



Department of Energy  
and Climate Change

**ENERGY MARKETS OUTLOOK**

DECEMBER 2008

*ofgem*





# **Energy Markets Outlook Report**

Presented pursuant to  
section 172 of the Energy Act 2004

Ordered by the House of Commons  
to be printed 18 December 2008

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ISBN: 9 78 010295 8256

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The information contained in this report constitutes general information about the outlook for energy markets. It is not intended to constitute advice for any specific situation. While every effort has been made to ensure the accuracy of the report, the opinions, judgements, projections and assumptions it contains and on which it is based are inherently uncertain and subjective, such that no warranty is given that the report is accurate, complete or up to date. To the fullest extent permitted by law, no liability (including for negligence or economic loss) is accepted in relation to its use and no responsibility is accepted for any consequences of acting on, or refraining from acting in reliance upon it.

## Foreword

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The new Department of Energy and Climate Change brings together the Government's work on three long-term challenges that face our country: ensuring that we have energy that is affordable, secure, and sustainable; bringing about the transition to a low-carbon Britain; and achieving an international agreement on climate change at Copenhagen in December 2009.

Today's structure of the energy market was designed in a world of abundant supply, British energy self-sufficiency, low commodity prices, and an emerging debate, but not a settled consensus, on climate change. Today all those assumptions have changed: there is international competition for resources, a need for new investment in supply, structurally higher energy prices, and an urgency about carbon emissions.

To respond to this new world, we need a market that secures future supply, including investment in nuclear power and carbon capture and storage; incentivises cuts in carbon emissions; and helps homes and businesses.

This report is intended to set out the nature and potential of the options that are – and may become – available to the UK energy market to enable it to respond to the first of those challenges over the medium to long term. It is intended to facilitate and inform debate and decision making by market participants and other energy market stakeholders. It complements and sets out the factual background to the development of the Government approach to that challenge, which has been set out in the Energy White Paper and will be taken forward next year with a series of publications including ones on carbon budgets, carbon capture and the Government's strategy on renewable energy.

I am grateful for the part that Ofgem, National Grid and the Department for Enterprise, Trade and Investment (Northern Ireland) have already played in developing the analysis set out here. I look forward to broad participation and wide-ranging discussion in the dialogue to follow.

A handwritten signature in black ink that reads "Ed Miliband".

**Ed Miliband**

# 1. Introduction

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## 1.1 About this report

- 1.1.1 This is the second Energy Markets Outlook report, following up the undertaking in “Meeting the Energy Challenge: A White Paper on Energy” (2007)<sup>1</sup> to introduce a new information service, authored jointly by DECC and Ofgem and providing forward-looking energy market information relating to security of supply, building on and expanding 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<sup>2</sup> 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<sup>3</sup> to monitor gas and electricity security of supply issues and publish reports.
- 1.1.3 The first report<sup>4</sup>, published in October 2007, initially examined how security of supply can be defined and measured and then went on to look at the supply and demand, in the UK and (where relevant) global markets, of the various primary energy sources in use in the UK. The balance between these is shifting with time but it is likely that all will continue to be important to the UK’s energy mix for the foreseeable future.

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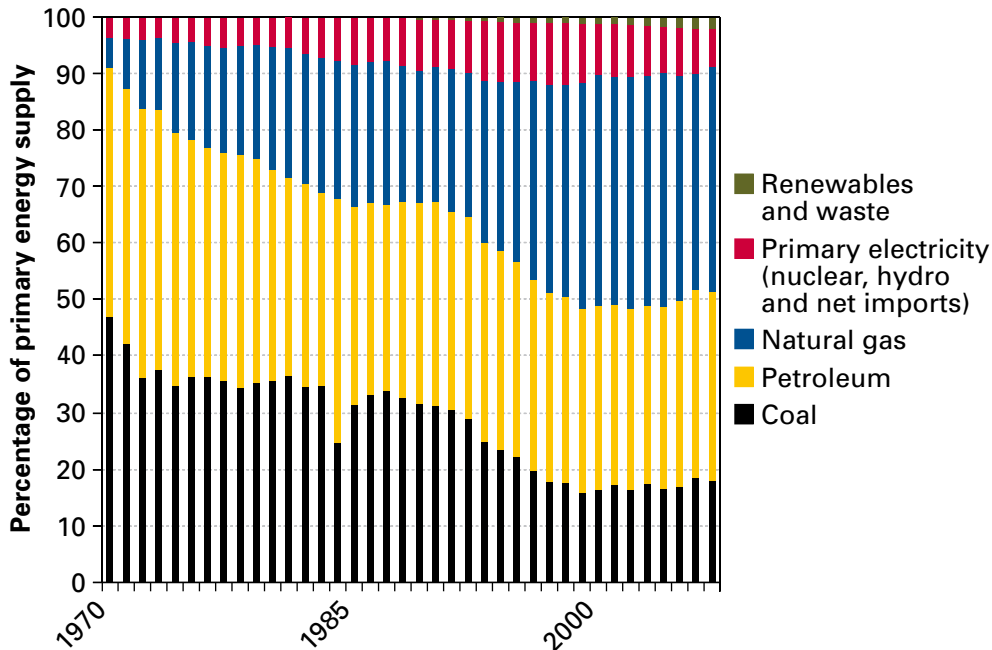
1 <http://www.berr.gov.uk/whatwedo/energy/whitepaper/page39534.html>. Paragraphs 4.36 – 4.38

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/whatwedo/energy/energymarketsoutlook/page41839.html>

Chart 1.1: Energy supply in the UK



Source: DECC Energy Indicators

1.1.4 This report follows the same overall structure, again drawing on expertise from a range of sources; in particular National Grid's Seven Year Statement and Ten Year Statement and analytical work undertaken for the development of the Government's ongoing Renewable Energy Strategy. It does not make predictions about future energy prices, although it does give qualitative consideration to their impact on supply and demand<sup>5</sup>.

1.1.5 We also again include a chapter on carbon, since the emergence of the EU Emissions Trading Scheme means that the price of carbon allowances and the operation of the carbon market, as with fuel, are likely to be an increasingly important factor in operational and investment decisions for electricity generating capacity.

1.1.6 Following the publication of the first report we organised three stakeholder events to examine in more detail the outlook for electricity and gas supply in Great Britain and for the development of a global market in Liquefied Natural Gas. We are grateful for the support of those who participated in those events. Many of the comments made there have been taken into account in this report.

<sup>5</sup> The assumptions on future fossil fuel prices which were used to inform the Government's Updated Energy Projections are available at <http://www.berr.gov.uk/whatwedo/energy/environment/projections/recent/page26391.html>. Information on actual price outturns is available at <http://www.berr.gov.uk/whatwedo/energy/statistics/publications/prices/index.html>



## 1.2 Developments since the last report

1.2.1 In this report we examine the security of supply implications of some important regulatory developments for the energy market over the past year.

- The UK Government published White Papers on the future of nuclear power and setting out the implementation framework to deliver a deep geological disposal facility for higher-activity nuclear waste. Paragraph 4.6.6 refers.
- Phase II of the EU Emissions Trading Scheme began on 1 January 2008, introducing a more substantive cost for carbon emissions than had been the case in Phase I. Discussion started on the EU's approach to Phase III, which is to begin in 2013. Chapter 10 refers.
- Also on 1 January 2008, the EU Large Combustion Plants Directive (LCPD) came into effect, introducing a new factor into the decision-making governing the operation of a number of coal-fired power stations. Discussion began on the European Commission's proposals for building on the LCPD and a number of other EU environmental laws in a consolidated Industrial Emissions Directive. Paragraph 4.4.6 refers.
- The European Union adopted a target to increase the amount of its energy demand met from renewable sources to 20% by 2020. The Government undertook a consultation to inform its consideration of ways of meeting the UK's share of the target. Paragraph 4.6.10 refers.
- The Government undertook a consultation on carbon capture and storage. Paragraph 6.2.6 refers.
- Developments were also observed in the energy market, notably the commencement of work on some new electricity generating projects and the announcement of several more. Section 4.5 refers.
- Concern grew about the longer term availability of oil, as both spot and forward oil prices hit an all-time high earlier in the year. Chapter 7 refers.
- The Energy, Climate Change and Planning Bills all received Royal Assent on 26 November. The Climate Change Act sets ambitious, legally binding emission reduction targets, the Energy Act underpins the achievement of those targets by creating the right legislative framework to support investment in more low

carbon sources of energy, and the Planning Act will ensure that these, and other energy infrastructure projects which are key to security of energy supply, are dealt with by an efficient and fair planning process.

### **1.3 New analysis in this report**

1.3.1 As well as considering the implications for security of supply of these developments, we have expanded and refined the analysis in the previous report in certain areas:

- constraints on new capacity deployment (see paragraph 4.5.4 and subsequent paragraphs);
- impact of renewables penetration on electricity security of supply (see box in chapter 4);
- peak oil (see box in chapter 7);
- coal supply and demand (chapter 6 refers).

### **1.4 The Energy Markets Outlook Website**

1.4.1 As well as the text of this report, the Energy Markets Outlook website<sup>6</sup> contains a number of more in-depth background papers and links to other relevant sites. We seek to update this on an occasional basis during the year.

### **1.5 Any comments?**

1.5.1 Please contact:

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<sup>6</sup> <http://www.berr.gov.uk/whatwedo/energy/energymarketsoutlook/page41839.html>

## 2. Executive Summary

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- 2.1 This second Energy Markets Outlook provides a detailed discussion of the risks and drivers associated with future security of energy supply, including scenarios for future security of supply of electricity and gas and the full range of other fuels, and provides a narrative on these scenarios. It builds on the first Energy Markets Outlook published in October 2007, and takes account of feedback and inputs provided through stakeholder engagement. It draws on technical modelling and other expert work and knowledge. It is not a statement of policy, and it does not make guesses about future prices.
- 2.2 The first result of problems with supply, however caused, is likely to be a jump in the price as the market responds, rather than physical interruptions to supply. Such price increases are costly for consumers, but actual supply interruptions have greater costs – forcing 10% of gas demand off the system involuntarily could cost the economy £300m a day.
- 2.3 The Government has ultimate responsibility for security of supply, but looks to the market to deliver the necessary infrastructure and diversity of competitive sources of energy. The Government seeks to facilitate this through a supportive regulatory framework, which is then administered by (in Great Britain) Ofgem and (in Northern Ireland) the Northern Ireland Authority for Utility Regulation (NIAUR), the independent energy Regulators.<sup>7</sup> Under this policy framework, energy companies invest to maintain secure and reliable supplies in response to price signals emerging from energy markets.
- 2.4 While future security of supply will be principally determined by market-based drivers, Government policy and action are also important. In this context, Government's role is to provide a stable regulatory framework. Where appropriate, Government may also provide incentives (for example for deployment of renewable technologies) and has a key role in removing barriers to ensure the widest possible range of options are available to the market. The Government and Ofgem also have a role in ensuring that the market has credible and timely information to help

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<sup>7</sup> <http://www.ofgem.gov.uk/>  
<http://www.niaur.gov.uk>

inform its investment and other strategic planning decisions.

