DEPARTMENT OF ENERGY & CLIMATE CHANGE

Energy Markets Outlook

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ofgem

Energy Markets Outlook Report

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Foreword by the Secretary of State

Britain is undertaking a major transformation in its use and sourcing of energy. We need to ensure that we have energy that is affordable, secure, and sustainable, and which supports the transition to a low-carbon economy in Britain and globally.

The UK Low Carbon Transition Plan and Renewable Energy Strategy published in July 2009 set out the Government's roadmap towards 2020 and the building of a low carbon energy system. They set out the prospect over the next 10 to 15 years for a significant change in our energy system as we shift decisively towards being a low carbon economy that includes:

- a substantial increase in renewable energy, new nuclear power stations and a significant increase in energy efficiency;
- large-scale investment in our electricity networks and in smart meters, as we move towards smarter grids and enabling consumers to better manage their demand; and
- large-scale demonstration and then deployment of carbon capture and storage, enabling clean coal to be a key part of the low carbon electricity generation mix.

In my view, a competitive market is pivotal to delivering the investment in our energy infrastructure needed for this low carbon future. We need a market that both secures reliable and affordable supplies of energy for homes and businesses, including investment in renewable energy, nuclear power and carbon capture and storage and incentivises cuts in carbon emissions and more efficient use of energy. But we also need effective regulation of the companies and networks that both protects consumers and enables the timely investment needed to support this transition. And finally Government must retain a strategic oversight of the development of the energy sector, and ensure that the conditions are right for the market to deliver.

As part of this strategic framework, the Energy Markets Outlook is intended to facilitate and inform debate and decision-making by market participants and other energy market stakeholders. It provides analysis and commentary on the current and future energy supply position and considers the likely impact of policy developments.

I welcome a continuing conversation with the industry and its customers to make sure our energy supplies remain secure as we move to a low carbon future.

Ed Miliband
Secretary of State for Energy & Climate Change

Introduction

1.1 About this report

1.1.1 This is the third Energy Markets Outlook report, following up the undertaking in "Meeting the Energy Challenge: A White Paper on Energy" (2007)[1] to introduce a new information service on security of supply with an annual report jointly authored by DECC and Ofgem. This report provides forward-looking energy market information relating to security of supply, and builds on and expands the work of the former Joint Energy Security of Supply (JESS) working group.

1.1.2 This report also discharges the Government's and Ofgem's obligation under section 172 of the Energy Act 2004[2] to report annually to Parliament on the availability of electricity and gas for meeting the reasonable demands of consumers in Great Britain; and the Government's obligation under certain EU Directives[3] to monitor gas and electricity security of supply issues and publish reports.

1.1.3 As in the first and second reports, published in October 2007 and December 2008 respectively[4] we set out how security of supply can be defined and measured and then look at supply and demand in the UK and (where relevant) global markets, of the various primary energy sources in use in the UK.

1.1.4 As the UK and other economies move to low carbon systems new challenges will emerge. We set out in the electricity and gas chapters some of the implications of a move to low carbon economy and the implications of more renewable generation. We set out in the other chapters, the issues around security of supply of the full range of fuels including coal, oil and nuclear fuel. We also include, in separate chapter a discussion of renewables and carbon.

1 http://www.berr.gov.uk/whatwedo/energy/whitepaper/page39534.html. Paragraphs 4.36 – 4.38
2 Available from http://www.statutelaw.gov.uk/Home.aspx
3 Directive 2003/55/EC of 26 June 2003 concerning common rules for the internal market in natural gas, augmented by Article 5 of Directive 2004/67/EC of 26 April 2004 concerning measures to safeguard security of natural gas supply; Directive 2003/54/EC of 26 June 2003 concerning common rules for the internal market in electricity, augmented by Article 7 of Directive 2005/89/EC of 18 January 2006 concerning measures to safeguard security of electricity supply and infrastructure investment
4 http://www.berr.gov.uk/files/file41995.pdf http://www.berr.gov.uk/files/file49406.pdf

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2. Executive Summary

2.1 Introduction

2.1.1 This is the third Energy Markets Outlook (EMO). The Energy Markets Outlook provides an assessment of the outlook for the energy market and supply over the next 15 years. It is not a forecast but it explores the drivers affecting demand and supply for key fuels, drawing on analysis by Government, Ofgem, National Grid and others. It also reflects recent developments in energy and climate change policy and their relationship with security of supply. The prospect for the next 10 to 15 years is for a significant change in our energy system resulting from a range of factors, notably the move to a low carbon economy. The next decade will see the closure of a number of coal and oil fired plant under European environmental legislation and also closure of existing nuclear plant. Major new investment is already underway and planned.

2.1.2 This summer the Government published its plan for becoming a low carbon country: cutting emissions, maintaining secure energy supplies, maximising economic opportunities, and protecting the most vulnerable. The UK Low Carbon Transition Plan sets out a framework for delivering green house gas emission cuts of 18% on 2008 levels by 2020.

2.1.3 Given the scale of change and the forward look, there are inevitably uncertainties surrounding both the level of demand for energy as well as the composition of supply to meet that demand.

2.1.4 In early 2009 Ofgem launched Project Discovery[5] which explores whether current market arrangements are capable of delivering secure and sustainable energy supplies over the next 10-15 years. Ofgem issued an interim consultation document in October setting out four energy scenarios for stakeholder comment and will produce a report setting out its conclusions early in the New Year.

5 See 'Project Discovery: Energy Market Scenarios' at: http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=2&refer=Markets/WhlMkts/Discovery

2.2 Overview of Security of Supply

2.2.1 Security of supply is a key element of Government energy policy and is central to Ofgem's role in protecting consumers. The roles and responsibilities of the key players are set out below.

- **Government** has a strategic role in ensuring that the overall policy framework is clear, promotes security of supply and supports the necessary investment in energy infrastructure and in promoting energy efficiency. For example, the Government is putting in place reform of the planning regime and taking steps to facilitate new nuclear power stations; it is proposing to increase and extend the life of the Renewables Obligation (by increasing support for qualifying offshore wind to 2 ROCs/MWh and extending the Obligation's life to 2037); and in the 2009 Pre-budget Report, the Government committed to support four commercial-scale CCS demonstrations which will be funded by a new CCS incentive to be introduced through the current Energy Bill.
- The **Regulators** (Ofgem in Great Britain and the Northern Ireland Authority for Utility Regulation in Northern Ireland) are responsible with the Government for protecting the interests of both current and future consumers. Ofgem's role includes promoting effective competition, wherever appropriate, and regulating monopoly companies.
- **Energy companies** are responsible for making investment in energy infrastructure and ensuring sources of energy are available to meet demand in a competitive market. The regulated network monopolies support this investment by ensuring that the UK's energy networks are developed in a timely way and continue to deliver high levels of reliability.

2.3 Security of supply outlook

2.3.1 As well as availability of primary fuel sources and transmission capacity, key drivers for security of supply in the short to medium term are the impact of global, EU and the Government's low carbon energy policies and the level of overall economic activity as the UK and the rest of the world emerges from recession. Our analysis for EMO shows that the recession-driven reduction in demand has resulted in a strengthened security of supply picture in the near term. Although the Russia/ Ukraine dispute last winter highlights the broader risks arising from import dependency, on this occasion the main impact on the UK was increased exports to other markets and there was little overall impact on the UK demand/supply balance. Our diversity of gas supply (including our North Sea reserves) and the LNG capacity that we have developed has strengthened our ability to deal with potential supply interruptions.

2.3.2 In the medium and longer term, the prospect of significant and rapid change in the way in which we consume and produce energy brings with it a number of potential challenges. The Government set out in the Low Carbon Transition Plan how it expects to meet them. On the demand side, the drive to a low carbon economy could change significantly the way we consume energy, including reducing overall energy demand by improving levels of energy efficiency, and switching to less carbon-intensive forms of energy use in transport and heat through growth in the numbers of electric vehicles and electric heating systems. On the supply side, the Low Carbon Transition Plan sets out how renewable energy sources will increasingly contribute to the energy mix, and how options for clean coal and new nuclear power stations will also be taken forward. The Transition Plan shows that these measures could lead to a substantial reduction in annual gas demand.

2.3.3 Ofgem's Energy Market Scenarios, developed as part of phase one of Project Discovery, demonstrate the extent of the uncertainties surrounding future developments in GB energy demand and supply. The scenario outcomes are determined by a number of factors, but two fundamental drivers are the pace of global economic recovery and global commitment to environmental action. For example, in the Green Transition scenario, rapid economic recovery combined with concerted environmental action delivers a significant shift towards renewable generation over the next decade and stable gas import dependency. The Dash for Energy scenario, however, implies growing gas demand as fossil fuelled generation continues to play a significant role. While the scenarios show that gas and electricity supplies can be maintained to customers, each scenario comes with risks to security of supply, potential price rises and varying carbon impacts. These scenarios are, of course, not forecasts but serve to test our resilience against a range of potential situations. Some scenarios are more likely than others.

2.3.4 There are a number of other key drivers for security of supply. In electricity generation, a large number of older coal and oil fired power stations will close by the end of 2015 under European environmental legislation and, based on current plans, only one of the existing nuclear power stations is due to be operational after 2023. There is significant new generation capacity under construction or with planning consent and DECC projections show that this would be sufficient to exceed peak demand through the next decade. In gas, while UK Continental Shelf (UKCS) production continues to decline, it will remain an important source of UK supply for many years to come. Gas will continue to have a significant role and have security of supply implications to the extent it is imported. But any such implications are increasingly addressed by sourcing gas from a diverse range of countries, via a diverse range of routes, and generous gas import capacity.

2.3.5 To date industry has taken timely action to ensure additional capacity comes on as demand grows and plant retires. Constrained access to finance and higher financing costs, as a consequence of the credit crunch, have resulted in a higher risk of deferral or cancellation of some projects (particularly those of smaller developers although larger companies with strong balance sheets may also still have to prioritize investments). Overall, however, significant amounts of investment is going ahead in both gas and electricity infrastructure.

2.4 Electricity

2.4.1 Generation diversity and the de-rated capacity margin relative to peak demand are key indicators of electricity security of supply. In the near term, generation capacity is more than likely to be adequate to meet demand with capacity margins currently around 34% (high by historic standards)[6].

2.4.2 For the medium to longer term, the ranges of electricity demand indicated here are wider than in last year's report primarily due to greater uncertainty surrounding the globaleconomy. This year's report shows a range of scenarios from DECC, Ofgem's Project Discovery and

6 National Grid's 2009/10 Winter Outlook.

National Grid. These scenarios show peak electricity demand broadly in the range of 50 to 70 GW in 2020. In terms of capacity margin, DECC analysis consistent with the Low Carbon Transition Plan suggests that de-rated capacity margin could be in the range 6 -13% in 2020, with the most recent analysis by Redpoint Energy for DECC (see chart 4.9) showing a capacity margin of 11% in 2020. Project Discovery scenarios present a range from 6 to 15% in 2020. Any projection of electricity capacity margin will be uncertain and would be likely to vary considerably due to the complex array of factors, including environmental policy and economic growth

2.4.3 In terms of generation capacity, some 12GW[7] of older coal and oil plant will close by 2015 as it does not meet limits on emissions of acid gases under the Large Combustion Plant Directive (LCPD). A further 7GW of nuclear stations reach the end of their expected operating life by 2018. Looking further ahead (to the 2020s) further nuclear plant closures are expected with only one of the current fleet likely to still be in operation after 2023 (though the exact closure dates are uncertain as nuclear plant lifetimes have been extended in the past). The proposed Industrial Emissions Directive (IED) would establish stricter limits on the emissions of sulphur and nitrogen oxides from power stations. The current text of the Directive could be expected to result in further closures, around and after 2020 and is subject to further consideration by the European Parliament.

2.4.4 Plant currently under construction goes a long way to ensuring adequate electricity capacity and supplies into the first half of the next decade. There are a large number of new generation projects at various stages of development. 9GW is under construction, a further 10.8GW already have consent and agreement for connection to the National Grid. While there are a number of generation projects (largely renewable) that are expected to connect to local networks, there is also an additional 50GW of projects at earlier stages of development.[8] However, there is inevitably some uncertainty as to what proportion of the total projects under development will be built and when, and the timing of closures of existing plant. .

2.4.5 A successful transition to a low carbon energy system is likely to lead to a very different generation mix. The Government's Low Carbon Transition Plan and Renewable

7 Source: DECC, based on plants identified as Opted Out under the LCPD
8 Source: National Grid, based on applications for network connection

Energy Strategy sets out policies for around 30% of electricity to be produced from renewable sources by 2020.

2.4.6 The intermittent nature of many renewable generation sources (in particular wind) will bring new challenges in relation to the operation of the electricity system including the need for investment in back up generation. The Government invited views on the challenges to the security of electricity supplies in its call for evidence 'Delivering secure low carbon electricity' published in August 2009.[9] Responses will inform the development of a 2050 roadmap, which will identify possible pathways to a low carbon UK, as well as informing work to ensure that the energy policy and market framework deliver the investment needed for affordable and secure supplies of low carbon energy.

2.5 Carbon market

2.5.1 The EU Emissions Trading System (EU ETS) and the carbon market continues to be a key consideration in future low-carbon investment decisions in the energy-intensive sectors, and as such has an impact on security of supply.

2.5.2 The revised EU ETS Directive agreed in December 2008 sets a reduction in the cap of 1.74% per year from 2013 onwards (compared with the first carbon budget period), and so gives a better long-term signal to investors.

2.5.3 Setting the right, long-term regulatory framework with a reducing cap on emissions (as the UK has done with the EU ETS) is important to providing certainty to investors, and to allowing the market to help achieve these reductions cost-effectively. Longer term, the most effective way of ensuring the carbon price is high enough is to limit the supply of allowances by tightening the cap. The EU is committed to reducing its overall emissions to at least 20% below 1990 levels by 2020, and is ready to scale up this reduction to as much as 30% under a new global agreement when other developed countries make comparable efforts. The EU ETS cap would be tightened as a key part of delivering any tighter EU target.

2.5.4 The EU Emissions Trading System (EU ETS) and the carbon market continues to be a key consideration in future low-carbon investment decisions in the energy-intensive sectors. and as such has an impact on security of supply.

9 http://www.decc.gov.uk/en/content/cms/consultations/electricsecure/electricsecure.aspx

The revised EU ETS Directive agreed in December 2008 sets a reduction in the cap of 1.74% per year from 2013 onwards and so gives a long-term signal to investors.

2.6 Renewable Energy

2.6.1 To complement the carbon markets, the Government is pursuing a number of strategic interventions to support low carbon investment such as renewable energy. The Renewable Energy Strategy set out the Government's plans for meeting the UK target of 15% of energy consumption from renewable sources by 2020.[10] Renewable energy consumption (across electricity, heat and transport) was 2.25% in 2008 and so meeting the 2020 target will require an almost seven-fold increase, which requires significant new investment. The Government's lead scenario as set out in the RES for 2020 projects 10% renewable energy in transport, 12% in heat and over 30% in electricity including 2% in small-scale generation.

2.6.2 While the UK is developing its renewable energy resources principally to address climate change, there may also be security of supply benefits to the UK from a growth in renewable energy where this brings with it a more significant reduction in imported fossil fuel demand than would otherwise have been the case. That said, the intermittent nature of many renewable generation sources will also bring new challenges as highlighted earlier. Government estimates show that moving to 15% renewable energy in 2020 could reduce annual fossil fuel demand by around 10% and annual gas imports by 20-30% from what they otherwise would have been in 2020.

2.6.3 The Government recently published its response to the summer consultation[11] on proposals to increase support for offshore wind projects to 2 ROCs/MWh for projects meeting specific criteria. The Government has also announced it will be extending the RO to 2037.

2.7 Nuclear Energy

2.7.1 The Government believes that new nuclear power stations have an important role to play in the UK's future energy

10 Reference tba
11 Government Response 2009 Consultation on Renewables Obligation http://www.decc.gov.uk/en/content/cms/consultations/elec_financial/elec_financial.aspx

mix alongside other low-carbon sources[12], and is taking active steps to facilitate this investment. This includes implementing reforms in the planning system and the publication of a draft Nuclear National Policy Statement to guide the new Infrastructure Planning Commission in its assessment of consent applications for new nuclear power stations.

2.7.2 The Euratom Supply Agency have expressed confidence that there are sufficient identified uranium resources to meet the current global demand for about 100 years and, with a strong market, sufficient uranium resources are likely to be identified to support a threefold global increase in nuclear power for over 100 years. As secondary supply sources of uranium are reduced, an increased production of primary uranium resources may be needed to meet global demand in the medium/long term.

2.8 Gas

2.8.1 The near term security of supply picture has improved, in the main, due to the decline in demand from industry and power generation due to the economic downturn. There have been important developments in liquefied natural gas (LNG) import infrastructure with the South Hook and Dragon terminals in Milford Haven, which have a combined capacity of 16.5 billion cubic metres (bcm) a year, equivalent to around 17% of UK annual demand, commercially operational for winter 2009/10. At the start of winter 2009/10 the UK had 25% more import capacity than at the start of the previous winter. Capacity alone, however, does not assure supply. It is also necessary for there to be sufficient availability and responsiveness to price signals.

2.8.2 While a major supply disruption in Europe combined with a very cold winter could affect security of supply in some circumstances, the Russia-Ukraine dispute in winter 08/09 had no direct impact on consumers in the UK. This was done to a range of factors including well-supplied global markets and recess-driven reduction on demand as well as the combination of our transparent and liberalised market, our diverse import capability, use of storage and our own indigenous production which, though declining, is still considerable.

12 *Meeting the Energy Challenge: A White Paper on Nuclear Power*, January 2008, http://www.berr.gov.uk/files/file43006.pdf

2.8.3 Looking further ahead DECC projections for annual gas demand, taking account of the measures published in the Low Carbon Transition Plan in July 2009 show forecast gas demand on a falling trend to 2020, rising thereafter. Ofgem also found that annual GB gas demand would fall in Project Discovery's'green scenarios' although it generally increases in the two other scenarios where low carbon energy targets are not met.

2.8.4 The ability to meet peak demand whether on a particular day or over a more prolonged period such as a cold winter is key to ensuring continuity of supply. National Grid's modelling suggests that meeting environmental targets will have less effect on reducing peak demand, than annual demand. This would be the case if gas-fired power generation was used to provide flexible peak-time support for intermittent wind generation.

2.8.5 UK gas production continues to decline. DECC's central projection is that UK gas production will fall from 64bcm to around 34bcm by 2020. Factors affecting production include investment levels, the ability to overcome technical issues, and issues related to geology. DECC's current projection shows import dependency rising slightly out to 2014 then broadly levelling off as a result of reduced demand brought about by low carbon policies. However, it should be noted that there are considerable uncertainties, and hence a wide range of sensitivities around this central case.

2.8.6 Additional gas import capacity is due to be delivered, with some 17.5 bcm of import capacity under construction, and at least another 24.5 bcm that has been proposed[13]. Looking to markets more broadly, there are encouraging developments in the European market while LNG markets are expanding as more countries install LNG export capacity. More remains to be done, however, to ensure that international markets are always open and reliably supplied.

2.9 Coal

The Large Combustion Plant Directive will lead to the closure of some 8GW of the existing 28GW of coal capacity by the end of 2015[14], with the Industrial Emissions Directive

13 National Grid *TBE*, summer 2009, page 57, table A2 "Under construction and proposed import projects": http://www.nationalgrid.com/NR/rdonlyres/3FCF87F1-6CB4-4B42-A185-AED337453821/35677/TBE2009DevelopmentofEnergyScenarios.pdf

14 Source: Digest of UK Energy Statistics

likely to lead to further closures after 2020. Coal power stations play a vital role today in providing the UK with secure energy supplies but, if coal is to continue to play its role in the UK's diverse energy mix, we need to find ways to reduce substantially its carbon emissions.

2.9.1 Under an environmentally ambitious new policy framework, new coal power stations are required to demonstrate carbon capture and storage technology (CCS) at commercial scale and, in the 2009 Pre-Budget Report, the Government committed to supporting four commercial scale CCS demonstrations with funding provided through a new CCS incentive that forms part of the current Energy Bill. This could enable a significant proportion of the closing coal capacity to be replaced by 2020. Moreover, the demonstration programme is a stepping stone to full CCS deployment, which would enable coal to remain an important part of the UK energy mix in the long term.

2.9.2 Against this background, a range of scenarios can be postulated for demand for coal in the UK over the next decades.

2.9.3 UK coal continues to play an important part in meeting domestic demand with investment being made in both deep mines and surface mining. These demand scenarios indicate further opportunities for indigenous production of coal, although issues such as planning consents in particular for surface mines would also need to be considered.

2.9.4 In all scenarios, however, there remains a significant reliance on imports. Russia currently supplies about half of the coal imported into the UK. Given the global abundance of proven coal reserves, availability is unlikely to limit its future use, but there are a number of international and environmental risks that could affect future prices.

2.10 Oil

2.10.1 The economic downturn has lowered the UK's demand for a broad range of petroleum products. This year, in the wake of last year's oil price spike and the economic recession demand is expected to fall below 83 million tonnes of oil equivalent (mtoe) (-3.7% year on year). Demand in 2025 is projected to be around 84mtoe. Transport has the dominant share of UK oil demand reflecting both rising transport demand, and less industrial and power sector consumption during the transition to a low carbon economy.

2.10.2 Since 2005, the UK has consistently been a net importer of crude oil, as production from the UK continental shelf has declined. The UKCS nonetheless provided a third of the UK refinery intake in 2008 and will continue to play an important part in supplying domestic refineries for many years to come. In 2008, net imports accounted for 13% of crude refined in the UK. Most of the UK's crude imports come from Norway, with the remainder largely supplied by Russia and Algeria.

2.10.3 In 2008 the UK produced almost 72 million tonnes of oil and natural gas liquids from the UK continental shelf. Oil production in the UK peaked in 1999 and is now declining, but there are still significant quantities to be produced. Based on DECC's latest assessment, the UK has produced approximately 65% of its Ultimately Recoverable Reserves.

2.10.4 The UK remains a net exporter of petroleum products. There are, however, significant and increasing imports of certain petroleum products reflecting the difference between the types of petroleum products consumed in the UK and the types produced by domestic refinery capacity. As a result there may need to be further investment in import and refinery capacity. The Government has established the Downstream Oil Industry Forum in order to identify barriers to investment, and to develop the UK's existing infrastructure.

2.10.5 The greater use of biofuels and particularly their widespread integration into the UK's supply infrastructure will present challenges for the retail fuel industry. Taking the technical constraints of the vehicle stock into account, greater biofuel use could reduce the UK's oil consumption by around 3% of forecast demand by 2020.

2.11 International Context

2.11.1 In the wider international context, EU member states have adopted various approaches to national energy security. However, the EU as a whole has agreed to increase the proportion of its energy demand met from renewable sources, and to improve its energy efficiency, primarily for the carbon benefits but also with a view to reducing its dependence on fossil fuel imports.[15] The EU has also agreed on the necessity of creating across the EU an efficient, liberalised and well connected energy market and the removal of commercial and infrastructural barriers to market responsiveness, for example, by effective unbundling.

2.11.2 Moreover a new EU Regulation on security of gas supply currently being negotiated is intended to lead to much greater EU resilience through greater co-ordination between Member States in preparing for and dealing with gas supply crises. The Government is working with the Commission and EU partners on this proposed Regulation to ensure that it maximises the effectiveness of the roles of Member States, gas undertakings and the European Commission.

2.12 Conclusion

2.12.1 The EMO is intended to inform and facilitate decision making by energy market participants and stakeholders. We welcome views and comments on the document to that end.

15 EU Climate and Energy Package 2008

3. Security of Supply in a Competitive Energy Market

3.1 Introduction

3.1.1 Security of supply is integral to the development of the future low carbon energy system. As the UK moves towards a substantially de-carbonised energy sector that will deliver an 80% reduction in carbon emissions by 2050 there will be new security of supply challenges and new opportunities.

3.1.2 The UK has an energy system with a track record of maintaining supplies with very few interruptions. While interruptions are a measure of the level security of supply, we discuss below the wider concept and definition of security of supply, and how it can be measured. These measures are then used as appropriate to consider the key security of supply risks and drivers associated with electricity, gas and the full range of fuels, in the following chapters.

3.1.3 Security of supply is a key element of Government energy policy and is central to Ofgem's role in protecting consumers. The roles and responsibilities of the key players are set out below.

- **Government** has a strategic role in ensuring that the overall policy framework is clear, promotes security of supply and supports the necessary investment in energy infrastructure and in promoting energy efficiency. For example, the Government is putting in place reform of the planning regime and taking steps to facilitate new nuclear power stations; it is proposing to increase and extend the life of the Renewables Obligation (by increasing support for qualifying offshore wind to 2 ROCs/MWh and extending the Obligation's life to 2037); and in the 2009 Pre-budget Report, the Government committed to support four commercial-scale CCS demonstrations which will be funded by a new CCS incentive to be introduced through the current Energy Bill.

- The **Regulators** (Ofgem in Great Britain and the Northern Ireland Authority for Utility Regulation in Northern Ireland) are responsible with Government for protecting the interests of both current and future consumers. Ofgem's role includes promoting effective competition, wherever appropriate, and regulating monopoly companies.
- Energy companies are responsible for making investment in energy infrastructure and ensuring sources of energy are available to meet demand in a competitive market. The regulated network monopolies support this investment by ensuring that the UK's energy networks are developed in a timely way and continue to deliver high levels of reliability.

3.2 What is security of energy supply?

3.2.1 There are different ways that security of supply can be measured. The primary measure of security of supply is the extent to which available sources of gas and electricity are able to meet demand. Secure energy means that the risks of interruption to energy supply, are low. Interruptions could be as a result of a power cut or shortages of key fuels.

3.3 Dimensions of Security of Supply

3.3.1 The objective of security of supply policy is to avoid involuntary interruptions to consumption of energy.

3.3.2 There are a number of ways in which security of supply can be considered:

- **physical security**: avoiding involuntary physical interruptions to consumption of energy (i.e., the lights going out or gas supplies being cut off)
- **price security**: avoiding unnecessary price spikes due to supply/demand imbalances or poor market operation (e.g. market power). That said, price movements are a key element of ensuring security of supply, by for example encouraging demand-side response in the short-term and sending investment signals in the medium to long-term.

- **geopolitical security**: avoiding undue reliance on specific nations so as to maintain maximum degrees of freedom in foreign policy.

3.4 Measuring security of supply

3.4.1 There are a number of indicators that market participants, Government and the regulator can use to understand the risks and develop appropriate responses to the security of supply position. The relative importance of each security of supply indicator will vary between different kinds of energy source and over different time periods, and they inter-relate. For example, a country might have a very limited *diversity* of sources of supply, but whether this is a major concern would depend on the *reliability* and availability of those sources.

3.4.2 Security of supply risks may be related to only one or to a combination of the dimensions set out above. The risk may be heightened when they act in combination with increased demand, for example a very cold winter might combine with a technical problem in gas storage.

The table below sets out some indicators of security of supply.

Indicators of Security of Supply

- **Capacity Margin**: the safety margin between likely demand and the physical ability to supply enough energy to meet that demand.
- **De-rated capacity Margin (electricity)**: The expected availability of plant taking into account the risk of unforced outages and variability of renewables generation output.
- **Reliability**: the probability that import, transmission and production capacity on the system is actually available to deliver supplies when and where it is required. This may be affected, for example, by technical or engineering problems or fuel availability. For example, in the case of imported commodities, availability may depend on wider geopolitical factors, such as resource nationalism and/or infrastructure investment shortfalls affecting one or another overseas supply source; or global market issues, notably whether the price in the UK is attractive enough to ensure that non-contracted supplies find their way here rather than to other, higher priced markets.
- **Availability**: while sufficient capacity is a requirement for ensuring security of supply, it is also essential that there is sufficient availability (i.e. gas flowing).
- **Adequacy of gas supplies on a cold day or through a cold period**: Adequacy of gas supplies can be measured, for example, to meet the demand on the coldest day in a twenty year period (the 1 in 20 peak day) and also to last through a longer period of high demand e.g. period of sixty days of exceptionally high gas demand statistically occurring every twenty years (1 in 20 severe winter).
- **Diversity** of energy sources, which has an impact on the probability of large amounts of supply being unavailable at the same time. This is particularly important where supply reliability is subject to a high level of uncertainty. Diversity may, for example, be geographic (not importing all fuels from the same country) or technological (not relying on a single type of generating capacity or fuel).
- Effective **price signals**, to ensure that market participants have appropriate incentives to react in a timely way to any mismatch between supply and demand.

3.5 Ensuring Security of Supply

3.5.1 The aim of security of supply policy in terms of Government policy is to ensure that the risks of interruption are minimised consistent with what is economically acceptable and to ensure that efficient processes are in place to mitigate and manage any interruption.

3.5.2 It is not possible to eliminate security of supply risks. Moreover, identifying or assessing the appropriate level of security of supply is challenging. For example, the costs of improving security of supply further may carry incremental costs out of proportion to the increased level of security achieved. The cost and benefits of any action to reduce security of supply risks need to be carefully assessed. In the UK market participants make that assessment based on commercial considerations in a competitive energy market. In the competitive market, energy suppliers will lose market share if they fail to deliver against customer expectations, and regulation means they will also face financial penalties if they fail to match supply and demand. There are also provisions to ensure there is sound information on which to plan network investments.

3.5.3 Government works to ensure the market has access to timely and credible information and is able to respond. The Government therefore conducts analysis and provides market information. This includes the Digest of UK Energy Statistics and documents such as the UK Low Carbon Transition Plan, Renewable Energy Strategy, coal and nuclear packages, National Policy Statements, and the recent call for evidence on electricity security of supply.

3.5.4 The Government and the regulators also work to deliver an improved framework to support investment, for example in the reforms to the planning process for nationally significant energy infrastructure projects and work to improve arrangements for grid access for new power stations.

3.6 Timescales for considering security of supply

3.6.1 The security of supply position is dynamic and should be considered from a short, medium and long-term perspectives.

3.6.2 From a **short-term** perspective, the main focus is the extent to which we can be confident that energy can be delivered when and where it is needed with the infrastructure capacity we have, i.e. the reliability of the mechanisms (both technological and commercial) which convert primary energy sources for use by the final consumer. In the short term, price may not always balance supply and demand because some consumers are shielded from the day to day spot prices and may continue to take gas or electricity when wholesale prices are high and the system is running short. This risk of interruption may be mitigated, however, through demand-side management. For example, through some industrial customers either on interruptible contracts or exposed to spot prices providing flexible demand. In addition, interruptions to GB imports from significant overseas producers or individual technical difficulties need not lead to interruptions but may cause price rises.

3.6.3 From a **medium term perspective**, the focus is on ensuring an effective environment for investment, both in addressing supply chain and financing constraints which may result in delays in commissioning of appropriate infrastructure. In this case, physical interruptions are unlikely, but prices would again be likely to rise to balance supply and demand.

3.6.4 From a **longer term perspective, for example, looking five to ten years ahead, the focus is on** larger scale investment. In this case, planning and technological development are critical. Clear investment signals are therefore needed if technologies such as Carbon Capture and Storage (CCS) are to be delivered, and there is to be delivery of new nuclear.

3.7 International Context

3.7.1 Security of supply is also a key policy driver at European and international levels and the Russia/Ukraine dispute last winter highlighted broader risks arising from import dependency. Despite the limited impact on the UK of this event, a major supply disruption in Europe combined with a very cold winter could affect security of supply in some circumstances. This highlighted the need for effective policy across Europe. Accordingly the European Commission has brought forward a draft Regulation on gas security of supply, which the UK Government has welcomed and is pursuing with the Commission and EU partners. More broadly, EU energy market liberalisation under the auspices of the Third Package should encourage greater transparency, better price signals and a more responsive integrated market with corresponding benefits for security of supply.

3.8 Context for subsequent chapters

3.8.1 The subsequent chapters of this report set out discussion and analysis of security and supply risks and drivers for the full range of energy sources and fuel.

4. Electricity

4.1 Introduction

4.1.1 This chapter sets out a discussion of the drivers of security of supply in the electricity market. As such it takes account of the strategy set out in the Government's Low Carbon Transition Plan and also draws on information provided by National Grid and in Ofgem's Project Discovery.

4.1.2 Electricity security of supply is, at a high level, determined by: the ability to produce or import it, future demand levels and the network infrastructure needed to deliver electricity to where it is used. A particular issue for electricity is that it is expensive and difficult to store, so supply and demand must be closely matched on a moment to moment basis.

4.1.3 The Government has set out in its Low Carbon Transition Plan its strategy for delivering secure electricity supplies, out to 2020. In this chapter we look first at the factors affecting future levels of demand. We then consider how electricity might be generated or imported to meet this projected demand. Finally, we look at current and future electricity networks, and how they could change to meet future needs – including a consideration of smart grids.

4.1.4 All this needs to be seen in the context of the need to move to a low carbon economy. Greenhouse gas emissions from electricity generation and heavy industry currently make up around 43% of the UK's total emissions. These emissions are covered by the EU Emissions Trading System (EU ETS). The existence of the EU ETS means that there is a price for each tonne of carbon dioxide emitted when generating electricity[16]. This is designed to provide an incentive to switch to less carbon-intensive forms of power generation. Net emissions from all energy-intensive sectors, including power generation, form part of the emissions included in the UK's carbon budgets. More about the EU ETS can be found in chapter 10 on carbon.

4.1.5 Where analysis in this chapter draws on data provided by National Grid it refers to electricity supply and demand in Great Britain. The electricity market in Northern Ireland is

16 Strictly speaking, this only applies to fossil fuel generation above 20MW

part of the Single Electricity Market, which is discussed in a box at the end of this chapter.

4.2 Electricity demand

4.2.1 Because electricity security of supply depends on the amount of generation capacity available to produce sufficient electricity to meet demand at any point in time, the most significant indicator in assessing electricity security is the peak – the highest instantaneous level of demand in any given year.

