decision-making process clear, appropriate and proportionate? If not, how can it be improved?

Key arguments and issues presented in responses

- B8 A number of respondents felt that the process was clear, appropriate and proportionate, although some felt that the process was unnecessarily elaborate compared to the way in which other EU Member States handle Justification where there was no separate Justification process. A number felt that this would result in any decision taking longer than necessary. However, some felt that the process and timeframes were necessary given the importance of the Justification Decision.
- B9 A number of respondents suggested that any further guidance on the proposed Justification process should make clear that the Justifying Authority will need to consider whether any new class or type of practice constitutes an existing practice which is already justified. Some

felt that the Justification process should be as open and transparent as possible and that there should be some form of public engagement.

- B10 Some respondents thought that any additional guidance should provide a clear definition of “health detriment” and on what constitutes a “practice”. On the latter point, it was felt that the Justification Regulations talked of a “new type or class of practice” rather than a specific design within a particular class or type of practice, and suggested that this could be made clearer. They felt that this was inconsistent with the Government’s technical consultation which referred to “nuclear power station technologies”.
- B11 A number of respondents felt that it should be possible for a single application to be made covering a range of reactor designs. This would involve establishing a technology envelope within a class or type of practice, which would be defined on the basis of similar potential health detriments and benefits.

Government response

- B12 The process that the Government is putting in place to assess Justification applications for new nuclear power stations is based on the existing Justification Regulations²⁶⁷. The Government believes that this process is fair, transparent and robust.
- B13 The Government will produce guidance on the process for considering Justification applications in relation to new nuclear power stations, which will sit alongside Defra’s Justification Guidelines²⁶⁸. This guidance will provide detail on the process for submitting and assessing Justification applications relating to new nuclear power stations and will provide clarity as appropriate.

1c. Is the indicative list of information, described in Appendix A²⁶⁹, appropriate for applicants to be able to make an application?

Key arguments and issues presented in responses

- B14 A number of respondents felt that the indicative list of information was comprehensive, although some asked for clarity on the required depth and breadth of any application. For example, would it need to cover aspects of the fuel cycle that were already justified; that occurred outside the UK; or were common with other industrial activities? Some felt that the risks associated with terrorism needed to be considered as part of the Justification process.
- B15 Some respondents suggested it would be helpful for any guidance to include a list of all the radiological health detriments that may

267 Justification of Practices Involving Ionising Radiation Regulation 2004 (S.I. 2004/1769).

268 www.defra.gov.uk/environment/radioactivity/government/legislation/justification.htm

269 Appendix A to The Future of Nuclear Power, *Consultations on the proposed processes for Justification and Strategic Siting Assessment*, URN 07/972, May 2007.



arise as well as a full list of all the potential environmental benefits and detriments to be considered. Some asked for clarity on whether detailed information on 'secondary' activities such as fuel manufacture and transport, which the respondent believed were existing practices, would be required and some felt it would be helpful to have clarity on which non-health detriments applicants should consider. Some respondents suggested the need for information about the lifecycle carbon footprint of proposed plants and a full cost/benefit calculation around each proposal.

- B16 A number of respondents believed that a full analysis of potential radiological health detriments was necessary, while decisions on which benefits to incorporate was a matter for the applicant.

Government response

- B17 The specific guidance the Government is producing will provide additional detail on the process as it applies to new nuclear power stations.
- B18 While it is for any applicant to include what information they feel is necessary and relevant to their application, the Government will, where appropriate, provide clarity on what information must and should be provided. However, this will provide guidance only and the Justifying Authority has the power to require additional information to be provided with respect to any application.

1d. The Government is planning, where possible, to consider concurrent applications for Justification (relating to new nuclear power station technologies) through a single Justification assessment process. Is the Government's proposal appropriate?

Key arguments and issues presented in responses

- B19 A number of respondents felt that the approach was appropriate and would enable reactor designs to be assessed more quickly, although some felt that considering concurrent applications would add complexity and could delay the process.
- B20 Some respondents felt that an application defined by a broad envelope of benefits and health detriments, within which a number of technologies could be shown to fit, would be suitable for a single Justification assessment. However, it was noted that any designs considered under a single Justification assessment needed to have similar health detriments and benefits.
- B21 It was suggested that this approach was consistent with the Justification Regulations, which talked of a "new type or class of practice" rather than a specific design within a particular class or type of practice. It was suggested that this was inconsistent with the

Government's technical consultation which referred to "nuclear power station technologies".