- 2.5 In terms of maintaining continuity of supply for customers, private companies in the market work with National Grid to meet consumers' demand. Ofgem oversees the market rules to make sure that energy suppliers face the full economic costs of any failure to match their supplies to their customers' demands. This enables them to make trade-offs between the costs and benefits of additional investments to reduce the risk of imbalances.
- 2.6 While discussion about security of supply often focuses on the risks arising from import dependency, or the margin of electricity generating capacity above peak electricity demand, shortcomings in these areas have not historically been the main causes of interruptions to energy supply. Other risks include:
- unplanned outages of transmission and distribution networks;
  - accidents, such as the fires at the Rough gas storage facilities and at the Coryton and Pembroke oil refineries;
  - extreme weather, such as the floods that affected much of the West of England in 2007 or the hurricanes that threaten oil supply in the Gulf of Mexico;
  - industrial action, such as the dispute at Grangemouth which affected petroleum deliveries and the operation of the Forties pipeline.
- 2.7 There are also other, lower probability risks, such as terrorism or pandemics – and climate change is a risk too, partly through its effects on extreme weather.
- 2.8 Over the next few years, Britain faces additional challenges. As plants start to close, the electricity generating industry faces a substantial challenge in ensuring delivery of the new generating capacity that will be needed if Britain is to maintain security of supply at similar levels to those so far enjoyed. In particular, as coal-fired plant closes by 2016 under the Large Combustion Plants Directive, there will be a requirement for replacement capacity. In the longer term, the move to a low-carbon economy will require substantial investment in renewables, and appropriate back-up capacity to deal with intermittency. The Government has also signalled the need for new nuclear plant in the mix, and the role for Carbon Capture and Storage in the context of fossil

fuel generation. The delivery of new generation plant, and potential upside to electricity demand, will also lead to a need for expansion and strengthening of the transmission network.

- 2.9 There is expected to be increasing diversity of the potential sources of gas supply to the UK, though there are widely differing views on the future sources of gas. For the medium and longer term, further investment in additional import and storage capacity is likely to be required. In particular, the need is recognised for additional gas storage in the UK over the coming years as UKCS supplies continue to decline and the UK becomes increasingly dependent on imports. Maximising the diversity of sources of supply and additional investment in import capacity are important in the medium term if the UK is to be able to maintain the position of being able to meet demand in the event of interruption to another supply route.
- 2.10 The downstream oil industry has the flexibility to respond to short-lived disruption of UK oil supply and the UK has well-established procedures in place to deal with supply emergencies, including through membership of international institutions. However, there are significant uncertainties as to how far and when the necessary new investment in upstream and downstream oil supply capability will be forthcoming. Continuing demand pressure on the one hand and a continuing slow supply and investment response on the other are reducing spare capacity and increasing pressure on inventories. The UK is obligated by its membership of the International Energy Agency and the EU to maintain extensive reserves of petroleum products and the level of stocks to be maintained is due to increase over coming years.
- 2.11 It is perhaps too soon to assess the effect of the economic downturn and financial market turmoil on investment in energy infrastructure due to difficulties in accessing, and higher cost of, finance. Equally we can expect to see some reduction in demand, both domestically and globally. The extent and duration of these effects will need to be monitored carefully.
- 2.12 There is a wide range of possible out-turns around future levels of electricity demand and new electricity build, as well as for the exact timing and sequence of plant closures. In any case, improvements in energy efficiency and demand-side responsiveness could also help to underpin

continued security, as well as limiting the need to invest in new generating capacity. In the longer term, the possibility of currently unforeseen technological advances in generation, transmission and distribution and demand side management enters into the equation. There are indications that the industry is already addressing these challenges. However, this is an area which the Energy Markets Outlook will continue to monitor closely.

- 2.13 More gas storage capacity and the maintenance of a broad diversity of import options should help to mitigate the risks of gas import dependency, but it is inevitable that the UK's security of gas supply will increasingly depend on EU and global gas market conditions. Further progress on EU market liberalisation will be important. Regional gas markets are on their way to globalisation, encouraged by more producing and consuming countries, Europe's growing dependence on external imports, tighter balances, increasing volumes of spot and short-term Liquefied Natural Gas (LNG) and higher prices. Spot and short-term LNG is beginning to play a greater role in inter-regional market balancing and price alignment. If this leads to more transparency on prices and flows and more competitive internal markets, interregional competition should improve global gas security in the long term.
- 2.14 A range of scenarios can be postulated for demand for coal in the UK over the next decades, driven primarily by assumptions about levels of coal fired power generation, which in turn depend on assumptions about the regulatory climate and the drive towards low carbon generation. Future demand for coal will provide an opportunity for indigenous production of coal, although issues such as planning consents, in particular for surface mines and rail infrastructure would also need to be considered. In all reasonable scenarios, however, there will continue to be a requirement for imports. Given the abundance of proven reserves of coal globally, the future use of coal is unlikely to be limited by resource availability, although there are a number of international issues and risks that could affect future prices.
- 2.15 Although the UK only recently became a net oil importer, we already have in place infrastructure, contractual arrangements and commercial relationships which should help ensure continuity and security of oil supplies for the UK from external sources, though the degree of resilience which these bring obviously depends on the size of any

supply problem. The UK also has a long-established refinery sector to process crude oil, even though it is unlikely that domestic production will ever fully match consumption of the different oil products.

- 2.16 While future security of supply will depend on investment by private companies, Government policy and action will define the choices that are made.
- 2.17 The Energy White Paper 2007 set out the Government's strategy to address the long term challenges faced by the UK of tackling climate change by reducing greenhouse gas emissions and ensuring the UK has secure, clean and affordable energy. The Government believes that independently regulated, competitive energy markets with an appropriate cost of carbon and support for emerging low carbon technologies are essential to delivering the twin goals of both secure energy supplies and lower emissions. The Government also considers that the best way to deal with future uncertainties is to ensure the market has access to all the technologies and options available, encouraging a diverse and increasingly low-carbon energy mix. A diverse range of low carbon energy sources are also helping to limit our future dependence on imported fossil fuels with all the uncertainties they entail. The Government is also promoting energy efficiency, as a means of reducing overall energy demand, and has announced other measures to encourage localised generation.
- 2.18 Dynamic markets and private investment are at the heart of the Government's energy policy, while there is also a role for Government in taking strategic action to shape the medium term framework and to ensure that the market delivers. Strategic Government action includes setting targets for deployment of renewables to implement the EU's target for meeting 20% of EU energy demand from renewable sources by 2020, promoting development of Carbon Capture and Storage Technology, and driving energy efficiency. The Government is also working to ensure that unnecessary barriers to the market working effectively are removed. Legislative changes to reform the planning system have been agreed in the Planning Act 2008, where the intention is to streamline the process for obtaining planning permission, removing avoidable uncertainty and delay from the process, while protecting environmental interests. As set out in the Planning White Paper, the Government has already introduced streamlined inquiry rules for major electricity projects.

- 2.19 The Energy Act 2008 will enable a fit for purpose regime for certain types of offshore gas infrastructure such as offshore gas storage. The Energy Act has also updated the legislative framework to reflect the availability of new technologies, such as carbon capture and storage, which would enable coal fired generation to be deployed in a way consistent with the transition to a low carbon economy, and emerging renewable technologies.
- 2.20 The Government is also ensuring there are no unnecessary barriers to the deployment of new nuclear power, and that the appropriate regulatory frameworks are in place for nuclear new build. In January 2008, the Government published a White Paper on nuclear power development. The White Paper also set out the timetable of facilitative actions necessary to enable energy companies to begin construction of the first new nuclear power stations in 2013-2014 to start operation in 2017-2020.
- 2.21 As mentioned in paragraph 2.17, the second half of the Government's approach is to ensure an appropriate cost of carbon and to provide support for emerging low carbon technologies within the context of competitive energy markets. The Government has set aggressive targets for the deployment of renewables, to implement the EU's target of delivering 20% of energy demand from renewable sources by 2020, and reductions in emissions, as set out in the Climate Change Act 2008. Its 2008 consultation sought views on how to achieve the level of deployment of renewable energy in the UK at the speed and scale required. This will help to shape the UK's Renewable Energy Strategy which will be published in first half of 2009. The Government has already been providing support for the development and deployment of renewable electricity and has recently taken powers in the Energy Act 2008 to introduce a Renewable Heat Incentive and a Feed in Tariff for small-scale renewable electricity generation.
- 2.22 The reform of the EU Emissions Trading Scheme and business confidence in there continuing to be a meaningful carbon price are key to future investment decisions. The current proposals for reforming the EU ETS go some way towards providing a longer-term carbon price signal and increased certainty for investors. They point to increasing scarcity in the carbon market (due to reduced supply) as the EU moves towards its 2020 emissions reduction target. This should support the carbon price, thus encouraging research, development and investment into innovative low-



carbon energy technologies to take an increasingly large place in the UK's overall energy supply mix.

- 2.23 Energy efficiency is an important strand to the Government's approach, offering the possibility of reduced emissions through reduced fuel consumption and a reduced need for new generation and gas supply infrastructure in the future.
- 2.24 The Government has promoted household energy efficiency through a combination of regulation, awareness-raising and incentives. Building regulations have increased the energy performance of new homes as well as that of replacement windows and boilers. The main policy in existing homes is the energy supplier obligation, which sets suppliers a target to deliver carbon-saving measures to households in Great Britain. The Carbon Emissions Reduction Target, which commenced in April 2008, represents a doubling of the target under the previous programme. A further 20% increase was announced in September 2008, as well as the introduction of a new Community Energy Saving Programme. Government announced in October its intention to move to a 10-year roll-out of smart meters to domestic households, which will help householders better manage their energy use. The Government is working closely with other European Countries on ambitious mandatory minimum appliance standards and labelling for the energy efficiency of new products sold within the EU.