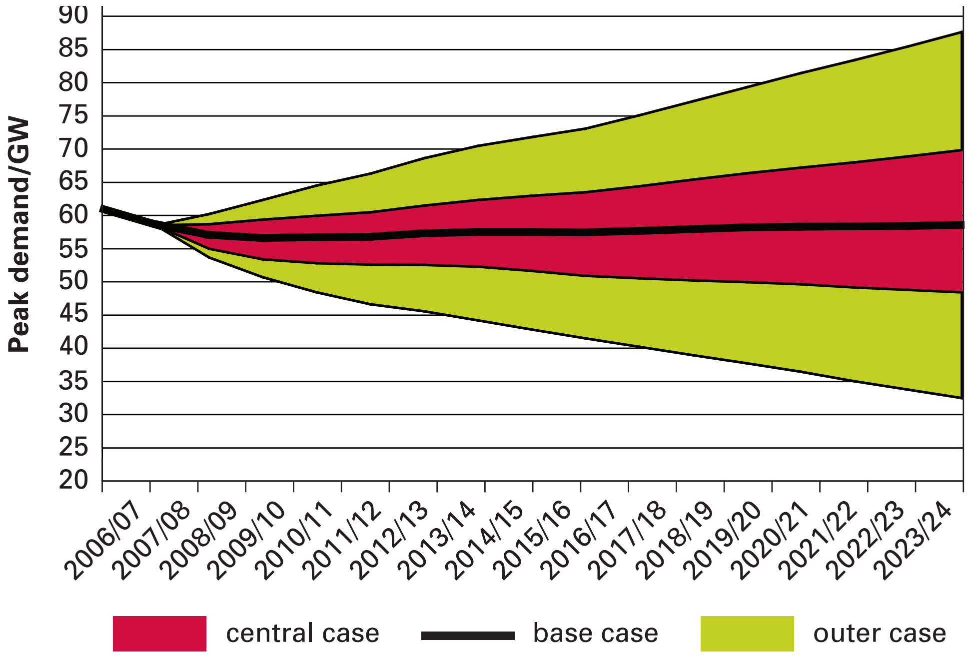
4.2.2 Over longer time horizons, there is considerable uncertainty about the level of peak electricity demand in the future, which is reflected in chart 4.1. There are a number of factors that are likely to influence how peak electricity demand develops – for example, higher economic growth would be expected to lead to increased levels of peak demand. In contrast, increased energy efficiency, and warmer temperatures, particularly in the winter, might be expected to put downward pressure on demand; whereas a combination of increasing summer temperatures and greater penetration of air-conditioning could eventually lead to the development of higher demand during summer. In the longer term, developments such as an increased reliance on electric-powered storage heating and electric vehicles could begin to reduce the difference between daytime and night-time demand, or possibly increase daily peak demands.

4.2.3 At the moment, demand is largely met by electricity transported across the transmission network from large generators to distribution networks. However, more extensive deployment of distributed energy, such as embedded Combined Heat and Power (CHP) and micro-generation is anticipated to increase the extent to which demand is met by local generation. This could lead to a reduction in demand on the transmission system and thus reduce the demand levels shown in chart 4.1[17]. Embedded generation is expected to steadily grow across the period due to various support mechanisms and in part the small incremental nature of any capacity additions. For example, the lead scenario in DECC's Renewable Energy Strategy

17 These figures are based on electricity demand on the transmission network, and so do not include generation that is connected at a distribution network or local level. Embedded generation therefore has the effect of reducing the demand shown in chart 4.1.

shows 2% of electricity coming from embedded renewable generation in 2020.

Chart 4.1: Future development of peak demand on the national transmission system



Source: National Grid

4.2.4 Chart 4.1 shows projections of future peak electricity demand with a base case, an outer fan (illustrating a simple summation of all sensitivities) and an inner fan illustrating combinations of sensitivities more likely to occur together. For example, the highest levels of demand shown in chart 4.1 are likely to be reached only if the relevant factors (such as the rate of economic growth, or the take-up of electric vehicles) were all stimulating demand growth and no factors were acting to reduce demand. In practice, these variables are not independent and it is extremely unlikely that they would all combine to push electricity demand in one direction. A narrower central range of more probable demand levels has therefore been highlighted on the chart. However, even within this range, there are still significant variations.

4.2.5 All the ranges are wider than those shown in last year's Energy Markets Outlook. This is driven principally by recent economic developments. The factors[18] that affect the actual demand outcome include, amongst other things, the take-up of energy efficiency measures, economic growth and the

18 See http://www.nationalgrid.com/uk/sys%5F09/default.asp?action=mnch2_7.htm&Node=SYS&Snode=2_7&Exp=Y#National_Grid_Forecasts for more details

timing of the recovery from the downturn, energy prices and the use of electric vehicles. National Grid's forecast peak demand as shown in chart 4.1 ranges from around 33 GW to around 88 GW in 2020, with a central case of 58 GW in that year. For the same year, Ofgem's Project Discovery shows four scenarios with peak demand ranging from 59GW to 68GW in 2020. DECC's Energy model uses 58GW as the central scenario for 2020. The economic downturn, and further energy efficiency policies, have also reduced the base case from last year's modelling.

4.2.6 The relative speeds of the economic recovery and of new generation build are an important factor in determining the security of electricity supply. Electricity demand is correlated with GDP, and drives new generation. All other things being equal, the higher the market believes that future GDP is likely to be, the more new generation is likely to be built. If the market over-estimates future GDP, more generation capacity is likely to be built than is necessary, increasing costs but also increasing the capacity margin (see section 4.4 for an explanation of this term) and so the security of electricity supplies. Conversely, if the market under-estimates future GDP, it could mean that less generation is built than would be needed to maintain current capacity margins. A significant determinant, therefore, of future security of electricity supply is how accurately the market predicts future GDP.

4.2.7 The introduction of advanced and smart meters to consumers in all sectors of the UK economy over the next decade will provide the means for improved demand management and so assist in matching demand with supply capacity. Smart meters allow for the introduction of innovative measures such as dynamic time of use tariffs[19] which could act to incentivise consumers to shift their available discretionary demand so that it more closely matches available supply, smoothing out peaks and troughs in electricity demand and assisting in addressing increased intermittency problems expected as the amount of renewable generation (mainly wind) increases. This could assist in using existing power stations more efficiently and reduce the need for standby plant. DECC is carrying out work to assess the role that demand side management may play in assisting future security of supply; the issue was raised as part of the DECC call for evidens "Delivering secure low carbon electricity[20]. Responses to which will be

19 Where the price paid per kWh can be different at different times
20 http://www.decc.gov.uk/en/content/cms/consultations/electricsecure/electricsecure.as

considered as part of the Government's 2050 roadmap work which will be published in spring 2010. The Government recently published its response to the smart meters consultation[21] and a document considering the development opportunities for a smarter grid[22].

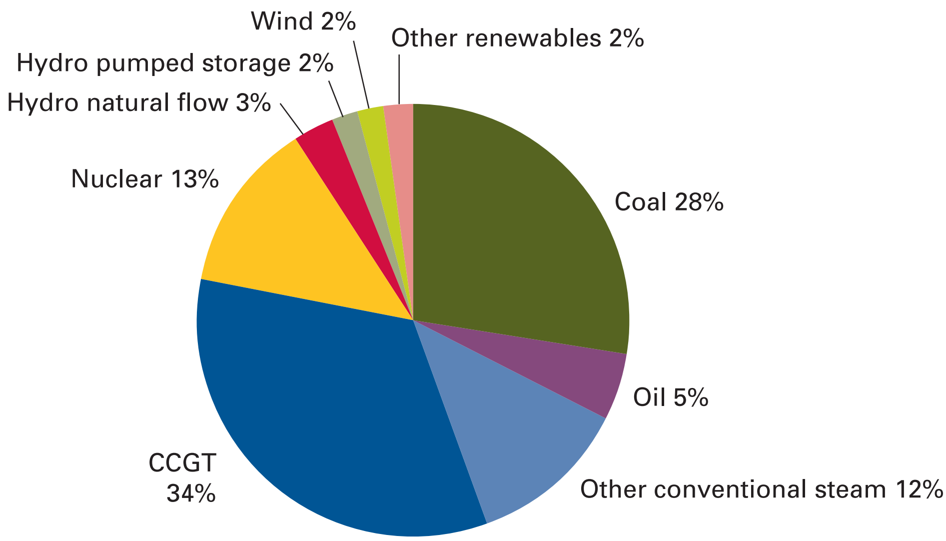
4.2.8 Work carried out for DECC by IHS Global Insight[23] has estimated current potential discretionary demand in the UK to range from 9GW to 17 GW (compared with the current level of around 1GW in National Grid's Winter Consultation Report[24]). However, it is currently difficult to estimate how much of this potential might be realised in the future.

4.3 Electricity supply

Present capacity

4.3.1 As at the end of 2008, the UK as a whole had a total of 83.5 gigawatts (GW) of electricity generating capacity of various kinds (Chart 4.2 source: DUKES). In addition Great Britain had the capacity to import and export the equivalent of 2.5GW from and to France and Ireland.

Chart 4.2: Electricity generating capacity in the United Kingdom, by technology[25], in 2008

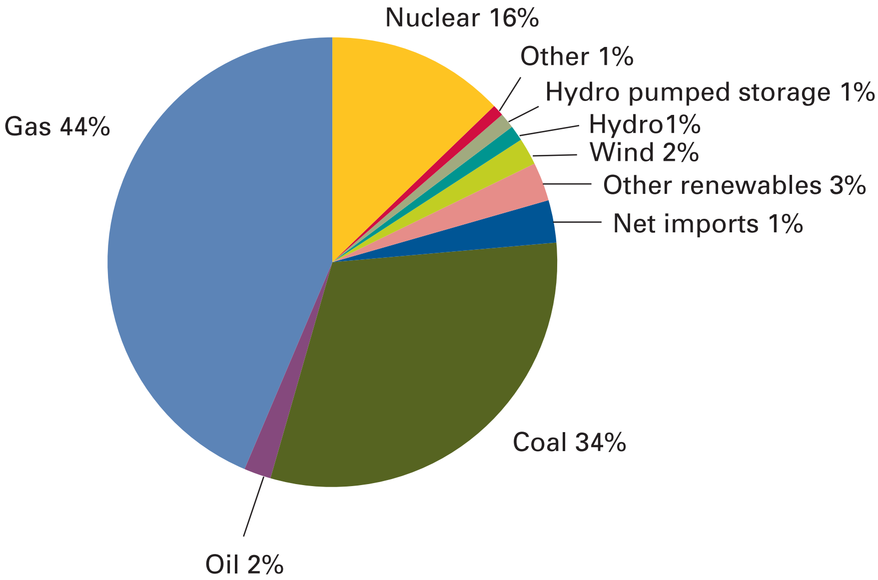


21 http://www.decc.gov.uk/en/content/cms/consultations/smart_metering/smart_metering.aspx
22 http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/network/smart_grid/smart_grid/aspx
23 See http://decc.gov.uk/Media/viewfile.ashx?FilePath=Consultations\Electricity supply security\1_20090804144704_e_@@_DSMreportGlobalInsight.pdf&filetype=4
24 http://www.nationalgrid.com/uk/Gas/TYS/outlook/
25 "Other conventional steam" includes mixed or dual fired thermal capacity and gas fired stations that are Open Cycle Gas Turbines, or have some CCGT capacity but mainly operate as conventional thermal stations.

4.3.2 The respective shares of generating technologies in electricity production are different from shares in capacity, since some plant generates more or less continuously (e.g. nuclear), some only at times of extremely high prices and/or demand (e.g. oil) and some depending on the availability of the power source (e.g. wind). Of the 401 TWh of electricity supplied in 2008, the breakdown by technology type was as shown in chart 4.3 below. Significant changes from the same data for 2007 include an increase in the proportion from gas generation (up from 41%) and a reduction in that from coal (down from 34%) and nuclear (down from 16%).

4.3.3 Electricity generation capacity has a finite lifetime, and faces increasingly strict environmental regulation. Both these factors, as explained in the next section, will lead to closures of some existing plant over the next decade. New plant is however being built, as explained in the subsequent section. We look in that section at the different drivers for building different types of generation.

Chart 4.3: UK electricity supply in 2008 (total: 401 TWh)

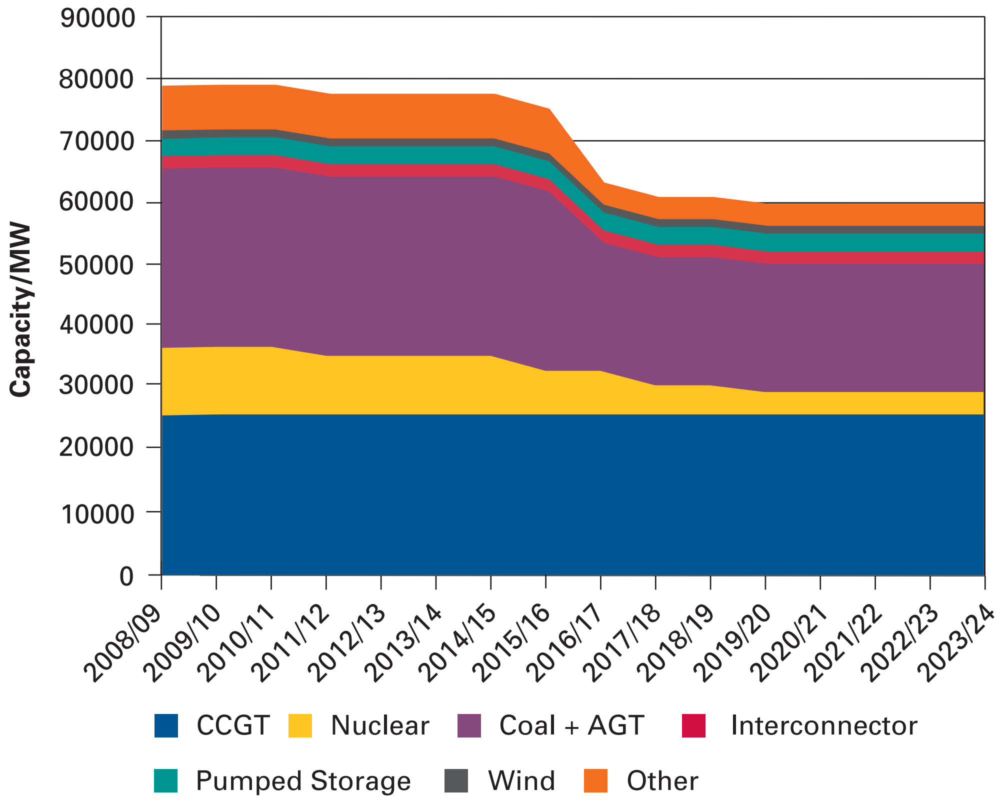


Plant closures

4.3.4 A substantial proportion of the UK's electricity generating capacity is expected to close over the next few years. Chart 4.4 below shows the development of existing GB generating capacity, based on capacity as reported in DUKES[26]and an assessment of likely closures. The GB market is not the only one affected by closures; some 600 MW of gas-fired capacity at the Ballylumford plant in Northern Ireland will also have to close by the end of 2015.

4.3.5 Provision is being made to build new capacity, as shown in chart 4.5. Estimates of the impact on the margin of spare capacity are shown later in this chapter.

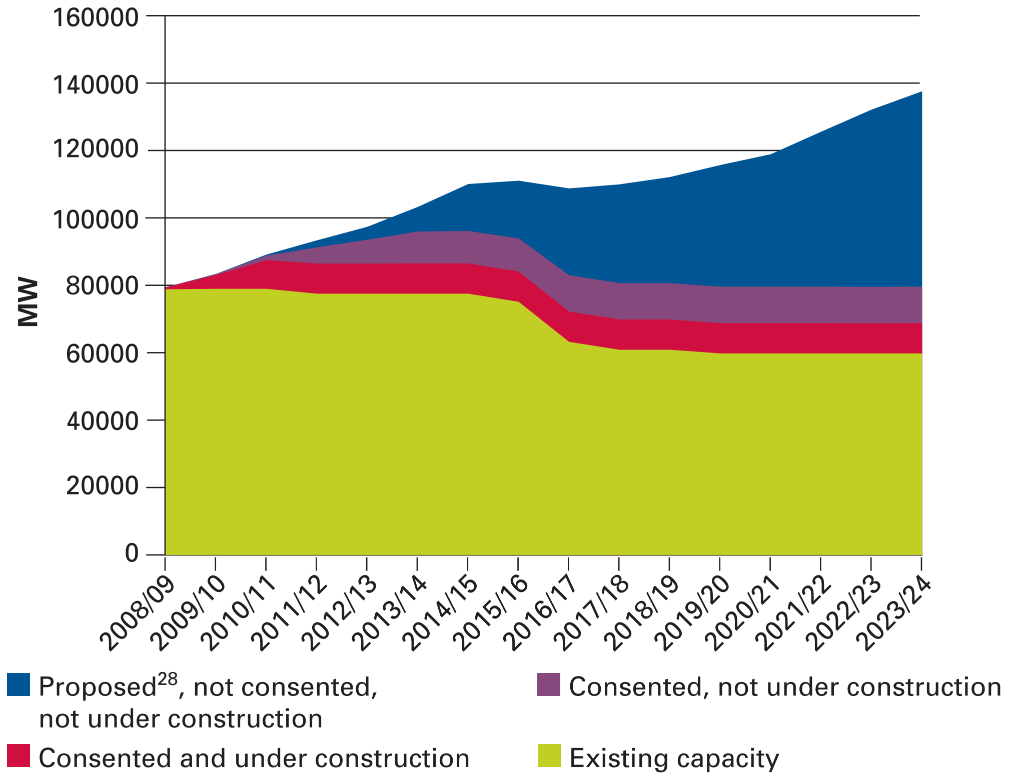
Chart 4.4: Development of existing GB generating capacity



Source: National Grid/ DECC

26 "Digest of UK Energy Statistics", available at www.decc.gov.uk

Chart 4.5: Existing and anticipated GB electricity generating capacity[27]



Reasons for expected closures 1: the Large Combustion Plants Directive and the Industrial Emissions Directive

4.3.6 The Large Combustion Plants Directive (LCPD)[29] requires large electricity generators, and some other industrial facilities, to meet stringent air quality standards. The Directive came into force from 1 January 2008. The LCPD however provides for generating companies to choose to opt out, which means they are only able to operate for a maximum of 20,000 hours over the period 2008-2015, and will have to close by the end of 2015. About 12 GW[30] of coal and oil generation capacity has been opted out under the terms of the Directive. Within this constraint, the timing of these closures is a commercial matter for plant owners, and this combined with the volatilities in commodity prices

27 Capacity figures are not de-rated. Assumptions about what capacity is 'existing' and what is 'under construction' are as in National Grid's August 2009 Seven Year Statement.
28 This capacity has been signalled as being proposed or under consideration through being Transmission Contracted. Transmission Contracted incorporates all existing and proposed stations that have a signed bilateral connection agreement with National Grid.
29 http://europa.eu/legislation_summaries/environment/air_pollution/l28028_en.htm
30 See http://www.defra.gov.uk/environment/quality/air/airquality/eu-int/eu-directives/lcpd/documents/lcpd_nationalplanannex.pdf for a list of opted-out plant

makes it impossible to predict with certainty the impact of the LCPD opted out closures on generation capacity in the period up to 2016. Current patterns of operation suggest a significant amount could close before 2015. For example, recently published data on the Environment Agency's website suggests that plants that have opted out of the LCPD are using a variety of strategies to determine how to use their allocated number of running hours[31].

4.3.7 In December 2007, the European Commission published a draft Industrial Emissions Directive (IED). This recasts seven existing Directives, including the current Integrated Pollution Prevention and Control Directive and the LCPD, into one in a move towards improved implementation and regulatory simplification. The current draft Directive would affect the remaining coal power stations as well as gas-fired power stations built before 2002.

Reasons for expected closures 2: Lifetime of nuclear plant

4.3.8 According to current timetables[32], up to 7.4 GW of existing nuclear generation capacity will have closed by 2020; these are shown in the table 4.1 below. All but one of the UK's existing nuclear power stations (Sizewell B) will have closed by 2023.

Table 4.1 Existing nuclear power station capacity

Station	Installed capacity (GW)	Expected to be closed by end
Wylfa	1.0	2010
Oldbury	0.4	2010
Hartlepool	1.2	2014
Heysham 1	1.2	2014
Hinkley Point B	1.3	2016
Hunterston B	1.2	2016
Dungeness B	1.1	2018

31 www.environmentagency.gov.uk
32 http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/issues/power_stations/power_stations/aspx

4.3.9 The operating lives of nuclear power plants can be extended, but only with the approval of the Health and Safety Executive's Nuclear Installations Inspectorate (NII). The decision whether to seek to extend the scheduled closure date is a commercial decision for the operators. These decisions will take into account such factors as plant safety and operating costs, as well as supply, demand and price expectations in the electricity market as a whole.

4.3.10 Since publication of the last EMO, decisions have been taken to extend the lives of Oldbury until 2010 and Wylfa until at least December 2010. Decisions about the potential extension to the operating lives of other existing stations are expected to be taken nearer their planned closure dates.

New build: quantity

4.3.11 As shown in National Grid's Seven Year Statement, there is 10.8GW of electricity generating capacity with consent to build, of which 6.7 GW is conventional capacity (gas). A further 9.0 GW is under construction. New capacity which is now at various stages of the planning, consent and construction process is presented in the following chart. The dates shown are from National Grid's Seven Year Statement[33]. Clearly, the further into the future we look, the fewer firm commitments have been made.

Source: DECC/National Grid Seven Year Statement

4.3.12 In practice, the type and total amount of new build could turn out to be higher or lower, particularly over the longer term. Generators' investment decisions fundamentally depend on expected future profitability, which is largely informed by investors' views of such factors as: likely future developments in the supply-demand balance, Government and regulatory policy, relative movements in fossil fuel and CO2 prices, and the capital cost of new plant.

4.3.13 Other factors may constrain the speed and quantity of new deployment. In the context of the Renewable Energy Strategy, BERR commissioned a report[34] from consultants Douglas Westwood on supply chain constraints on the deployment of renewable electricity technologies in the UK. A separate report by Sinclair Knight Merz[35] examined constraints on the growth of UK renewable generating

33 http://www.nationalgrid.com/uk/Electricity/SYS
34 http://www.berr.gov.uk/files/file46792.pdf
35 http://www.berr.gov.uk/files/file46772.pdf

capacity. Both reports provide conclusions about constraints on the development of new capacity in the energy industry more generally. We look briefly below at some of the main issues likely to be taken into account in considering investment in the main technology options.

New build: Planning

4.3.14 The draft National Policy Statements (NPSs) for energy infrastructure were published for consultation and Parliamentary scrutiny on 9 November 2009[36]. NPSs will be the primary consideration for the new Infrastructure Planning Commission (IPC) when it deals with planning applications for nationally significant energy infrastructure projects under the Planning Act 2008. The Government intends that the IPC will start to receive applications from 1 March 2010 for nationally significant energy infrastructure. This will include energy infrastructure for onshore electricity generation above 50MW, offshore capacity above 100MW, overhead lines above 132kV, major gas and oil pipelines and major gas storage and transmission infrastructure.

New build: Fossil fuels

4.3.15 A significant part of our future renewable electricity supply may be generated from wind. Output from each windfarm varies over time, depending on the local wind conditions. As the proportion of electricity generated from renewables increases, this results in an increasing system requirement for flexible power stations to provide back-up (or for more demand side flexibility) to ensure that demand can be met during periods when wind output is low. Currently, coal and gas-fired power stations can provide this flexibility. However, to the extent that this type of flexible generation is provided by fossil fuels, such as imported gas, there will be a link to oil prices (dependent on the continued global link between oil and gas prices) and the possibility of more volatile prices. New gas generation may find itself running at lower load factors than at present, and with a different pattern of operation than today.

4.3.16 11.8 GW of CCGT is at various stages in the planning and development process (source: National Grid). At present, there is no new coal plant with planning consent. Further

36 https://www.energynpsconsultation.decc.gov.uk/

details on coal-fired generation and CCS can be found in chapter 6.

New build: Nuclear

4.3.17 In January 2008 the Government published a White Paper[37] setting out the Government's policy on nuclear power. It stated:

4.3.18 *The Government believes new nuclear power stations should have a role to play in this country's future energy mix alongside other low carbon sources; that it would be in the public interest to allow energy companies the option of investing in new nuclear power stations; and that the Government should take active steps to facilitate this.*

4.3.19 The White Paper described a series of facilitative actions that the Government would take to enable energy companies to invest in new nuclear power stations. The Office for Nuclear Development, which sits within DECC, is making good progress on these facilitative actions.

4.3.20 Under one of these facilitative actions, the Government has conducted a Strategic Siting Assessment (SSA) to establish which sites in England and Wales are potentially suitable for the deployment of new nuclear power stations by the end of 2025. A list of ten potentially suitable sites was included in the draft National Policy Statement (NPS) for nuclear power, published for consultation and Parliamentary scrutiny on 9 November[38].

4.3.21 Within the context of the overall strategic framework set by the Government, in principle new nuclear should be free to contribute as much as possible towards meeting the need for 25GW of new non-renewable capacity.[39] The Government expects that under this approach a significant proportion of the 25GW will in practice be filled by nuclear power, with the first generating plant available from 2108.

4.3.22 In spring 2009, the Nuclear Decommissioning Authority (NDA) ran a successful auction to sell land adjacent to its nuclear sites at Wylfa, Oldbury and Bradwell. In October

37 *Meeting the Energy Challenge: A White Paper on Nuclear Power*, January 2008, http://www.berr.gov.uk/files/file43006.pdf

38 www.energynpsconsultation.decc.gov.uk

39 https://www.energynpsconsultation.decc.gov.uk/nuclear/

2009 the NDA completed the sale of land adjacent to its existing site at Sellafield[40] for potential new nuclear build.

The Government recognises the fundamental importance of the need to manage radioactive waste effectively and particularly the need to make progress towards a long-term disposal solution. In June 2008 the Government published the White Paper on Managing Radioactive Waste Safely. This sets the framework for managing higher activity radioactive waste in the long term through geological disposal, coupled with safe and secure interim storage and ongoing research and development. At the same time, local communities were invited to express an interest in opening up without commitment discussions with Government on the possibility of hosting a geological disposal facility at some point in the future. Formal "expressions of interest" by communities about potential involvement, which is the first step in the process, have already been received by the Government.[41]

New build: Renewables

4.3.23 Latest statistics[42] from October 2009 show that 2.5 GW of renewable projects are under construction. A further 8.5GW of projects have planning permission and are awaiting construction and over 9.5 GW more are going through the planning process.

4.3.24 In July 2009 the Government published its Renewable Energy Strategy[43], setting out the path for the UK to meet our legally-binding target to ensure 15% of our energy comes from renewable sources by 2020. The lead scenario shows more than 30% of our electricity generated from renewables, up from about 5.5% today. Much of this will be from wind power, on and offshore, but biomass, hydro and wave and tidal are also expected to play an important role.

4.3.25 This increase in renewable generation has many implications for the electricity system. We discuss these in the renewables chapter.

40 http://www.nda.gov.uk/news/sellafield-land-sale-agreed.cfm
41 www.copelandbc.gov.uk/PDF/08-PR-%20jun-25%20expression-%20of-%20interest.pdf
www.allerdale.gov.uk/council-and-democracy/council-news/news-releases.aspx?prid=1020
www.cumbriacc.gov.uk/news/2008/december/09_12_2008-121129.asp?Layout=Print
42 http://www.restats.org.uk/2010_target.htm chart 9.4 'RESTATS progress datasheet'
43 http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx

Embedded or Distributed Generation

4.3.26 As well as large power generation that connects to the high-voltage transmission network, there are smaller generation plants connected to the distribution networks.

4.3.27 Generation plant can also be located on an industrial/commercial site or through micro-generation in homes. This could form an increasing part of our generation mix. The Renewable Energy Strategy suggested that we might see several GW of this by 2020.

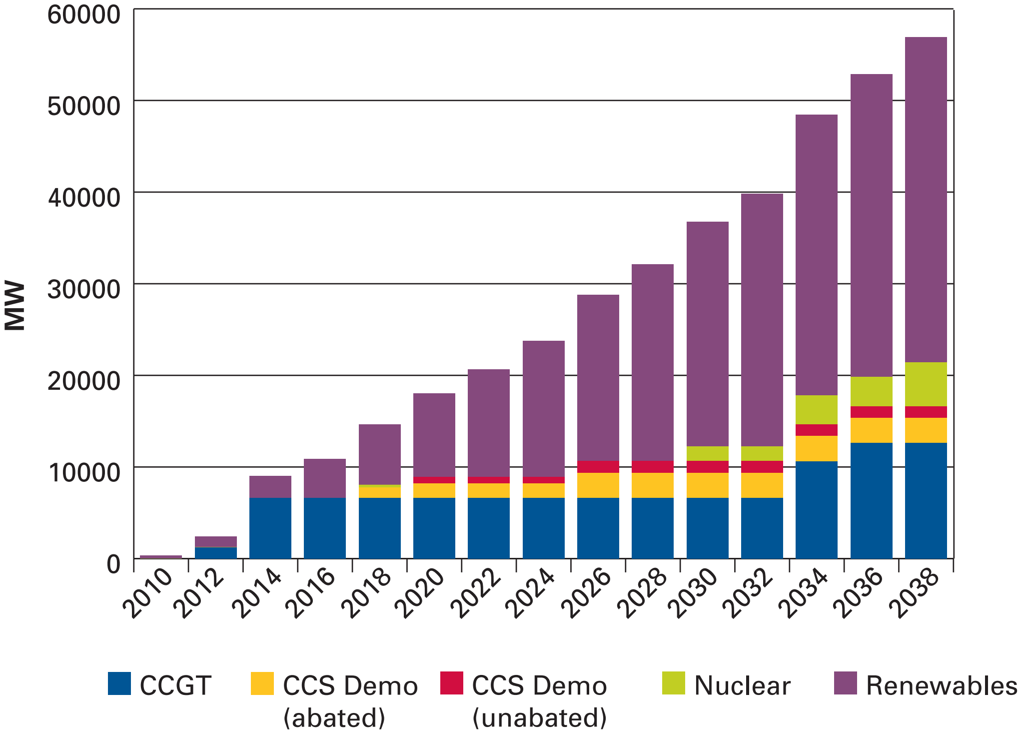
4.3.28 For the purposes of investors in large scale generation, this embedded or distributed generation acts like a reduction in demand for large scale generation. The possible future growth of embedded or distributed generation is therefore a factor in forming a view about future demand for large scale electricity generation, and thus in investors' decisions.

Overall generating mix

The combination of the target to increase the proportion of energy supplied from renewable sources, and the requirement to close a substantial amount of existing generating capacity, presents a formidable investment challenge. A wide range of possible combinations of closures of existing plant and new build of various technology types is possible in response. Chart 4.6 below shows one possible scenario for future build. This is based on recent modelling analysis conducted by Redpoint for DECC.[44] Numerous factors will influence how the total generating mix develops over the medium term; for example high fossil fuel prices might be expected to encourage faster nuclear build, while the pace and nature of renewables build is likely to be influenced by supply chain issues and the performance of the various technology types. What is eventually built may therefore differ significantly from what is shown in chart 4.6 below.

44 http://www.decc.gov.uk/Media/viewfile.ashx?FilePath=Whatwedo\UKenergysupply\Energymix\Renewableenergy/RenewableEnergyStrategy\1_20090715120542_e_@@_RedpointImplementationoftheEU2020RenewablesTargetintheUKElectricitySectorROReform.pdf&filetype=4

Chart 4.6: New build UK electricity generating capacity. Source: Redpoint analysis for response to CCS consultation

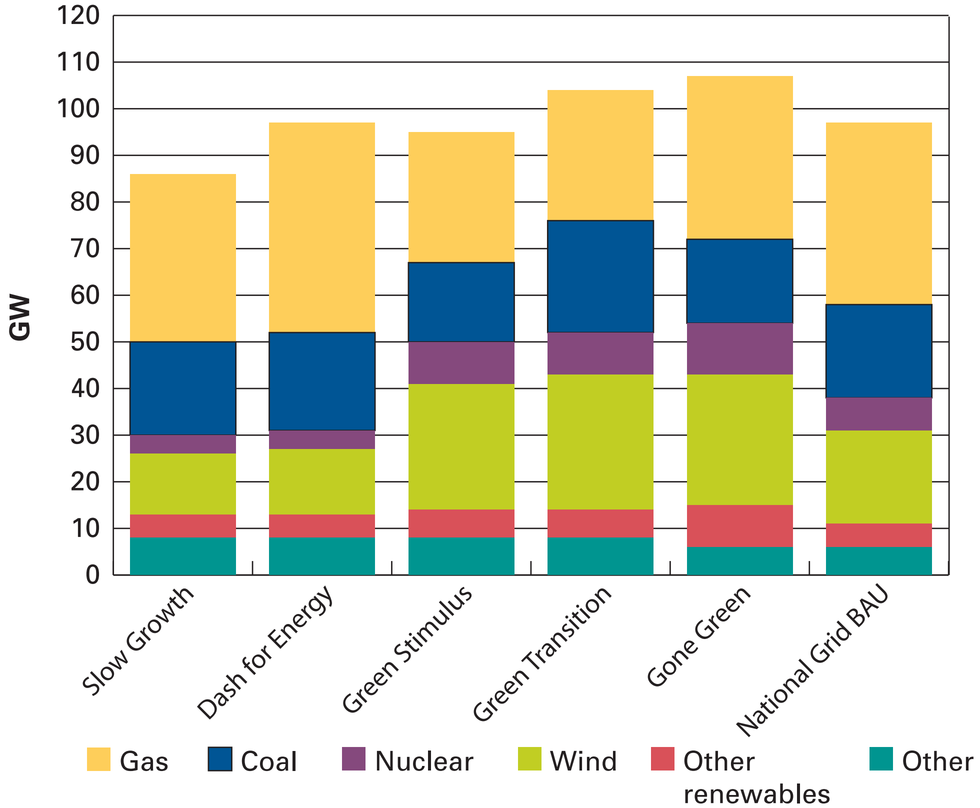


4.3.29 As in the 2008 EMO, Redpoint Energy's modelling shows gas-fired capacity expanding in the next few years, quickly followed by a rapid expansion in renewable capacity. This is consistent with the plant currently under construction. In the modelling, new nuclear capacity starts generating around 2020, although the Government expects the first new nuclear power station to be available by 2018. A small amount of new coal demonstrating CCS starts generating around the same time. Other scenarios are set out in Ofgem's Project Discovery[45] and also by National Grid (chart 4.7 below). For example, in the Green Transition Scenario, by 2020 wind and CCGT generation is providing the majority of capacity (about 29GW and 28GW respectively).

4.3.30 A number of means of matching electricity supply and demand will also be further developed. For example, greater energy efficiency and/or more price-responsive demand may be more cost-effective and efficient ways of ensuring that supply and demand meet than would be building additional supply capacity. The Government's call for evidence, which included questions about the scope for making the demand side more responsive, recently closed.