Government response

- B22 The Government believes that considering concurrent applications for Justification through a single assessment will allow both applicants and the Justifying Authority to focus resources. This will enable the Justifying Authority to assess a number of designs with similar health detriments and benefits together, which may reduce the number of individual applications and therefore the number of assessments.
- B23 The Government confirms that it should be possible to assess an application defined by a broad envelope of benefits and health detriments, within which a number of designs could be shown to fit, as a single Justification assessment. The Government can also confirm that this would only be possible if the designs had similar health detriments and benefits. However, the Government will still need to consider whether an application can be treated as relating to a single class or type of practice when it receives the application. This approach is consistent with the Justification Regulations.

1e. Are there any other ways in which the draft Justification process can be improved? If so, we welcome your suggestions.

Key arguments and issues presented in responses

- B24 A number of respondents submitted views on how the proposed process could be improved. For example, some felt that it would be helpful to set out a specific timetable for the Justification process and decision, including any plans for public engagement.
- B25 Some suggested publishing a list of nuclear technologies that would not be considered and processing designs that had already been Justified by other Member States more rapidly.

Government response

- B26 The guidance the Government is producing will provide additional detail on the process for submitting and assessing Justification Applications along with an indicative timeframe and any plans for public engagement. The Justification Regulations do not cater for the fast tracking of designs justified outside the UK.



A combined Strategic Siting Assessment and Strategic Environmental Assessment process

Overview

- B27 The consultation document on the Strategic Siting Assessment (SSA) set out a proposed process for determining the suitability of potential sites for new nuclear electricity generation and identifying siting criteria. It also set out proposals for conducting a Strategic Environmental Assessment under the Strategic Environmental Assessment Directive (SEA)²⁷⁰. The UK's own implementing regulations require such factors to be taken into account in developing plans or programmes which will have consequences for the environment. The consultation document on the SSA presented a site selection approach which incorporated the SEA into the Strategic Siting Assessment. The results of the SSA would inform a subsequent Governmental policy statement on siting for new nuclear power stations, as part of a potential National Policy Statement (NPS) on new nuclear power stations.
- B28 Respondents to the consultation provided a range of comments on the proposed SSA process. Some agreed that the SSA process was logical and robust, and that the approach incorporating the SEA was a reasonable one. Others commented that the process could be addressed by building on existing sites or that it should be evident early on in the process which areas of the country are suitable or those which can be ruled out, which led to questioning whether there was a need for a detailed process as set out in the consultation document, and whether there was scope for compressing stages 1 and 2. Others commented on the need for greater clarity on whether the SSA would provide a list of existing sites or localities, or a particular grid reference. There were, however, a number of themes which emerged from the responses and these are set out below in response to each of the questions in the Technical Consultation Document.

2a. Is the proposed approach to the Strategic Siting Assessment a logical approach to identifying suitable sites? If not, how could it be improved?

Key arguments and issues presented in the responses

- B29 Some respondents commented that the final statement for the SSA should not restrict the eventual number of sites or be exhaustive. The reasons for these include:
- enabling a workable market in sites
 - some sites which might be successful in the SSA process may be found to be unsuitable at site-specific level when more detailed work is carried out, thereby reducing the number for developers to choose from

²⁷⁰ Directive 2001/42/EC of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (O.J. L197, 21.7.2001, p.30).

- enabling other suitable sites to come forward at some point in the future
- that it impacts on the ability to deliver any substantial programme.

B30 Although no specific question was asked, a number of respondents provided detailed comments on the criteria. These comments included:

- the need for the SSA to limit the number of exclusionary criteria, as it was felt that there were, perhaps, only one or two criteria such as population density that were truly exclusionary at the national level, and not those for which there might be technical solutions
- those criteria which have an economic effect or could be mitigated against should be treated as discretionary criteria
- using the opportunity of the SSA to define appropriate demographic criteria taking account of developments in reactor design and UK and international experience, and that such criteria should be used as the basis for siting policy
- that it would be appropriate for criteria on, for example, flood risk management, effect of climate change, and public acceptability
- consideration should be given to issues of staffing such a facility.