## 3. Security of Supply in a Competitive Energy Market

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### 3.1 Introduction

3.1.1 The objective of ensuring security of supply is an explicit element of the UK Government's energy policy, along with carbon reduction, tackling fuel poverty and the promotion of competitive energy markets. It also has a high profile in the energy policies of other states and international institutions.

3.1.2 In the case of the UK, the Government looks to the market to deliver the necessary energy infrastructure and competitive sources of energy within the regulatory framework which it sets for the market. This framework is administered by (in Great Britain) Ofgem and (in Northern Ireland) the Northern Ireland Authority for Utility Regulation (NIAUR), as competition authorities<sup>8</sup>; and by the Environment Agency and the Health and Safety Executive in their respective fields of competence. The Government also looks to promote energy efficiency to reduce demand resulting from improved energy efficiency contribute to the UK's security of supply as well as to its climate change targets.

3.1.3 It is still largely on the supply side that the main responsibility falls for matching supply and demand with a minimum of price volatility. There are strong commercial and regulatory incentives in place to ensure this. In a competitive market, if energy companies fail to offer reliable and competitively priced supply, they are likely to lose market share as customers look to alternative suppliers. A further safeguard is provided through regulatory arrangements such as the Unified Network Code in the gas market and the balancing mechanism in the electricity market. These provide for financial consequences, which can be very heavy, where market participants fail to ensure a balance between offtakes and inputs.

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8 <http://www.ofgem.gov.uk/>  
<http://www.niaur.gov.uk/>

## 3.2 Dimensions of security of supply

3.2.1 Security of energy supply may be considered in different terms, depending on context:

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

3.2.2 Security of supply risks may be related to only one or to a combination of these dimensions:

- technical problems on an electricity distribution network may cause localised physical interruptions to supply, although price and geopolitical conditions are stable;
- individual technical difficulties need not lead to interruptions, but may cause price rises; for example, the market can offset difficulties with gas production from the UK Continental Shelf by taking gas from more expensive sources such as storage or imports instead;
- supply chain constraints 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;
- geopolitically-inspired interruptions to export from significant overseas producers, or constraints on investment and production of fossil fuels, may cause prices to rise and, if price rises do not lead to supply flowing from elsewhere and/or demand reductions, eventually to fuel shortages.

## 3.3 Timescales for security of supply

3.3.1 Any of these risks may happen at any time and the difficulty of assessing their likelihood and likely impact increases, as with all discussion about the future, the further forward we look. So too does the range of available investment options, as the lead times associated with the

different types of response and different technologies vary. Moreover, the lead times may themselves shorten as a result of technical innovation. Given the flexibility of the market to adjust over time, then, conclusions about security in the longer term should be drawn only with extreme caution.

- 3.3.2 In the short term, the main concern 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 into energy for use by the final consumer. There may be a particular concern, for example, in the case of wind-powered electricity generation, where the output of the wind fleet as a whole can vary significantly in relatively short timescales. We examine this further in paragraph 9.2.2.
- 3.3.3 In the medium term, the focus is on the availability of infrastructure, the planning process and supply chain issues such as the availability, both within the UK and internationally, of raw materials, machine components and project management and engineering skills. There may be a particular concern, for example, in the case of electricity generating capacity construction projects. We examine this further in paragraph 4.5.4 and subsequent paragraphs.
- 3.3.4 In the longer term, there is a wider range of options open to market participants, including significant capital investment and the development of new technology. Given this, the key concern in this time-frame is likely to be the availability of primary sources of energy. There may be a particular concern, for example, about the long term availability of fossil fuel reserves. We examine this further in the peak oil box at the end of chapter 7.

## 3.4 Indicators of security of supply

- 3.4.1 Measuring security of supply is primarily about measuring the *risk* (rather than the actual outturn) of involuntary interruptions to supply. The concept of *expected energy unserved* combines possible levels of shortfall (between supply and demand) with their probabilities, to give a probability-weighted amount of unserved demand<sup>9</sup>, thus quantifying the risk itself rather than the factors which

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9 The derivation of *expected energy unserved* is explained in full at <http://www.berr.gov.uk/files/file41822.pdf>.

contribute to the risk. We summarise scenarios for future levels of expected energy unserved in electricity in paragraph 4.7.7.

- 3.4.2 This measure can also be used to examine the relative importance of the factors which influence security of supply. These may be categorised as follows:
- **capacity margin:** the safety margin between likely demand and the physical ability to supply enough energy to meet that demand;
  - **reliability:** the probability that the capacity on the system is available to deliver supplies when 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 the rise of 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 markets;
  - **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.
- 3.4.3 The relative importance of these will vary between different kinds of energy sources and over different time periods, and they inter-relate. For example, we might have a very limited *diversity* of sources of supply, but whether this is a major concern would depend on the *reliability* of those sources.
- 3.4.4 In general, our analysis suggests that the single most important influence on expected energy unserved is the overall balance, the margin, between demand and physical supply capacity. In this report we therefore take that indicator as our main proxy for security of supply, adding qualitative commentary where appropriate on other factors

such as production and/or distribution reliability, diversity and the functionality or otherwise of the relevant markets.

## 3.5 The optimal level of security of supply

3.5.1 Any level of security depends on the balance between the costs and the benefits of increasing security, but carrying out a comparison of this type is far from straightforward in practice:

- the costs of interruptions to supply vary widely, depending on various factors including their frequency, duration and timing; whether and how much advance warning can be given; which customer groups are affected; and the extent of contingency preparedness on the part of energy users. For example, the Value of Lost Load (VOLL) for gas has been assessed at £5 – £30/therm<sup>10</sup>;
- the risks driving the level of security are often qualitative and uncertain; weather conditions and technical availability can be subjected to probabilistic analysis on the basis of historic experience, but the development of EU and global market liquidity require more subjective assessment;
- quantifying the extent to which a particular policy measure, or the addition of extra capacity, would reduce the risk and size of interruptions is technically challenging.

## 3.6 The international context

3.6.1 In addition to the specific risks to the security of supply of individual energy sources dealt with in the following chapters, there are some which are international in nature.

3.6.2 Globally, energy security is threatened by the fact that rapidly increasing energy demand from the emerging markets has not been matched by corresponding levels of investment in increased oil and gas production. Most forecasts suggest these supply constraints are likely to persist and (particularly in the case of gas) worsen in the coming decade. The result will be increasing competition for limited oil and gas supplies which pushes up prices,

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<sup>10</sup> <http://www.berr.gov.uk/files/file38980.pdf>

increases consumers' vulnerability to supply shocks, and gives producers increased leverage.

- 3.6.3 Although the UK remains one of the least import-dependent countries in the EU, we cannot expect to be immune from security of supply challenges facing the EU as a whole, especially given the increasing interconnection between the UK and other EU markets. In both oil and gas, risks are increased by the fact that remaining global reserves are concentrated in a small number of countries and increasingly held by national oil companies.
- 3.6.4 Individual EU Member States have adopted various approaches to national energy security. For example, France seeks to reduce its energy dependence by relying heavily on nuclear power for its electricity and diversifying its gas imports. Italy and Germany are both heavily dependent on Russia for gas supply and have entered into bilateral commercial deals. As a major hard coal producer, Poland's energy import dependency is among the lowest in the EU but because of environmental concern over the carbon implications of coal burn and political concern over greater dependence on Russian gas, the Polish Government is considering building nuclear power plants and an expansion of electricity interconnections.
- 3.6.5 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, partly for the carbon benefits but also with a view to reducing its dependence on fossil fuel imports. The EU has also agreed to the establishment of a fully functioning competitive energy market, and the removal of commercial and infrastructural barriers to market responsiveness, within the EU. This will:
- enable and encourage suppliers to respond to price signals and increase the flow of energy around the EU in the event of a localised shortage, hence improving market resilience;
  - ensure, through the unbundling of network utilities, that there are stronger incentives to build infrastructure to meet market demand, e.g. cross-border interconnectors and network reinforcement needed for the connection of renewables;
  - improve diversification of supply to each market, as it will be easier to contract for supply through other networks; and

- improve the incentive on individual Member States to engage in a common external policy – the more it is the case that once energy supplies are in the EU they will move freely to wherever they are needed, the more it is in the interests of member states to support each other, rather than see each other as competitors, in negotiation with external suppliers.

3.6.6 The European Commission published its 'Second Strategic Energy Review: an EU Energy Security and Solidarity Action Plan' on 13 November, together with a number of supporting documents. It focuses on energy security, identifying five areas for action: infrastructure and diversification of energy supplies; external energy relations; oil and gas stocks and crisis response mechanisms; energy efficiency; and making the best use of the EU's indigenous energy resources. The European Council in Spring 2009 is expected to agree an Action Plan to implement the recommendations of the Strategic Energy Review.

## **3.7 Conclusion**

3.7.1 The Government will continue to take very seriously the security of energy supply in terms of both physical supply and price volatility, while recognising that there are no simple or easy answers. The analysis set out in subsequent chapters is intended to help market participants reach their own view of the levels of demand, which is essential for planning to meet our future demands, alongside a strategic role for HMG in assessing the scale and nature of the risks and the extent to which action to address it is appropriate, and to facilitate and inform debate about the risks we face.



## 4. Electricity

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### 4.1 Introduction

- 4.1.1 Both the demand for electricity and the level and nature of capacity that will be available to produce it are subject to a degree of uncertainty over the next decade. In this chapter we look separately at the factors affecting future levels of demand and supply, and then at the relationship between them.
- 4.1.2 The Government's commitment to meeting the UK's share of the EU target of delivering 20% of energy from renewable sources by 2020 means that a much higher proportion of our total generating capacity in future is likely to depend on sources which are subject to intermittency. We consider here the impact on security of supply and some of the technological and commercial means which are, or might become, available to manage it.
- 4.1.3 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 described in a separate box at the end of the chapter.