45 The Project Discovery Scenarios are currently the subject of consultation; http://www.ofgem.gov.uk/MARKETS/WHLMKTS/DISCOVERY/Pages/ProjectDiscovery.aspx

Chart 4.7 Generation mix in 2020 in Ofgem's "Project Discovery" scenarios, and in National Grid's "Gone Green" and "Business as Usual" scenarios[46]



4.4 Security of electricity supply: the capacity margin

4.4.1 This section brings together the discussion above about electricity supply and demand. One of the most important factors in ensuring continued security of electricity supplies is that there must be sufficient and increasingly low carbon capacity to generate electricity to meet demand, including a level of spare capacity. This spare capacity is referred to as the "capacity margin" – the percentage by which generating capacity exceeds expected peak demand. There is no universally agreed "right" level of the capacity margin, and no level of the margin can guarantee a 100% reliable electricity supply. There is also a need to strike a balance between the desire for an electricity system that is as secure as possible, and the cost of any given level of security, which ultimately will be borne by electricity consumers.

46 Note that the exact definitions of plant type vary between Ofgem and National Grid scenarios, for example in this chart National Grid's definition of 'Interconnectors' only includes capacity utilised at peak (2GW) and not the total capacity of interconnectors.

4.4.2 It is not possible to give an exact relationship between the two measures, but analysis done by DECC indicates that expected energy unserved – the expected size of any interruptions – falls very rapidly as the capacity margin increases. We therefore face diminishing returns in terms of increased security from increasing the capacity margin.

4.4.3 This relationship between expected energy unserved and the capacity margin can be used when looking at the benefits from increasing capacity or reducing (peak) demand. For example, relatively small changes to the capacity margin can make a significant difference to a system that is not particularly secure – and conversely, for a system that is already quite secure, it may be very expensive to increase significantly the level of security.

4.4.4 The capacity margin is often discussed in "de-rated" terms. The de-rated capacity is the expected availability of plant during the peak, taking into account the risk of unforced outages and factors such as variability of renewables generation output. This reflects the fact that some forms of generating capacity are more reliable, and hence more likely to be available at the time of peak demand, than others. The de-rating factors used in the analysis underlying chart 4.8 are set out in the table on the following page.

4.4.5 The de-rated capacity margin depends on demand on the one hand, and on the quantity and nature of generating capacity on the other.

Chart 4.8: Modelled level of (de-rated) capacity margin[47]

Source: Redpoint

4.4.6 The analysis underlying this chart includes existing generation (until it closes) and new generation which Redpoint's analysis for DECC suggests would be built. The capacity margin shown is the de-rated capacity margin. De-rating factors[48] used are as shown in table 4.2.

47 Based on recent analysis conducted by Red Point for DECC and published alongside the response to the consultation on carbon capture & storage. The graphs shown are the counterfactual (i.e. CCS demonstration only).

48 The factors for renewable generation should be read in the context of paragraphs 4.4.8 and 4.4.9. More detail on how these figures were derived can be found in Annex E of the report by Redpoint Energy (http://www.decc.gov.uk/Media/viewfile.ashx?FilePath=What we do\UK energy\Energy mix\Renewable energy\Renewable Energy Strategy\1_20090715120542_e_@@_RedpointImplementationoftheEU2020RenewablesTargetintheUKElectricitySectorROReform.pdf@filetype=4). In other words, while the de-rating factor for a thermal or nuclear generating plant is largely independent of the other plant on the system, the de-rating factor for wind power is not. It depends on the amount of wind power already installed and where that is located.

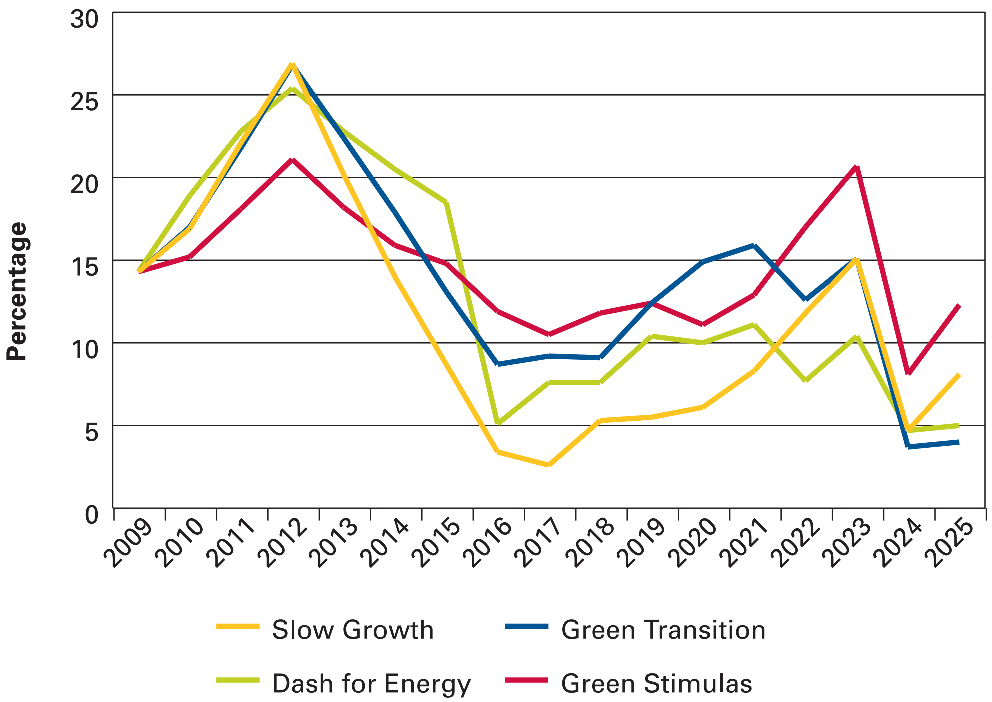
Table 4.2 De-rating factors

	2009	2020
Gas	90%	90%
Coal	90%	90%
Nuclear (existing)	78%	81.16%
Nuclear (new)	94%	94%
Hydro	70%	70%
Pumped storage	100%	100%
Wind	28%	19.23%
Tidal Stream	35%	33.45%
Wave	30%	29.91%
Biomass	92%	92%
Other renewables	40%	40%
Waste energy	40%	40%
Barrages and Tidal Range	13%	12.76%
Oil	95%	95%
GT	90%	90%
Interconnector	95%	95%

4.4.7 This is a more favourable outlook for the capacity margin than those suggested by the same consultants' modelling for the 2007 Energy White Paper for a number of reasons. This, together with discussions with stakeholders, has contributed to the Government's assessment in its recent call for evidence on "Delivering Secure Low Carbon Electricity", that the risks to security of supply over the next decade are manageable. This view was supported in National Grid's consultation on system operation to 2020.

4.4.8 However, future electricity margins remain subject to a margin of uncertainty. Other possible scenarios are set out in Ofgem's Project Discovery analysis. The de-rated capacity margin within the Project Discovery scenarios range from 6 to 15% by 2020. These are shown in chart 4.9 below.

Chart 4.9 Modelled level of (de-rated) capacity margin from Project Discovery



Source: Ofgem

4.5 Electricity Networks

Current network reliability

4.5.1 The three transmission network operators in Great Britain face regulatory incentives and statutory obligations that, among other things, create an operating environment designed to minimise energy unsupplied. Historically, the record of the electricity transmission network in Great Britain has been impressive. For instance, for 2008/09, the National Grid transmission network in England and Wales experienced a loss of unsupplied energy of only 335.5MWh[49]. This equates to a transmission reliability of approximately 99.99974%, measured in terms of the index of unsupplied energy to energy actually delivered.

4.5.2 The operators of electricity distribution networks in Great Britain also face incentives to reduce the number and

49 "Report to the Gas & Electricity Markets Authority: GB Transmission System Performance Report 2008- 2009", National Grid. Available at http://www.nationalgrid.com/NR/rdonlyres/2DC98143-EECA-4864-AA64-1B9597C01444/37464/GBTransmissionSystemPerformanceReport_0809_Final.pdf

duration of interruptions to supply over their network. Since these "quality of service" incentives were introduced, an average distribution service customer would have experienced only four interruptions in total over the five years from 2001-2 to 2005–6. The average duration of such interruptions is about 90 minutes.

4.5.3 The size and location of our network infrastructure are important in minimising any transmission constraints, both now and in the future with a lower carbon generation mix. We consider future build of network capacity below.

Future development of electricity networks

4.5.4 There is a significant programme of investment underway in GB electricity networks. Ofgem through the 2007-12 Transmission Price Control and the current Distribution Price Control (2005-10) have agreed around £10 billion of investment. The investment programme includes funding for replacement and maintenance of network assets, in order to ensure continued network reliability, as well as for network expansion in order to connect new generation projects including those remote from the main inter-connected transmission system.[50]

4.5.5 The Government and Ofgem have been involved in the industry process to examine possibilities for developing the network further to support the connection of new generation developments including up to 35 GW of renewable generation and potential new nuclear power stations. The Electricity Networks Strategy Group (ENSG), chaired by DECC and Ofgem, published a report[51] in March 2009. The ENSG has identified a programme of works designed to meet specific generation and demand scenarios that may arise in the future. Using the findings of the ENSG, the Transmission Operators (TOs) are now identifying which transmission projects they intend to take forward. Certain elements of these projects have already been funded through Ofgem's transmission price control and current TO incentive arrangements. Ofgem are consulting on possible changes to incentive arrangements that may be needed to support the efficient and timely future development of the transmission network.

50 See www.ofgem.gov.uk/Networks/Pages/Ntwrks.aspx for more detail
51 Available at www.ensg.gov.uk

4.5.6 The Government and Ofgem have also announced a new offshore transmission regulatory regime to connect the potential 39 GW[52] of offshore wind in UK waters in the most cost effective and efficient manner. This regime will provide opportunities for new entrants to the market to design, finance, build and maintain offshore transmission assets with an estimated value of up to £15 billion. Competitive tenders run by Ofgem started in July 2009.

4.5.7 In the longer term a network that enables both generation and demand to play an active part in delivering the most efficient solution is envisaged. Alongside the response to the smart meters consultation, the Government presented a smarter grid opportunities document on 3 December 2009. Next year the Government will issue a road map on how a smarter grid may be delivered as part of the trajectory towards 2050.

4.5.8 Smart grids, along with smart meters will enable consumers to visualise their energy use, and could increase the ability of distributors and transmission owners to monitor and control demand patterns and real time use. This new provision of information is expected to contribute to much more active and intelligent management of the electricity system by electricity consumers, for example at peak demand, as well as increasing engagement of consumers in their energy use. As demand for electricity is likely to increase past 2020 as electric vehicles and electricity-based heating become more common, a smarter grid would facilitate this change whilst allowing us to manage increasingly intermittent supplies as the proportion of renewable energy increases.

4.5.9 In terms of interconnection, the UK currently has a 2 GW link to France, and a 450 MW link between Northern Ireland and Scotland.

4.5.10 Increased[53] inter-connection may provide important security of supply benefits, such as access to additional power supplies which could help manage supply fluctuations. On the other hand, with greater interconnection, there can be circumstances where tighter markets and higher prices outside the UK could result in electricity being exported, thereby tightening the market in the UK. However, it would

52 This exceeds the 35GW figure in the previous paragraph, because it relates to total potential in UK waters, rather than the amount of generation needed to deliver the 2020 target.

53 The GB transmission system is linked to the transmission system of France by an interconnector with a capacity of 2 GW. In addition, the Moyle interconnector links Northern Ireland with Scotland and has a capacity of 450 MW.

be expected that UK prices would rise at times of domestic market tightness, and depending on the supply/demand balance with interconnected markets, this would encourage electricity flows to reverse. Interconnection also introduces an additional variable when balancing the system, and an additional uncertainty to be managed, although the ability to access other markets could help system balancing. There is evidence from the US and Europe that extensive interconnection across System Operator boundaries can lead to difficulties in predicting power flows, particularly when faults occur and circuits trip. However, this can be managed through close cooperation and information exchange between System Operators and is less of a problem with DC interconnection, as power flows can be controlled.

4.5.11 There are plans to develop an East-West Interconnector linking the UK and Irish electricity grids. National Grid, in a joint venture with Dutch TSO TenneT, is building an interconnector between the UK and the Netherlands which is expected to be completed by late 2010. National Grid is also considering further links with Belgium, France and Norway. Also the Irish investment company Imera has two planned links, between Ireland and GB and between GB and France.

Grid access

4.5.12 If the UK is to meet its climate change targets and ensure security of supply, large amounts of renewable and other low carbon generation need to be able to connect to our electricity networks. The UK will also need to connect other essential generation needed to replace the existing nuclear and fossil fuel plant that will close within the next decade and provide back up for the future use of variable and intermittent generation. There is a high level of interest in investment in new generation with some new generation projects waiting for a number of years for a suitable connection opportunity and in some cases being offered connection dates as late as 2023.

4.5.13 The Government has recognised that uncertainty around grid access may delay or deter essential future investments, and took powers in the Energy Act 2008 to intervene to facilitate access to the electricity transmission system. Ofgem wrote to the Secretary of State on 25 June 2009 to recommend that he use those powers to facilitate reform of transmission access arrangements. The Secretary of State announced on 15 July 2009 that he would exercise those powers in order to see the grid access reform process started by industry through to a timely and successful conclusion. The focus will be primarily on access rights for new entrants. The Government is currently consulting on the principles of a model for grid access reform. The intention is to make the necessary changes by June 2010.

4.5.14 Ahead of these enduring access reforms, urgent steps have already been taken – with Ofgem, National Grid and industry – to make sure that projects that are ready to go can connect. In May 2009, Ofgem approved a new interim regime[54] that has so far allowed National Grid to invite around 5.5 GW[55] of projects to apply for earlier connection. However, this is only an interim arrangement and it is necessary to ensure there are enduring arrangements in place which clarify for investors the long-term framework for new connection.[56]

4.6 Conclusions

4.6.1 In the long term, future demand is uncertain, as it depends on factors such as the speed of economic recovery, vehicle and/or heat electrification and the impact of energy efficiency measures.

4.6.2 However, based on current projections, plant currently under construction and planned go a long way to ensuring adequate electricity capacity and supplies into the first half of the next decade. Given that major new generation plant can be delivered with a lead time of five to seven years, depending on market signals and how the market responds to risks and uncertainties, there is scope for additional plant to be constructed. The Government has set out in its Low Carbon Transition Plan, its strategy for delivering secure electricity supplies, out to 2020.

54 http://www.ofgem.gov.uk/networks/Trans/ElecTransPolicy/tar/Documents1/20090508%20derogations%20interim.pdf

55 http://www.nationalgrid.com/NR/rdonlyres/9EA2D495-DFCO-4728-A23B-670EA28D6B50/38433/TNQCUOct09v10.pdf

56 For further information please refer to Ofgem's website: http://www.ofgem.gov.uk/Networks/Trans/ElecTransPolicy/tar/Documents1/20090508%20derogations%20interim.pdf

The Single Electricity Market

The Single Electricity Market has been in operation in Ireland since November 2007. It is a first in Europe covering two member states and coupling two transmission systems operated by two system operators and collectively known as the all island system. The two systems are coupled by a single north south tie line which is due for substantial reinforcement in 2012. The SEM is coupled to the GB market by the Moyle ‘interconnector’ which is, interestingly, not an interconnector for EU purposes as it joins two regions of the same member state. Substantial further interconnection to GB and France is planned.

The origins of the SEM date back to November 2004 when Northern Ireland’s Department of Enterprise, Trade and Investment (DETI) and the Republic of Ireland’s Department of Communications Marine and Natural Resources (DCMNR) together with the Northern Ireland Authority for Utility Regulation (NIAUR) and the Commission for Energy Regulation (CER) published a Development Framework for an All Island Energy Market, setting out the dates by which they expect to achieve these unified markets.

CER and NIAUR initiated the first phase of the project as set out in the Framework Document – the establishment of an all-island wholesale electricity market, known as the Single Electricity Market (SEM). The SEM high-level design was completed in June 2005 and on foot of this the CER and NIAUR (jointly known as the Regulatory Authorities) set to work on the implementation of a suite of arrangements necessary for SEM Go Live by 1 November 2007. The Single Electricity Market (SEM) which commenced, as planned, on 1 November 2007 created a single market for the trading of wholesale electricity in Northern Ireland and the Republic of Ireland.

The SEM is a centralised or gross mandatory pool market with electricity being bought and sold through the pool under a transparent market clearing mechanism (save for generators which have a maximum export capacity of less than 10MW for whom direct participation is voluntary). Generators receive the System Marginal Price (SMP) for their scheduled dispatch quantities, capacity payments for their actual availability (based on fixed amounts determined annually), and constraint payments for differences between the market schedule and actual dispatch due to system constraints. Suppliers purchasing energy from the pool pay the SMP for each trading period, capacity costs. The rules of the market are set out in the SEM Trading and Settlement Code.

The SEM is a unique inter-jurisdictional market that comes under the governance of both CER and NIAUR. In view of this, robust joint regulatory and governance arrangements were required to be set up. Accordingly the SEM Committee was established by legislation in Republic of Ireland and Northern Ireland (section 8A of the Electricity Regulation Act 1999 as inserted by section 4 of the Electricity Regulation (Amendment) Act 2007, and Article 6 (1) of the Electricity (Single Wholesale Market) (Northern Ireland) Order 2007 respectively)

At the end of the first year of the market, there were 45 participants registered in the SEM, 13 of whom have joined since the start of the market. These participants had a registered market capacity of 9,856MW. The market operator, SEMO, processes energy payments of approximately €3 billion annually, with a further €600m being paid in capacity payments.

One of the main issues facing the SEM at present is the expected high levels of wind generation on the island with a government target of 40% by 2020 for Ireland and a similar target expected to be announced shortly for Northern Ireland. The RAs are currently reviewing the market arrangements to ensure that they are robust to these levels of intermittent generation, that investment in an appropriate mix of plant for the island's future energy needs is promoted and to facilitate the achievement of the targets.

5. Gas

5.1 Introduction

5.1.1 This chapter provides a range of projections and assesses the drivers which have a bearing on gas security of supply over the coming years. There is a degree of uncertainty over the outlook for the demand, supply and imports of gas as the global economy emerges from recession. There is also some uncertainty over how events which affect the European and global gas markets, to which the UK is increasingly linked, will develop.

5.2 Background

5.2.1 The level of future gas demand in the UK will depend on a number of factors, including economic growth, renewable penetration and fuel prices, which are hard to project accurately. In addition to meeting demand in GB, supplies are also needed to meet demand for gross exports to Ireland (Northern Ireland and the Republic). Gas is also exported from GB to the Continent through the IUK Interconnector, particularly in the summer months when seasonal swing in demand means prices tend to be lower and stocks are being filled.

5.2.2 This summer the Government set out a range of policies that are expected to help reduce the level of gas demand significantly in the coming years as we make the transition to a low carbon economy.[57] Even with these environmental policies, the UK is likely to require significant amounts of gas for many years to come.

5.2.3 There are a number of potential sources of supply of gas to meet UK gas demand. These include:

- Production from the UK Continental Shelf which, although it is expected to decline, will continue to have an important role to play for many years to come;
- Imports by pipeline from Norway (via Vesterled, Langeled and the Tampen Link);

57 UK Low Carbon Transition Plan: http://decc.gov.uk/en/content/cms/publications/lc_trans_plan/lc_trans_plan.aspx

- Imports from the Continent through the IUK interconnector with Belgium and the Balgzand Bacton Line (BBL) pipeline from The Netherlands; and
- Imports of liquefied natural gas (LNG) by tanker (to date to the Isle of Grain, Teesside and Milford Haven).

Gas storage facilities also provide a role in matching supplies from these sources and demand, particularly peak demand.

5.2.4 Work in the last year which has reviewed gas security of supply includes:

- The Wicks Review[58] – an independent review of energy security, which looks in detail at a range of energy security issues, including gas market issues.
- Project Discovery[59] – Ofgem's Project Discovery began in early 2009 and explores whether current market arrangements are capable of delivering secure and sustainable energy supplies over the next 10-15 years. Ofgem has recently held a public consultation on phase one of this work, identifying the scale of the challenge and risks facing the GB and wider European and global energy markets through scenario and stress test analysis.

Throughout this chapter a range of projections from DECC, National Grid and Ofgem are used. By way of background:

- DECC produces regular projections for annual UK production, demand and thus net-import requirements[60]. There are two main projections which are presented in this chapter. First, a projection which predates the measures set out in the Low Carbon Transition Plan, to provide context and continuity and secondly, a scenario which includes the measures set out in the Low Carbon Transition Plan.

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58 Malcolm Wicks' review of international energy security "Energy Security: a national challenge in a changing world": http://decc.gov.uk/en/content/cms/what_we_do/change_energy/int_energy/security/security.aspx

59 http://www.ofgem.gov.uk/Markets/WhlMkts/Discovery/Pages/ProjectDiscovery.aspx

60 Chapter 4 in, and Annex F to, the *Digest of UK Energy Statistics 2009* (published in July 2009 at http://www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx) provide background information on the production, transmission and consumption of natural gas in the UK. See also the data on gas on the DECC Energy Statistics website at http://www.decc.gov.uk/en/content/cms/statistics/source/gas/gas.aspx. DECC also publishes Updated Energy (and Emissions) Projections at http://www.decc.gov.uk/en/content/cms/statistics/projections/projections.aspx. The UEP exercise provides updated projections and analysis of energy use and CO2 emissions in the UK. It incorporates all firm environmental policy measures and is based on updated assumptions consistent with the most recent UK Budget announcements. These projections inform energy policy and associated analytical work across Government Departments.

- National Grid produces regular projections for both peak and annual GB production and gross-demand[61]. There are two main projections which are presented in this chapter. First, a "Business as Usual" projection in which only incremental changes to the current markets and frameworks are envisaged and environmental targets are not met and, second, a "Gone Green" projection which assumes the Government's climate change targets are met[62].
- Ofgem's Project Discovery has produced scenario analysis to put the debate regarding UK energy in the wider global and environmental context. This scenario analysis was issued for consultation in October 2009.

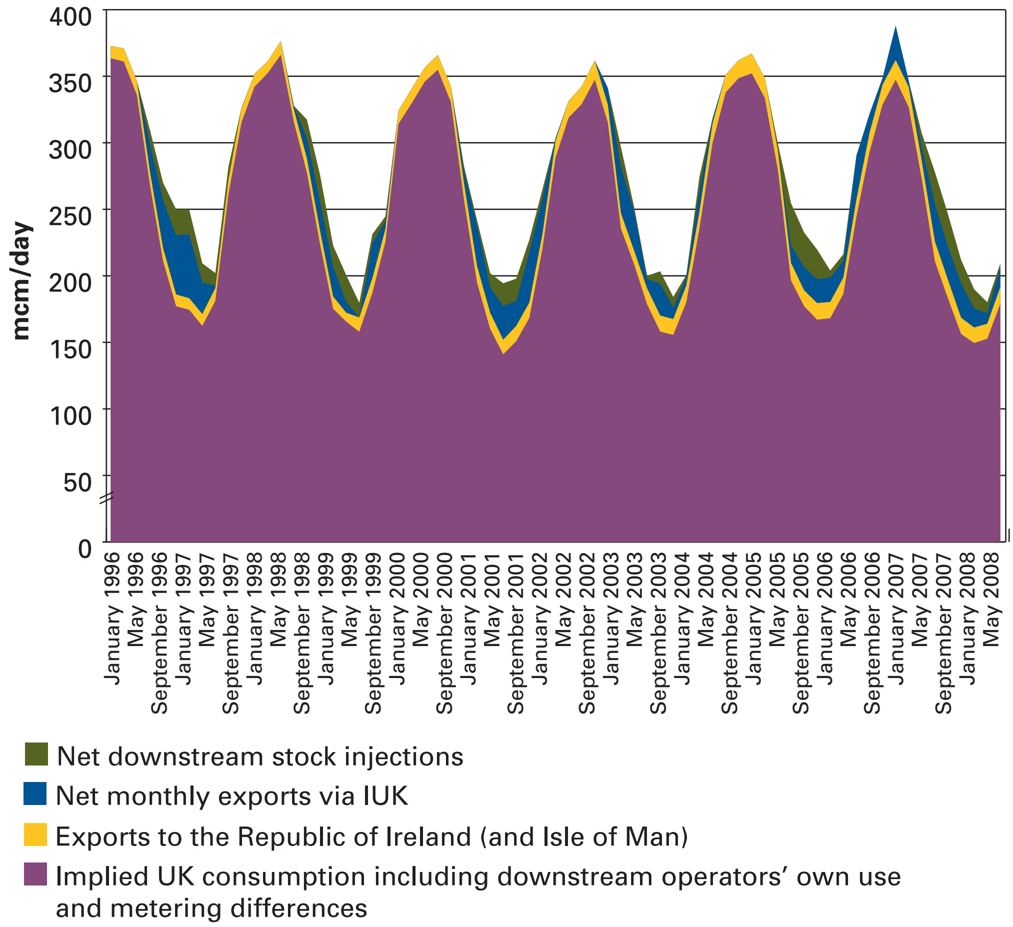
5.3 Demand

5.3.1 Demand for gas varies day-by-day although it tends to be much lower in summer than in winter, despite gross exports and injections into storage, as shown in Chart 5.1. This seasonality is driven by household and business demand for gas for space heating, which is driven largely by temperature levels. For this reason, wholesale prices for gas also tend to show a seasonal pattern. Demand for industrial purposes and electricity generation tends to be much less seasonal and tends to be driven more by the price of gas relative to the prices of other fuels and the price of electricity.

61 Historic data are available in National Grid's Gas Transportation Ten Year Statement 2008 (the TYS, available via http://www.nationalgrid.com/uk/Gas/TYS/) while National Grid's publication *Transporting Britain's Energy 2009: Development of NTS Investment Scenarios* ("TBE 2009", published in July 2009 at http://www.nationalgrid.com/uk/Gas/OperationalInfo/TBE/ focuses on the development of investment scenarios for the NTS but also covers UKCS and LNG developments; all of the National Grid projections presented here are consistent with TBE 2009. TBE 2009 provides a detailed explanation of the basis for National Grid's demand and supply projections.

62 See *'Gone Green' a Scenario for 2020* (National Grid, June 2008); available from http://www.nationalgrid.com/corporate/Our+Responsibility/Our+Impacts/Energy+Delivery+and+Climate+Change/Seealso/gonegreen2020.htm). See also: *ENSG 'Our Electricity Transmission Network: A Vision for 2020' (National Grid, July 2009); available from* http://www.ensg.gov.uk/assets/ensg_transmission_pwg_full_report_final_issue_1.pdf

Chart 5.1: UK Monthly Gas Demand



Source: DECC Energy Statistics (November 2009)[63]

Annual Demand

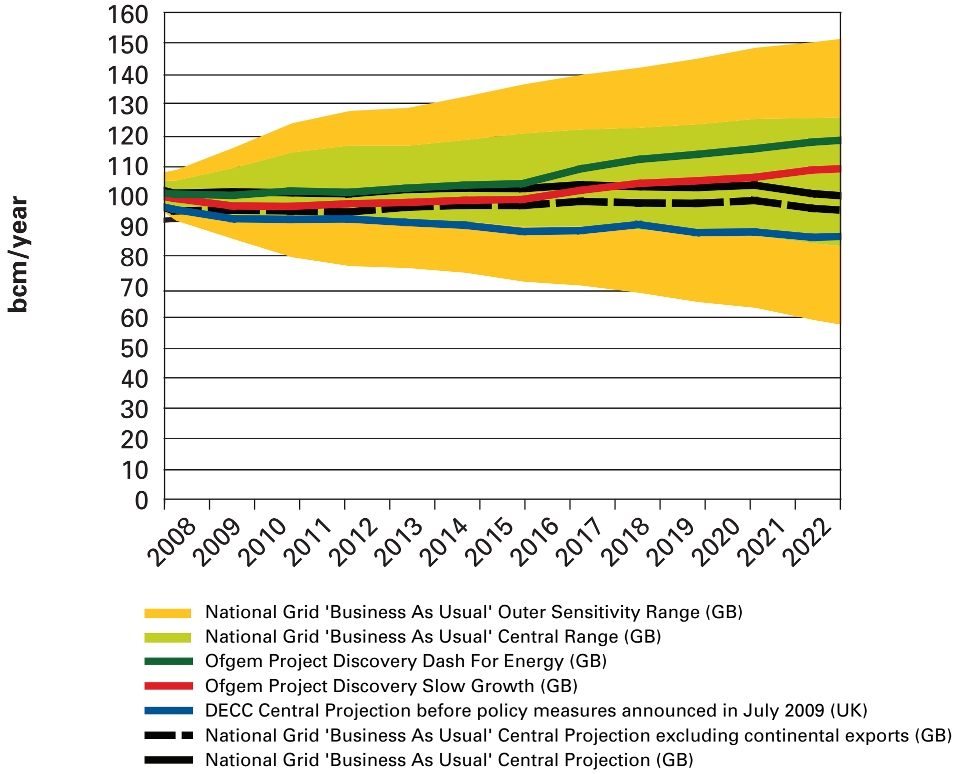
5.3.2 Charts 5.2 and 5.3 show projections by National Grid, Ofgem and DECC for annual gas demand under different scenarios. Chart 5.2 shows the scenarios where environmental targets are not met. The outer fan, based on National Grid's modelling, illustrates a summation of all sensitivities, while an inner fan illustrates combinations of sensitivities which are more likely to occur. For example, the highest levels of demand shown in chart 5.2 are likely to be reached only if all the relevant factors (such as the rate of economic growth and gas prices) were stimulating demand growth and no factors were acting to reduce demand. In practice, these variables are not independent and it is extremely unlikely that they would all combine to

63 Net downstream stock injections relate to increases in the amount of gas in UK storage. Net monthly exports via IUK relate to the volume of gas exported from the UK to Belgium via the Bacton–Zeebrugge Interconnector (UK) pipeline ("IUK") to Belgium minus the volume of gas that is imported, on a monthly basis; in months where there is more gas flowing into the UK than out of it through IUK net exports are zero.

push gas demand in one direction. A narrower central range of more probable demand levels has therefore been highlighted on the chart. However, even within this range, there are still significant variations. DECC's projection pre-dating the announcement of measures in the Low Carbon Transition Plan is below National Grid's central projection but within the National Grid sensitivity range.

5.3.3 Ofgem's data is part of its scenario analysis for the Project Discovery consultation on energy market scenarios. Under the two scenarios where environmental targets are not met ("Dash for Energy" and "Slow Growth"), gas demand continues to increase over the period to 2020. In "Dash for Energy", this increase is due to assumed strong economic growth and a corresponding demand for energy from fossil fuels, with security of supply taking precedence over environmental concerns. In the "Slow Growth" scenario, economic growth is assumed to be slower, but lower gas prices and a lack of investment in nuclear and renewable generation, causes gas demand for generation, and therefore total gas demand, to increase over the period.

Chart 5.2: Range of Annual Net Gas Demand Projections based on scenarios without Government Carbon Reduction measures [64]



5.3.4 Chart 5.3 shows the scenarios from National Grid, Ofgem and DECC when environmental targets are met. DECC's post-Transition Plan central case for annual net demand shows that annual gas demand is projected to fall through the next decade to 2020. The key factors driving this decline are a combination of energy efficiency measures, the successful implementation of the renewable energy strategy and in the short-term the economic downturn.

5.3.5 Much of the expected saving of gas to be made from renewable energy occurs in the large scale electricity sector although the heat and small scale electricity sectors also contribute. The Low Carbon Transition Plan sets out plans to:

- increase the share of renewable heat from less than 1% now to around 12% by 2020;
- increase the share of renewable electricity from 5.5% now to around 30% by 2020; and
- boost energy efficiency.

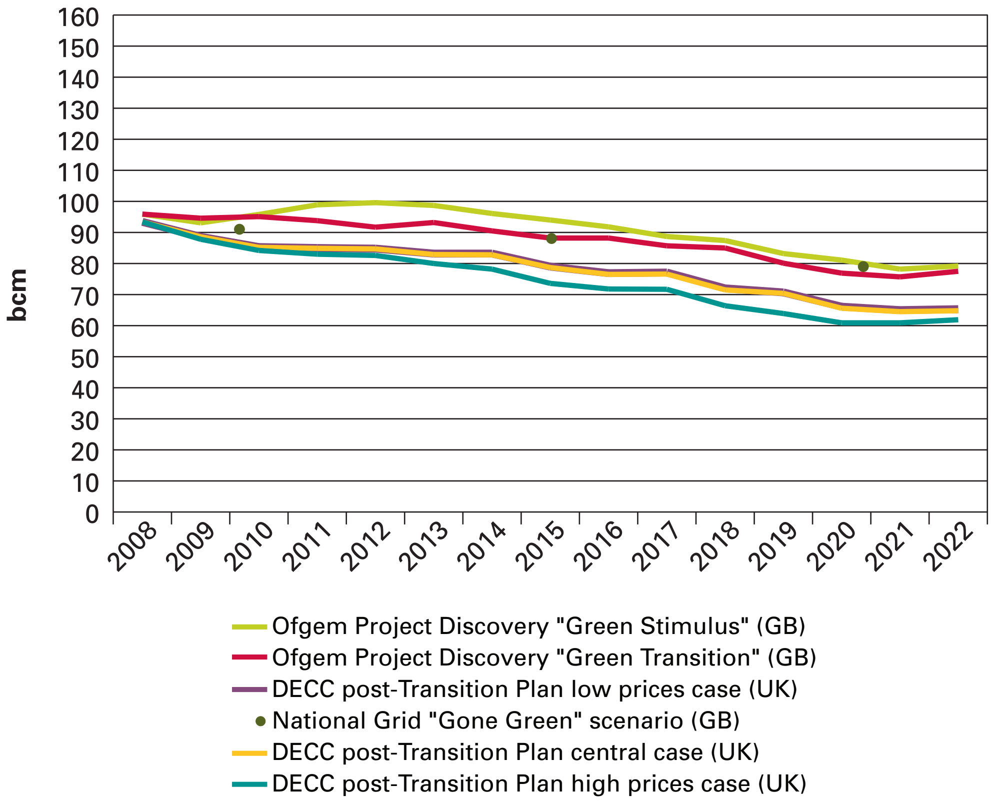
64 Project Discovery data includes exports to Ireland. National Grid data includes exports to the continent and Ireland. National Grid "Business as usual" data is based on the policies in place when *Transporting Britain's Energy* was published on 9th July 2009, this was prior to the publication of the Government's *Renewable Energy Strategy*.

5.3.6 DECC's projections show that by 2020 demand falls to some 66 bcm a year compared to around 89 bcm today. A rise after 2020 comes about when the impact of economic growth on increasing demand for gas begins to offset the effect of the earlier policy initiatives in reducing demand[65].

5.3.7 National Grid's 'Gone Green' scenario has lower electricity demand and a smaller share of that demand being provided by gas powered stations, compared to the 'Business as Usual' scenario. This scenario predates the economic recession and consequently demand does not fall in the early part of the projection period.

5.3.8 In Ofgem's two green scenarios ("Green Transition" and 'Green Stimulus'), it is assumed that a global agreement on tackling climate change is reached and effective energy saving measures are put in place. These, combined with a shift towards renewable generation in place of gas, lead to declining GB annual gas demand.