B31 A number of comments were related to the nominations process mentioned in the SSA process. In general, the comments welcomed the nominations process. Specific comments were made on the need to provide an early indication of guidelines on who can make a nomination and the information required to support a site. It was pointed out that the information for the nomination phase should be limited to publicly available information and that a nomination must not require on-site studies.

B32 There were some comments on the interaction with the planning process. Some respondents said that the SSA seemed to be appropriate so long as the normal planning processes were followed for developments. Others supported the intention to include the outcome of the SSA as a material consideration in a NPS which would provide the framework for consent for the independent Infrastructure Planning Commission. Others felt that the requirements for a NPS should be included in the SSA, such as the need for local engagement at the sites likely to be affected, and that such consultation should happen at Stage 3 of the SSA, which should not affect the timescales for the SSA overall. Other comments related to the validity of the NPS, and questioned whether there would be enough sites on the final list for the NPS to be sufficiently durable to enable replacement of nuclear capacity.

B33 There were some general comments and some concerns about the timescales proposed for the SSA and SEA in the Technical Consultation Document. Some respondents felt that the timescales as set out were realistic and consistent with ensuring effective consultation takes place, but that it was essential that the SSA sticks to the 18 months-2 years timescale. Others felt that the process was over-elaborate and could lead to unnecessary delays.



B34 A number of respondents commented on the geographical scope of the SSA/SEA. Some said that these should be UK wide, whilst others said they should in particular cover England, Scotland and Wales. Some respondents expressed concern that the approach of the Devolved Administrations could delay development in those areas.

Government response

B35 We acknowledge the concerns that people have raised on the SSA. In the main, it will be appropriate to address these concerns as we take the SSA forward as they relate to the implementation of the process, in particular in the development of the criteria and the nominations process. However, it is worth noting here that in response to concerns raised with regard to the planning system and the need to ensure alignment with the planning reforms, Government has considered the scope for bringing the requirements for the NPS more closely into Stage 3 of the SSA. The Planning Bill reforms propose consultation with those local communities likely to be affected by the proposals and a requirement for parliamentary scrutiny. In taking forward the NPS, we will build these elements into it as necessary. Also in response to the concerns raised regarding the timescale, Government will endeavour to limit the slippage which could potentially arise. We have set out the process we will take forward for the SSA and SEA in Section 3 of this White Paper.

2b. Does the proposed incorporation of the SEA into the SSA represent a reasonable and robust approach to assessing environmental issues that would be raised by the construction and operation of new nuclear power stations?

Key arguments and issues presented in the responses

B36 Respondents made a range of points on the incorporation of the SEA into the SSA. Some respondents felt that the incorporation of SEA is important to ensure that the SSA is as comprehensive and legally robust as possible. Some also commented that the process looks robust and reasonable from the level of detail provided but that details on how the SEA would apply need to be clarified. Some respondents stressed the importance of the SEA as an integral part of the SSA which would help to minimise the possibility of a further SEA after completion of the SSA, and before site-specific planning proposal could be considered. Some respondents were concerned to ensure that the timing of the different stages are integrated properly so that the process is capable of delivering a list of sites that meet the criteria, whilst ensuring that environmental and other effects such as health and socio-economic impacts are properly assessed.

B37 A number of respondents expressed concerns about the iterative nature of the SEA, and the scope for delay and duplication. Some respondents thought that the SEA may extend the overall timescale beyond that

outlined in the consultation which would produce uncertainty about the eventual availability of sites. Others, however, felt that the SEA could be completed thoroughly in the timescale available. Overall, respondents felt that Government would need to ensure that the iterative nature of the SEA process is carefully managed so as not to increase the timescales and add delay to the overall timetable.

- B38 There was also some concern around the potential for duplication of issues covered by the SEA and the Environmental Impact Assessment (EIA) which developers need to complete as part of the planning process. Some respondents felt that the SEA should be applied at the locality rather than site level so that the assessment remains strategic and does not overlap with the EIA.
- B39 There were some comments on the interaction with other policies. Some respondents felt that the SEA for the SSA would need to be able to support the NPS, and that this should be covered in any scoping document for the SEA.