### 4.2 Electricity demand

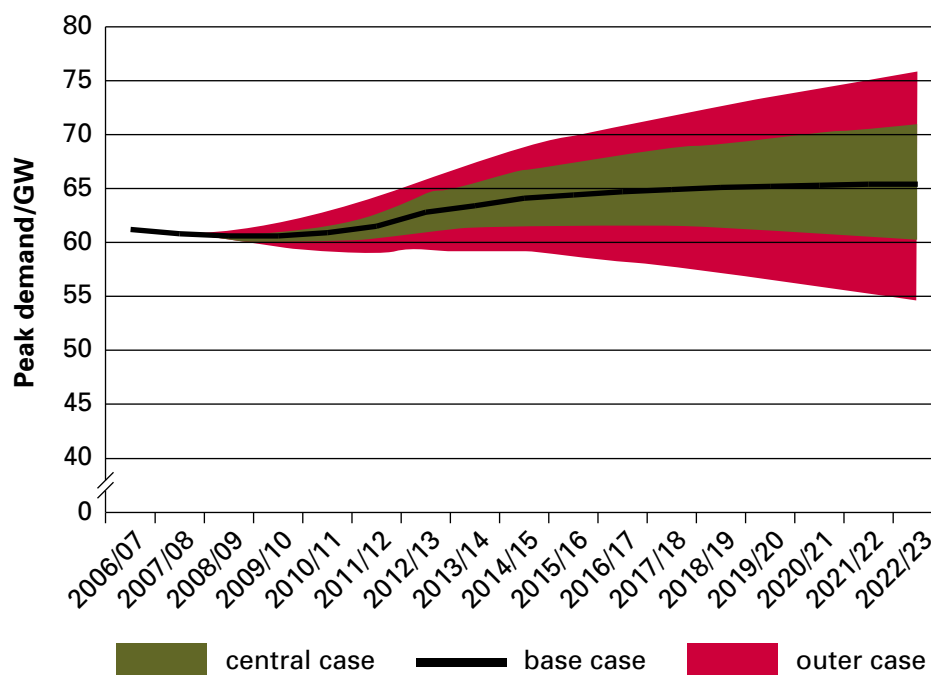
- 4.2.1 Because electricity security of supply depends on generation capacity being able to produce sufficient electricity to meet demand at a particular point in time, the most significant indicator in assessing electricity security is the peak – the highest instantaneous level of demand in any given year.
- 4.2.2 The chart below shows that there is considerable uncertainty about the level of peak electricity demand in the future, particularly over longer time horizons. There are a number of factors that are likely to influence how it develops. For example, higher economic growth and lower electricity prices would be expected to lead to increased levels of peak demand. In contrast, increased energy efficiency, perhaps as a result of environmental policy, 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 system 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.

4.2.4 The highest levels of demand shown here would be reached only if the relevant factors were all stimulating demand growth and no factors were acting to reduce demand. In practice, these variables are not independent and it is 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. Even within this range, however, there are still major variations.

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



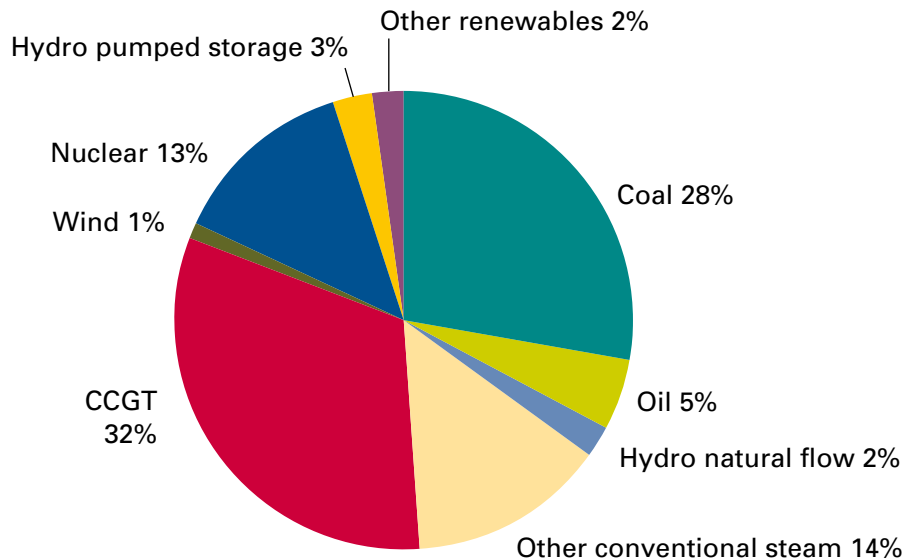
Source: National Grid

### 4.3 Electricity supply capacity: Present

4.3.1 As at the end of 2007, the UK as a whole had a total of 83 GigaWatts (GW) of electricity generating capacity of various kinds. In addition Great Britain had the capacity to import and export a total of 2500 MegaWatts (MW) from and to France and Ireland.

4.3.2 The total given above is larger than that in National Grid's Seven Year Statement. This is largely because some 2 GW is located in Northern Ireland. In addition, some generating capacity supplies electricity into local distribution networks rather than into the GB Transmission System, for which National Grid is responsible.<sup>11</sup>

*Chart 4.2: Electricity generating capacity in the United Kingdom, by technology (total 82.591 GW)*



Source: *Digest of UK Energy Statistics 2008, table 5.7*<sup>12</sup>

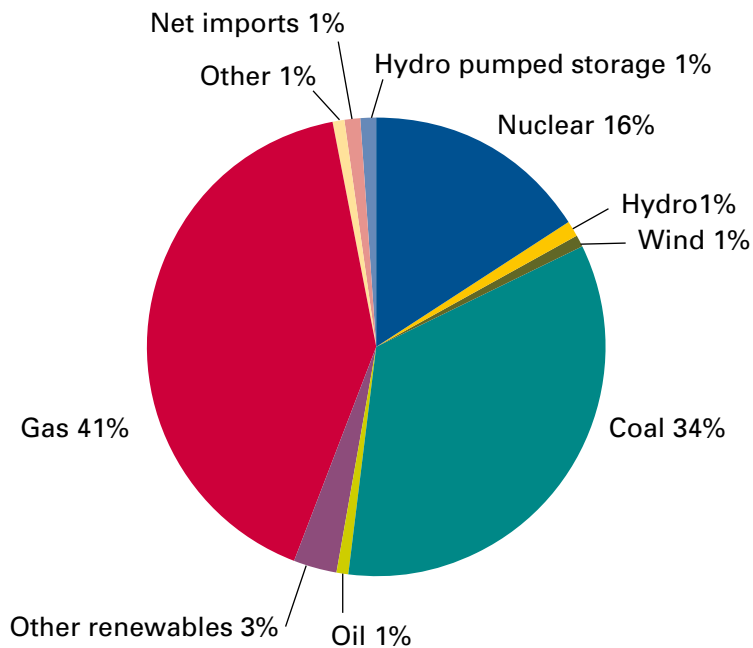
Notes: "Other conventional steam" includes mixed or dual fired thermal capacity and gas fired stations that are Open Cycle Gas Turbines, or have some CCGT capacity but mainly operate as conventional thermal stations.

4.3.3 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 408 TWh of electricity generated in 2007, the breakdown by technology type was as follows:

<sup>11</sup> <http://www.nationalgrid.com/uk/Electricity/SYS/>

<sup>12</sup> <http://www.berr.gov.uk/whatwedo/energy/statistics/publications/dukes/page45537.html>

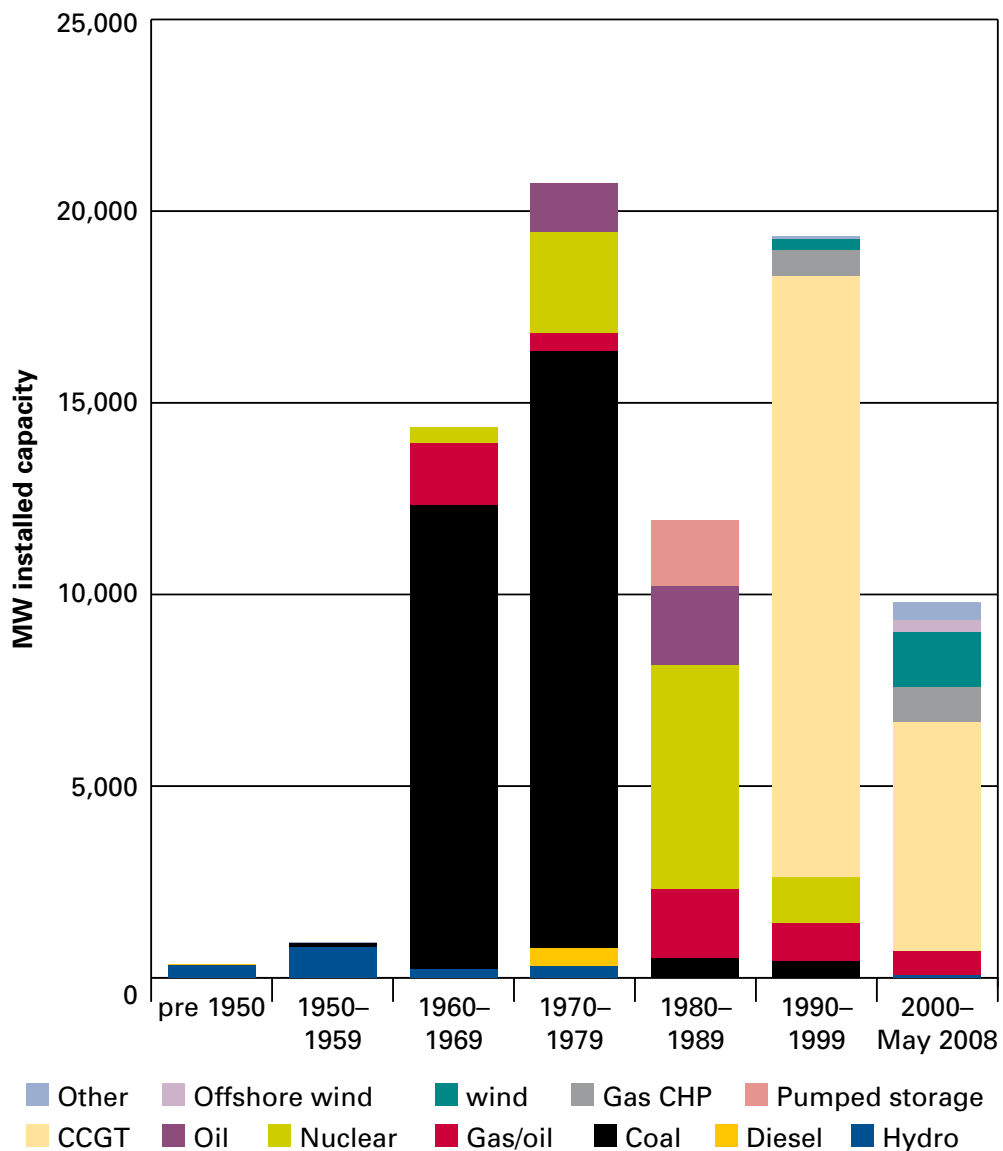
Chart 4.3: UK electricity generated in 2007 (total: 407,671 GWh)



Source: Digest of UK Energy Statistics 2008, table 5.1

4.3.4. The UK's electricity fleet comprises plant of a wide range of ages as well as technology types, including some hydro plants which were first commissioned in the early part of the twentieth century. While about a quarter of our present generating capacity has been commissioned since 1995, over 40% of it was built between 1965 and 1975.