Chart 5.3: Range of Annual Net Gas Demand Projections assuming Government Carbon Targets are met[66]



Source: DECC (July 2009; consistent with The UK Low Carbon Transition Plan Emissions Projections), National Grid (July 2009) and Ofgem (October 2009).

65 The projections do not make assumptions about future policy measures that may also affect demand.

66 Project Discovery data includes exports to Ireland.

5.3.9 The range of scenarios, as shown in charts 5.2 and 5.3, demonstrate that there is considerable uncertainty surrounding the level of future gas demand. The projections are sensitive to the assumed level of the demand drivers. In particular, gas demand could be driven to a large extent by environmental policies and economic growth. According to DECC's projections the UK will continue to maintain diverse sources of gas to ensure supplies are secure in the event of demand fluctuations, particularly as more gas import and storage capacity is built during the next decade.

Peak Demand

5.3.10 The ability to meet peak gas demand whether on a particular day or over a more prolonged period such as a severe winter is particularly important in a security of supply context. Chart 5.4 shows peak demand based on National Grid's and Ofgem's peak demand scenarios. An outer fan shows the full range of possible peak demand levels, while an inner fan shows combinations of sensitivities that are more likely to occur, as illustrated by National Grid and Ofgem's projections which are within National Grid's central range.

5.3.11 National Grid's peak demand is slightly lower in the "Gone Green" scenario than in the "Business as Usual" scenario, although the effect is not as pronounced as for annual gas demand. This is partly because wind intermittency could lead to a need for gas-fired generation on cold, still days, leading to significant peak demand.

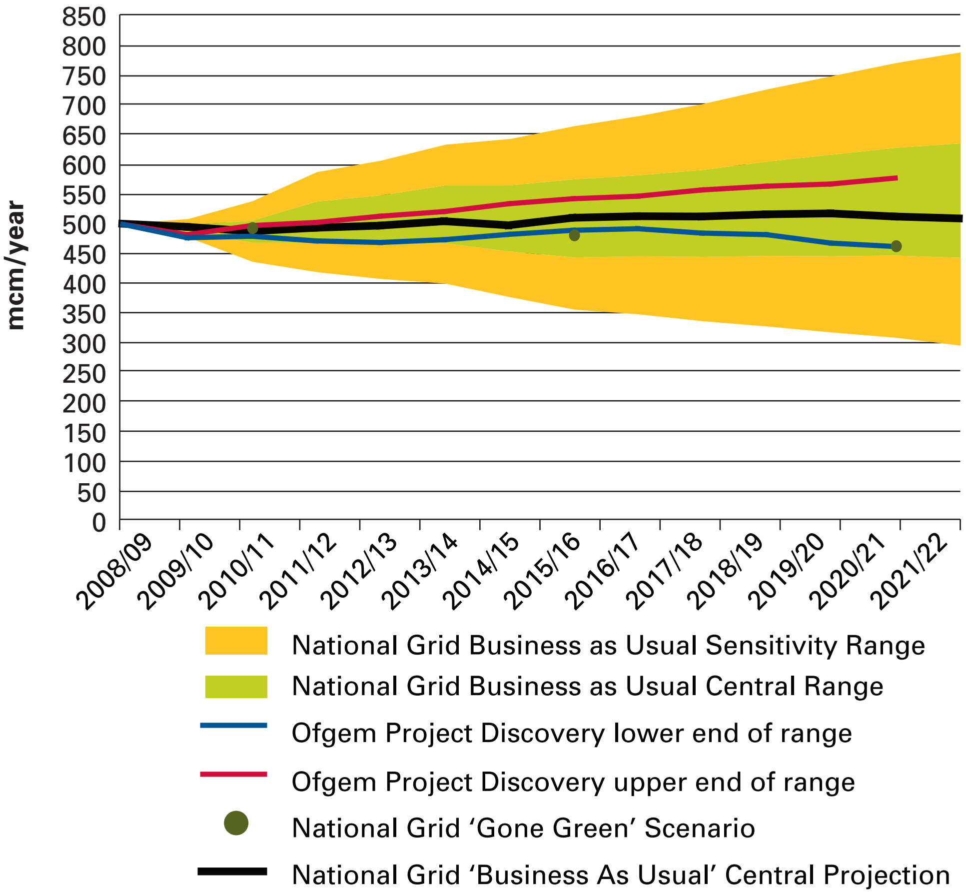
5.3.12 Similarly in Ofgem's Project Discovery, peak demand ranges from 472mcm to 584mcm per day across the different scenarios by 2020. As with annual demand, peak demand falls in the "Green Transition" and "Green Stimulus" scenarios due to energy efficiency measures and a shift away from the use of gas demand in generation. However, in "Dash for Energy" and "Slow Growth", peak demand increases, corresponding to the increase in annual demand.

5.3.13 There could be changes to the pattern of demand which raises new challenges. Increasing amounts of wind generation, which is variable and relatively unpredictable[67] could increase the volatility of gas demand as gas-fired

67 More about the impact on gas generation can be found in chapter 4

generators are likely to play a key role in balancing the electricity market. The gas market will need to respond to this challenge in the coming years by becoming increasingly flexible.

Chart 5.4 GB Peak Demand Sensitivity Analysis[68]



Source: National Grid and Ofgem

Project Discovery's Severe Winter Scenarios

5.3.14 One of the areas that Ofgem looks at in the Project Discovery consultation is how demand can be met during a severe (1 in 20) winter, measured over the coldest 60 day period. The analysis shows that the "Dash for Energy" and "Slow Growth" scenarios would either require the interconnectors to operate at a higher level than the assumed annual average rate and/or balancing by way of demand reduction.

5.3.15 Project Discovery also identified a number of potential stress tests, including reverse gas interconnector flows[69]

68 Ofgem and National Grid scenarios include exports to Ireland.
69 BBL at zero and the IUK at 50% export

resulting from a Russia-Ukraine gas dispute during an over 1-in-20 severe winter. The scenario most affected by this stress test is "Slow Growth", since it is under this scenario which the GB market would be most reliant on interconnector imports and where the least storage is built due to low demand and levels of investment. Under this stress test demand reduction is required in the slow growth scenario.

5.3.16 It should be noted that the stress tests in Project Discovery are intended to be representative of types of shock that GB could face, e.g. gas not flowing through the interconnectors, LNG supplies being diverted, low electricity supplies from variable sources etc.

Demand-side Response

5.3.17 At times of market tightness, mechanisms on the demand-side are also used to ensure demand and supply balance. Most demand-side flexibility is provided from the power generation sector, which can switch between a range of fuel sources – at present primarily coal, oil and gas. Some large consumers of gas can also be flexible in their gas use. During a period of high prices these customers may, where technically feasible, choose to switch to alternative fuel or to scale back or cease production; these options can be realised by ceasing to purchase gas, or (for companies on firm gas supply contracts) by selling gas back to the market.

5.3.18 A key element for sending signals to bring about efficient demand-side response (or greater supply) at times of tightness is the GB's liquid wholesale gas market, which helps to ensure that prices reflect market tightness. Customers (and producers) exposed to these price signals will therefore have incentives to respond. Non-daily metered customers (such as households and small businesses) are not exposed to fluctuations in wholesale gas prices and therefore do not reduce demand when wholesale prices are high. In future, smart-metering could play a role in ensuring security of supply in a cost-effective way by signalling the true costs of consuming gas at times of market tightness.

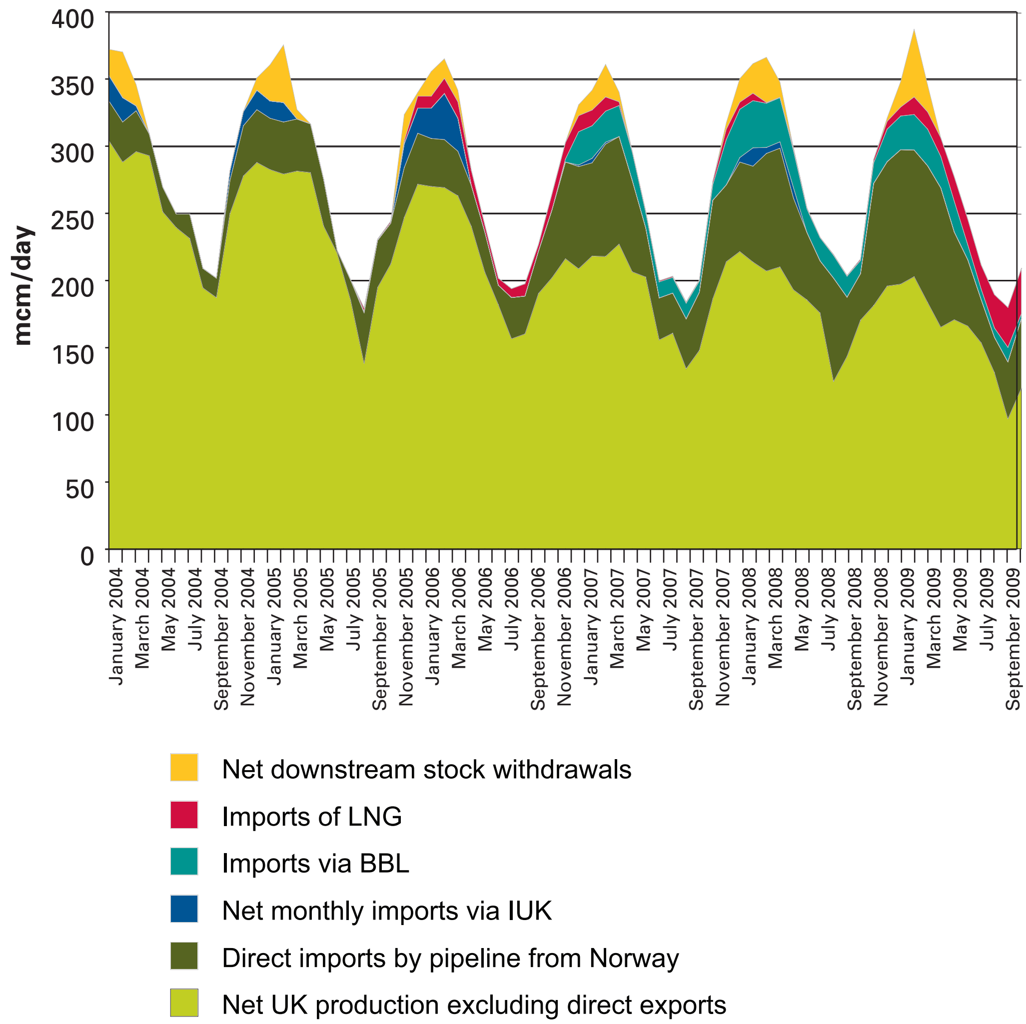
5.4 Supply

5.4.1 The production of gas from the UKCS peaked in 2000 and although it has been declining since, it will still continue to have an important role to play in GB gas supplies for many years to come. Chart 5.6 illustrates the monthly variation in the principal sources of UK gas supply. The seasonal flexibility in supply from UK production, so-called 'swing supply' has also reduced. This partly reflects a greater share of production from associated gas fields and less from dry gas fields[70] and partly also because a smaller proportion of production is sold under long-term buyer-nomination contracts.

5.4.2 Norwegian gas has become an increasingly important source of supply, not only at peak times but throughout the year. Imports of gas from the Continent are also becoming increasingly important especially those from The Netherlands. Gas from storage is important at times of peak demand.

70 Associated gas fields hold both oil and gas, and gas is produced as a joint-product with oil. Since oil is the higher value product, production tends to be governed by conditions in the oil market. Dry gas fields contain only natural gas and so their production reflects supply and demand conditions in the gas market much more.

Chart 5.6: UK Monthly Gas Supply



Source: DECC Energy Statistics (November 2009).[71]

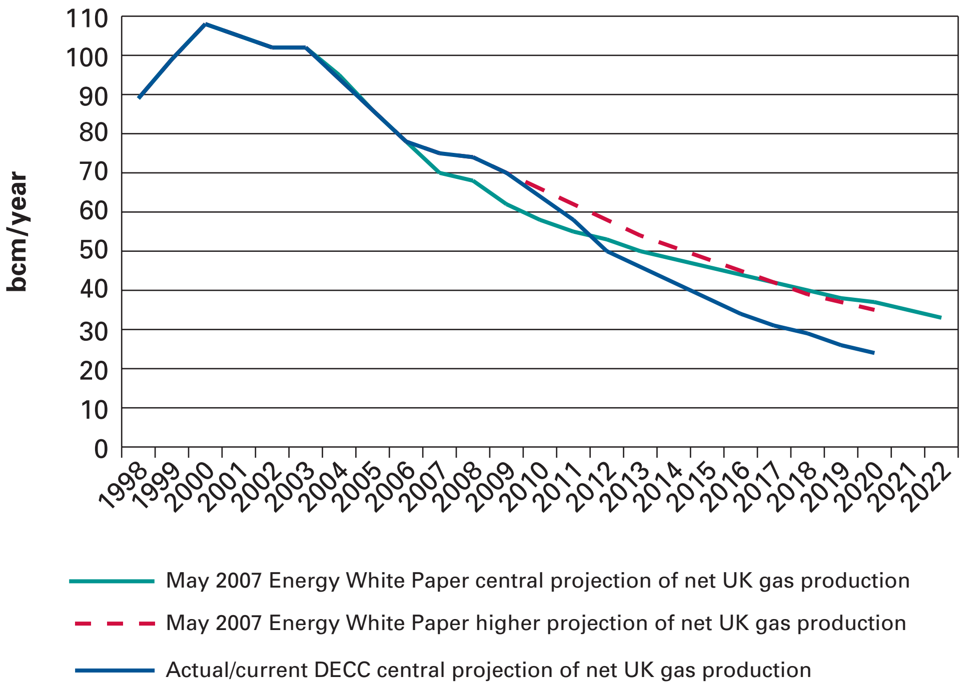
5.5 UK Production

5.5.1 Production of gas from the UKCS is expected to continue to decline although it can be expected to provide a significant proportion of our annual gas needs for many years to come. The Government and industry are committed to maximising the potential of remaining UK oil and gas reserves. To make the most of the potential of the UKCS, the rate of production decline needs to be reduced as far as possible. For example, the Government has been encouraging and supporting industry in a collaborative

71 Net downstream stock withdrawals relates to decreases in the volume of gas held in UK storage Net monthly imports via IUK relates to the volume of gas imported to the UK from Belgium via the Bacton–Zeebrugge Interconnector (UK) pipeline ("IUK") to Belgium minus the volume of gas that is exported, on a monthly basis; in months where there is more gas flowing out of the UK than into it through IUK net imports are zero Net UK production excluding direct exports – net here refers to (gross) production less producers' own use; direct exports are exports from offshore fields directly to The Netherlands and Norway

process aimed at bringing forward significant investment in gas infrastructure from the area west of Shetland. Compared with the baseline level in the May 2007 Energy White Paper (EWP), as shown in Chart 5.7, DECC is now projecting higher net UK gas production in 2020. The level is very close to the higher level assumed in the EWP if higher investment is maintained. As with projections of demand, projections of UK gas production are inherently uncertain and should be treated as indicative rather than definitive.

Chart 5.7: Actual and Projected UK Annual Net Gas Production

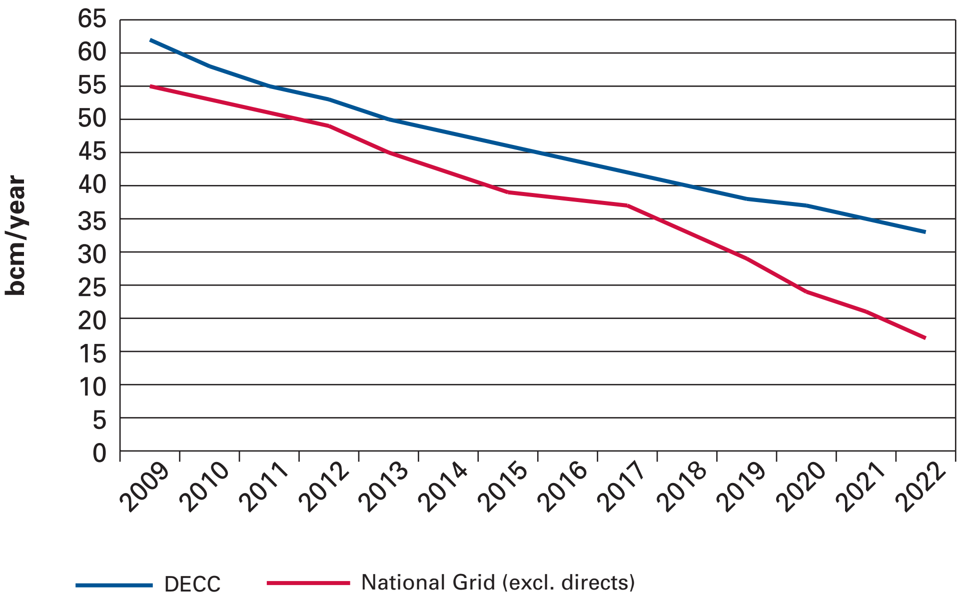


Sources: DECC (October 2009; see https://www.og.decc.gov.uk/information/bb_updates/chapters/Section4_17.htm; production after 2014 is assumed to decline at 4.5 per cent per annum) and Updated Energy and Carbon Emissions Projections: the Energy White Paper (May 2007; available from http://www.decc.gov.uk/en/content/cms/publications/white_paper_07/white_paper_07.aspx).

5.5.2 DECC's latest projection assumes a lower annual rate of decline than previously; this reflects recent industry data for the next five years (on which the medium-term projections are based) and an assumed lower rate of decline thereafter, reflecting recent experience and the trend of the current projections. However, as set out in previous Energy Markets Outlook reports, there are a range of views and this is reflected by including National Grid's projections in Chart 5.8.

5.5.3 DECC's projections are consistent with DECC's current view of the size of the remaining recoverable UK gas resource base. From 2015 onwards, DECC's central projection of UK gas production is higher than that of National Grid's projection. This is partly due to the exclusion of gas that does not go into the grid in National Grid's projections but also reflects different views on the outlook for UKCS production particularly from 2017 onwards.

Chart 5.8: UK/GB Net Gas Production Projections



Source: DECC (October 2009), National Grid (July 2009)

5.5.4 DECC's projections of UK natural gas production do not include biogas. National Grid's latest Business as usual forecasts do include biogas but, even by 2020, the maximum volume they project is less than 1 bcm a year. Analysis carried out for DECC estimates that biogas production from food waste, landfill gas and sewage treatment could deliver 2.5 bcm of biogas per year by 2020[72]. However National Grid analysis suggests, that with greater diversion of waste to biogas production, this figure could be higher[73]. The range of views on domestic production, along with sensitivities around the central case for gas demand, will of course affect the assessment of the requirement for imports, which are required to make up the difference.

72 Enviros (2008) Barriers to renewable heat. Part 2.b Biogas options. http://www.decc.gov.uk/en/content/cms/consultations/cons_res/rescon_support/rescon_support.aspx

73 *The potential for Renewable Gas in the UK: A paper by National Grid,* January 2009

5.6 Imports

5.6.1 Since 2004 the UK has imported more gas than it has exported. Import reliance, although neither new to the UK nor uncommon around the world, can bring additional risks of disruption to supply sources. This section considers the UK's import capacity and potential sources for imports and risks associated with the deliverability of imports.

Import Capacity

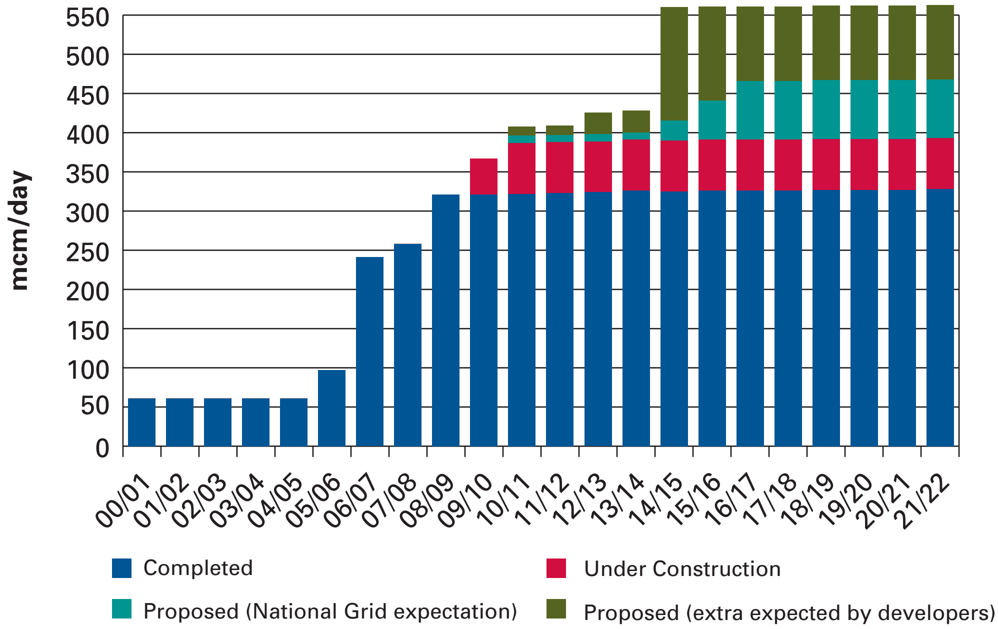
5.6.2 The UK has a large and growing import capacity which will contribute to security of supply by enabling gas imports to be received from a diverse range of sources. This combination of diversity and over-capacity could also help to deliver competitive prices since it should be possible to import significant volumes of gas from whichever is the cheapest source. However, while sufficient capacity is a requirement for ensuring security of supply, it is also essential that there is sufficient availability of gas (i.e. gas molecules flowing).

5.6.3 Following a period of significant commercial investment in import infrastructure, capacity has increased more than five-fold during the last decade, and will be 123 bcm by the start of the coming winter. This compares to UK annual demand in 2008 of around 100 bcm. This investment enables importation of gas from Norway, from the Continent and by LNG tanker.

5.6.4 In the last year, import capacity has been expanded at the Isle of Grain and two LNG terminals have been commissioned at Milford Haven. The South Hook LNG terminal has now commenced commercial operations and the Dragon Terminal began commercial operations in September 2009. Together they have a capacity of over 16 bcm per annum. In total import capacity now has a deliverability of 337 mcm per day – sufficient deliverability to meet demand on a typical winter day alone – even in the absence of gas supplies from storage and the UKCS.

5.6.5 More import infrastructure is due to be delivered: some 17.5 bcm of import capacity is under construction (including an expansion of the BBL pipeline) and at least 24.5bcm has been proposed (though the extent to which all those plans will come to fruition is uncertain). Chart 5.9 shows deliverability (i.e. the amounts of gas that can be delivered each day) of current and potential import capacity.

Chart 5.9: Possible Evolution of UK Gas Import Deliverability



Source: National Grid (July 2009).

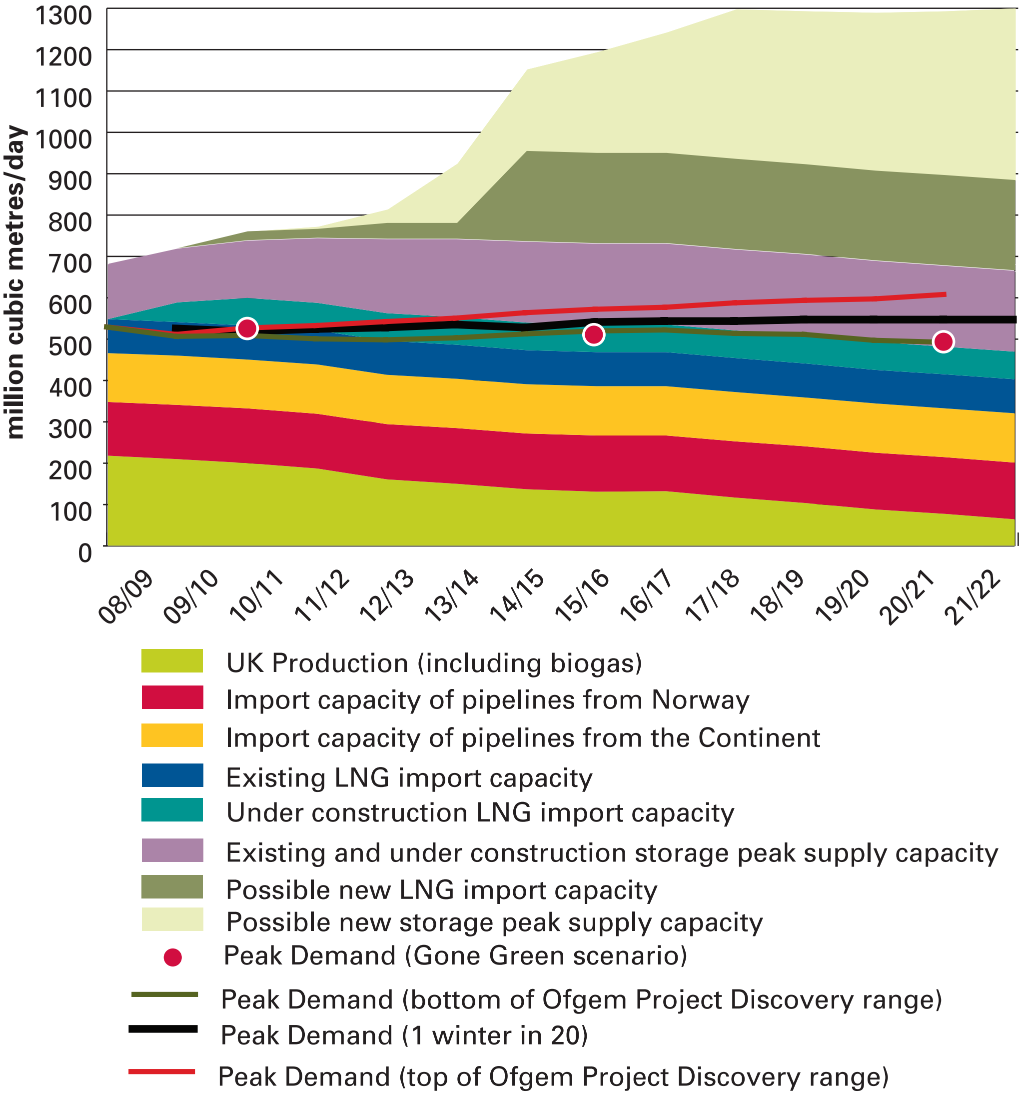
Box 5.1: Facilitating the delivery of infrastructure

Although not sufficient in itself, to ensure security of supplies key pieces of infrastructure need to be delivered at the right time and in sufficient quantity. The absence of capacity constraints also contributes to affordable prices.

In recent years the planning system has been seen as a major barrier to the development of infrastructure. The Government is encouraging new investment in gas storage and import infrastructure through reform of the planning and consents regulatory framework to ensure that it is clear and consistent and reflects the national need for new infrastructure. The Energy Act 2008 paves the way for a new, fit for purpose licensing scheme which will enable offshore gas storage and import projects to come forward. The reforms set out in the Planning Act 2008 are intended to ensure that the Infrastructure Planning Commission can handle applications for development consent for gas supply infrastructure in England and Wales comprising, amongst other things, gas storage facilities, LNG import facilities, gas reception facilities and connection pipelines.

The announcement alongside Budget 2009 which clarified that cushion gas is eligible for tax relief under the capital allowances regime should act as a further incentive for investment in additional gas storage capacity.

Chart 5.10: GB Peak Daily Winter Gas Demand and Supply Capacity (nominal) including possible projects



Source: National Grid (July 2009, including peak demand assumptions) and Ofgem's Project Discovery (October 2009).

5.6.6 Having sufficient capacity to meet demand peaks is not enough in itself. A 'buffer' of spare capacity on the system is required in case there are physical outages in the delivery infrastructure.

5.6.7 Analysis by National Grid, in consultation with DECC, undertaken to assess the impacts of the draft Regulation on Gas Security of Supply suggests that in the event of disruption of the largest gas supply infrastructure, the remaining infrastructure has the capacity to deliver the necessary volume of gas to satisfy total gas demand of the calculated area during a period of 60 days of exceptionally high gas demand in a 1 in 20 winter.

Norway

5.6.8 The UK's first pipeline from Norway was commissioned in 1977 and Norway has been a reliable, stable and secure supplier of gas to the UK as well to Europe as a whole. Today, Norway has the capacity to export approximately 45 bcm a year to the UK (and 85 bcm a year to continental Europe). In 2008 alone imports to the UK totalled nearly 26 bcm. The Langeled pipeline was commissioned in 2006, connecting Norway's offshore gas system to Easington, and has a capacity to meet 25% of the UK's annual demand. There are potential opportunities for additional gas supply from Norway, both from existing areas and, in the longer term, from the far North such as the Barents Sea.

The Continent

5.6.9 Being a part of the European gas market gives the UK access to a wider pool of gas enhancing security of supply. The diversity of gas sources to which the UK has access, via its pipelines with Europe as well as the spare capacity available in those pipelines, reduces the impact of potential supply problems in a source country or supply route. The UK gained its first interconnection to Continental Europe in 1998 with the IUK Interconnector linking the UK and Belgium; in 2006 the BBL (Bacton Balgzand) pipeline was completed between the UK and The Netherlands. Today, import capacity through the Interconnector is 25.5 bcm per year and 15 bcm per year through the BBL. In 2008 alone imports from Belgium and The Netherlands totalled over 9 bcm.

5.6.10 Compared to the UK gas market, wholesale markets in Europe tend to be less liquid and transparent. Risks to imports from Europe may include, lack of access to pipeline infrastructure or low market liquidity or competitiveness outside UK borders.

5.6.11 The UK imports little or no gas directly from Russia, but the EU as a whole is currently highly dependent on Russian gas which accounts for around 40% of all EU imports. The Russia/Ukraine dispute had little impact on the UK wholesale prices last winter (although more gas was exported to Europe to meet increased import demand whilst more LNG was imported and stocks were drawn down at a faster rate[74]).

74 IEA Natural Gas Market Review 2009, page 38. http://www.iea.org/w/bookshop/add.aspx?id=33

5.6.12 The Government's view is that European gas security of supply is best ensured by an open and integrated EU market so that customers and shippers in the UK, and across Europe, have access to a wide range of gas and capacity and also that a single EU market is also the best way of ensuring affordable supplies of gas to consumers. The Third Package of EU internal market legislation, which entered into force on 3 September 2009, is a major step forward. But more needs to be done. First, the package must be implemented in full and in time by all member states. Second, more detailed technical rules will be needed to open up the markets and underpin the greater integration of EU energy markets (which is envisaged through the European network codes as provided for in the Third Package). European Regulators are developing framework guidelines that set the objectives for the new codes, with the aim of improving capacity allocation mechanisms on pipeline infrastructure in Europe.

5.6.13 The proposed EU Regulation on Security of Gas Supply – currently under negotiation – is also expected to contribute to security of supply. The overall aim is to enhance Member State and EU resilience through better market functioning, with non-market measures to deal with a supply disruption being permitted only as a last resort; by improving the quality and co-ordination of Member States' preventative and emergency planning; and by ensuring the actions of one Member State do not impact negatively on others.

5.6.14 DECC with support from Ofgem is evaluating the implications of the proposed Regulation for the UK as it goes through the negotiating process in Brussels, taking account of the measures GB already has in place relating to the protection of vulnerable customers and contingency plans for extreme conditions [75].

Imports from the rest of the world

5.6.15 In recent years the UK's LNG regasification capacity has increased significantly, with terminals at Milford Haven and the Isle of Grain, and the Teesside GasPort facility, although the actual imports of LNG to the UK have tended to be relatively small.

75 For information on the Government's arrangements for handling potential gas shortages and emergencies see: http://decc.gov.uk/en/content/cms/what_we_do/uk_supply/resilience/gas_electric/gas_electric.aspx

5.6.16 More broadly the LNG market is moving towards globalisation due to a number of factors:

- Although the LNG market is relatively small – providing only 7.3% of all (world) gas consumed – the LNG market is important in terms of gas traded accounting for 24.8% of this market[76]. This is expected to continue growing rapidly.
- World regasification capacity is now around twice as great as world liquefaction capacity. Having surplus regasification capacity allows for a large degree of flexibility in where LNG cargoes can be shipped to. This facilitates price arbitrage on the part of producers such that LNG can be delivered to where the price is highest.
- An increasing proportion of LNG is not contractually committed to one specific destination.
- Advances in liquefaction, regasification and LNG shipping technology have pushed down costs and increased trading between basins. Average shipping distances have increased from around 5,700km in 2000 to around 7,100km in 2008[77].

5.6.17 These developments are encouraging – since they foster the growth of a deep and liquid global market for LNG. Such a market would mean that the UK would need to compete on price with a larger range of other markets to attract gas although it would also mean an increase in the number of potential suppliers competing to supply LNG to the UK too. The impact on LNG prices that the UK would face is not clear, but on balance a global gas market is welcome since it will be easier to attract large volumes of gas that the UK may need in the event of a supply disruption or surge in demand.

5.6.18 Risks remain to the development of a global gas market. These risks are both economic and political in nature. For instance:

- global investment in the LNG (and upstream) supply chain will need to keep pace with future world demand despite the recent credit crunch; and
- the increasing concentration of reserves could allow suppliers to exercise market power either individually or if this facilitates the creation of a cartel.

76 IEA Natural Gas Market Review 2008, from tables on page 27
77 IEA Natural Gas Market Review 2009, page 98

5.6.19 However, it may be noted that in the near term, the availability of LNG to the UK is likely to be high. This is due to:

- the recent economic downturn which has depressed demand for LNG globally;
- increased amounts of LNG on spot markets as customers exercise the downward flexibility on bi-lateral contracts; and
- the large falls in the demand for LNG in the United States due to the recent boom in shale gas there, removing a large competing source of demand in the Atlantic basin.

5.6.20 It should be noted that even with a much deeper and more liquid LNG market, the responsiveness of LNG supplies will always be limited by how quickly it can be shipped to the UK. The market participants may need to find ways to cope with any delays between when the gas is needed and when LNG cargoes can arrive – perhaps by developing more gas storage – to prevent any increased reliance on LNG from translating into greater market volatility.