Government response

- B40 We acknowledge the concerns raised in relation to the SEA. As with the SSA, we will consider these in taking forward the SEA, for example ensuring that there is a minimal overlap between the SEA and the EIA, and ensuring that the iterative nature of the SEA does not lead to unnecessary duplication and delay. We also take on board the concerns expressed on the need to ensure that any requirement for a SEA for the NPS is covered by the SEA from the SSA. We will consider the best way to link these processes as we move forward with the SEA.
- B41 The proposals at Section 3 of this White Paper set out how the SSA and SEA will be taken forward as an integrated approach.



ANNEX C

Regulatory and advisory structure for nuclear power

- C1 This Annex explains aspects of the existing and future regulatory and advisory committee structure for nuclear power.

Oversight of nuclear power stations in the UK

- C2 Government recognises that the way in which any new nuclear power stations might be consented, built, operated and decommissioned is an area of particular concern to many people. The purpose of this Annex is to outline the protections currently in place, and which would apply to any new nuclear power stations, to ensure that these processes are carried out safely and effectively. We also set out the terms of reference of the re-constituted Committee on Radioactive Waste Management, and describe the role of a new Nuclear Liabilities Financing Assurance Board.
- C3 In Great Britain, the main regulatory bodies are the Nuclear Installations Inspectorate (NII), a division of the Health and Safety Executive, the Environment Agency in England and Wales and the Scottish Environment Protection Agency in Scotland.
- C4 These agencies regulate radioactive discharges from nuclear power stations and have responsibilities (see below) for ensuring that workers, the general public and the environment are protected against exposure to radioactivity. In Northern Ireland (NI) the relevant authorities would be the Secretary of State, HSENI and the Department of the Environment.
- C5 Nuclear security is the responsibility of the Office for Civil Nuclear Security (OCNS) which has been part of the HSE since April 2007. It places strict obligations on operators and requires site security plans to be regularly reviewed. For any new build, the OCNS will ensure that security measures are included in plans for the construction of any new nuclear power stations from the outset. Doing so will avoid the need for retrofitting security measures once construction is underway and will enable regulators to make an early judgement with regard to establishing the most appropriate measures at any construction site should approval be given²⁷¹.
- C6 New powers to be introduced in the Energy Bill will put into place a framework to ensure that operators of any new nuclear power stations

²⁷¹ <http://www.hse.gov.uk/nuclear/ocns/ocns0607.pdf>

pay their full decommissioning costs and their full share of waste management and disposal costs.

- C7 This framework requires operators to provide and have approved a programme, outlining how they intend to manage waste and decommissioning, along with detailed costing of these plans and proposals for how these costs will be financed.
- C8 In recognition of concerns raised in the consultation, we intend to create a new independent advisory body, the Nuclear Liabilities Financing Assurance Board (NLFAB). This new board will provide independent scrutiny and advice on the suitability of the decommissioning programmes submitted by operators of nuclear power stations.
- C9 The NLFAB will advise the Secretary of State for Business, Enterprise and Regulatory Reform on the financial arrangements operators plan to put in place to cover waste management and decommissioning. The NLFAB will also advise the Secretary of State on the regular reviews and ongoing scrutiny of funding arrangements, once new nuclear power stations are operational.
- C10 The Board is expected to consist of experts from relevant fields such as current or former fund managers, pension trustees, actuaries and nuclear engineers. The board members will be appointed by the Secretary of State.
- C11 The NLFAB will have a tightly defined, solely advisory role. Its work will focus on ensuring that the operators of new nuclear power stations put in place robust financial arrangements for clean up.

Safety regulation

- C12 The Health and Safety Executive has statutory responsibility for ensuring that there is an adequate framework for the regulation of safety at nuclear sites in the UK. This responsibility covers the licensing and day-to-day regulation of nuclear sites and the regulation of work-related health and safety generally.
- C13 The legal framework requires nuclear operators to demonstrate to the satisfaction of the HSE's Nuclear Installations Inspectorate (NII) the safety of activities at nuclear sites and that they are complying with the strict conditions of their nuclear site licence, and other relevant safety legislation.
- C14 Licensing applies throughout the lifetime of a nuclear installation from design and construction to eventual completion of decommissioning and clean-up. Licence conditions cover all the arrangements for managing safety, including the production of adequate safety cases for all operations, the appointment of competent personnel, staff training and supervision, handling and storage of nuclear material, control of



organisational change, response to accidents and emergency planning arrangements.