Chart 4.4: Power stations (operational at end May 2008):  
Commissioning dates



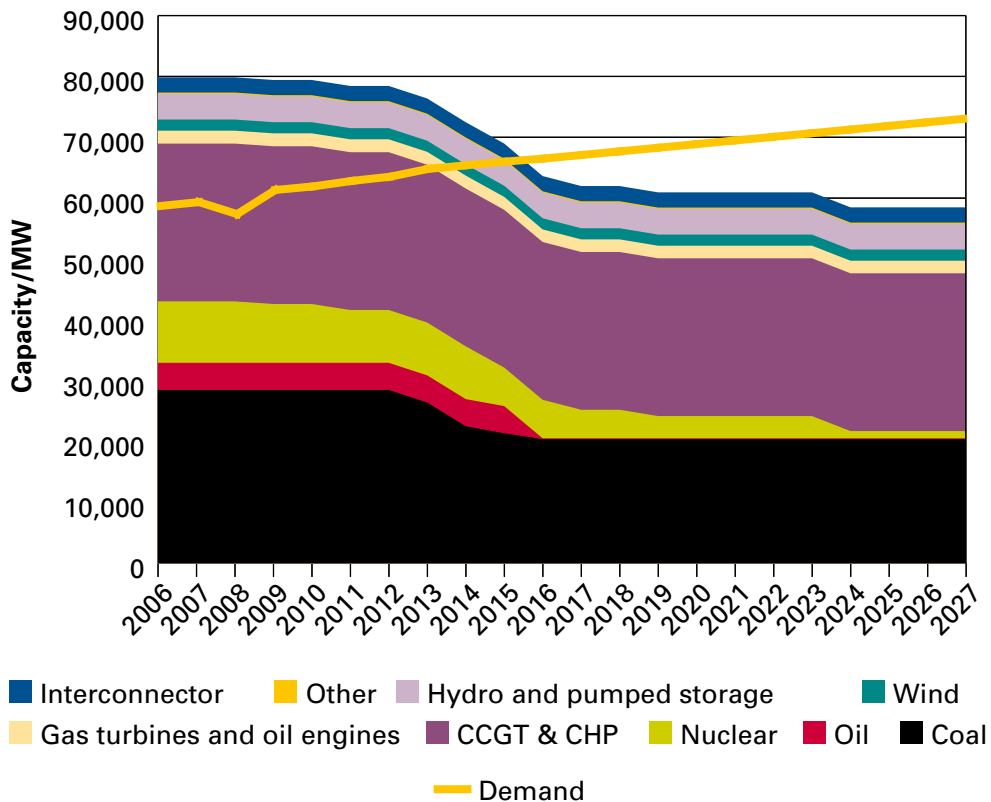
Source: *Digest of UK Energy Statistics, table 5.11*

4.3.5. Future levels of generating capacity will depend on how much of this existing plant is retired from service and how much new plant is built.

## 4.4 Plant closures

4.4.1 A substantial proportion of the UK's electricity generating capacity is expected to close over the next few years, which would (if no provision were made to replace the capacity) reduce the UK's total capacity. In addition to the GB closures represented below, some 600 MW of gas-fired capacity at the Ballylumford plant in Northern Ireland will also have to close by the end of 2015.

Chart 4.5: Development of existing GB generating capacity



Source: Digest of UK Energy Statistics/DECC

## Plant closures: The Large Combustion Plants Directive

4.4.2 The Large Combustion Plants Directive (LCPD)<sup>13</sup> requires large electricity generators, and some other industrial facilities, to meet more stringent air quality standards from 1 January 2008. Plant which has “opted out” of this obligation will have to close by the end of 2015 or after 20,000 hours of operation from 1 January 2008, whichever is the sooner. Some 12 GW of coal and oil-fired generating plant falls into this “opted-out” category<sup>14</sup>.

4.4.3 The exact timing of these closures is a commercial matter for plant owners, taking into account factors such as other environmental restrictions and the state of repair of the plant. For example, if a facility suffers serious technical difficulties and would otherwise only have a limited life in any case, then it may not be economic to invest in repair and maintenance. Hence, it is impossible to predict with certainty the precise timing of the impact of the LCPD on generation capacity.

<sup>13</sup> <http://www.defra.gov.uk/environment/airquality/eu-int/eu-directives/lcpd/index.htm>

<sup>14</sup> There is a full list of LCPD opted-out plant on the Energy Markets Outlook website <http://www.berr.gov.uk/whatwedo/energy/energymarketsoutlook/page41839.html>

- 4.4.4 Early experience since the start of LCPD implementation on 1 January 2008 suggests that load factors among the opted-out coal-fired plant have declined, with such plant tending to run only at times of higher electricity prices. However, it would be premature to seek to draw conclusions about the way in which remaining hours of operation will be used.
- 4.4.5 Oil-fired power stations tend to run for fewer hours over the year as a whole, producing electricity only at times of very high demand. They are therefore less likely to run out of hours before the end of the period.

## The Industrial Emissions Directive

- 4.4.6 In December 2007, the European Commission published a draft Industrial Emissions Directive (IED). This consolidates seven existing Directives, including the current Integrated Pollution Prevention and Control Directive and the LCPD, in a move towards further tightening of emission limits and regulatory simplification. Negotiations on the new Directive started in summer 2008, with discussions in Council and the European Parliament on the large combustion plant elements taking place over the autumn of 2008. Whilst there is a desire on the part of the Commission and some Member States to reach an agreement by early 2009, failure to do so will result in negotiations running into the European Parliamentary elections and so may postpone any conclusion until late 2009 or 2010. As drafted, the Directive is due to come into force at the beginning of 2016.
- 4.4.7 As presently proposed by the European Commission, the Directive would mean that more UK coal plant owners would face the choice between substantial new investment in technical upgrades to enable them to meet the new standards, or closure by the end of 2015. It would also mean that owners of pre-2002 CCGTs would face the same decision. It is likely that some of these would choose closure, as the investment in plant which is approaching the end of its operating life may not be economic in all cases, so increasing the amount of closures in generating capacity during the next decade. This could have a particular impact on plant that is expected to operate as a back-up as intermittent renewable generation is rolled out to meet the 2020 EU target.

## Plant closures: Nuclear

- 4.4.8 The operating lives of nuclear power plant can be extended, but only with the approval of the Health and Safety Executive's Nuclear Installations Inspectorate (NII). The decision whether to apply to the NII for an extension of the operating lives of nuclear power stations beyond their scheduled closure dates is a commercial decision for the operators. According to current timetables, 7.3 GW of nuclear generation capacity will have closed by 2020 and all but one of the UK's nuclear power stations will have closed by 2025<sup>15</sup>.
- 4.4.9 Since publication of the last Energy Markets Outlook, the decision has been taken to extend the lives of Hunterston B and Hinkley Point B to 2016. Decisions as to the extension or otherwise of the operating lives of other stations are expected to be taken nearer the time and will take into account such factors as plant safety and operating cost, as well as supply, demand and price expectations in the electricity market as a whole.

## 4.5 New build: quantity

- 4.5.1 As at September 2008, there is some 10 GW of conventional electricity generating capacity with consent to build, of which 7.5 GW is under construction. In addition there is about 8.3 GW of renewable generating capacity classified as "awaiting construction" while 1.5 GW is under construction<sup>16</sup>; and a second electricity interconnector to the Continent with a capacity of 1.3 GW is being built. We are also aware of a further 50 GW which is at earlier stages of the planning and development process<sup>17</sup>.
- 4.5.2 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<sup>18</sup>. Clearly, the further into the future we look, the fewer firm commitments have been made.

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15 There is a full list of the UK's nuclear power plants and their scheduled closure dates on the Energy Markets Outlook website <http://www.berr.gov.uk/whatwedo/energy/energymarketsoutlook/page41839.html>

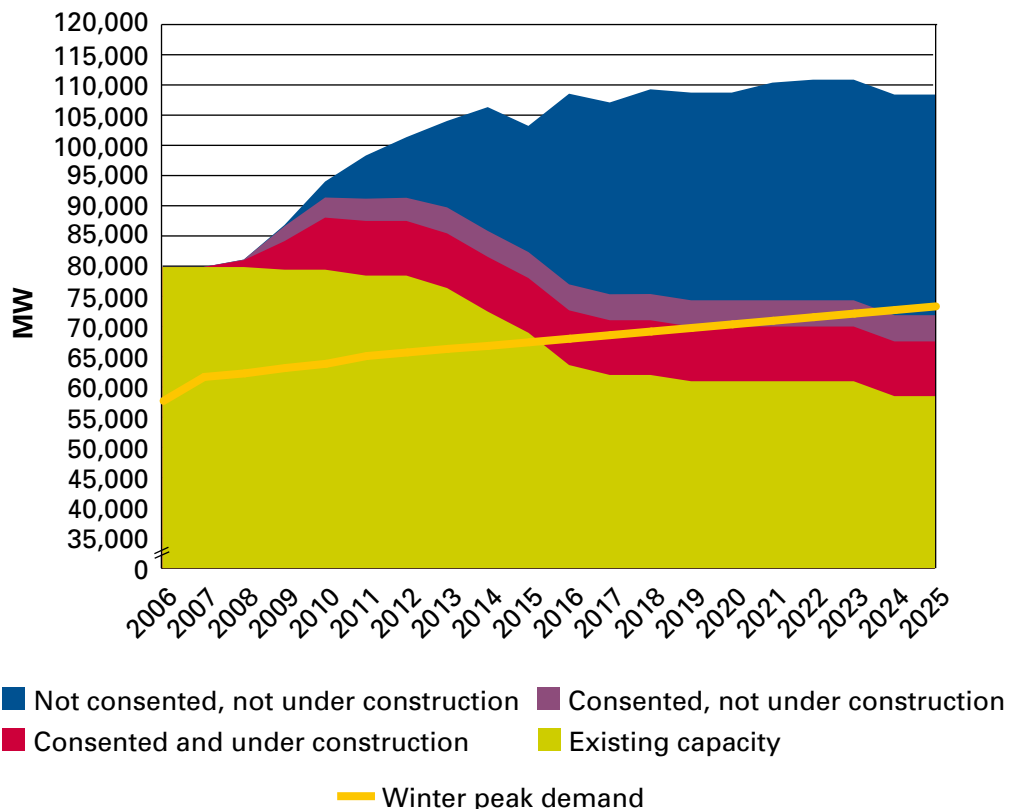
16 Figures on renewable generating capacity consented and under construction change very rapidly so these figures are likely to be outdated by the time of publication