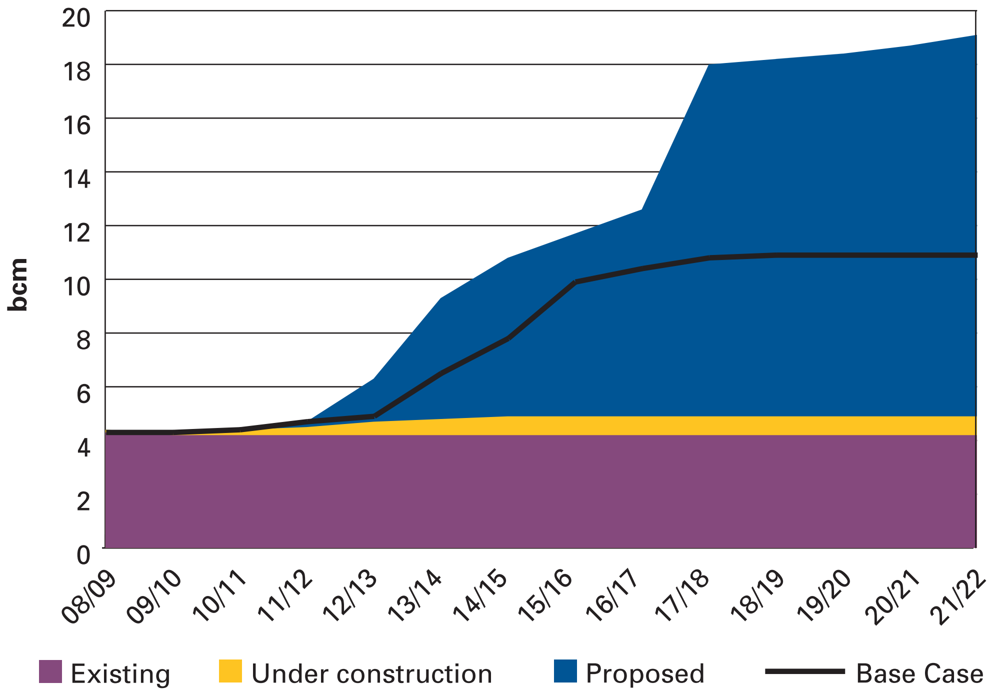
5.7 Storage

5.7.1 Storage is one means of managing seasonal demand fluctuations – gas tends to be put into storage in the summer months when gas is cheap and abundant and taken out in the winter months when the demand for gas is highest and prices higher. Storage is also one option for dealing with short-term demand fluctuations or supply disruptions

5.7.2 Storage capacity is often described in terms of a number of days' worth of supply but this is not a particularly satisfactory or meaningful measure since stored gas is not used on its own to meet demand. Instead, gas from storage is used to supplement supply from other sources to a greater or lesser extent depending on overall demand and the availability of other supplies. For example, the UK's largest gas storage facility, Rough, is capable of delivering over 10% of typical UK winter daily demand and could do so continuously for about eleven weeks if it started from full; other facilities can collectively deliver more per day, but would run out of gas much more quickly if they were to run at their maximum rate.

5.7.3 For many years the UK has relied on gas stored beneath the North Sea for its supplies, and this will continue to make an important contribution to our supplies, but as production gradually declines more gas is likely to be held in commercial storage. At present there are some 19 commercial gas storage projects at various stages of development in the UK. Three facilities[78] are under development, and commercial operation began recently at the Aldbrough gas storage facility in Yorkshire – although Aldbrough's present capacity is significantly less that of its intended final capacity. Chart 5.11 below shows storage space in terms of existing facilities, those under construction and those proposed.[79]

Chart 5.11: GB Gas Storage Capacity



Source: National Grid (July 2009; consistent with Figure A19 in TBE 2009).

5.7.4 For their Base Case, National Grid assume that not all of the storage proposals will proceed as planned and that some delivery dates will slip. Under this scenario the UK is expected to be able to store about 12% of its expected annual demand by 2020/2021.

5.7.5 As more gas storage is developed so gas deliverability will increase too. If all current storage proposals were to go

78 The three gas storage facilities currently under development are: Holford in Cheshire, due 2011/12; Caythorpe in East Yorkshire, due 2011/12; and Stublach in Cheshire, due 2013/14.

79 There is a list of existing, under construction and publicly announced proposals for gas storage facilities at Table A2 in TBE 2009

ahead then the maximum storage deliverability would increase from around 120 mcm/day to above 600 mcm/day, far in excess of forecast peak day demand. Under National Grid's Base Case, by 2021 the UK is expected to have capacity to meet just over 70% of its expected peak daily demand from stored supply.

Outlook for Supply

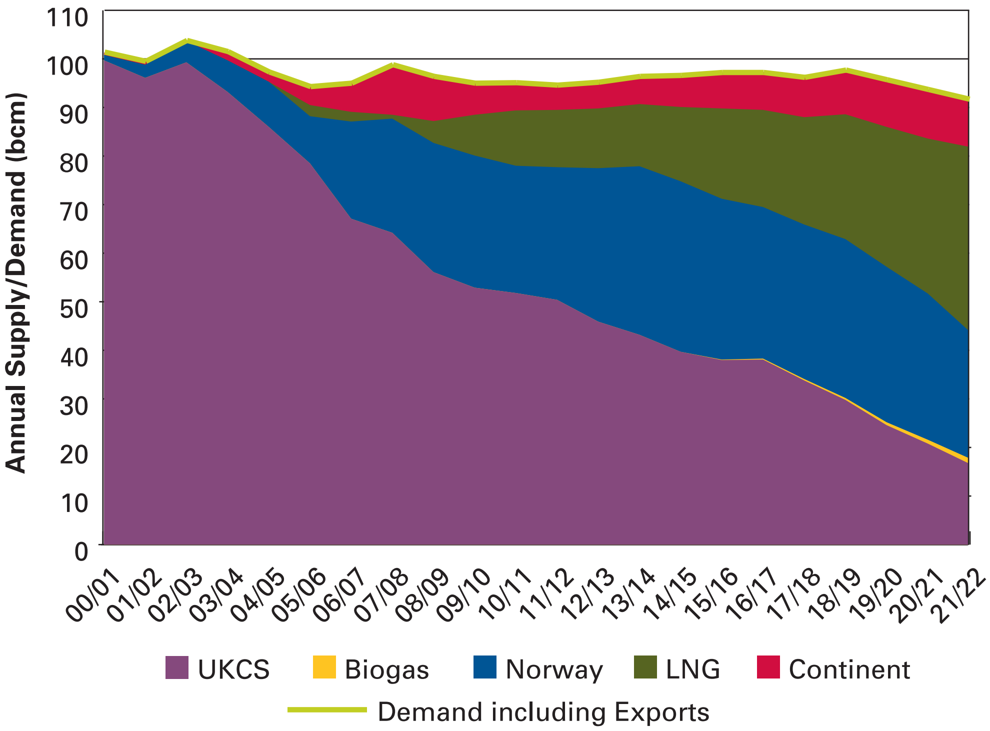
5.7.6 In the UK, gas suppliers have a responsibility to ensure that their customers' demands are met. As well as the reputational and commercial risks involved in not being able to offer gas supply at competitive prices, gas suppliers face financial penalties, which can be very severe, if they fail to balance their inputs into the National Transmission System with their customers' offtakes on a daily basis. The suppliers have an incentive to help ensure that they minimise these risks. Options include diversity of sources and supply routes, contractual arrangements or vertical integration with producers and/or importers, holding gas in storage and reliance on the daily market as well as the construction of new import and supply facilities.

5.7.7 The ability to meet peak demand, whether on a particular day or over a more prolonged period such as a severe winter, as well as average demand levels for gas is particularly important in a security of supply context. Each of the sources of supply – UK production, imports from Europe or LNG, and storage – will deliver a greater or lesser proportion of demand at any time depending on several factors which vary daily or seasonally and with varying levels of predictability or manageability, such as price, production conditions and contractual arrangements.

5.7.8 The extent to which flows from each of the different sources and supply routes (including the UKCS) would respond to price signals resulting from changes in the supply–demand balance within the UK market is subject to some uncertainty deriving from a range of factors – commercial, technical, weather-related, geopolitical, seismological, industrial-relations led, for example.

5.7.9 There is therefore a wide range of possible supply sources that could be used to meet the UK's gas demand out to the medium term. Chart 5.12 shows how GB annual demand could be met in National Grid's 'business-as-usual' demand scenario and assuming National Grid's profile of UKCS production; supply is met with pipeline gas from Europe and a rapidly growing amount of LNG[80]. National Grid's data pre-dates DECC's most recent forecasts where the central projection shows that the UK will require significantly less imports in future than implied by this graph which would further improve our security of supply.

Chart 5.12: National Grid Base Case Annual Supply–Demand Match



Source: National Grid (July 2009; consistent with Figure 16 in TBE 2009).

80 Project Discovery annual gas supply sources for each scenario are at page 32 of Ofgem's Discovery consultation document.

5.8 Conclusion

5.8.1 This chapter covers a range of scenarios and projections which are all based on different models and assumptions. They all point to the conclusion that both annual and peak UK gas demand is expected to fall if low carbon energy targets are met. However in other scenarios, such as two Project Discovery scenarios, gas demand is rising.

5.8.2 It is important that the market has sufficient capacity to allow enough gas to be delivered to the market under a range of circumstances – including a 'buffer' of spare capacity in case of supply disruption. As well as sufficient capacity, it is also essential that there is sufficient availability of gas. While there are risks of interruption along any supply route, the UK's large and growing import capacity allows a significant amount of gas to be imported from a diversity of sources.

6. Coal

6.1 Introduction

6.1.1 In this chapter we report scenarios developed for future demand for coal in the UK, drawn from a variety of sources. As the majority of demand is from the power sector, future levels of coal fired generating capacity and output from it are the key determinants of coal demand. The development and deployment of technologies such as carbon capture and storage (CCS) is likely to have an impact on coal demand further into the future, as will policy developments from a domestic or EU level.

6.1.2 We also set out scenarios for future indigenous production of coal, present scenarios for import requirements, and examine the prospects for the global coal market, and issues affecting import of coal into the UK.

6.1.3 This chapter draws on the Government's Updated Emissions Projections (UEP) and analysis carried out by Redpoint to inform policy decisions affecting new coal power stations[81].

Policy Development: EU

6.1.4 At an EU level, the proposed Industrial Emissions (Integrated Pollution Prevention and Control) Directive (IED), which would modify the regulatory framework established by the LCPD, would directly impact existing and new coal power stations by establishing stricter limits on the emissions of sulphur and nitrogen oxide. Under the LCPD, some 8GW of existing coal capacity will close between now and the end of 2015. The proposed IED, as politically agreed at the Environment Council in June, would be expected to result in further closures. The proposed Directive now needs to be further considered by the European Parliament.

81 Carbon Capture and Storage demonstration: analysis of policies on coal/CCS and financial incentive schemes: A report for the Department of Energy and Climate Change, November 2009 – URN 09D/817. Redpoint. http://www.decc.gov.uk/en/content/cms/consultations/clean_coal/clean_coal.aspx

6.1.5 The EU Emissions Trading System incentivises emissions reductions by capping the amount of carbon that can be emitted from certain industrial installations including coal power stations. In December 2008 the cap for the third phase of the scheme was set, reducing emissions by 1.74% per annum from 2013 to 2020, which would result in a 21% reduction in emissions in 2020 from 2005 levels. The cost of meeting these lower caps, whether through the purchase of additional carbon allowances, or through making efficiency reductions, is an operational cost for coal power stations that in time will make the economics of running coal power stations less attractive unless more cost-effective ways to reduce emissions can be found.

Policy Development: Domestic

6.1.6 In November 2009 Government confirmed an ambitious policy framework to enable the transition to clean coal as part the UK's move to a decarbonised electricity system[82].

6.1.7 Key elements of the framework for clean coal include:

- **No new coal without CCS.** In the 2009 Pre-budget Report, the Government doubled its funding commitment to support four commercial-scale CCS demonstrations. These will be funded by a new CCS incentive. Any new coal power station is required to demonstrate the full CCS chain (capture, transport and storage) at commercial scale.
- **A long term transition to clean coal.** Our ambition is to see CCS ready for wider deployment from 2020 and for any new coal plant constructed from then to be fully CCS from day one. We expect demonstration plant will retrofit CCS to their full capacity by 2025, with the CCS incentive able to provide financial support. A rolling review process, which is planned to report by 2018, will consider the appropriate regulatory and financial framework to further drive the move to clean coal. In the event that CCS is not on track to become technically or economically viable, an appropriate regulatory approach for managing emissions from coal power stations will be needed.

6.1.8 The framework could have significant impacts upon the future use of coal within the UK. In the short to medium

82 http://www.decc.gov.uk/en/content/cms/consultations/clean_coal/clean_coal.aspx

term four new coal power stations may be constructed, taking advantage of the financial incentive to demonstrate CCS. Additional coal power stations could be built if alternative sources of funding for CCS demonstration are forthcoming. In the longer term, should CCS become a commercially viable technology, then domestic and imported coal may continue to contribute to our energy supply as we make the necessary transition to a low carbon economy.

6.1.9 The new policies are reflected in the draft National Policy Statements (NPSs)[83] which, once designated, will be used by the Infrastructure Planning Commission in deciding whether new coal power stations are given planning consent. The draft NPSs are subject to public consultation (which will run until 22 February 2009) and Parliamentary scrutiny. Government intends to finalise and formally approve the energy National Policy Statements in 2010.

6.2 UK Demand

6.2.1 A significant proportion of demand for coal in the UK (just over 83% in 2008) comes from the electricity sector and so is closely linked to the level of generation by coal-fired power stations. Of the remaining 17%, the majority is from the iron and steel sector and is met mainly by imported coking coal from Australia, Canada and the USA. This chapter concentrates mainly on steam coal for power generation, but also includes estimates of total coal demand, and implications for import requirements.

6.2.2 The level of coal-fired generation capacity in the mix will depend on the timing of any closure of existing plant and investment in new plant. Decisions on closures and on investment in new plant would be expected to depend on factors such as the environmental and regulatory regimes, technological developments (e.g. Carbon Capture and Storage, and clean coal development) and the expected relative price of gas, coal and carbon allowances. They may also be influenced by the evolving profile of the mix, i.e. the expected levels of gas, nuclear and renewables and the need for baseload and peaking plant. For example, an increased level of intermittent capacity in the electricity generating mix is likely to increase the importance of generating plant whose output can readily be adjusted to

83 Details of the consultation on draft National Policy Statements for energy infrastructure can be found at https://www.energynpsconsultation.decc.gov.uk/home/

compensate for fluctuations in the supply-demand balance. One purpose of the UK's demonstration projects is to check how this capability for coal is affected by CCS.

6.2.3 Chart 6.1, below, shows a range of scenarios for coal-fired generation capacity. It should be noted that these sets of scenarios have been developed for distinct purposes, and reflect different sets of assumptions, as set out below. Most significantly:

- DECC UEP (Updated Emissions Projections) (a high, central and low case for fossil fuel prices – N.B. the coal prices in this model do not necessarily apply to coking coal). The UEP provide a set of estimates of future carbon emissions and reflect only measures that are already in place or can reasonably assumed to be in place in the near future. The UEP data used was produced to help inform the UK Low Carbon Transition Plan[84]. The assumptions include 31% of UK electricity capacity through renewable energy sources, and 4.1 GW of new coal capacity built by 2020 (including 1GW of installed CCS). Closure of existing coal power stations are hastened in the early 2020's due to the impact of the IED as currently politically agreed.
- Redpoint Modelling. The Redpoint scenarios were commissioned to model the impact on the generation mix of a range of regulatory and financial incentives to inform the framework for the development of clean coal[85].
- The trajectories differ from one another in the assumptions they make regarding: level of coal build; regulatory constraints on the operation of coal plants; whether demonstration CCS plants have to retrofit or not; different DECC forecasts for energy and fossil fuel prices. This gives rise to a wide range of possible outcomes for coal capacity, the output of coal power stations and ultimately coal usage.
- A selection of Redpoint trajectories are shown in the charts. These are not intended to represent the policy outcomes that are most likely to happen, but are chosen to give an idea of the potential range of outcomes for coal generation. These trajectories feature the following sets of assumptions:

84 UK Low Carbon Transition Plan: National strategy for climate and energy. DECC 2009.

85 Carbon Capture and Storage demonstration: analysis of policies on coal/CCS and financial incentive schemes: report by Redpoint. DECC, 2009.

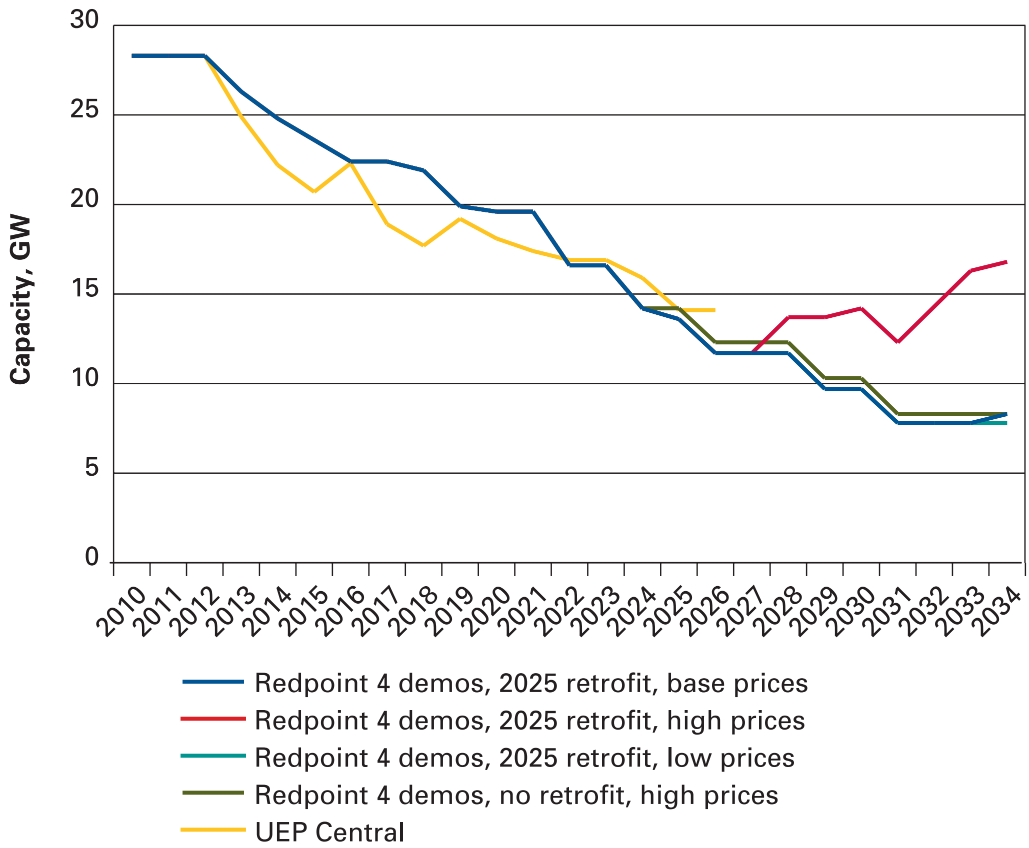
– Four CCS demonstration plants built, which are retrofitted in 2025, with central (base) commodity prices;

– Four CCS demonstration plants built, which are retrofitted in 2025, with high commodity prices;

– Four CCS demonstration plants built, which are retrofitted in 2025, with low commodity prices;

– Four CCS demonstration plants built, no retrofit, with high commodity prices.

Chart 6.1 – Coal Power station capacity (GW)



All of the projections follow a similar trend of coal capacity declining over the period out till 2025. Coal capacity declines from a current level of around 28GW to between 10-14GW by 2025. The decline is driven by the closure of coal power stations up to 2016 due to the LCPD Directive and due to the proposed IED Directive as politically agreed.

6.2.4 From 2025 the trajectories show further decline to between 6 and 8GW of coal capacity by 2034. The one exception is the "Redpoint 4 demos, retrofit, high prices" trajectory. This trajectory, reflecting a scenario where CCS technologies are successfully proven to be safe and effective at capturing storing carbon dioxide and the impact of high fossil fuel and electricity prices, shows around 5GW of new coal capacity fitted with CCS being built between 2025 and 2034 even without any additional financial incentive for CCS. This provides a total of around 16GW by 2034.

6.2.5 The trajectories highlight how coal's role in the future energy mix will depend upon a combination of advancements in technologies to avoid and /or or capture emissions and the prevailing economic conditions, particularly fossil fuel and electricity prices, which will influence future investment decisions.

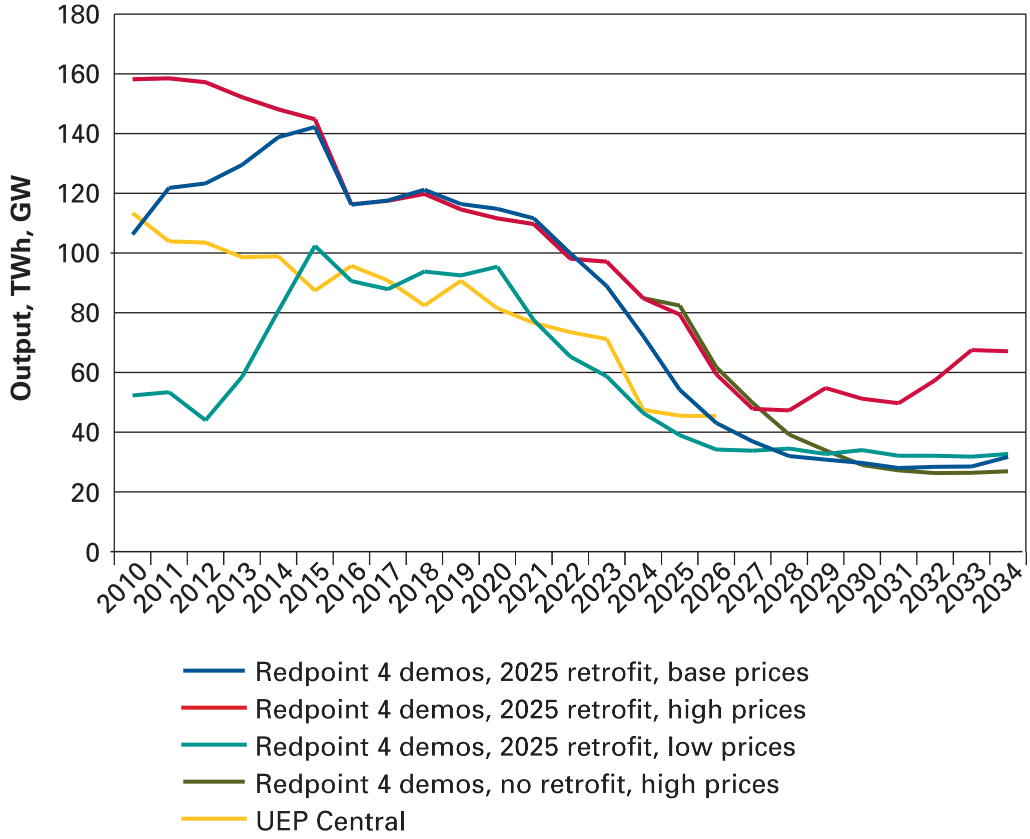
6.2.6 Government intends to undertake a rolling review of CCS technologies, and plans to publish a report by 2018. The report will consider the appropriate regulatory and financial framework to further drive the move to clean coal in light of evidence from efforts to demonstrate CCS and in the context of the need to move to a low carbon economy.

6.3 Generation Output

6.3.1 Once a particular level of coal capacity is available, the extent to which it will run will also depend on a range of factors, including demand, the availability of other sources of generation in the mix, any environmental constraints on running time and fuel price relativities, particularly the price of coal and gas relative to each other, to the electricity price and the price of carbon under the EU ETS.

6.3.2 Chart 6.2 shows scenarios of output based on the assumptions that underpin Chart 6.1.

Chart 6.2 – Generation Output (TWh)



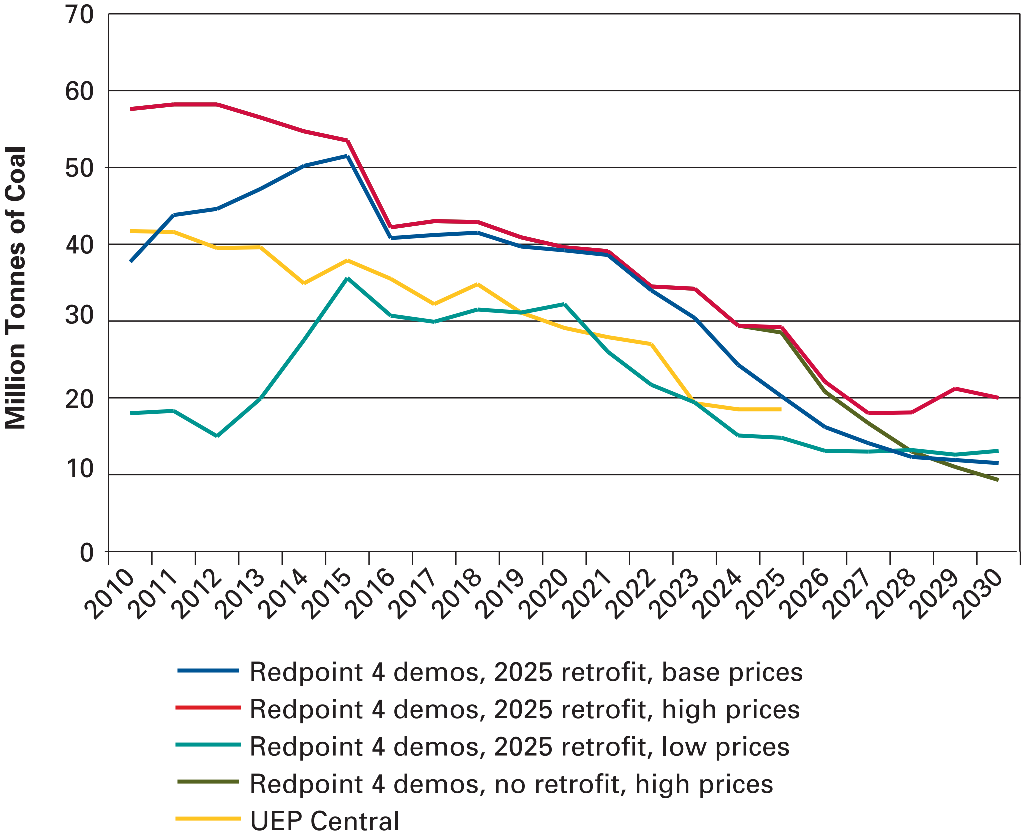
6.3.3 In general, the impact of declining capacity feeds through into lower output from coal power stations. For instance, the impact of the proposed IED in reducing capacity (shown in chart 6.1) results in generally lower output from coal power stations compared to those presented in last year's EMO report.

6.3.4 However, the charts also show how relatively higher prices tend to favour increased output from coal power stations.

6.4 Coal demand for power generation

6.4.1 Coal demand for power generation can be estimated from output figures by applying appropriate conversion factors. Different conversion factors are applied to new and existing plant (reflecting different thermal efficiencies); the conversion factors forming a time series, reflecting that over time, older, less efficient plant would be expected to close first, increasing the average efficiency of the remainder of plant. The same scenarios for Charts 6.1 and 6.2 have formed the basis for the output forecast presented in chart 6.3

Chart 6.3 Coal demand for power generation (Mt)



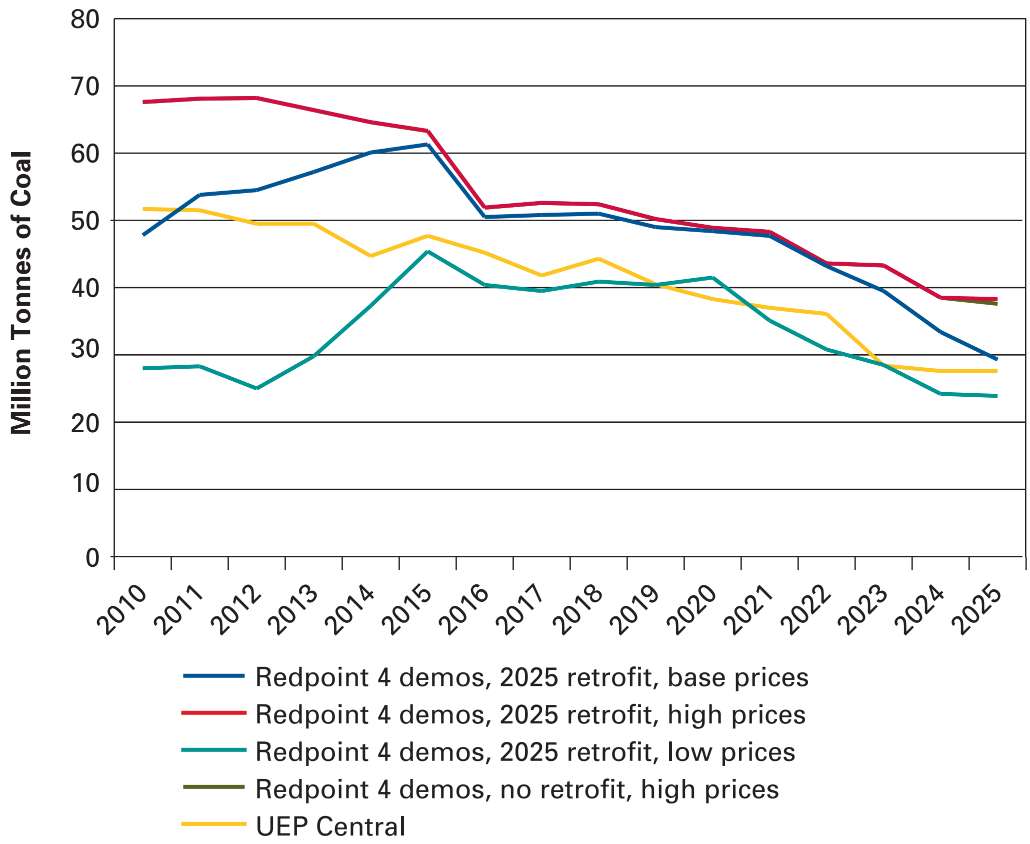
6.4.2 The analysis here considers aggregate demand for coal. In practice, account would also need to be taken of the need for different types of coal, for example in terms of sulphur context and NOx (nitrous oxides) emissions. Typically, low sulphur coal would be needed for the LCPD opted out fleet (8.2 GW of capacity. For all plant (opted in and opted out), coal with a particular NOx profile may be needed depending on whether NOx reduction equipment had been fitted (e.g. low-NOx burners.)

6.4.3 Coal demand presented in this year's EMO report is lower than that presented last year on account of the lower output as shown in chart 6.2.

6.5 Total demand for coal

6.5.1 Coal is also required for non-power uses, including coking and smelting. Chart 6.4 shows the total demand and reflects the expectation that the demand in the non-power sector is projected to remain stable with a slight fall from 11.9 million tonnes in 2008 to 9 million tonnes in 2025.

Chart 6.4 Total demand for coal (Mt)



6.6 UK Supply: Indigenous production

6.6.1 The Coal Authority estimates that the UK has 3,405 million tonnes (Mt) of coal resources in the UK. Of this, 260 Mt is economically recoverable coal in the 'reserves category' (i.e. proved and probably mineable coal) at current deep mines and sites subject to conditional deep mine licences. A further 70 Mt are at existing surface mines, those with planning approval granted and those currently in the planning process. In addition, estimates suggest there to be 260 Mt of previously proven reserves remaining in closed deep mines still in licence. With a further 2,030 Mt of potential deep mine prospects and 785 Mt at potential surface mine prospects, including those in pre-planning and resources within former conditional licences.

6.6.2 A number of factors affect levels of production of coal in the UK, of which about half comes from deep mines and half from surface mines. The successful introduction of clean coal technologies, in particular carbon capture and storage, would potentially provide opportunities for indigenous coal producers.

Deep mines

6.6.3 Production from deep mines may be considered in terms of:

- output from existing mines
- potential for reopening of closed or mothballed deep mines (e.g. Harworth)
- potential for investment in new deep mines.

6.6.4 With the exception of Welbeck, which is due to close in 2010, all of the UKs major deep mines have investment programmes in place which should allow them to maintain current production levels until at least 2015. Further tranches of investment would be needed to maintain access to reserves thereafter. Increases in the coal price in recent years made the economics of re-opening closed or mothballed mines more attractive and despite the fall back since mid-2008 some operators are continuing to pursue such projects. Greater certainty around continuing demand for coal beyond 2020 could help the case for such projects, as could significantly higher confidence in forward price levels.

Surface mines

6.6.5 The surface mining industry aims to maintain production through a five-year rolling site replacement programme which requires a sufficient flow of planning consents for new mines. Few sites in production now have sufficient reserves to be active beyond 2012, but there are extensive unworked shallow coal reserves suitable for surface mining, subject to approvals within relevant minerals planning guidance.

6.6.6 The recent report – 'Energy Security: a national challenge in a changing world'- by the Prime Minister's Special Representative on International Energy, Rt. Hon. Malcolm Wicks MP identified that indigenous coal production could be maintained at around 20 million tonnes per annum through to at least 2025 with major investment in deep mines and planning permission to exploit further surface mines.

6.7 UK Supply: Stocks

6.7.1 Coal stock levels are relatively high at present, as generators are deliberately building stocks to take advantage of the steep contango in the forward price curve. These stocks will be drawn down over the coming months as generators look to cash in the difference between the current and forward prices.

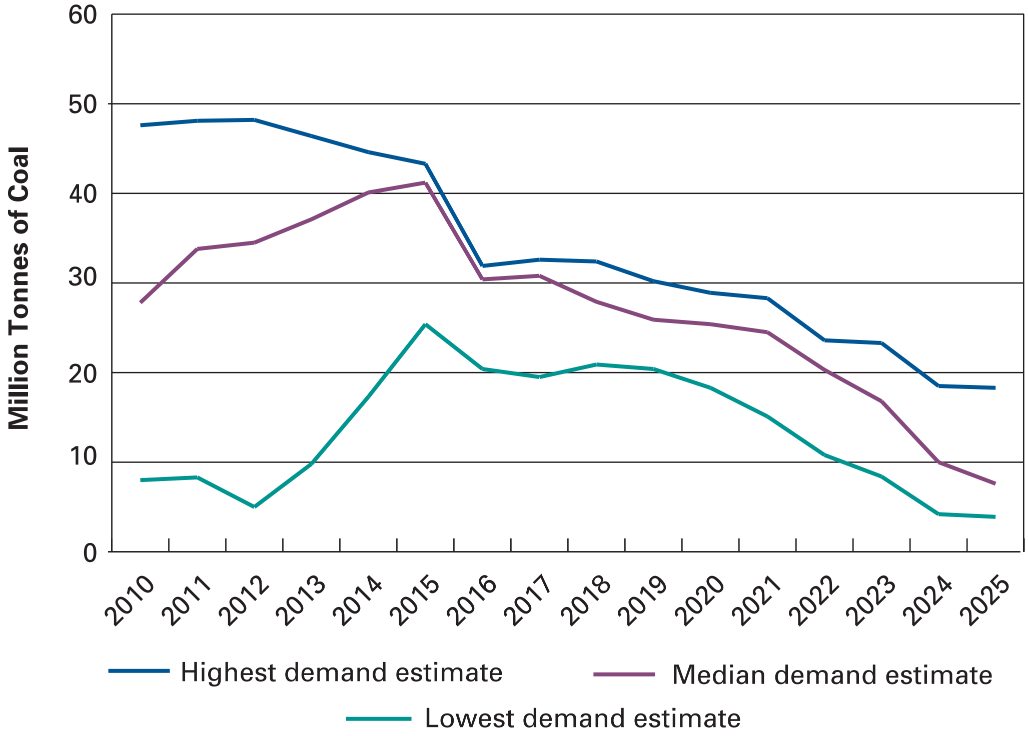
6.8 UK supply: imports

6.8.1 There follows from the above scenarios for demand and indigenous production, a range of scenarios for future import requirements. This is shown in Chart 6.5, which shows the upper and lower boundaries of the ranges for these scenarios and is based on a scenario of indigenous coal production remaining constant at 20 million tonnes per annum. Were indigenous production to be lower than this, then for the same level demand, the import requirement would rise accordingly.