- C15 NII inspects nuclear sites and scrutinises operators' safety cases to ensure that the evidence they present is robust. Safety cases are frequently required before NII will consent to the start of certain operations, such as restarting a reactor after major maintenance. In addition, licensees must review and re-assess the safety of their plants periodically and systematically, generally every ten years. HSE's reports on licensees' Periodic Safety Reviews (PSRs) are usually published.

Security regulation

- C16 The Office for Civil Nuclear Security (OCNS) is the security regulator for the UK's civil nuclear industry. It is part of the Health and Safety Executive (HSE) and is responsible for approving security arrangements within the industry and enforcing compliance. OCNS conducts its regulatory activities on behalf of the Secretary of State for Business, Enterprise and Regulatory Reform and under the authority of the Nuclear Industries Security Regulations 2003.
- C17 OCNS also undertakes vetting of nuclear industry personnel with access to sensitive nuclear material or information. It works closely with BERR policy officials, other Government departments and with overseas counterparts.
- C18 In the UK, civil nuclear operators must have site security plans dealing with the security arrangements for the protection of nuclear sites and radioactive material on such sites. The arrangements cover, for example, physical protection features such as fencing, CCTV and turnstile access, the roles of security guards and the CNC, the protection of proliferation-sensitive data and technologies and the trustworthiness of the individuals with access to them. Transporters of nuclear material also have to be approved by OCNS, acting for the Secretary of State, and approval of a transport plan is required before the transport of certain categories of nuclear material.
- C19 OCNS may give directions to operators or carriers at any time, for instance in the light of a change in the threat level for the industry. This is aided by OCNS being an active member of the UK intelligence community.
- C20 OCNS determines and keeps under review the numbers and tasking of the Civil Nuclear Constabulary's officer at licensed nuclear sites. CNC is an armed police force tasked with protection of nuclear material and nuclear sites.
- C21 OCNS publishes an annual report on the HSE website²⁷² and publishes guidance for the industry. One key document covers the control of sensitive nuclear information, entitled "Finding a Balance".

²⁷² www.hse.gov.uk

Environmental regulation

- C22 The Environment Agency and the Scottish Environment Protection Agency are the principal environmental regulators in England and Wales and in Scotland respectively. They have a number of regulatory roles in relation to nuclear sites. These include under the:
- Radioactive Substances Act 1993, regulation of all disposals, including discharges to air, water and land, of radioactive wastes off or on nuclear sites
 - Water Resources Act 1991, regulation of abstraction from, and discharges to controlled waters (inland and marine surface waters, and groundwater)
 - Pollution Prevention and Control Regulations 2000/ Pollution Prevention and Control (Scotland) Regulations 2000 (as amended), regulation of certain installations including, for example, combustion plant used as auxiliary boilers and emergency stand-by power supplies, and incinerators used to dispose of combustible waste
 - Environmental Protection Act 1990 regulating disposals of waste by deposit on or into land, including excavation materials arising from construction; and acting as enforcing authority for the remediation of certain contaminated land which has been designated a “special site” in accordance with the Contaminated Land Regulations 2006.
- C23 Additionally in England and Wales, local authorities or the Environment Agency usually take responsibility for flood defences. However, at nuclear sites operators take direct responsibility for their local flood defences as part of their safety obligations. To facilitate this, the Environment Agency usually makes agreements or other arrangements with site operators so that respective responsibilities are clear.

Safeguards regulation

- C24 Nuclear safeguards regulation aims to verify that States comply with their international obligations not to use nuclear materials (plutonium, uranium and thorium) for nuclear explosives purposes. Global recognition of the need for such verification is reflected in the requirements of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) for the application of safeguards by the International Atomic Energy Agency (IAEA). Also, the Treaty Establishing the European Atomic Energy Community (the Euratom Treaty) includes requirements for the application of safeguards by the European Commission.
- C25 BERR is responsible for the UK Government input into the development of the international nuclear safeguards regimes. This aims to ensure that the IAEA safeguards regime is technically equipped to provide the assurances demanded of it by the international community (e.g. to develop and implement new safeguards strengthening measures), and also to ensure that nuclear non-proliferation policy properly reflects safeguards and verification-related considerations.