17 There is a full list of projects on the Energy Markets Outlook website <http://www.berr.gov.uk/whatwedo/energy/energymarketsoutlook/page41839.html>

18 <http://www.nationalgrid.com/uk/Electricity/SYS/>



Chart 4.6: Existing and anticipated GB electricity generating capacity



Source: DECC/National Grid Seven Year Statement<sup>19</sup>

4.5.3 In reality, the type and total amount of new build could turn out 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 CO<sub>2</sub> prices, and the capital cost of new plant.

4.5.4 Other factors may constrain the speed and quantity of new deployment. In the context of the Renewable Energy Strategy, BERR commissioned a report<sup>20</sup> from consultants Douglas Westwood on supply chain constraints on the deployment of renewable electricity technologies. A separate report by Sinclair Knight Merz<sup>21</sup> examined constraints on the growth of UK renewable generating capacity. Both reports provide conclusions about constraints on the development of new capacity in the energy industry more generally, as set out below.

19 “Consented and under construction” includes 7.2 GW of CCGT’s under construction and an estimate of renewables under construction, taking account of embedded generation.

20 [http://renewableconsultation.berr.gov.uk/related\\_documents](http://renewableconsultation.berr.gov.uk/related_documents)

21 [http://renewableconsultation.berr.gov.uk/related\\_documents](http://renewableconsultation.berr.gov.uk/related_documents)

## Skills

- 4.5.5 Worldwide competition for human resources arises from expanding energy demand in emerging economies such as China and India, which puts pressure on upstream production capacity to expand, and increases the need for upgrading and replacing energy infrastructure in more developed economies. This is creating cross-sectoral competition for experienced staff, in particular engineers and project managers, although attracting new young people appears to be less of a problem, at least for the renewables sector.
- 4.5.6 The National Skills Academy for Nuclear was launched in January 2008. It has been set up to assess and approve training providers and, in June, entered into its first agreement for apprentice training. The Academy continues, with the Cogent Sector Skills Council, to develop training content and standards. The aim is to start 2500 students on nuclear apprenticeships in the next 5 years.
- 4.5.7 Development of Foundation Degrees with the Universities of Central Lancashire and Portsmouth is well advanced and foundation degree courses on nuclear decommissioning, nuclear related technology, nuclear project leadership and HVAC (heating, ventilation and air-conditioning) energy engineering commenced in October 2008. Over 40 students are enrolled on these programmes. A further foundation degree in nuclear engineering will be launched in January 2009. At least 150 students will enrol on these programmes over the next 3 years.

## Planning

- 4.5.8 There are numerous examples where major infrastructure projects, both for generating plant and transmission networks, have been delayed for a number of years in the planning and consenting processes. This causes delay, uncertainty and expense for all parties concerned and acts as a disincentive for investors.
- 4.5.9 The measures set out in the Planning Act<sup>22</sup> aim to make the planning and consents regime, including for major energy infrastructure projects, more streamlined and certain whilst ensuring that the rights of interested parties are safeguarded. It is intended that policy will be clearly set out

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<sup>22</sup> <http://services.parliament.uk/bills/2007-08/planning.html>

by Ministers in National Policy Statements (NPSs); and that consents will be granted by a newly established Infrastructure Planning Commission (IPC) that will have to ensure decisions are in line with national policy as defined in the appropriate NPS.

## Supply chain components

4.5.10 The Douglas Westwood report identified a number of specific constraints in the supply chain for the construction and operation of renewable electricity generating plants, some of which are also relevant to other energy infrastructure projects. For example, turbines for wind projects include blades, gearboxes, bearings, generators and forged and cast components which also form part of conventional generating turbines. Obtaining vessels and also staff able and willing to work offshore is cited as a particular concern for offshore wind turbines and wave and tidal installations, and this is also likely to be an issue for offshore oil and gas production. Other constraints are more specific to renewable technology, such as silicon for solar panels and feedstock for biomass plants.

## Grid access

4.5.11 The forthcoming substantial changes in the electricity generating fleet require large scale investment in and development of the high voltage electricity transmission network. This includes the need to extend and reinforce the transmission infrastructure into areas of the UK where the network has historically been either limited or non-existent. For example, the Highlands and Islands of Scotland have the greatest density of renewable energy resources in the UK; but the existing transmission network was not designed, and is not currently able, to transport significant quantities of electricity from there to the main centres of electricity demand in Scotland's Central Belt and northern England.

4.5.12 Elsewhere in Great Britain there are sites on the transmission network which are less heavily constrained, such as the South-West of England, and which could potentially accommodate additional new generation with minimal reinforcement. The cost-reflective charging mechanism in GB means that charges are locationally based, and provide signals to generators as to which are

the most cost-effective places to site their plant. This means that because there is spare capacity in these areas, generators building in these locations are more likely to get connected faster, and will pay less to use the system as they are essentially preventing it from being reinforced elsewhere, thereby saving costs to consumers. However, as the transmission system in the South-West of England becomes utilised to capacity, these charges will increase to provide incentives for generation to build elsewhere.

- 4.5.13 Building the necessary additional network capacity is itself subject to the same constraints as other large energy infrastructure construction projects, leading to delays in enabling new renewable generating capacity to feed electricity into the transmission network. For example, the original estimated completion date for the Beaulieu-Denny reinforcement, which is intended to transport (mainly renewable) electricity from the north of Scotland to centres of demand further south, was 2008; but it is yet to be started. The planning application is subject to a public inquiry (the inquiry itself ended in December 2007, with the Reporters currently in the process of writing up the findings).
- 4.5.14 The Government and Ofgem jointly published a final report on their Transmission Access Review in June 2008. This sets out a comprehensive set of measures intended to remove or significantly reduce the barriers to all forms of generation gaining access to the transmission network, so speeding up the connection of new generation. For an interim period a “connect and manage” system is being implemented under which generators will be able to use the transmission network when local connection works have been completed, irrespective of whether wider network reinforcements have been made.
- 4.5.15 For the longer term, a more fundamental reform of the way generators gain access to the transmission network is necessary. National Grid and the electricity industry are currently developing proposals for modifications to the existing Grid Codes to deliver this change. These proposals will need to be approved by the Gas and Electricity Markets Authority.
- 4.5.16 In addition, the way in which new grid infrastructure is planned and developed also needs to be accelerated. Ofgem are taking forward, with the transmission companies and the System Operator, development of appropriate

financial incentives to deliver the new network needed to meet the 2020 target. National Grid is leading a significant study to identify the likely scenarios and associated investment to deliver the transmission capacity required for 2020. This work is being overseen by the Electricity Networks Strategy Group, a senior industry group chaired by the Government and Ofgem.

- 4.5.17 DECC and Ofgem are also leading a project to put a new regulatory regime in place to connect up to 33 GW of offshore wind projects currently proposed in UK waters to the GB onshore grid in the most cost effective way. The new regime will ensure that there is an enduring framework in place beyond 2010 for offshore wind and other forms of offshore renewables. It is proposed that the regime should be based on competitive tenders for offshore transmission licences to own and maintain (as well as design, finance and construct where required) the transmission assets for connecting offshore renewable projects. Consultation is ongoing – in early 2009, there will be a final consultation on the full package of proposals for the offshore transmission regulatory regime. The first competitive tenders for eligible existing projects are expected to be run from ‘go-active’ in April 2009 with the regime being fully established at ‘go-live’ in April 2010.

## **4.6 Nature of new build**

- 4.6.1 Numerous different factors influence the choice between different technologies and fuels for new electricity generating capacity. Government policies such as the EU Emissions Trading Scheme and the Renewables Obligation (RO) are intended to encourage investment towards renewable and other low-carbon technologies, but considerations such as likely future fuel availability and prices, fuel efficiency, capital and operating costs and the extent to which the technology is able to respond to demand conditions are also highly relevant, as are local issues such as the availability and cost of land space, access to fuel or other primary energy sources and the local supply-demand balance. We look briefly below at some of the main issues likely to be taken into account in considering investment in the main technology options.

## Fossil fuels

- 4.6.2 As at Autumn 2008 we are aware of about 18 GW of new Combined Cycle Gas Turbine generating capacity projects at various stages in the planning and development process. Some 10.5 GW of this has consent to build and about 7.5 GW of this is under construction. We are also aware of about 13.6 GW of coal projects under development, but none of these has consent to build as yet.
- 4.6.3 Coal and gas-fired power stations have the advantage that they can be operated flexibly, regardless of weather conditions, in response to variations in demand from consumers and in supply from other generators. With gas and coal sourced from different parts of the world and coal reserves available from a much wider range of countries than is the case for gas, one provides a useful insurance against the other in case of supply problems and/or price increases. Some gas plant is able to hedge to a certain extent against high gas prices and/or problems with natural gas supply, by switching to distillate fuel. We examine the availability of gas and coal in chapters 5 and 6 respectively.
- 4.6.4 On the other hand, the availability and cost of carbon allowances as well as fuel has to be taken into account. Coal in particular is responsible for significant carbon dioxide (CO<sub>2</sub>) emissions. The Government carried out a consultation, Towards Carbon Capture and Storage,<sup>23</sup> during 2008 seeking views on further steps that could be taken to prepare for and support the development of Carbon Capture and Storage technologies, currently the only option for delivering significant reductions in fossil fuel power station emissions.