6.8.2 The trend for volumes of imported coal to fall from 2005 levels to 2010 is due to increasing UK domestic production and declining demand from power stations. From 2010, there are scenarios where domestic production of coal starts to fall, and depending on assumptions about demand, import requirements can be expected to increase or to decrease. The potential for indigenous surface mined coal has a significant influence on overall import requirements.

6.8.3 Plans for the ports and rail network would need to take into account likely patterns in the future transport of coal, in particular if there were to be a significant increase in import requirements.

Chart 6.5 possible range for coal imports – based on a scenario of indigenous coal production of 20 million tonnes per annum



6.9 Global supply and demand; supply to the UK

6.9.1 The remainder of this chapter focuses on the availability of imported coal (both steam and coking coal, together termed "hard coal"). Coal is a globally traded commodity so that availability will depend on global supply and demand conditions. In addition, there are a number of issues specific to the UK.

World coal reserves

6.9.2 Coal is the most abundant fossil fuel in terms of reserves. Global coal reserves at the end of 2005 are given as 847.5 billion tonnes, estimated to be sufficient for almost 150 years at current rates of production[86]. These reserves are geographically well-dispersed, with economically recoverable reserves of coal available in more than 70 countries worldwide, and in each major world region.

6.9.3 It should be noted, however, that accessing new reserves could be associated with higher mining and/or infrastructure costs in the medium term. Coal and lignite

86 The World Energy Council's 2007 Survey of Energy Resources http://www.worldenergy.org/documents/ser2007_final_online_version_1.pdf – which is a triennial survey.

resources were reported in 2007 as totalling 8,710 billion tonnes coal equivalent[87], suggesting that proven, recoverable, reserves are around 10% of total resources.

6.10 Supply and Demand: international hard coal trade

6.10.1 World coal consumption grew by 3.1% in 2008, the first below-average increase since 2002. Coal nonetheless remains the fastest-growing primary energy source for the sixth consecutive year. China accounted for more than 85% of global growth and imports were very strong for the first 6 months of 2009 with a 53% increase compared to the previous period in 2008.[88]

6.10.2 Most of the world's coal demand continues to be met by indigenous production with around 15% of production being traded internationally. International seaborne trade for steam coal is mainly considered in terms of two main demand areas – the Asia-Pacific market and the Atlantic market. In the Asia-Pacific market the main importers are Japan, Korea, Taiwan, China and India and the main suppliers are Indonesia and Australia. In the Atlantic market the main importers are the UK, Germany and the United States and the main suppliers are Russia, Colombia and South Africa. Main flows are illustrated by the chart below.

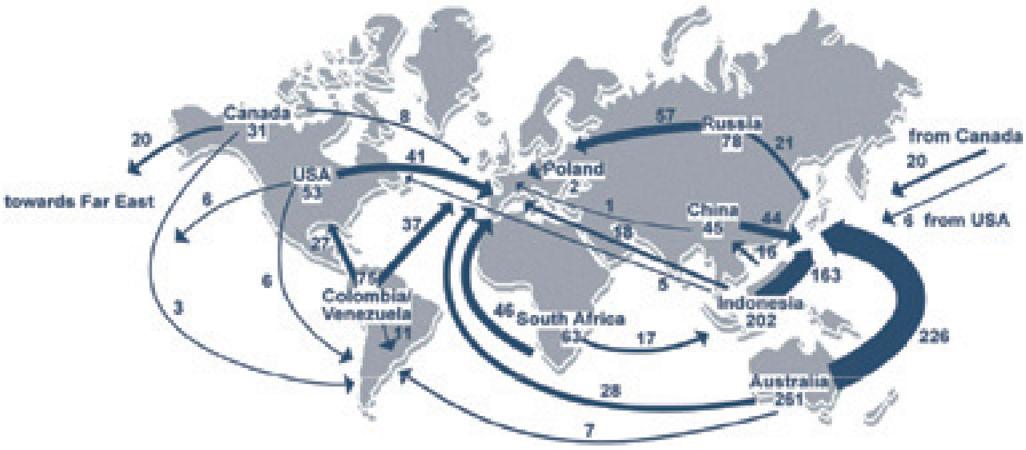
6.10.3 IEA projections for 2030 show that, based on reserves estimates, increased world coal demand can be met by traditional supplying nations, with exports from Australia, Russia and South Africa expected to increase.

87 The German Federal Institute for Geosciences and Natural Resources (BGR). This figure relates to coal of 7,000 kcal/kg calorific value

88 BP Statistical Review of World Energy – 2009 www.bp.com/productlanding.do?categoryId=6929&contentId=7044622

Chart 6.6: International hard coal trade 2005

Seaborne Hard Coal Transport 2008: 839 Million Tonnes (Mt)



Seaborne trade: 839 Mt incl. 632 Mt steam coal 207 Mt coking coal
Global hard coal production: 5.85 Bt
Source: VDKI, Hamburg 2009

6.11 Factors that might affect international availability

6.11.1 A number of factors could increase demand or reduce availability of coal on the international market in the short, medium or longer term:

- Economic growth rates of rapidly developing nations have been consistently under-estimated. This applies particularly to China, but is also relevant to India, Russia, Brazil and parts of South-East Asia. How these countries emerge from the current economic downturn will be particularly relevant.
- Whilst China is expected to remain broadly self-sufficient in coal, small proportionate changes in the supply/demand balance can have a major impact on international trade.
- India is considered less likely to meet its own demand, and could become a major importer, competing with Europe for South African supplies.
- Russia is expected to increase generation from coal, which may increase domestic demand, and reduce quantities available for export.

6.11.2 Factors which could depress coal demand and prices include more robust and effective climate change policies (unless or until carbon capture and storage can be deployed cost effectively at scale). A major fuel-switch to gas or other alternative forms of electricity generation would be likely to depress international prices.

6.12 Issues affecting security of supply of coal imports to the UK

Constraints on use of types of coal for UK generators

6.12.1 Regulatory limits on sulphur and nitrogen oxide (SOx and NOx) emissions place constraints on the relative volumes of different quality coals that can be used by UK coal-fired power stations. This is a particular constraint for plant that is opted out of the Large Combustion Plants Directive (LCPD) and has therefore accepted restricted running hours and closure by 2016 as an alternative to fitting flue gas desulphurisation (FGD) equipment to remove SOx for longer term running. Such plant typically requires low sulphur coal to comply with other emissions regulations. For all plant that remains after 2016, or is newly built, the requirement for FGD removes the constraint on sulphur content of coal used.

6.12.2 The recent political agreement at the EU Council in relation to the Industrial Emissions Directive (IED), if ratified by the European Parliament, will result in the option of further Transitional National Plans from 2016, together with a new opt-out facility. These measures would help phase in ELVs for SOx and NOx within the IED and would enable older power stations to continue running until 2020 or 2023, albeit at reduced load factors, without the need to install costly abatement equipment for NOx.

6.12.3 In order to fully comply with the ELV requirements of the IED, some plant is likely to fit NOx abatement equipment such as Selective Catalytic Reduction (SCR). Once SCR is fitted, the NOx constraint on types of coal that can be used is removed. Any fitting of NOx abatement equipment up to 2016 may therefore open up the range of coals that can be used in the intervening period.

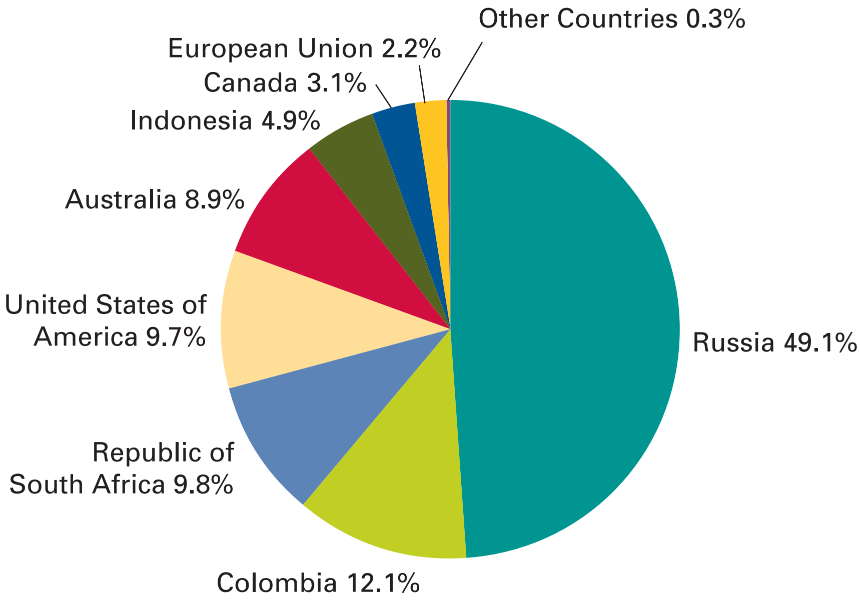
The role of Russian coal

6.12.4 Russian coal is generally well-suited for use in the UK, in terms of its low sulphur content and its volatile content (which allows it to be burnt with acceptable NOx emissions), and there has been a significant increase in the use of Russian coal in the last few years. Russia now accounts for nearly half imports – see Chart 6.7 which shows figures at 2008. High overall demand for coal imports into the UK has led to greater use of smaller ports, which are suited to Russian supply.

6.12.5 Alternative sources of coal are available, principally from Colombia, USA, and Indonesia. However, these coals are currently more expensive/less available than Russian coal. This is on account of higher freight rates for shipping (in the case of Indonesian coal) or because of competition from more natural geographical markets, such as North America for Colombian coal, and Japan for Indonesian coal. South African coals are available but are currently less attractive in terms of NOx emissions. (Australia remains the world’s principal supplier of coking coal, and most Australian imports to the UK are destined for the coking market. Coking coal prices have conventionally been higher than those for steam coal for generation and appear to have recovered more rapidly from the recent economic downturn.)

6.12.6 The main Russian coalfields are a long way from port and supply interruptions have been caused in the past as a result of congestion and shortage of rail cars. These are also risk factors which could affect supply or cause upward pressure on prices. It would be fair to say, however, over recent years Russian supplies have been reliable.

Chart 6.7: Breakdown of UK coal imports in 2008



6.13 Conclusion

6.13.1 A range of scenarios can be postulated for demand for coal in the UK over the next decades. These are driven primarily by assumptions about levels of coal fired power generation, which in turn depend upon assumptions about the future regulatory framework and the carbon price. These demand scenarios provide an opportunity for indigenous production of coal, although in all scenarios described here, there is a significant reliance on imports.

6.13.2 While there are a number issues and risks that could affect future prices the abundance of proven reserves of coal globally, suggests that the future use of coal is unlikely to be limited by resource availability.

7. Oil

7.1 Introduction

7.1.1 This chapter outlines key trends in the demand and supply of crude oil and petroleum products in the UK. As part of this it explores the impact of the financial downturn on the sector and highlights potential issues relating to security of supply.

7.1.2 In 2008, 71.5 million tonnes of oil and natural gas liquids (NGLs) were produced from the UK continental shelf, equivalent to 91% of total UK demand, but just 1.8% of global production. While these shares will fall further as production from the continental shelf continues to decline, the UKCS will play an important role for many years to come.

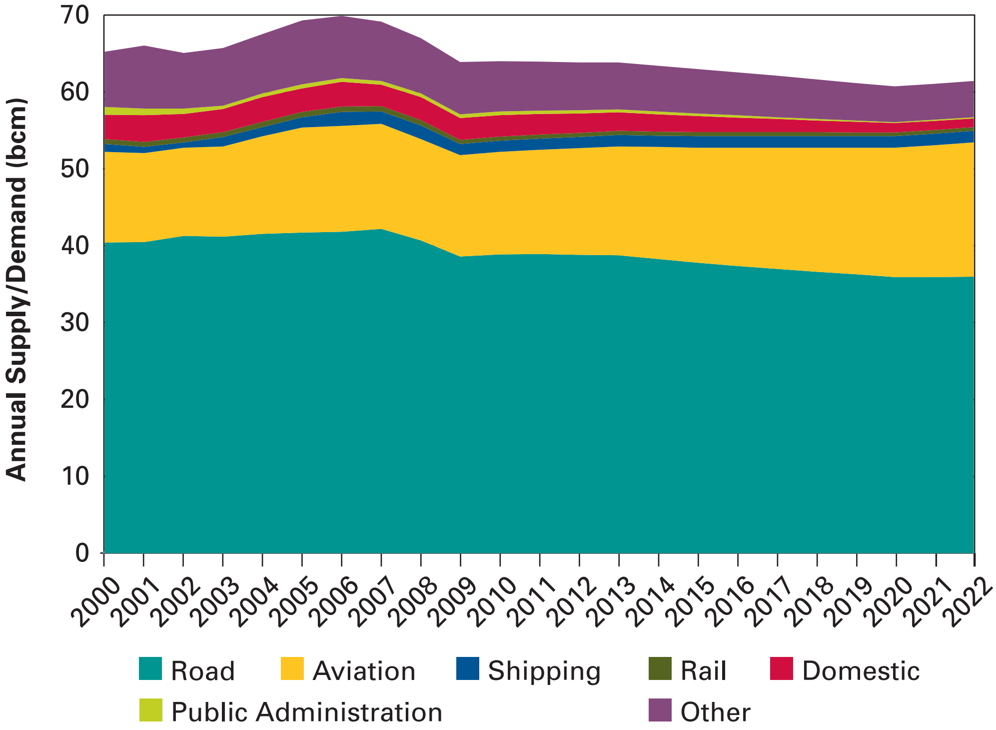
7.1.3 The UK also maintains a substantial domestic refining industry and remains a net exporter of petroleum products, with net exports equal to 7% of final consumption in 2008 and significant imports of certain petroleum products.

7.2 UK Demand

7.2.1 The UK accounts for around 2% of global oil demand, with final consumption spread across a wide range of fuel and non-energy products. Total UK oil demand (including bunkers) is expected to decline from 86.4 million tonnes of oil equivalent (toe) in 2008 to around 84 million toe in 2025 as Government initiatives to reduce demand combat the effects of economic growth. This year, however, in the wake of the oil price spike and current economic conditions, demand is projected to fall below 83 million toe (-4.4% year on year), with additional downward pressure resulting from Government energy efficiency measures and displacement by biofuels.

7.2.2 Total UK demand for petroleum products amounted to 76 million tonnes in 2008, of which the vast majority, 67.5 million tonnes (89%), was used as fuel. Of this, road transport accounts for 55% of demand with aviation accounting for a further 18%. Transport's dominant share of UK demand is the culmination of rising absolute demand for transport fuels, declining industrial demand, and a significant shift away from the use of fuel oil to generate electricity. This trend growth in transport's share of oil demand is expected to continue in the future.

Chart 7.1: UK Final Consumption by Sector[89,90]



Source: DECC Updated Energy Projections

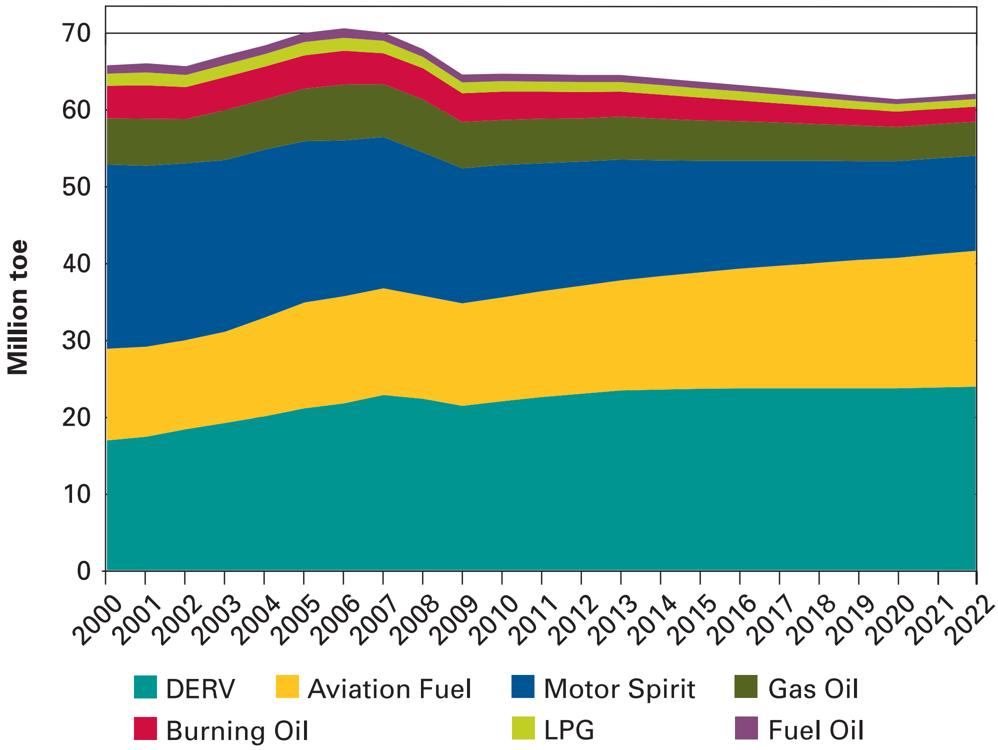
7.2.3 The economic situation has already had a noticeable impact on petroleum product demand. Deliveries of all petroleum products are down by around 5% in the six months to June 2009. Deliveries of aviation turbine kerosene (ATK) and motor spirit are both down by around 4% and gas/diesel oil deliveries are down by over 5%. The economy is a key factor, although demand has also been affected by the oil price spike, with diesel demand in particular hit by significant market tightness, and by increasing biofuel use. As an indication of their cumulative effect, commercial sales of road diesel were down over 11% last year compared with 2007.[91] These levels of demand are clearly atypical and demand is expected to rise when economic growth returns.

89 DECC is currently reviewing its demand forecasts. The DECC Updated Energy Projections may be revised to reflect better the impact of, for example, the increasing use of biofuels and renewable heat, vehicle fuel efficiency trends and changes in the vehicle parc, the change in sulphur specification for off-road diesel and the impact of IMO MARPOL VI etc.

90 Historic data up to 2007 inclusive.

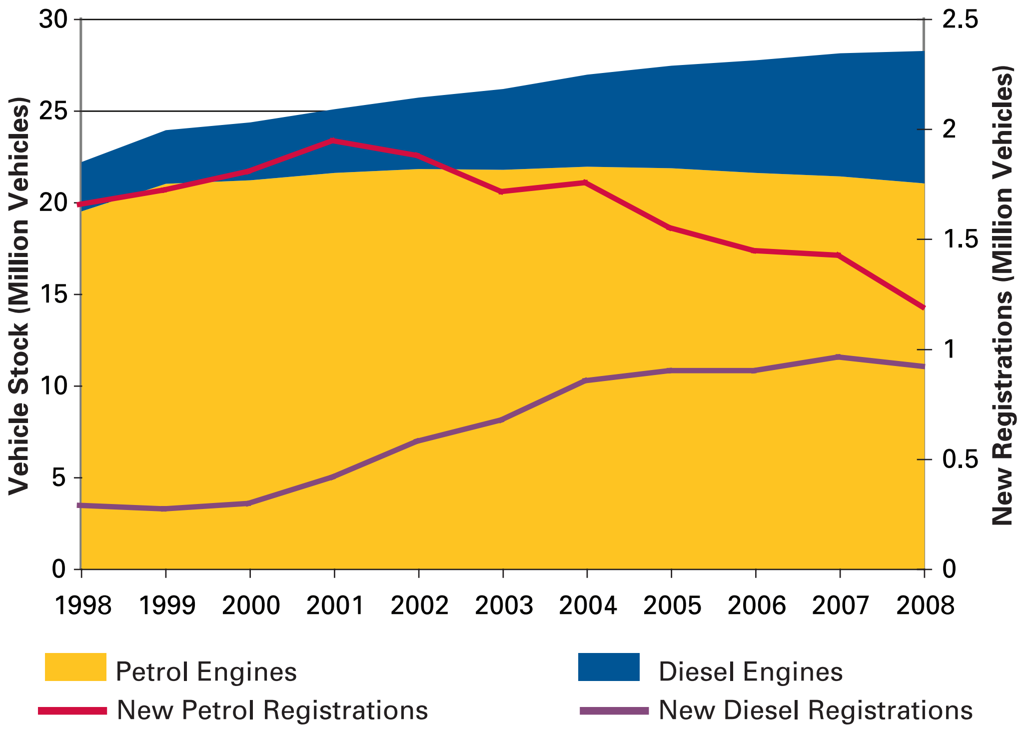
91 DECC, Energy Trends (2009) Table 3.5 http://decc.gov.uk/en/content/cms/statistics/source/oil/oil.aspx.

Chart 7.2: UK Final Consumption by Product1[92]



Source: DECC Updated Energy Projections

Chart 7.3: UK Vehicle Stock and New Registrations by Engine Type



Source: Department for Transport

7.2.4 As the economy recovers, road diesel demand is expected to rise, displacing demand for both petrol and gas oil. The

92 Historic data up to 2008 inclusive.

displacement of petrol occurs as diesel vehicles' share of vehicle stock continues to increase (see Chart 3 above).

7.2.5 The displacement of gas oil results from tighter sulphur regulations. At present, the UK has two related 'diesel-like' grades, road diesel and gas oil – commonly known in the UK as 'red diesel'. Gas oil is supplied for non-road mobile machinery (NRMM)[93], commercial heating applications and stationary equipment, and contains sulphur up to 1000 milligrams per kilogram (mg/kg). Road diesel however is essentially 'sulphur-free' (i.e. <10mg/kg).

7.2.6 The EU Fuel Quality Directive (2009/30/EC) will reduce the permitted sulphur content of all gas oil for NRMM use to a maximum of 10mg/kg from 2011. In the case of gas oil for use in rail vehicles, this change will be implemented one year later (2012). These changes are needed to ensure the reliable operation of pollutant emissions control systems, which will be fitted to new off-road equipment from 2011 to meet EU air quality requirements. Requirements on gas oil for other purposes are unaffected.

7.2.7 The oil industry has indicated that they expect to meet the sulphur free NRMM gas oil requirement largely by supplying road diesel for use in NRMM. As the duty rates applicable to gas oil are not affected by the Directive, fuel suppliers will simply add a red excise marker dye to road diesel for NRMM use.

7.2.8 The shift in demand that results from this combination of changes to the vehicle stock and fuel specifications is likely to widen the current imbalance between domestic refinery output and UK consumption, discussed in the supply section below. Similar pressures are observed at the European level and, as refinery utilisation recovers in the medium term, these two factors may contribute to a tightening of the road diesel market and an increase in the differential between pump prices for diesel and petrol. Combined with improving fuel efficiency for petrol engine vehicles, this rising differential may slow or even reverse growth in diesel engines' share of the vehicle stock in the UK and Europe beyond 2015.

7.2.9 Future UK demand for gas oil and fuel oil is also likely to be affected by increasingly tight maritime sulphur regulations, specifically, through amendments to the International

93 NRMM includes tractors and other mobile agricultural equipment, forestry equipment, construction equipment, forklifts, portable generators, railway engines, and inland shipping vessels.

Maritime Organisation (IMO) MARPOL Annex VI regulations on ship emissions. The main changes are:

- stepped reductions in permitted sulphur levels for marine fuel oil from the current 4.5% to 3.5% by 2012; with a further reduction to 0.5% from 2020 subject to a feasibility review to be completed no later than 2018; and
- a reduction in the limits for Sulphur Emission Control Areas (SECAs) from the current 1.5% to 1% from March 2010, with a further reduction to 0.1% from January 2015. In the current Annex VI, there are two designated SECAs: the Baltic Sea and the North Sea, including the English Channel.

7.2.10 These changes will probably result in the substitution of fuel oil by marine gas oil and thus alter current demand patterns. The degree of substitution is likely to be strongly influenced by the cost of onboard flue gas scrubbing, which could make it possible for ships to meet tighter emissions standards despite the use of higher sulphur fuels.

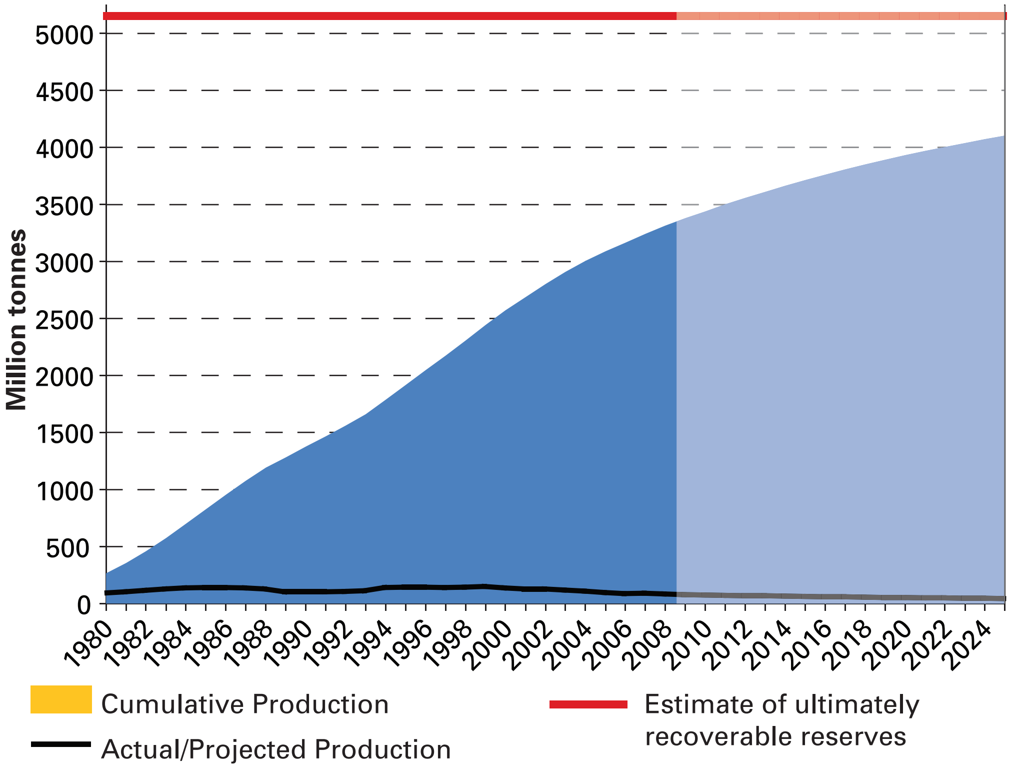
7.2.11 Reported demand for aviation turbine kerosene (ATK) or jet fuel has declined slightly in recent years, after a period of substantial growth from 2002. Some of this decline may reflect demand displacement to other countries in order to overcome supply constraints at Heathrow and Gatwick airports following the Buncefield explosion and fire in December 2005. Although supply capacity has now been restored, ATK demand is likely to fall further in 2009 due to the recession, but resume trend growth as economic growth and, more importantly, airport capacity expansions support future demand for air travel. Beyond 2020, these drivers may be increasingly counteracted by fuel efficiency gains and more expensive air travel in the face of tighter environmental regulation, notably through the EU Emissions Trading System.

7.2.12 Heating oil and industrial kerosene (known collectively as superior grade burning oil or SGBO) accounted for just over 5% of the UK's final consumption of petroleum products in 2008. Absolute demand is down on previous years and the market is showing signs of maturity. As for oil products generally, demand in the near future is likely to be depressed by the recession. SGBO demand will also face displacement by low carbon heat technologies and efficiency improvements, partly as a result of Government initiatives like the Heat and Energy Saving Strategy and the Renewable Energy Strategy, which will help encourage a gradual reduction of non-transport oil demand after 2012. As a result, SGBO demand is expected to trend downward for the foreseeable future.

7.3 UK Supply: UK Production

7.3.1 Oil production in the UK peaked in 1999 and is now declining, although the UKCS will play an important role for many years. The rate of decline will depend on the level of investment and the success of further exploration. Based on DECC's latest assessment, the UK has produced approximately 65% of its Ultimately Recoverable Reserves[94] (Chart 4). However, the UK's reserves estimates have very slightly increased over recent years (Chart 5). DECC's latest projections of UK oil production are close to the levels shown in the last Energy Markets Outlook and project UK production to be between 45-65 million tonnes (including NGLs) in 2014[95], falling from 71.5 million tonnes in 2008.

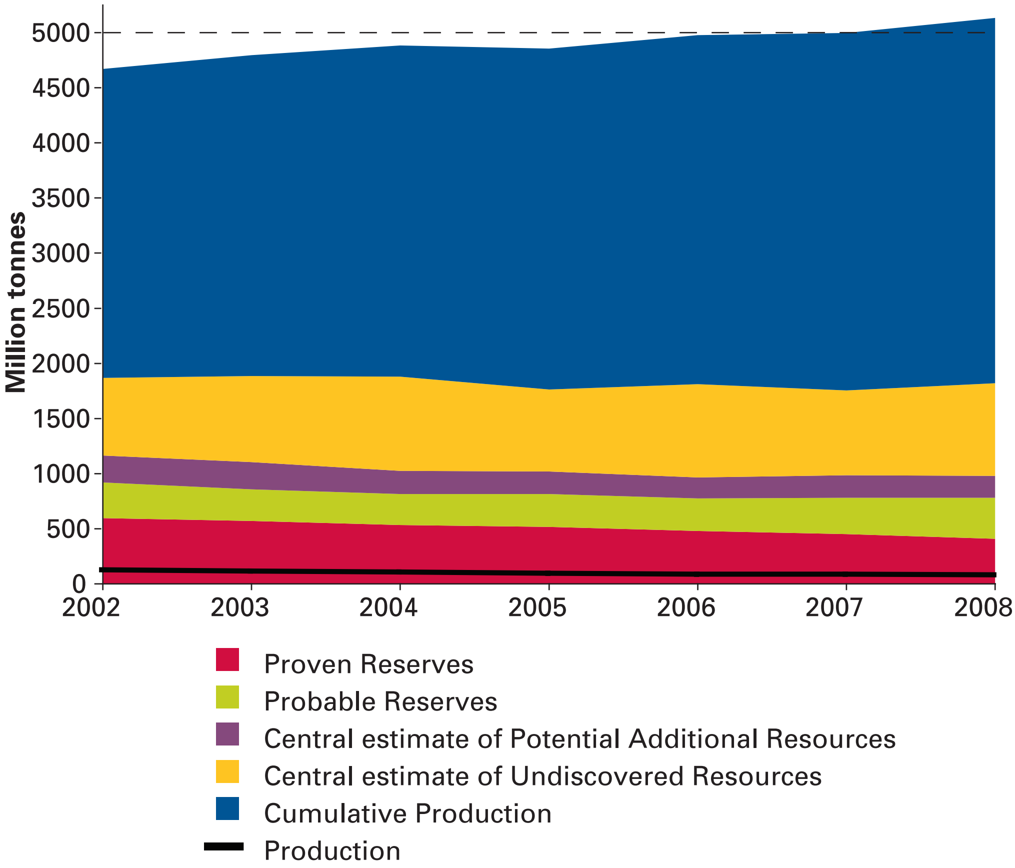
Chart 7.4: UK Oil Reserves and Production



Source: DECC Analysis

94 URR is an estimate of the total amount of oil that will ever be recovered and produced, BP.
95 https://www.og.decc.gov.uk/

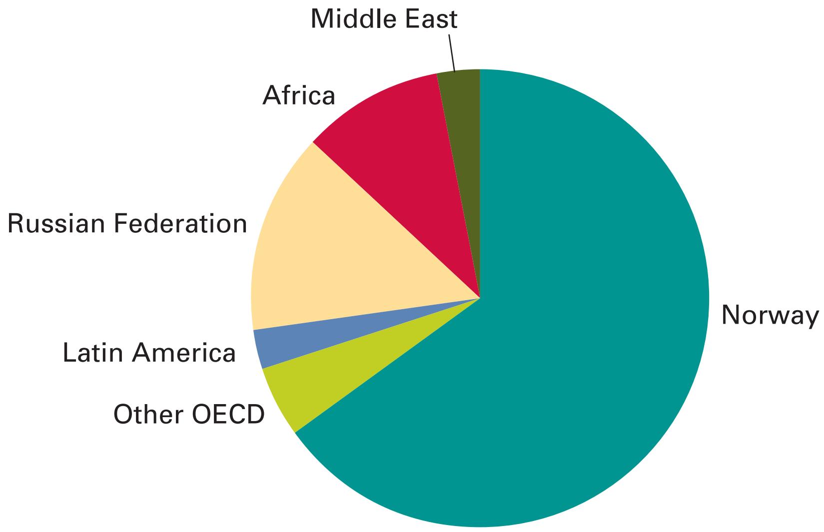
Chart 7.5: Evolution of Estimated Ultimately Recoverable UK Oil Reserves



Source: DECC Analysis

7.3.2 Since 2005, the UK has consistently been a net importer of crude oil, as production from the UK continental shelf has declined. In 2008, net imports accounted for 13% of crude refined in the UK. Most of the UK's crude imports come from Norway, with the remainder largely supplied by Russia and Algeria (see Chart 6 below). Although supplies tend to be sourced nearby in order to minimise transport costs, the UK's coastal import infrastructure gives us the flexibility to source imports from a range of suppliers. Although we are net importers of crude, the UK remains a net exporter of petroleum products.

Chart 7.6: 2007 UK Imports of Crude Oil by Source



Source: IEA Oil Information, 2009 Ed.