- C26 Responsibility for overseeing compliance with the UK commitment to the international safeguards regimes belongs to the UK Safeguards Office at the Health and Safety Executive (HSE).
- C27 The UK Safeguards Office (UKSO) is part of the Nuclear Directorate of the HSE and oversees the application of nuclear safeguards in the UK to ensure that the UK complies with its international safeguards obligations by:
- working with the UK nuclear industry and others with safeguards reporting requirements, and safeguards inspectors from the European Commission and the IAEA, to make sure that the safeguards measures applied are both effective and efficient
 - ensuring that safeguards measures do not place unreasonable demands on, or result in unnecessary commercial disadvantage to the UK organisations involved
 - helping to negotiate facility specific safeguards reporting and inspection arrangements with the European Commission and/or the IAEA
 - assisting UK operators, especially those unfamiliar with the subject, in meeting safeguards requirements
 - implementing the UK's Additional Protocol
 - providing support to safeguards officials in BERR on safeguards policy issues that arise from the work of HSE (UKSO).

Transportation of nuclear materials regulation

- C28 The safety and security of nuclear material (including irradiated or spent nuclear fuel) is subject to rigorous regulation, which fully takes into account international obligations and commitments. These regulations meet the requirements of European Directives²⁷³ for transport of radioactive materials as well as the International Atomic Energy Authority's Standard for the Safe Transport of Radioactive Material²⁷⁴.
- C29 The security for the transportation of nuclear material is regulated by the Office for Civil Nuclear Security (OCNS). OCNS is kept fully briefed about terrorist threat intelligence and in turn keeps security arrangements under review at all times. OCNS is satisfied with the thorough measures that have been taken to prevent the theft or sabotage of nuclear material in transit.
- C30 The safety of nuclear transports (and security of less sensitive nuclear material) is regulated by the Department for Transport under The Carriage of Dangerous Goods and the Use of Transportable Pressure Equipment Regulations 2007.

²⁷³ Council Directive 94/55/EC of 21 November 1994 on the approximation of the laws of Member States with regards to the transport of dangerous goods by road.

Council Directive 96/49/EC of 23 July 1996 on the approximation of the laws of Member States with regards to the transport of dangerous goods by rail.

Council Directive 86/618/Euratom of 27 November 1989 on informing the general public about health protection measures to be applied and steps to be taken in the event of a radiological accident.

²⁷⁴ TS-R-1 (2005 Edition).

Committee on Radioactive Waste Management (CoRWM)

- C31 Following the announcements by UK Government and the Devolved Administrations, on 25 October 2007, a new CoRWM has been appointed under revised terms of reference. The Committee is jointly appointed by sponsoring Ministers from Defra, BERR and the Devolved Administrations.
- C32 The role of the reconstituted Committee is to provide independent advice to Government on the long-term management, including storage and disposal, of radioactive waste. CoRWM's priority task will be to provide independent scrutiny on the Government's proposals, plans and programmes to deliver geological disposal as the long term management option for the UK's higher activity wastes.
- C33 CoRWM is an Advisory Non-Departmental Public Body (NDPB).
- C34 CoRWM shall consist of a Chair and up to fourteen members. Seats are not representative of organisation or sectoral interests and the skills and expertise which will need to be available to the Committee will vary depending on the programme of work.
- C35 CoRWM will undertake its work in an open and consultative manner, engaging with stakeholders and publishing advice (and the underpinning evidence) that is meaningful to the non-expert, in an open and transparent way. The Committee will also undertake ongoing dialogue with Government, the Nuclear Decommissioning Authority (NDA), local authorities and stakeholders, and will liaise with appropriate advisory and regulatory bodies to provide an annual report of its work.
- C36 CoRWM's advice, and the response of UK Government and relevant Devolved Administrations, will be made available to Parliament and Assemblies. Parliamentary and assembly committees will also have the opportunity to engage directly with CoRWM and may propose work for inclusion in the Committee's work programme to sponsoring Ministers.