## Nuclear

- 4.6.5 As at Autumn 2008 we are aware of up to 11.5 GW of new nuclear generating capacity under consideration<sup>24</sup>, but none of this has formal consent to build as yet.

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<sup>23</sup> <http://www.berr.gov.uk/files/file46810.pdf>

<sup>24</sup> Contracted to connect to the National Transmission System. This is a normal part of the overall concept, planning and development process and does not prejudice any decisions as to whether plant will receive the necessary regulatory consent to build and operate.

- 4.6.6 In January 2008 the Government published a White Paper on nuclear power<sup>25</sup> setting out the Government's policy on nuclear power development. It stated:

*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.*

The White Paper also set out the timetable of facilitative actions necessary to enable energy companies to begin construction of the first new nuclear power station in 2013 – 2014 and start operation in 2017 – 2020.

- 4.6.7 Within the context of EdF's proposed £12.5 billion takeover for British Energy Group announced on 24 September 2008, EdF announced their objective to build four new reactors, each with capacity of about 1.6 GW, at Hinkley Point in Somerset and Sizewell in Suffolk, to come on line from 2017. In addition, the Government has reached an agreement with EdF that the company will sell land to other potential nuclear operators at some specific sites in certain circumstances. This move is expected to accelerate development of new nuclear power stations in the UK by making desirable sites available to at least one further operator.
- 4.6.8 In June 2008 the Government published a White Paper on the management of radioactive waste<sup>26</sup> setting out the framework for implementing geological disposal for the UK's higher-activity radioactive waste. Local communities were invited to open, without commitment, discussions with Government on the possibility of hosting a geological disposal facility at some point in the future.

## Renewables

- 4.6.9 As at Autumn 2008 we are aware of about 18 GW of renewable projects under development. Of this, about 8.3 GW has received consent to build and about 1.5 GW of this is under construction.

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25 <http://www.berr.gov.uk/files/file43006.pdf>

26 <http://www.defra.gov.uk/environment/radioactivity/mrws/index.htm>

4.6.10 In June 2008 the Government also published a consultation document on the UK Renewable Energy Strategy<sup>27</sup> seeking views on how to drive up the use of renewable energy in the UK as part of an overall strategy for tackling climate change and to meet the UK's share of the EU target to source 20% of the EU's energy from renewable sources by 2020. It states that because of limitations on the roll-out of renewable heat and transport, approximately half of the UK's share of the target might need to be met in the electricity sector, implying that about a third of the UK's electricity would need to come from renewable sources by 2020.

### The impact of increased renewables penetration on security of electricity supply

As explained in chapter 3, there are different aspects to security of energy supply – physical, price and geopolitical. Security of supply may also be considered over different timescales. We explained that security of supply may be influenced by any or all of: the amount of spare supply capacity; the level of diversity of (for example) supply routes and technologies; the reliability of elements of the supply chain, including fuel supplies; and by the responsiveness of the supply-demand balance to price signals and vice versa.

Renewable energy provides clear security advantages over other technologies from some of these perspectives. In the very long term, of course, the fuel inputs to renewable energy are much more plentiful than those forms of energy production which depend on the irreversible use of finite geological resources, i.e. fossil fuels and uranium. As these geological resources become scarcer and the easily accessible reserves are depleted, the commodity price can be expected to rise, encouraging both demand reduction and the development of previously unexploited supply sources as well as increasing the competitiveness of alternative energy sources. Investment and experience in these alternatives should ensure cost reductions through economies of scale and technological improvement.

Even in the nearer future, increasing our ability to meet our energy needs from indigenous sources will increase the diversity of our supplies and help to reduce the geopolitical risks which may arise from dependence on external suppliers. For example, the renewables consultation document showed that increased investment in renewables in the UK to meet a 15% renewable energy target in 2020 will reduce annual gas imports in 2020 by 12 – 14%.

<sup>27</sup> <http://renewableconsultation.berr.gov.uk/>



However, the intermittent nature of some forms of renewable energy<sup>28</sup>, in combination with the present lack of an economically viable means of storing electricity, does present new challenges to the maintenance of the short-term reliability of electricity supply in particular. This is because within any electricity system, supply and demand have to be kept in balance on a second-by-second basis. A higher level of penetration by generating capacity whose output is unpredictable (except in the short term) and uncontrollable (except by curtailment) means that the whole electricity system needs to become more flexible. This is not only a challenge for the system operator but also has implications for the efficiency, reliability and economic viability of other electricity generating plant.

Reliable, non-intermittent electricity generating capacity still has to be available to ensure that demand can be met at times of high demand and low wind output. New conventional capacity will, therefore, still be needed to replace the plant which is expected to close over the next decade or so, even if large amounts of renewable capacity are deployed. The extent and timeliness of investment in new capacity will therefore be key to ensuring security of electricity supplies in the medium term.

In the British market, electricity generating capacity does not earn money simply for existing; it earns money only when it generates, or through ancillary service contracts with National Grid requiring capacity to be available to provide standing reserve or fast start capability. This means that wholesale electricity prices are likely to rise to high levels at times when high demand and low wind speeds coincide. This is necessary in order to cover the costs of plant which does not generate very often, and so ensure that generators are incentivised to provide the necessary capacity.

There may, of course, be the reverse issue when wind speeds are high and demand is low, for example during the summer or overnight. The system may not be able to absorb all of the output of both wind and other “must-run” generating plants such as nuclear plant and plant which needs to be kept running in order to enable a reliable and rapid response to demand and wind output variability and unplanned outages. Prices may therefore go very low or even negative at such times.

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<sup>28</sup> The intermittency and otherwise of different renewable energy sources are considered in chapter 9

It is therefore possible that uncertainty over returns on investment, because of the difficulty of knowing how often plant will get the opportunity to run and the technical challenge of running plants more flexibly than they were designed for, will discourage or delay investment in new conventional capacity – or speed up the closure of existing capacity – and hence increase the risk of occasional capacity shortfalls.

However, Redpoint’s modelling<sup>29</sup> suggests that, as long as price signals are allowed to operate freely, the market should be able to provide sufficient capacity to maintain a very low probability of interruptions. This is because, despite lower load factors and lower average wholesale electricity prices, conventional capacity that is able to generate flexibly will benefit from substantially higher prices in hours when it does generate.

One challenge for industry will be to understand how the market signals, and hence their business models, will change with a high proportion of wind generation on the system. Investors have indicated that uncertainties over the market and regulatory framework are particularly difficult for them to assess, so companies may decide to wait until such uncertainties are reduced before investing. The publication of the renewables consultation document<sup>30</sup> on 26 June 2008 and the Renewable Energy Strategy in 2009 is intended to provide the market with greater certainty over future renewables policy.

Provided there is sufficient back-up capacity available on the system, the technical challenges of maintaining reliable supplies of electricity with high levels of wind generation should be manageable, albeit at higher cost than today. In the longer term, of course, it is possible that other means of improving flexibility in the supply-demand balance, such as improved electricity storage technology and dynamic demand response technologies, will also emerge.

4.6.11 The Government expects the majority of this to come from onshore and offshore wind, with important contributions from biomass, hydro and potentially major tidal range projects in the Severn Estuary and elsewhere. We examine the availability of the natural resources and the potential constraints on the deployment of technologies to exploit them in chapter 9.

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29 “Implementation of the EU 2020 renewable target in the UK Electricity Sector: Renewable support schemes” Redpoint et al (2008) available at [http://renewableconsultation.berr.gov.uk/related\\_documents](http://renewableconsultation.berr.gov.uk/related_documents)

30 <http://www.berr.gov.uk/energy/sources/renewables/strategy/page43356.html>

## Impact on the electricity market

4.6.12 The Renewable Energy Strategy consultation document also examines the issues related to a high level of renewable penetration in terms of day-to-day operation of the system<sup>31</sup>. These issues can be categorised as follows:

- additional reserve and response requirements: the System Operator, National Grid, will need to manage more and larger short term fluctuations in the supply-demand balance;
- additional pressure on other plant: conventional capacity is likely to have to run more flexibly than it has previously done, with possible implications for its efficiency, reliability and economic viability;
- additional capacity requirements: a greater total absolute amount of capacity will be needed to maintain a sufficient surplus of supply over demand when there is a higher proportion of intermittent capacity in the mix.

4.6.13 Greater variations in electricity prices, as a result of the increasing amount of generating capacity with low running costs on the one hand and the increasing running cost of conventional plant on the other, may also bring forward the development of innovative ways of arbitraging between high and low price periods. These might, for example, include new techniques of “dynamic demand management” utilising new technologies such as commercial-scale electricity storage and demand control devices which reduce electricity offtake for non-sensitive appliances such as refrigerators at periods of high demand. The future widespread use of electric vehicles could provide distributed energy storage capacity via batteries and could potentially improve the efficiency of the electricity grid by smoothing power demand between day and night. So too could storage heating.

4.6.14 With the exception of some niche markets, fuel cells are at the pre-commercial stage, with developers striving to make significant improvements in the areas of cost reduction and durability. The Government is assisting this by supporting research, development and demonstration under the Technology Strategy Board and Environmental Transformation Fund Programmes. Considerable interest is being shown in the potential use of fuel cells in distributed generation/combined heat and power, particularly at the

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31 In sections 3.9 and 10.4

individual household scale. Earlier this year it was announced that two UK utilities had entered into collaboration with separate UK fuel cell developers, which, subject to satisfactory technical progress, could lead to commercial roll out of these technologies from about 2011.

- 4.6.15 Further to a consultation exercise in 2007, the Government is also moving ahead with the deployment of advanced metering for larger businesses and assessing the case for deployment in smaller businesses and households<sup>32</sup>. On 28 October, DECC announced, as part of the Energy Bill debate, that smart meters would be rolled out to domestic customers. This technology has the potential to encourage shifts in daily demand use away from peak periods, through the conscious decision of the consumer and also, perhaps, by encouraging installation of demand control devices.