7.4 UK Supply: Downstream

7.4.1 While the UK has the potential to remain a net exporter of products for the next two decades, based on its current level of refinery capacity, there are significant imbalances between the domestic production and consumption of several products. As a result, the UK is reliant on imported aviation turbine kerosene (ATK), around half of which is sourced from the Middle East, and gas/diesel oil, with the former Soviet Union accounting for more than a quarter of imports. Conversely, the UK exports fuel oil and petrol. In part, these imbalances reflect the fact that UK refineries, are configured to enhance petrol production. As a result, despite being a net exporter of products, 31% of UK product demand is met by imports.

7.4.2 With the demand for ATK and diesel projected to rise, the UK's import dependency for these products will also increase, assuming that domestic refining capacity remains unchanged. As a result, the infrastructure required to unload and transport products inland will come under increased pressure and new investment to allow for capacity additions will probably be required. Further information on the challenges facing the UK's downstream sector (which comprises the refining, distribution and marketing of oil products) can be found in section 7.7 below.

7.5 Biofuels

7.5.1 The greater use of biofuels in future will present challenges for the UK retail fuel industry. Although biodiesel can be blended into diesel at refineries and then transported through the primary supply infrastructure, technical constraints mean that ethanol can only be blended at road delivery terminals. As a result, ethanol blending requires suppliers and product storage operators to install ethanol blending facilities at their terminals.

7.5.2 Varying technical limits to the biofuel content that engines can handles may also necessitate multiple fuel specifications in order to raise average biofuel content while maintaining the availability of grades suitable for all vehicles[96]. Many filling stations have a limited number of tanks and pumps, and most are currently able to supply a maximum of three or perhaps four products. The introduction of multiple biofuel blends may therefore be limited unless there is significant investment in filling stations to enable the supply of multiple blends, with the default supply limited to those grades suitable for all vehicles.

7.5.3 In addition to their use in road fuels, biofuels may start to displace oil demand from mobile machinery and other transport sectors. As noted in section 2.6 above, rail and non-road mobile machinery (NRMM) are likely to switch to automotive specification diesel as a result of the Fuel Quality Directive, thereby expanding biofuel use into these areas.

7.5.4 Increasing the proportion of biofuels in retail petrol, diesel and other transport fuels will reduce fossil fuel demand over the coming years. However, biofuels contain less energy per litre than conventional fossil fuels and, as a result, the proportion of petroleum saved will be slightly less than the proportion of biofuels in the mix. Taking the technical constraints of the vehicle stock into account, the UK's consumption of oil could be reduced by 2.5 million toe in 2020, around 3% of forecast total UK oil demand.

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96 Although this note talks about transport fuels generally and there are plans to mix biofuels into kerosene and other transport fuels, our focus is petrol and diesel. Currently, the RTFO mandates that the blend of biofuels across petrol and diesel must average at least 3.25%. Industry fuel standards currently allow up to 5% bioethanol content in petrol and 7% biodiesel content by volume in diesel. It is possible for some, but not all, cars to run on petrol and diesel which contain higher biofuel content. There are also some forms of biofuel that can be used at higher percentage blends, or even unblended, without damaging vehicles. However, these fuels still suffer from limited availability and it is unclear how their use will change in the future. Thus, we have assumed that there are persistent technical limits on biofuel content in the transport mix.

7.5.5 Looking towards 2020, sustainable biofuels may offer the potential to enhance the environmental sustainability of aviation. However, more stringent reliability standards and the need for internationally accepted specifications has meant that the development and approval of aviation biofuels has lagged behind the automotive sector.

7.5.6 Work is currently underway within the responsible technical authorities to develop new or revised specifications that include biofuels, enabling their use in commercial aircraft and their distribution via the current aviation fuel distribution infrastructure. A specification for 50% blends of biomass-to-liquid jet fuel has recently been developed and approved. Building on this milestone, the further approval of 50% hydrogenated vegetable oil blends is anticipated by end 2010. However, these fuels are likely to have restricted commercial availability for the foreseeable future in the absence of significant investment in new production facilities.

7.5.7 For shipping, the limited availability of biofuels at marine bunkering terminals and their unattractive prices in comparison with marine gas oil and fuel oil makes the large scale use of biofuels unlikely in the near future.[97] However, the UK will continue to work with the International Maritime Organisation to reduce lifecycle CO_2 emissions from shipping.

7.5.8 Further information on biofuel targets, the feedstocks used and the associated sustainability issues are covered in the Renewable Energy chapter.

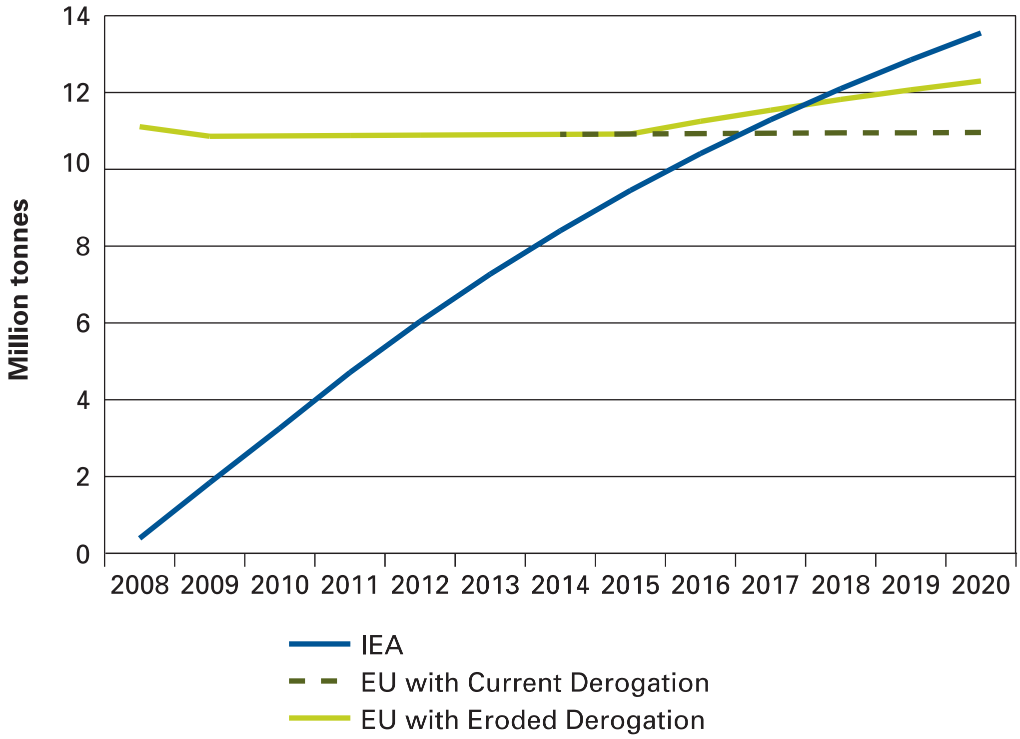
7.6 UK Emergency Stocks

7.6.1 In order to alleviate a disruption to the global supply of oil, the UK is required to hold a minimum level of oil stocks by both the International Energy Agency (IEA) and the EU.[98] Currently, the UK's obligations are met through regulation requiring refiners and importers to hold stocks. The size of an individual company's Compulsory Stocking Obligation (CSO) is proportional to the quantity of petroleum products it supplies to the UK market.

97 International Maritime Organisation (IMO), Second IMO GHG Study (2009).
98 Further information is available at http://decc.gov.uk/en/content/cms/what_we_do/change_energy/int_energy/policy/emergency_oil/emergency_oil.aspx

7.6.2 IEA member countries are obliged to hold stock levels equivalent to at least 90 days of their net imports. At present, the EU requires that the UK hold stocks equivalent to 67.5 days of consumption. The EU obligation is the larger of the two and is set to increase over time in recognition of the UK's growing import dependency.

Chart 7.7: UK's International Oil Stocking Obligations



Source: DECC Analysis

7.6.3 As shown in Chart 7 above, rising net imports will cause both obligations, but especially the IEA requirement, to rise substantially beyond 2016. In order to meet the UK's obligations in future, additional storage capacity will be required. In light of this challenge, the Government is reviewing the compulsory stocks regime and, if better, cost-effective alternatives can be identified, will consult on the options in 2010.

7.7 Downstream Challenges

7.7.1 The UK's downstream oil industry is both mature and highly competitive. However, low returns have resulted in limited discretionary investment in the UK's downstream infrastructure, which has instead been driven by regulatory requirements.

7.7.2 Alongside the challenges of the financial crisis discussed below, the downstream industry is faced by challenges stemming from changing demand patterns, the UK's export markets and tightening regulatory requirements.

7.7.3 As was shown in chart 7.2, UK product demand is likely to continue shifting, with rising diesel and ATK demand exacerbating existing imbalances between domestic output and consumption. The downstream sector will have to adapt to ensure that it is still in a position to comfortably meet these new patterns of demand.

7.7.4 Demand will also be changing in some of the UK's key petroleum product export markets. At present, a significant proportion of the UK's petrol supply is shipped to the United States, where high prices and economic recession caused final consumption of petrol to fall by more than 3% in 2008. Falling prices should allow petrol consumption to grow marginally this year and next, but absolute US demand is projected to remain relatively weak compared to pre-recession levels over the next few years.[99] Although crude prices should adjust to reflect lower demand, global demand weakness and rising competition from new export refineries, especially in Asia, may put pressure on UK refineries geared to meeting petrol demand abroad. Refiners could find alternative markets for petrol, but refinery closures cannot be ruled out.

7.7.5 However, demand is not the only source of challenge for the downstream sector. It will also have to adapt to a number regulatory changes. These include the RTFO and the Fuel Quality Directive, amendments to the MARPOL Annex VI regulations, more stringent safety regulations post-Buncefield and the rising requirements and possible revision of the CSO. Each has implications for the industry's infrastructure requirements. Biofuels commitments will require further blending facilities and logistics options, while the CSO necessitates additional stockholding capacity. Combined with these pressures are growing product imbalances and a resulting rise in import demand. Meeting this additional demand will require investment in the UK's logistical infrastructure, probably in the form of expanded import facilities and additional fuel distribution pipelines.

99 Energy Information Administration, Short-Term Energy Outlook (September 2009) http://www.eia.doe.gov/emeu/steo/pub/contents.html.

7.7.6 In recognition of the challenges facing the UK's downstream sector, the Government has established the Downstream Oil Industry Forum (DOIF) Task Group and the Aviation Fuel Task Group. These groups will facilitate the Government's work with industry to identify barriers to investment, sustain and develop currently available infrastructure, identify options for new fuel supply infrastructure and ensure the future resilience of the UK's petroleum supplies.

7.8 Impact of the Current Economic Situation

7.8.1 For the upstream sector, the impact of current economic conditions has been subsidiary to the effects of the recent swings in oil prices. For about five years until early 2008, oil prices had been on a fairly consistent rising trend, which supported very strong exploration and development activity worldwide. The level of demand for equipment and services produced strong inflationary pressures, but UKCS investment was maintained at historically high levels of around £5bn a year. In 2008, oil prices rose rapidly to a peak of almost $150/bbl, but then fell sharply. Though prices have since recovered to 2007 levels, costs have not fallen to the same extent. As a result, the main constraint on North Sea oil and gas developments is the economic robustness of new or incremental development projects rather than the availability of finance. It is however clear that banks are adopting more conservative investment criteria than before the financial crisis, and there are fewer banks active in oil and gas lending. Consequently, companies are having to work harder at securing finance.

7.8.2 The tougher economic outlook will make itself felt through lower levels of exploration and development investment. Exploration activity held up quite well in the first half of the year because of existing commitments, but a fall is expected in the second half.

7.8.3 UKCS development investment has been sustained at high levels in recent years and has materially slowed the inevitable decline in UKCS production to around 5-6% a year. The last full survey of investment intentions indicated that, in autumn 2008, companies expected to maintain investment at roughly the same level. More recent indications however point to a fall in expenditureand some medium-to-longer term impact on UKCS production may be expected. At present however, development projects are continuing to come forward largely as expected.

7.8.4 The broader downstream oil industry is not expected to be seriously impacted by the financial crisis, although demand has declined and the major integrated refiner/marketers and independent refiners have been impacted by weaker refining margins. Refinery capacity utilisation is believed to have been maintained despite reduced demand, although a number of turnaround projects have been undertaken, temporarily reducing throughput.

7.8.5 In response to reduced demand, several of the major fuel suppliers have re-optimised their distribution activities. Contracts with road haulage companies have been renegotiated to reduce the number of vehicles and drivers involved and work shifts have been altered to reduce or discontinue weekend deliveries. A limited number of redundancies have also been experienced by road haulage companies responsible for fuel distribution.

7.8.6 The reduction in demand has been felt most keenly by fuel distributors supplying products like LPG and diesel. A number of the 200 or so fuel distributors have experienced difficulty maintaining trade credit insurance, with some distributors unable to secure cover for supplies to road hauliers and construction companies. In response, the distributors have introduced cash on delivery terms for those customers for which they can no longer obtain cover.

7.8.7 In the case of distributors required to carry trade credit insurance as a condition of their overdraft facilities, the lack of cover has reduced credit availability and put otherwise viable distributor businesses at risk. Although the tightening of terms offered by trade credit insurers represents normal practice in this difficult market, the Government has announced a number of measures to help SMEs, including the Enterprise Finance Guarantee Scheme and a £75m fund to convert businesses' debt into equity.

7.9 Global Oil Market

7.9.1 At the end of 2008, oil was trading at about $40/bbl following a precipitous price collapse as the scale of the global economic downturn became apparent. However, over the course of 2009, the price of oil has begun to rise again. Earlier this year, sustained price increases were largely motivated by falling OPEC supply, following the group's cumulative 4.2 million barrels per day (mb/d) reduction in quotas. More recently, and despite continued weakness in the fundamentals, prices have tended to move in line with changing sentiment concerning the prospects for economic recovery.

7.9.2 Global oil demand is expected to decline again in 2009 to average around 84.4mb/d. The last time that global oil demand contracted in two consecutive years was 1982-3. As demand has fallen away, and OPEC has cut back supply, spare capacity has increased substantially and is currently in excess of 6mb/d. It is likely that spare capacity will increase further next year as new projects come online, before declining in 2011 as demand recovers. Spare capacity is not expected to fall below 6mb/d before 2012, presenting a relative benign supply outlook for the next few years.[100]

7.9.3 However, in the longer term, the shocks to the oil market noted above may have important implications for the UK's security of supply. The global refining sector will have to weather a sustained period of lower throughputs, potentially threatening the UK's ability to source products domestically, and oil sector investment will decline, risking a supply crunch as the global economy recovers.

7.9.4 IEA projections of refining supply suggest that distillation capacity will increase by 7.6mb/d during 2008-2014, resulting in an overall excess of global refining capacity.[101] Given that state-controlled operations may run despite weaker margins, OECD refineries could face significantly lower utilisation rates. High exit costs mean that any shutdowns are likely to be temporary. However, even a temporary shutdown at a UK refinery would put additional pressure on domestic infrastructure and probably increase the UK's reliance on imported products.

7.9.5 With regard to investment generally, the significant decline in prices last year has so far outpaced costs, reducing companies' cash flow. The combination of falling cash flow from which to finance capital expenditure and lower forecast oil prices has prompted significant cutbacks in capital spending and driven a number of project delays and cancellations.

100 IEA, Medium-Term Oil Market Report (2009).
101 IEA, Medium-Term Oil Market Report (2009) 76.

7.9.6 In May, the IEA estimated that global upstream oil and gas investment budgets for 2009 had already been cut by around 21% compared with 2008. Between October 2008 and end-April 2009, around 2mb/d of oil production capacity had been deferred indefinitely or cancelled, with a further 4.3mb/d delayed by at least 18 months. Canadian oil sands projects account for the bulk of this postponed capacity, but most of the upstream industry's cutbacks are likely to be in exploration, boding ill for future reserve additions.[102]

7.9.7 To date, the upstream industry has been hit hardest, with smaller companies making the largest cutbacks. The super-majors[103] plan cuts of about 5%, but this number grows to 20% or more for smaller operators, as their higher debt-to-equity ratios and smaller cash reserves make obtaining finance prohibitively expensive, if not impossible. Given that cutbacks appear most pronounced in regions with high development costs and with industries dominated by small players and small projects, investment in non-OPEC countries is expected to drop the most. However, relative to other energy sectors, the oil industry is characterised by a high level of self-financing and low debt-to-equity ratios, shielding it somewhat from the withdrawal of financial markets.[104]

7.9.8 The global downstream sector has also seen projects delayed, with over 1.6mb/d of capacity postponed indefinitely or cancelled between September 2008 and end-April 2009. Overall, refiners are expected to reduce capital spending in 2009 by up to 20%, as current profitability and difficulty accessing debt markets counterbalances the prospect of future returns.

7.9.9 The decline in global investment is of particular concern given the IEA's warning last year that $6.3bn of oil infrastructure investment would be required between 2007-2030 to meet rising global demand.[105] Although it will be some time before the effects are felt, falling global investment poses a number of risks to future supply. Even brief cutbacks could be problematic in the longer term if they affect programmes mitigating the decline of existing fields. Based on the IEA's analysis of decline rates , if capital spending on developing existing fields in 2009 and

102 IEA, The Impact of the Financial and Economic Crisis on Global Energy Investment (2009).
ExxonMobil, Shell, BP, Chevron and Total.
103 IEA, The Impact of the Financial and Economic Crisis on Global Energy Investment (2009).
104 IEA, World Energy Outlook (2008) 88.
105 IEA (2008).

2010 was reduced proportionally with upstream spending (i.e. by 21% compared with 2008), the production-weighted global decline rate would rise by about 0.5 percentage points, assuming the cutbacks are the same across all types of fields and regions. This implies that an additional 350 thousand barrels per day of capacity would be lost each year.[106]

7.9.10 Recognising these energy security and price risks, the UK has been working with international partners through the International Energy Forum (IEF), the G8 and the G20 on issues that affect oil price volatility and future oil security. By pursuing a more transparent and better functioning oil market, we will diminish barriers to investment and reduce the risk of excessively volatile oil prices.

7.9.11 The UK is tackling these threats to energy security and price stability through four streams of work:

- Improving regulation, enforcement and transparency in commodity derivative markets, notably by implementing the recommendations of the International Organization of Securities Commissions' (IOSCO) Commodities Task Force.
- Improving the surveillance conducted by international energy and finance institutions on what is driving oil prices and the macroeconomic risks associated with oil market developments.
- Enhancing the transparency and accuracy of oil data, through improvements to the quality and timeliness of data submitted to the Joint Oil Data Initiative, and supporting efforts to develop more consistent demand and supply forecasts.
- Strengthening producer-consumer dialogue through initiatives like the London Energy Meeting, as a result of which the IEF convened an Expert Group to consider price stabilisation measures and develop proposals on the appropriate institutional architecture for the global oil market.

106 IEA, The Impact of the Financial and Economic Crisis on Global Energy Investment (2009).

7.10 Conclusion

7.10.1 The economic downturn has lowered the UK's demand for a broad range of petroleum products. This year, following last year's oil price spike and the economic situation demand is expected to fall below 83 million tonnes of oil equivalent (mtoe) (-3.7% year on year). Demand in 2025 is projected to be around 84mtoe. Transport has the dominant share of UK oil demand reflecting both rising transport demand, and less industrial and power sector consumption.

7.10.2 Since 2005, the UK has consistently been a net importer of crude oil, as production from the UK continental shelf has declined. The UKCS, however still, provided a third of the UK refinery intake in 2008 and will continue to play an important part in supplying domestic refineries for many years to come. In 2008, net imports accounted for 13% of crude refined in the UK. Most of the UK's crude imports come from Norway, with the remainder largely supplied by Russia and Algeria.

7.10.3 In 2008 the UK produced almost 72 million tonnes of oil and natural gas liquids from the UK continental shelf. Oil production in the UK peaked in 1999 and is now declining, but there are still significant quantities to be produced. Based on DECC's latest assessment, the UK has produced approximately 65% of its Ultimately Recoverable Reserves.

7.10.4 The UK remains a net exporter of petroleum products. There are, however, significant and increasing imports of certain petroleum products. As a result there may need to be further investment in import and refinery capacity. The Government has established the Downstream Oil Industry Forum in order to identify barriers to investment, and to develop the UK's existing infrastructure.

7.10.5 The greater use of biofuels and particularly their widespread integration into the UK's supply infrastructure will present challenges for the retail fuel industry. Taking the technical constraints of the vehicle stock into account, greater biofuel use could reduce the UK's oil consumption by around 3% of forecast demand by 2020.

7.10.6 It may be noted that In the upstream sector, lower prices and less exploration may impact the investment necessary to meet demand and stabilise oil prices in future. Given the scale of these challenges, Government will need to partner effectively with both industry and other nations and is actively attempting to do so through the use of joint taskforces and multilateral groups.

7.10.7 The UK is tackling these threats to energy security and price stability by improving regulation, transparency and market information and through strengthening producer-consumer dialogue through initiatives like the London Energy Meeting.

8. Nuclear fuel

8.1 Introduction

8.1.1 This chapter focuses on the supply and demand of nuclear fuel in the UK and globally. Prospects for nuclear power generation in the UK are also considered in chapter 4. It may be noted that uranium supply is unlikely to limit nuclear power for at the very least the lifetime of a new generation of reactors. Moreover, uranium (as yellowcake) is also easy to stockpile.

8.2 Demand for nuclear fuel in the UK

8.2.1 The UK currently has 19 operating reactors at ten nuclear power stations. In 2008, the UK's nuclear power stations provided 52.48 TWh electricity, which equates to around 13 per cent of the UK's electricity supply.[107]

8.2.2 The current expected closure dates for operational nuclear power stations, assuming no lifetime extensions, is such that following 2023 there will be only one nuclear power station operating in the UK. Nuclear plant lifetimes have been extended in the past. The commissioning of new nuclear power stations, by commercial operators, is expected to take place in the coming years.

8.2.3 Since the last Energy Markets Outlook was published the UK Government has made progress in taking forward facilitative actions to enable the private sector to bring forward plans to develop new nuclear power stations. The Government expects the first new nuclear power stations to be available by 2018. A summary of some of the facilitative actions and other key processes that will help facilitate the development of new nuclear power in the UK is given below.

8.2.4 The UK Government is streamlining the planning process for nationally significant infrastructure, including new nuclear power stations. This includes an assessment of sites to determine whether they would be potentially

107 Digest of United Kingdom Energy Statistics 2009. http://www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx

suitable for new nuclear power stations. This assessment was included in a draft National Policy Statement for nuclear power, which the Government published on 9 November and will be subject to Parliamentary scrutiny and a 15 week consultation closing on 22 February 2010.

8.2.5 In December 2008 the Government published a public consultation on an application from the Nuclear Industry Association (NIA) for Regulatory Justification[108] of four nuclear reactor designs. The consultation closed on 25 March 2009. The Government published the Secretary of State's proposed decisions in respect of the EPR and AP1000 reactor designs in November 2009 and this will be subject to a 15 week consultation closing in February 2010. This process is to meet the requirement of EU legislation that the benefits of a new nuclear power station should outweigh any possible health detriments.

8.2.6 A Generic Design Assessment[109] of reactor designs (GDA) is being undertaken by the regulatory authorities in the UK. This is intended to ensure the technical aspects of designs for nuclear power plants are assessed ahead of site-specific licence applications.[110]

8.2.7 In April 2009, the Nuclear Decommissioning Authority announced that it had successfully completed the sale process for land adjacent to three of its sites, at Wylfa in Anglesey, Bradwell in Essex and Oldbury in Gloucestershire. The process to offer for sale land adjacent to its Sellafield site concluded in October 2009[111]. All four of these sites are included in the draft National Policy Statement for nuclear power, which lists 10 sites that the Government has judged to be potentially suitable for the deployment of new nuclear power stations by the end of 2025. Within the context of the overall strategic framework set by the Government, in principle new nuclear should be free to contribute as much as possible towards meeting the need for 25GW of new non-renewable capacity.[112] The Government expects that under this approach a significant proportion of the 25GW will in practice be filled by nuclear power.

108 http://www.berr.gov.uk/energy/sources/nuclear/whitepaper/actions/justification/page45386.html
109 http://www.berr.gov.uk/energy/sources/nuclear/whitepaper/actions/gda/page47716.html
110 http://www.hse.gov.uk/nuclear/reactors/
111 http://www.nda.gov.uk/news/sellafield-land-sale-agreed.cfm
112 https://www.energynpsconsultation.decc.gov.uk/nuclear/

8.3 Uranium supply

8.3.1 The Government's policy[113] is that any new nuclear power stations that might be built in the UK should proceed on the basis that spent fuel will not be reprocessed. Although reprocessing could make a contribution to security of supply through the creation of raw materials for MOX fuel, the Government does not believe that uranium resources or the future price of uranium will be limiting factors for new nuclear power stations. The cost of uranium is a relatively small component of the cost of nuclear generation. The UK is not a uranium producer and all natural uranium is imported.

8.3.2 The OECD/NEA[114] concluded in November 2008 that identified uranium resources are sufficient to fuel an expansion of global nuclear generating capacity, without reprocessing, at least until 2050. Based on regional geological data, resources that are expected to exist could increase uranium supply to several hundreds of years.

8.3.3 One of the advantages of nuclear power for energy security is the high energy content of uranium – 1 tonne of uranium (heavy metal) has the energy equivalent of 14 000 to 23 000 tonnes of coal[115]. For comparison, the energy content[116] for black coal is around 29GJ/t and the energy content for U (heavy metal) is around 560,000GJ/t.

8.3.4 As uranium (as yellowcake) may be stockpiled, it is possible to maintain a large amount of energy reserves within a small volume of material compared to traditional fossil fuels. The stockpiling of fuel in the UK is the responsibility of the utilities concerned and information on the stock levels in the UK is commercially confidential.

8.3.5 This year the World Nuclear Association (WNA) and the Euratom Supply Agency (ESA) have raised concerns about global uranium supply in the medium term due to the reduction of supply from secondary sources[117], and the need for primary sources[118] to fill the gap. The World

113 Meeting the Energy Challenge: A White Paper on Nuclear Power. January 2008. http://www.berr.gov.uk/files/file43006.pdf
114 Nuclear Energy Outlook. OECD/NEA, November 2008.
115 Nuclear Energy Outlook. OECD/NEA, November 2008.
116 IOR Energy. Australia. http://www.ior.com.au/ecflist.html
117 Secondary supply sources also known as "already-mined uranium" or "above ground resources", is material that has been held in inventory or that has been previously used but has then been reprocessed into a form suitable for further use. OECD/NEA. Forty Years of Uranium Resources, Production and Demand in Perspective. 2006.
118 Primary supply sources is newly mined and processed uranium. OECD/NEA. Forty Years of Uranium Resources, Production and Demand in Perspective. 2006.

Nuclear News[119], referring to the WNA report 'The Global Nuclear Fuel Market Supply and Demand 2009-2030', reported that nuclear energy's fuel supply infrastructure should be able to meet world demand in the short term, but expansion will be needed across the entire fuel cycle beyond 2020, with uranium production needing to be increased substantially from its current level.

8.3.6 The Euratom Supply Agency has stated that the world market share of secondary supplies (more than 30%) demonstrates that these sources are important for the current balance along the supply chain. The EU is less dependent on secondary sources. However, it should be noted that these supplies might become more scarce from 2013 onwards, when the Russian HEU (highly enriched uranium) down-blending programme is expected to come to an end and these secondary supplies are replaced by new Russian enriched material which should be put on the market at market prices, mainly to be bought by US utilities. For the longer term, this also supports the need for investment in new projects to gradually replace secondary supplies.

8.4 Import requirement

8.4.1 The total demand from the EU nuclear industry in 2008 amounted to 19,146 tonnes of uranium, which is approximately 30% of global demand[120] The primary uranium supplier to the EU is Canada which met 25% of EU demand in 2008, followed by Russia (17%) and Australia (16%).[121]

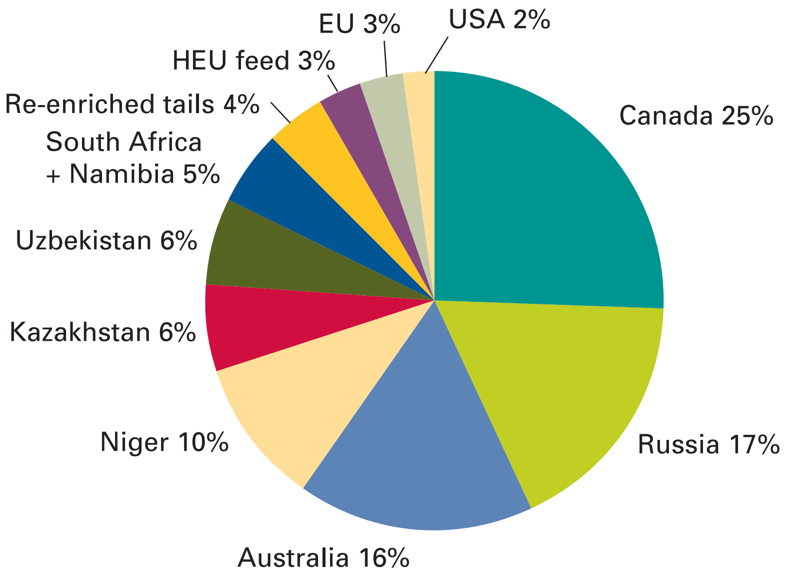
8.4.2 The EU nuclear industry sources uranium under the auspices of the Euratom Supply Agency (ESA). The ESA was established in order to implement one of the principal requirements of the European Atomic Energy Community (Euratom) Treaty[122], to ensure that all users of nuclear power in the Community receive regular and equitable supplies of ores and nuclear fuels.

8.4.3 ESA monitors the market, in particular the supply of natural and enriched uranium to the EU, ensuring that EU utilities

119 World Nuclear News (September 2009). http://www.world-nuclear-news.org/ENF_More_U_mines_needed_as_nuclear_grows_1009091.html
120 Euratom Supply Agency Annual Report 2008. September 2009. http://ec.europa.eu/euratom/anreport_en.html
121 Euratom Supply Agency Annual Report 2008. September 2009. http://ec.europa.eu/euratom/anreport_en.html
122 http://europa.eu/legislation_summaries/institutional_affairs/treaties/treaties_euratom_en.htm

have diversified sources of supply and do not become over-dependent on any single source.

Chart 8.1: Sources of uranium delivered to EU utilities in 2008



Source: Euratom Supply Agency Annual Report 2008

8.5 Global uranium demand

8.5.1 There are 436 reactors operating across the world today with another 52 under construction[123]. Globally, for nuclear power stations, there is a total net installed capacity of 370.221 GW(e). In 2009, to date, construction has begun on new nuclear power stations at 6 sites, 5 in China and 1 in Russia.

8.5.2 The OECD's Nuclear Energy Agency (NEA) has analysed uranium demand out to 2050 and they have produced figures for low and high case scenarios. The low case assumes nuclear power will grow to 576GW(e), and the high case assumes growth to 1418GW(e).

8.5.3 OECD/NEA conclude that currently identified uranium resources are sufficient to fuel all nuclear power plants in the NEA high scenario to 2030. However, the report notes that a market price for uranium that stimulates the required investments will need to continue if uranium demand is to be met in the 2030 to 2050 time frame.

8.5.4 The OECD/NEA report also notes that even the high uranium demand scenario could be met. The report states

123 IAEA Power Reactor Information System (PRIS). http://www.iaea.org/programmes/a2/

by 2050[124], should more widespread acceptance of nuclear technology lead to a global nuclear renaissance, as depicted in the NEA high scenario (1418 GWe), the resulting additional demand for uranium could be met by a combination of increased production and the successful deployment of advanced reactor and fuel cycle technologies.

8.6 Uranium supply: resources

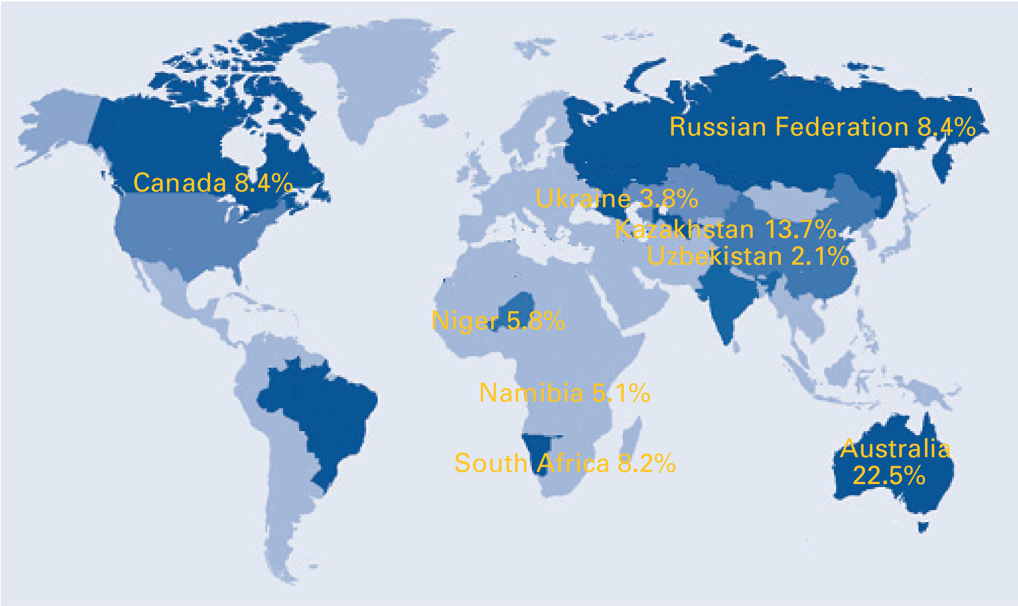
8.6.1 Nuclear energy benefits from having a diverse supply of fuel so insuring against potential interruptions. In this sense uranium is less vulnerable than other fuels. Deposits of uranium are widely dispersed across a number of countries. The potential sources include countries that we do not currently rely on for fossil fuels. There are also considerable resources available in OECD countries.

8.6.2 With respect to the future supply of natural uranium, the Euratom Supply Agency have expressed confidence that sufficient resources exist. The ESA has stated that Identified uranium resources in the ground (around 10 million tU) will suffice to meet the present demand for about 100 years. As a strong uranium market is sustained, undiscovered conventional resources (another 10.5 million tU) are likely to be identified, which could extend uranium supplies to more than 100 years for a stock of nuclear power plants numbering up to three times the total today.

8.6.3 The identified global uranium resource base is spread throughout 43 countries and is listed in the OECD/IAEA Red Book[125]. Examples of countries with major uranium resources are given in Figure 8.1.

124 Nuclear Energy Outlook. OECD/NEA. November 2008.
125 Uranium 2007: Resources, Production and Demand. OECD Nuclear Energy Agency and the International Atomic Energy Agency. June 2008. http://browse.oecdbookshop.org/oecd/pdfs/browseit/6608031E.PDF

Chart 8.1 – Major identified natural uranium resources



Source: Euratom Supply Agency Annual Report 2008

8.6.4 Although there is confidence in the amount of uranium resources that exist, the Euratom Supply Agency[126] recommends that EU utilities take action to mitigate against potential supply constraints. The Supply Agency recommends that EU utilities maintain an adequate level of strategic inventories, tailored to their individual circumstances. Furthermore, ESA recommends that utilities cover most of their needs under long-term contracts with diversified primary production sources at equitable prices.

8.7 Uranium supply: exploration and production

8.7.1 The Euratom Supply Agency Annual Report 2008 has reported a significant increase in uranium exploration over the preceding five years. The ESA has stated the number of junior companies actively involved in uranium exploration has increased from a handful in 2003 to more than 400 in 2008. Several plans for new uranium production capacity around the world and for increasing output from existing facilities are still being developed. Additional discoveries can be expected, if favourable market conditions stimulate exploration. Promising early results already suggest additional discoveries in several countries, such as Kazakhstan, Canada, Namibia, Niger and Australia.

126 Euratom Supply Agency Annual Report 2008. September 2009. http://ec.europa.eu/euratom/anreport_en.html

8.7.2 The ESA Annual Report provides confidence for exploration levels going forward and presents Australian uranium exploration as an exemplar. The ESA Report states Global expenditure on exploration and mine development is not expected to decline, compared with previous years, remaining at over €476 million. Most producing countries reported significant increases in capital expenditure, perhaps best exemplified by Australia, where domestic exploration and mine development investment totalled a little over €2 million in 2002, then increased to €42 million in 2006 and reached an estimated €129 million in 2008.

8.8 Conclusion

8.8.1 The UK is looking to the future development of new nuclear power stations, and estimates that the first electricity generated from a new nuclear power station could be around 2017/18[127]. As stated in the 2008 Nuclear White Paper the Government believes that there should be sufficient reserves to fuel any new nuclear power stations constructed in the UK. The OECD/NEA[128] has stated that there are sufficient reserves of uranium to fuel increased global nuclear generation at least to 2050.

8.8.2 The Euratom Supply Agency have expressed confidence that there are sufficient identified uranium resources to meet the current demand for about 100 years and, with a strong market, sufficient uranium resources are likely to be identified to support a threefold increase in nuclear power for over 100 years. As secondary supply sources of uranium are reduced an increased production of primary uranium resources may be needed to meet global demand in the medium/long term.

127 http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/nuclear/office/office.aspx

128 Nuclear Energy Outlook. OECD/NEA, November 2008.

9. Renewable Energy

9.1 Introduction

9.1.1 This chapter considers the availability of renewable resources to help meet the UK's future energy needs, the issues around the deployment of renewable technologies, and the relationship with security of supply.

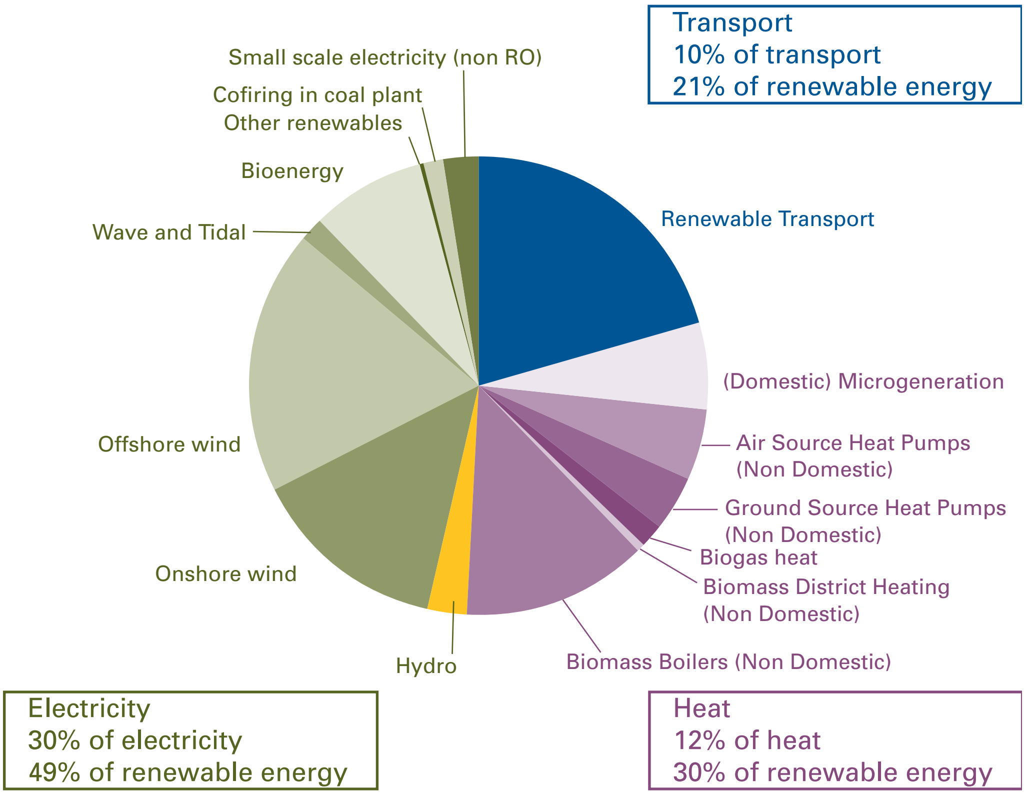
9.1.2 The UK has previously chosen to address security of energy supplies mainly through diversification, ensuring that we do not become over-exposed to any one supply source, supply route or import point. This approach will continue with a successful transition to a low-carbon energy system, with renewable sources working alongside nuclear and clean fossil fuels as key energy sources. Within renewables there will also be opportunities to develop a diverse range of energy supplies from sources including wind, wave, tidal, biomass and others.

9.1.3 In July the Government published its Renewable Energy Strategy,[129] which set out Government plans for meeting the UK target of 15% of energy consumption from renewable sources by 2020. Renewable energy consumption (across electricity, heat and transport) was 2.25% in 2008. Meeting the 2020 target therefore means an almost seven-fold increase, which will require significant new investment. Government estimates show that moving to 15% renewable energy in 2020 is expected to reduce annual fossil fuel demand by around 10% and gas imports by 20-30% from what they would have been in 2020.

9.1.4 In order to deliver the 15% target there will need to be increases across the three main energy sectors of electricity, heat and transport. While the Government has not set individual targets for these sectors, the Governments lead working scenario for 2020, as shown in Chart 9.1, suggests that the UK would have 10% renewable energy in transport, 12% in heat and over 30% in electricity including 2% in small-scale generation.

129 The UK Renewable Energy Strategy 2009 http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx

Chart 9.1: Illustrative breakdown of sectors for 2020 based on the lead Renewable Energy Strategy scenario



Source: DECC analysis based on Redpoint (2009) Element (2009) and Nera (2009) and DfT internal analysis

9.2 Renewable resources

9.2.1 This section considers the possible supply and deployment issues of the various renewable resources which the UK will draw on in reaching the 2020 target.

Wind and its Intermittency

9.2.2 Wind power is currently one of the most developed and cost-effective renewable energy technologies. The UK has the largest potential wind energy resource in Europe. While offshore wind is more technologically challenging and currently more expensive than onshore wind, it has a larger potential due to a stronger and more consistent wind resource out to sea, leading to higher power outputs per turbine and more hours spent generating each year.

9.2.3 The UK's total wind resource has been assessed as having the potential to deliver over 1,000 TWh of electricity per annum, although the availability of suitable onshore sites and the capability of seabed standing wind turbine generators restrict this to about 150 TWh/annum exploitable resource[130].

9.2.4 One issue that is often raised in connection with wind power is that of intermittency. No energy generating technology capacity delivers all the time and Current wind turbines operate at maximum capacity where wind speeds are between 14 m/s and 25 m/s but with wind speeds below 4 m/s the output from wind turbines is zero. At wind speeds of 25 m/s or above, wind turbines are designed to cut out generation for safety reasons.

9.2.5 However, with a good dispersion of wind turbines, aggregated wind output over the UK as a whole can be expected to be smoother than output from any individual site or region. Wind availability varies with electricity demand; both are higher during winter months, and during daylight hours, than during the summer and at night. For 85% of the time, half or more of the UK experiences some wind.[131]

9.2.6 Electricity generation will need to be flexible enough to operate when wind generation is low. Analysis led by Redpoint for the Renewable Energy Strategy consultation[132] and final report,[133] and an intermittency study undertaken by Pöyry,[134] suggest that there will be sufficient incentive for encouraging investment in flexible generation. Both studies assume that plants can earn a return on their investment by operating flexibly, generating more at times of system tightness and capturing the prevailing prices.

Biomass/biofuel

9.2.7 The UK wood-fuel market is in its infancy and the supply chain is dominated by small and medium-sized enterprises.

9.2.8 In response to concerns that energy crops and food crops compete for the same land, the Government is encouraging and contributing to research on the social, economic,

130 *Quantification of Constraints on the Growth of UK Renewable Generating Capacity*, Sinclair Knight Merz 2008 (Table 1). http://www.berr.gov.uk/files/file46779.pdf
131 Environmental Change Institute (ECI), University of Oxford: Wind power and the UK wind resource, 2005
132 Redpoint et al (2008): 'Implementation of EU 2020 Renewables Target in the UK Electricity Sector. Renewable Support Schemes'
133 Redpoint and Trilemma (2009): 'Implementation of EU 2020 Renewables Target in the UK Electricity Sector: RO Reform'
134 Pöyry (2009): 'Multi-client Study: The Implications of Intermittency On the Electricity Markets of GB and Ireland'

environmental and land use effects of biomass crops. The UK is also working at a European and Global level to support the introduction of efficient and effective sustainable criteria for biomass

9.2.9 Currently 6 TWh of heat and power is generated from biomass municipal solid waste and about 18 TWh from landfill gas.[135] If all the food and wood waste sent to landfill were used for energy it would generate 42 TWh[136], The Government will be consulting later this year on the scope for banning certain materials or kinds of waste from landfill.

9.2.10 The technical potential of biogas generation for heat and power is about 10-20 TWH or more.[137]

9.2.11 Several syngas gasification demonstration plants operate in Europe using a range of biomass feedstocks, from animal slurry to wood. The use of gasification for more advanced processes, such as producing synthetic, renewable natural gas, is not expected to become commercially available at scale until the latter half of the next decade. The process produces high levels of industrial-strength heat and analysis indicates that, given current estimates of construction and operation costs, we are likely to see only a few smaller-scale sites in the UK by 2020. There are also competing uses for syngas for the production of biofuels and as a feedstock for the renewable chemicals industry.

9.2.12 Transport biofuels are made from renewable biological resources, including plant matter such as agricultural crops, or waste matter such as cooking oil or treated industrial waste. The two most common biofuels in use today are bioethanol, which can be blended into petrol, and biodiesel, which can be blended into diesel. At present, biofuels are the most readily deployable renewable fuels in the transport sector.

9.2.13 The supply of biofuels in the UK is driven by the Renewable Transport Fuel Obligation (RTFO), which started operation in April 2008. In 2008/09, around 2.6% of all UK road fuels came

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135 Government expects the amount of energy generated from landfill gas to fall over time as the available landfill sites are used. The figures for current energy use are from BERR (2008): 'Digest of United Kingdom Energy Statistics 2008', Table 7.6

136 Analysis for the Government's Waste Strategy for England set out that the most effective use of most biomass waste is to generate energy (via anaerobic digestion for wet food waste, and combustion (even over recycling) for contaminated waste wood). The biomass element of solid recovered fuel (SRF) also counts towards our renewable energy targets. Defra (2007): 'The Waste Strategy for England'

137 The estimate was generated for Defra/DTI/DfT (2007) 'UK Biomass Strategy'; Later reports indicated that the technical potential might be as much as 27 TWh - Enviros Consulting (2008): 'Barriers to Renewable Heat part 1: Supply Side'

from biofuels. Current trajectories require 3.25% of transport fuel to come from biofuels in 2009/10, rising to 5% in 2013/14. The biofuels targets will need to rise significantly by 2020 in order to meet requirements under the Renewable Energy Directive (RED) and the Fuel Quality Directive.[138]

9.2.14 The UK's supply of biofuels is sourced from a combination of domestic production and the global market. In 2008, around 705 ktoe of biodiesel were consumed in the UK, with around 255 ktoe produced domestically. If all planned plant were to become operational and existing plant operates at full capacity, total UK biodiesel production could grow to 430 ktoe per year by 2010, equivalent to 2.2% of the UK's diesel consumption in 2008.[139] Bioethanol consumption reached 116 ktoe in 2008, the majority of which was imported. Total annual capacity for bioethanol production in the UK could reach 283 ktoe per year by 2011, equivalent to around 2.2% of the UK's petrol consumption in 2008, if all planned plant were to become operational.[140]

9.2.15 The long-term targets for biofuels help to encourage investment in new technologies. Advanced fuels derived from waste or non-food crops like algae will be important to reduce competition with food crops for land and to provide better greenhouse gas savings compared to many existing biofuels.

Wave and tidal power

9.2.16 The UK has extensive wave and tidal stream resources, alongside a small number of tidal range sites. For example, the tidal range in the Severn Estuary is one of the highest in the world and the direction of the prevailing winds and the size of the Atlantic Ocean mean that the UK has wave power levels which are among the highest in the world.[141] The amount of these resources which could be exploited is limited by the accessibility of suitable sites, but the Sustainable Development Commission has nevertheless estimated that between 15% and 20% of current UK electricity demand could be met from marine and tidal

138 The EU Renewable Energy Directive contains a mandatory 10% renewable transport target for each Member State. In addition, the Fuel Quality Directive requires fuel suppliers to deliver a 6% reduction in the lifecycle greenhouse gas emissions of petrol and diesel by 2020.
139 DECC, Digest of UK Energy Statistics (DUKES) (2009) 7.25
140 DECC, DUKES (2009) 7.26. DECC calculations
141 DUKES 2009 para 7.42

energy[142], including up to 5% of the UK's electricity demand from the Severn[143,144].

9.2.17 Marine energy has benefits for the UK in terms of security of supply, economic opportunities and being less intermittent than many other mainstream renewable technologies. Tidal range and flows are entirely predictable for many years in advance. Wave strength and speed are affected by the same issues of intermittency and variability as power from wind turbines but wave states are more readily predictable over longer timescales than wind.

9.2.18 The Government is developing, in cooperation with the private sector, a Marine Action Plan which will set out the key steps to realise the vision of mainstream deployment of wave and tidal energy technologies over the coming decade and out to 2030. The draft Marine Action Plan is expected to be published for public consultation by the end of March 2010.

Hydro & Other

9.2.19 Hydropower is a reliable and generally predictable source of renewable electricity and one of the few that is not intermittent. It is also flexible and can be used on demand specifically in the form of pumped storage, although this is not regarded as renewable generation as another form of generation is required, at times of low demand, to pump the water up to the reservoir.

9.2.20 The UK hydro sector is a mature technology sector and the peak of hydro development was seen in the middle of the twentieth century. The UK currently has over 1.5 GW of conventional hydro capacity, eligible under the Renewables Obligation, installed. Most of the opportunities for the development of large scale hydro schemes have now been utilized. Given the environmental impacts associated with these schemes, it is unlikely that we will see further development of large-scale hydropower in the UK at the level experienced in the last century. That said, the 100MW site at Glendoe on Loch Ness commenced generation

142 *Future Marine Energy*, The Carbon Trust 2006 http://www.carbontrust.co.uk/ publications/ publicationdetail.htm? productid=CTC601

143 *Turning the Tide: Tidal Power in the UK* Sustainable Development Commission 2007 http:// www.sd-commission.org.uk/pages/tidal.html

144 *Turning the Tide: Tidal Power in the UK* Sustainable Development Commission 2007 http:// www.sd-commission.org.uk/pages/tidal.html

December 2008 and is the largest conventional hydropower station to be built in well over 50 years.[145]

9.2.21 Other sources of renewable energy include solar thermal, air-source heat pumps, ground-source heat pumps, solar voltaics, microwind and micro-hydro. These sources make a very low contribution to the UK's overall energy supply at present, but the number and variety of sites that could be utilised for generation make it clear that they have the potential to make a significant contribution to renewable energy and carbon reduction targets.

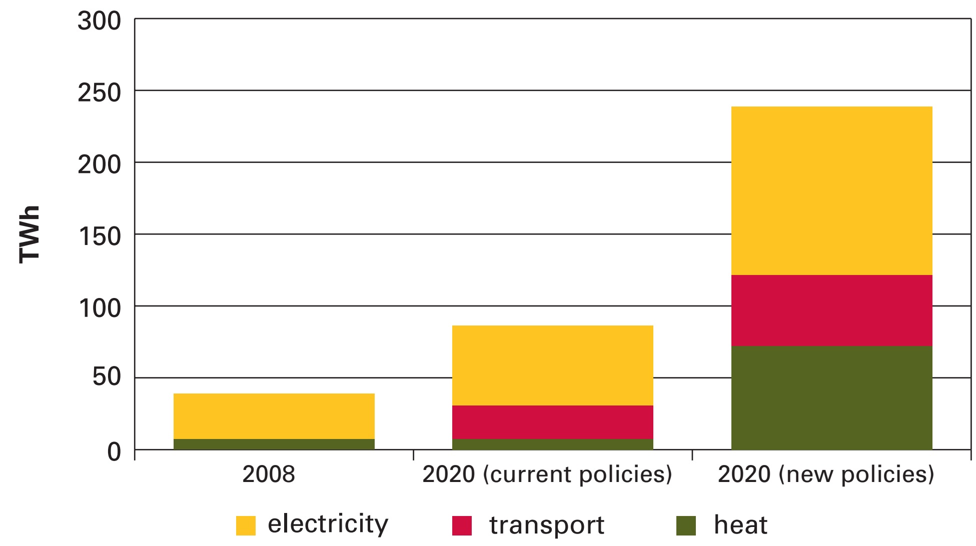
9.2.22 There may be scope for [further] electrical energy storage, which could allow energy production to be decoupled from its supply. Currently the only viable utility-scale energy storage technology is pumped storage, which is itself only possible in certain geographies. The UK currently has four pumped storage facilities with a maximum capacity of approximately 3 GW (about 3% of total generation capacity). Scottish and Southern Energy plc (SSE) is proposing to develop two new pumped storage facilities, with a proposed installed capacity of between 300 MW and 600 MW each. Other than pumped storage, there are very limited large-scale storage technologies capable of commercial deployment

9.3 Renewable Deployment – Office of Renewable Energy Development (ORED)

9.3.1 On 15 July 2009, the Government announced the launch of a new 'Office for Renewable Energy Deployment' (ORED). ORED will lead the work on delivery of the Government's renewable energy target. If the UK is to meet this target a substantial increase in the rate of deployment will be required (Chart 9.2).

145 Due to a rock fall within the tunnel from the reservoir to the turbines, Glendoe is out of commission. Initial reports suggest that it may be 2011 before it is able to recommence generation.

Chart 9.2: Growth in Renewable Energy



Source:

9.3.2 ORED has a clear remit to address deployment issues and to stimulate greater investment. ORED will work with a number of organisations who will have a role to play in the delivery of these measures, including central Government, local and regional authorities, Government Offices, stakeholders such as the Carbon Trust and National Non Food Crops Centre and planning bodies such as the Planning Advisory Service and Planning Inspectorate.

9.3.3 ORED will deliver:

- greater financial support across new and established renewable technologies;
- improvements in the planning process to speed up deployment; and
- encouragement for investors both in deployment and the renewables supply chain.

9.4 Conclusions

9.4.1 The UK has excellent renewable resources but converting enough of this energy into usable electricity, heat and transport by 2020 presents a major challenge. The intermittent nature of many renewable generation sources (in particular wind) will bring new challenges in relation to the operation of the electricity system and investment in essential back up generation and wholesale electricity prices are expected to become more volatile. The Government has invited view on the challenges to the security of electricity supplies in its call for evidence 'Delivering secure low carbon electricity' published in August 2009[146]. The analysis in Chapter 5 on Gas issues sets out the reduced import dependency resulting from increased renewable generation.

9.4.2 The Government's Renewables Energy Strategy has set out a clear framework to drive up the use of renewable energy in the UK. The strategy could provide around £100bn worth of investment opportunities and up to half a million jobs, both here in the UK and abroad, in the renewable energy sector by 2020. The establishment of ORED will help businesses, communities and individuals to take advantage of the opportunities available to increase the production of renewable energy and so increase future security of supply.

146 http://www.decc.gov.uk/en/content/cms/consultations/electricsecure/electricsecure.aspx

10. Carbon

10.1 Introduction

10.1.1 This chapter summarises the impact of the EU Emissions Trading System (EU ETS) on UK energy markets. This includes a consideration of the impact on security of supply due to the introduction of a carbon price, through the EU ETS, and sets out some of the policies which will influence the emerging carbon market.

10.2 EU Emissions Trading System (EU ETS)[147]

10.2.1 The EU ETS is a market mechanism that allows abatement to be undertaken at least cost. It aims to provide (static) incentives to reduce current emissions and provide dynamic incentives to reduce emissions in the future.

10.2.2 The EU ETS is one of the key policies introduced to help meet the EU's greenhouse gas emissions reduction target of 8% below 1990 levels by 2012 under the Kyoto Protocol. Phase I of the EU ETS ran from 2005 – 2007, and Phase II runs from 1 January 2008 until 31 December 2012. Phase III starts in 2013. The rules for Phase III have been significantly revised and will help to deliver the EU's target of reducing overall greenhouse gas emissions by 20% below 1990 levels by 2020.

How it works

10.2.3 The EU ETS introduces a cost of carbon for industries covered by the System[148]. This includes electricity generation and other carbon-intensive industries such as steel, glass and paper production and emissions from all industrial installations with a thermal capacity above 20MW.

147 Further information on the EU ETS: http://www.decc.gov.uk/en/content/cms/what_we_do/change_energy/tackling_clima/emissions/eu_ets/eu_ets.aspx

148 EU ETS Directive 2003/87/EC legislation, European Commission http://ec.europa.eu/environment/climat/emission/implementation_en.htm

10.2.4 For each EU ETS Phase (I & II), a National Allocation Plan (NAP)[149] for each EU Member State sets a cap on emissions from all installations covered by the System. These are converted into allowances which are distributed to installations. Operators of installations must monitor and report their emissions of carbon dioxide on an annual basis. At the end of each year, installations must surrender one EU ETS allowance (EUA) for each tonne of carbon dioxide (tCO2) emitted.

10.2.5 In the UK in Phase II, all sectors other than Large Electricity Producers (LEPs) are allocated allowances to reflect their projected emissions. LEPs have been given less free allocation of allowances than other types of installations as they are better able to pass on the cost of carbon to the consumer because they are not subject to international competition.

10.2.6 Operators have the flexibility to trade the allowances needed for compliance. Because European Union Allowances (EUAs) are the same in every EU country, and can be freely traded between them, there is a single EU carbon price[150]. If the cost of reducing carbon emissions for an individual EU ETS installation is less than the cost of EUAs, it is cheaper to reduce carbon emissions and either sell surplus allowances on the market or avoid having to buy allowances. Similarly, an installation that emits more than its allocation can buy additional allowances. As a result, carbon emissions should be reduced where it is least costly to do so.

10.2.7 In addition to EUAs, operators can use project credits for compliance[151]. These are generated from mechanisms set up under the Kyoto Protocol. In Phase II, operators can use: Certified Emission Reduction Units (CERs) from the Clean Development Mechanism (CDM)[152]; and Emissions Reduction Units (ERUs) from Joint Implementation (JI)[153] projects.

149 UK Phase II NAP http://www.decc.gov.uk/en/content/cms/what_we_do/change_energy/tackling_clima/emissions/eu_ets/euets_phase_ii/phaseII_nap/phaseII_nap.aspx
150 Current prices can be found on a number of websites, including http://pointcarbon.com/
151 Linking Directive (2004/101/EC)amends the EU ETS Directive 2003/87/EC to enable Member States to allow operators to use credits obtained through Kyoto Mechanisms http://ec.europa.eu/environment/climat/emission/implementation_en.htm
152 CDM, UNFCCC http://cdm.unfccc.int/about/index.html
153 JI, UNFCCC http://ji.unfccc.int/

10.3 Experience in Practice

10.3.1 Phase II of the EU ETS has broadened in scope from Phase I to cover CO2 emissions from glass, mineral wool, gypsum, flaring from offshore oil and gas production, petrochemicals, carbon black and integrated steelworks[154]. Emissions from aviation will be included in the EU ETS from 2012[155]. In 2008, UK EU ETS emissions covered 49.8% of UK CO2 emissions.

10.3.2 The auctioning of EUAs was introduced in Phase II. The UK intends to auction approximately 7% of the UK cap over Phase II and held its first auction in November 2008. The UK has continued to hold a number of successful auctions since, and is implementing a non-competitive bidding facility as part of the auction programme, with the first non-competitive auction to be held in January 2010.

10.3.3 A recent DECC report[156], based on the Phase II 2008 verified emissions data, shows that some 900 UK installations covered by the EU ETS emitted 265.0 $MtCO_2$ (Chart 10.1), compared to the UK annual cap of 245.6 MtCO2. This corresponds to:

- emissions 8% over the UK annual cap;
- emissions 24% in excess of the amount of free allocation to those installations.

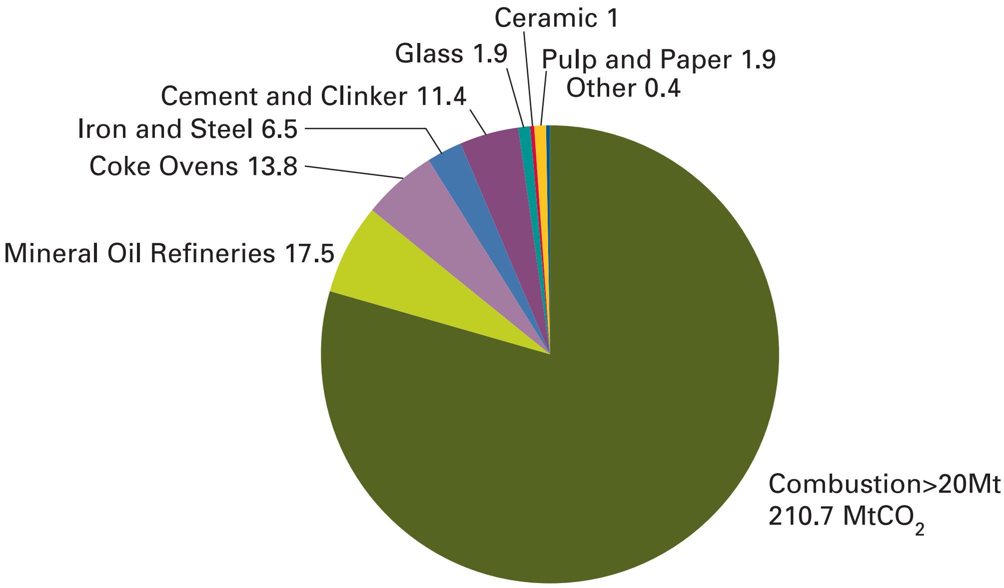
10.3.4 This suggests that it was cheaper for UK installations to purchase allowances from auctions or the open market rather than to undertake abatement internally.

154 In Phase II, the overall cap is set at 2082.68 Mt CO2 per year. This will deliver an EU-wide reduction of c.123 MtCO2e or 6% below 2005 emissions. In the UK the cap is set at 245.6Mt CO2 per year.

155 Inclusion of aviation in the EU ETS http://www.decc.gov.uk/en/content/cms/what_we_do/change_energy/tackling_clima/emissions/eu_ets/aviation/aviation.aspx

156 DECC Report on 2008 EU Emissions Trading System emissions data (September 2009). Report and sector level summary table are available at: http://www.decc.gov.uk/en/content/cms/what_we_do/change_energy/tackling_clima/emissions/eu_ets/publications/publications.aspx

Chart 10.1: Total 2008 verified emissions by sector (Total: 265.0 $MtCO_2$)



EU 2020 Climate & Energy Package[157]

10.3.5 In December 2008, EU leaders and the European Parliament agreed a package of measures aimed at reducing greenhouse gas emissions by 20% by 2020 compared to 1990 emissions. The EU Climate and Energy Package[158] represents a significant step forward in climate policy in the EU and towards an international climate agreement at the end of this year.

10.3.6 The EU has also committed to increasing its 20% reduction target for EU emissions (compared to 1990 levels) to 30% by 2020 in the context of an ambitious international climate change deal to be agreed at Copenhagen. The EU 2020 package will be reviewed following an international agreement on climate change to ensure that it is consistent with an increased level of EU ambition.

157 European Commission information on the EU Climate & Energy Package: http://ec.europa.eu/environment/climat/climate_action.htm
158 DECC information on the EU Climate & Energy Package http://www.decc.gov.uk/en/content/cms/what_we_do/change_energy/european/european.aspx

Phase III of the EU ETS

10.3.7 The revised EU ETS Directive[159] aims to make more emissions reductions, create more predictable market conditions and improve certainty for industry through longer term carbon price signals. Key changes to the Directive for Phase III from 2013 include:

- a tighter and EU wide central cap (Chart 10.2) with an annually declining trajectory (1.74% of 2005 emissions) to 2020 and beyond. This will create scarcity in the carbon market and drive emission reductions to deliver an overall reduction of 21% below 2005 verified emissions by 2020;

- a significant increase in auctioning levels – at least 50% of allowances will be auctioned from 2013; compared to around 3% across the EU in Phase II. This will ensure that the cost of carbon is better integrated into business decisions. There will be 100% auctioning from 2013 for the power sector in the UK;
- access to international project credits from outside the EU will be limited to 50% of the reductions required in the EU ETS;
- Carbon Capture and Storage (CCS) will be recognised as abatement under the EU ETS. Up to 300 million allowances will be made available from New Entrant Reserve[160] to help stimulate CCS demonstration projects and innovative renewable energy technologies.

EU Allowance Price Scenarios 2008 – 2020

10.3.8 DECC's forecast for the traded price of carbon published in July 2009 alongside the transition plan is €35/tCO²e in 2020 under the 20% target agreed in December 2008. DECC will publish revised carbon price forecasts in the New Year which will take into account the impact of the recession and the result of the negotiations at Copenhagen.

159 Revised EU ETS Directive text: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0063:0087:EN:PDF

160 For Phase III the New Entrant Reserve is a community-wide quantity of allowances set aside for new entrants joining the EU ETS for the first time.

10.4 Conclusion

10.4.1 The EU ETS and the carbon market continues to be a key consideration in future low-carbon investment decisions in the energy-intensive sectors. The UK Government believe the best approach to providing certainty to investors is to set the right, long-term regulatory framework with a reducing cap on emissions (as we have done for the EU ETS), and allow the market to help achieve these reductions cost-effectively.

10.4.2 The EU is committed to reducing its overall emissions to at least 20% below 1990 levels by 2020, and is ready to scale up this reduction to as much as 30% under a new global agreement if other countries make comparable efforts. The level of the EU ETS cap will be revised to ensure it is consistent with an increased level of EU ambition.

Glossary of Acronyms

AGT: Auxiliary Gas Turbine

ATK: Aviation Turbine Kerosene

BBL: Balgzand-Bacton Line- Gas import pipeline

BERR: Department for Business, Enterprise and Regulatory Reform which assumed the Energy Policy responsibilities of the former Department of Trade and Industry on 27 June 2007 until September 2008, when these responsibilities transferred to the Department of Energy and Climate Change

BNFL: British Nuclear Fuels Plc

CCGT: Combined Cycle Gas Turbine

CCS: Carbon Capture and Storage

CDM: Clean Development Mechanism

CER : Carbon Emissions Reduction

CHP: Combined Heat and Power

CRC: Carbon Reduction Commitment Energy Efficiency Scheme

CSO: Compulsory Stocking Obligation

DECC: Department of Energy and Climate Change

DOIF: Downstream Oil Industry Forum

DSM: Demand Side Management

DUKES: Digest of UK Energy Statistics

EEU: Expected Energy Unserved

ENSG: Electricity Networks Strategy Group

ERU: Emissions Reduction Unit

ESA: Euratom Supply Agency

EUA: European Union Allowances

EU ETS: EU Emissions Trading Scheme

GEMA: Gas and Electricity Markets Authority

GJ/t: Giga Joule per tonne

GW: GigaWatt

IAEA: International Atomic Energy Agency

IEA: International Energy Agency

IMO: International Maritime Organisation

IOSCO: International Organisation of Securities Commissions

IUK: Gas interconnected import pipelines

JI: Joint Implementation

LCPD: Large Combustion Plant Directive

LEP: Large Electricity Producer

LNG: Liquefied Natural Gas

LPG Liquid Petroleum Gas

MW: MegaWatts

MWh: MegaWatt hours

NAP: National Allocation Plan

NGO: Non Government Organisations

NIAUR: Northern Ireland Authority for Utility Regulation

NPS: National Policy Statements

NRMM: Non–load Mobile Machinery

OCGT: Open Cycle Gas Turbine

OECD: Organisation for Economic Co-operation and Development

OPEC: Organisation of Petroleum Exporting Countries

RED: Renewable Energy Directive

RO: Renewable Obligation

RTFO: Renewable Transport Fuel Obligation

SECA: Sulphur Emissions Control Area

SEM: The Irish Single Electricity Market

SGBO: Superior Grade Burning Oil

SUEK: Siberian Coal Energy Company- Russia's largest coal business

TBE: Transporting Britain's Energy (a National Grid Report)

TSO: Transmission System Operator

TWh: Tera Watt hours

UKCS: United Kingdom Continental Shelf: runs from the outer edge of territorial sea to a median line agreed between the UK and neighbouring countries

UKERC: United Kingdom Energy Research Centre

WNA: World Nuclear Association

Glossary of technical terms

De-rated capacity margin: the proportion by which electricity generating capacity, multiplied by a de-rating factor that reflects the different availabilities of each type of generating technology, exceeds annual peak electricity demand.

European Union Emissions Trading System (EU ETS): Formerly referred to as the EU Emissions Trading Scheme, it is a Europe-wide cap and trade scheme that started in 2005 as one of the EU's key policies to tackle its greenhouse gas emissions. It allows an organisation to decide how and where they will reduce emissions by trading their emissions allowances so that emissions are reduced at least cost. The cost of emissions allowances is determined by the carbon market, and by the demand for, or availability of, allowances.

Expected Energy Unserved (EEU): The expected volume of inadequate electricity generation or gas supply during a given period.

Large Combustion Plants Directive (LCPD): A directive placing restrictions on the emissions of substances including Sulphur Dioxide.

MARPOL: International Convention for the prevention of pollution from ships.

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