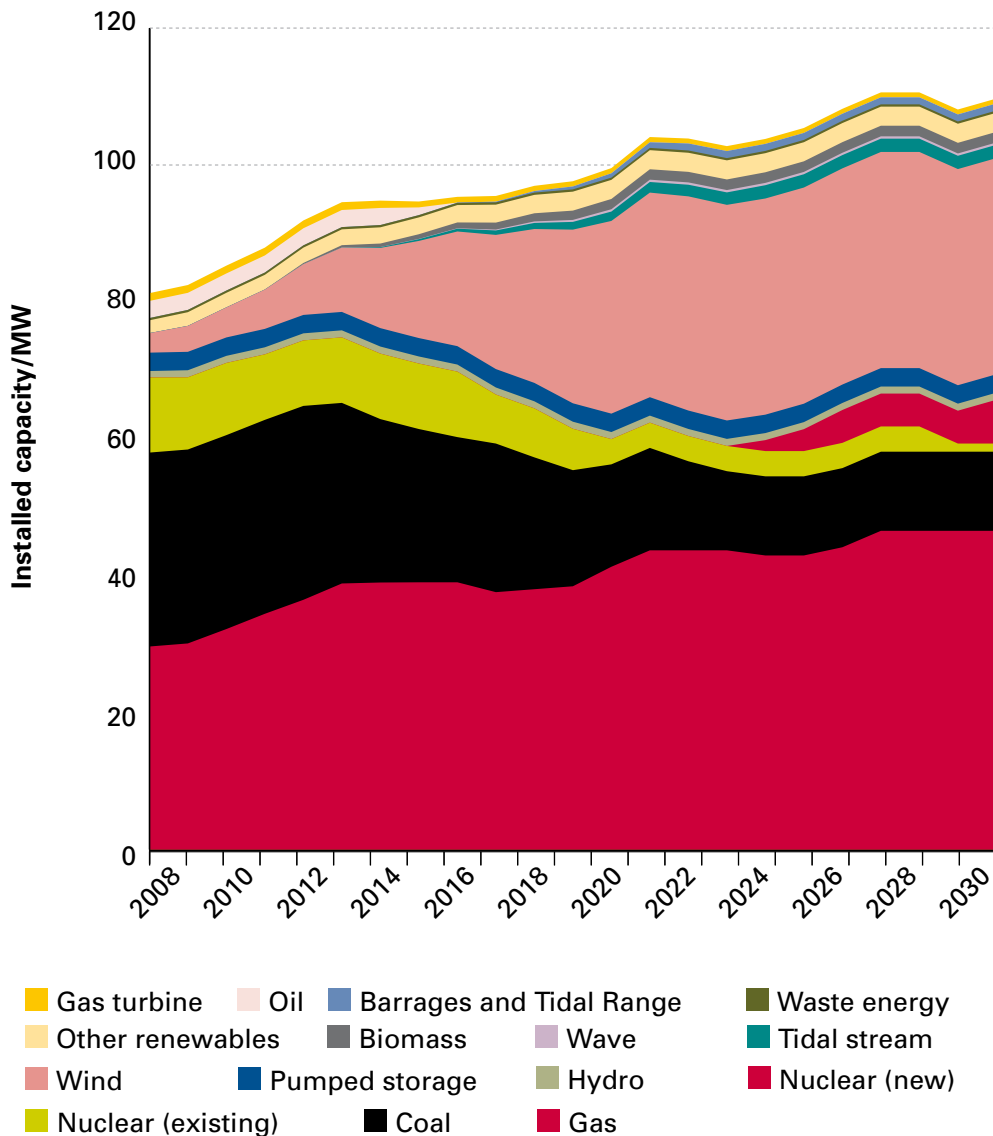
## Generating mix

- 4.6.16 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. Numerous factors, many of which are extremely uncertain, will influence how the total generating mix develops over the medium term; for example high fossil fuel prices might be expected to encourage earlier 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.
- 4.6.17 We show here the modelled development of the capacity mix under one scenario, in which the Government targets a 32% share of electricity demand to be met from renewable sources by 2020 by extending the current Renewables Obligation. The scenario used here is the central case used for illustration in the consultation document. No decision has been taken as to the level of renewable electricity deployment which the Government will aim for, or the means it will use to reach the target level.

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<sup>32</sup> <http://www.berr.gov.uk/whatwedo/energy/whitepaper/consultations/billing-metering/page40854.html>

Chart 4.7: Development of UK total (including existing) electricity generating capacity, under a policy environment designed to deliver 32% of the UK's electricity from renewable sources by 2020 through extension of the Renewables Obligation



Source: Redpoint<sup>33</sup>

4.6.18 This scenario suggests that, in total, the UK will need investment in some 47 GW of new capacity by 2020. This represents about 57% of current total capacity and an average annual deployment rate for new capacity of roughly 4 GW. This has been achieved in individual years<sup>34</sup>; 5.6 GW of new capacity was commissioned in 1967, 4.7 in 1971 and 4.2<sup>35</sup> in 1974 (and these totals do not include any plant which has since closed). However, a sustained period of new build at this rate represents a significant challenge.

33 "Implementation of the EU 2020 renewable target in the UK Electricity Sector: Renewable support schemes" Redpoint et al (2008) available at [http://renewableconsultation.berr.gov.uk/related\\_documents](http://renewableconsultation.berr.gov.uk/related_documents)  
 34 Digest of UK Energy Statistics 2008 <http://www.berr.gov.uk/whatwedo/energy/statistics/source/electricity/page18527.html>, table 5.11  
 35 3870 MW of this is at one coal station, Drax in Yorkshire

- 4.6.19 The modelling shows gas-fired capacity expanding in the next few years, quickly followed by a rapid expansion in renewable capacity. Nuclear capacity reduces at first as scheduled closures take place, and begins to expand in later years. A relatively small amount of new coal capacity is deployed as closures take place.
- 4.6.20 The gas dominance of the non-renewable generation mix increases in the medium term under this scenario. Unless this capacity is also able to switch to alternative fuels, such as distillate gas which can be stored on-site, this dominance would be likely to adversely affect the ability of the electricity generating industry to reduce its demand for gas in response to high gas prices or difficulties in obtaining gas, with consequences for the price both of gas and of electricity.
- 4.6.21 It is possible that supply chain constraints will act as a barrier to the market's ability to deliver this amount of new construction. If this is the case, it may be that other means of matching electricity supply and demand will 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.

## **4.7 Security of electricity supply: the capacity margin**

- 4.7.1 The capacity margin is the percentage by which generating capacity exceeds expected peak demand. It is given here on a de-rated basis to reflect 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 here are 70% for existing nuclear capacity and 90% for other non-wind capacity, including new nuclear. These figures reflect historically experienced average forced outage rates during peak demand periods.
- 4.7.2 In the case of wind and other intermittent renewables (wave and tidal), capacity has been de-rated using an appropriate estimate of the capacity credit. This is a measure of the amount of conventional thermal generation that intermittent generation could replace during times of peak load without any increase in the probability of lost load. It is not a static figure; it depends critically on the

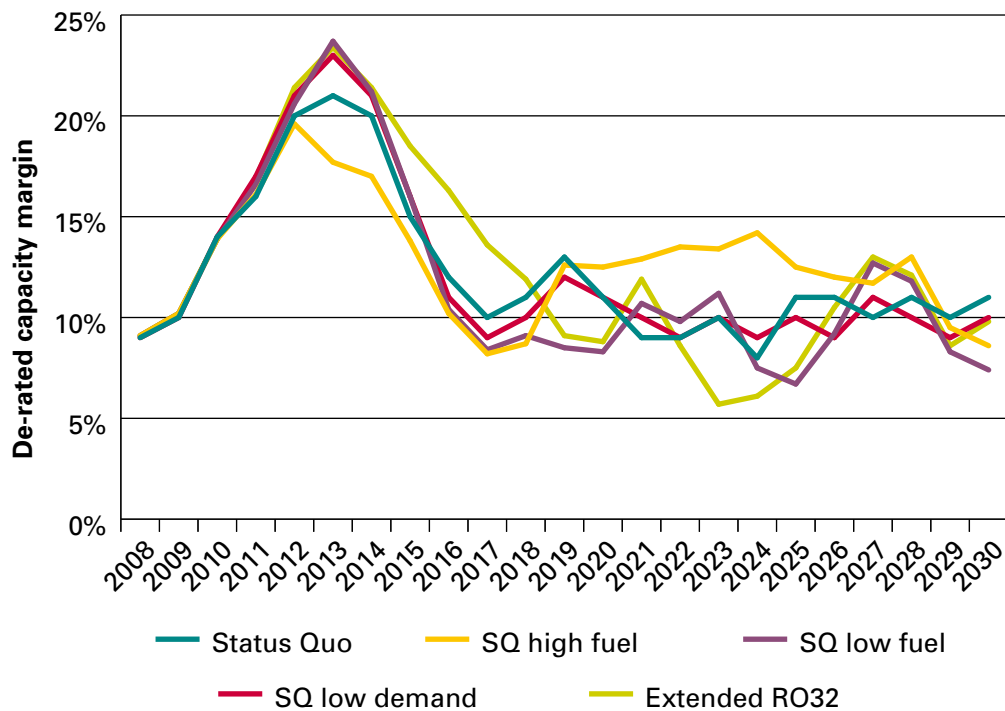
level, type and geographic distribution of penetration of intermittent generation on the system<sup>36</sup>. Therefore, the de-rating factors applied to wind, wave and tidal power evolve over time and vary between scenarios. For example, the de-rating factors applied to wind power in the scenarios set out below vary from 28% in the early years to 18 – 26% towards the end of the period, when penetrations are higher. Different assumptions of availability are possible and these would of course give rise to different results.

- 4.7.3 The effective capacity margin then depends on demand on the one hand, and on the quantity and nature of generating capacity on the other. As explained above, all are subject to a wide range of uncertainty. This means that the theoretical range of possible future effective capacity margins is very wide indeed.
- 4.7.4 In reality, however, we are unlikely to see such a wide range in the effective capacity margin because the supply of and demand for electricity, as with any commodity in a functioning market, are related to each other through price. Market participants respond to the level of expected prices, based on their expectations of supply and demand. If there is excessive supply, prices will tend to decline, which in turn will eventually encourage operators to withdraw production. This will lead in time to the reduction and elimination of the 'over-supply'. Conversely, if the market is expected to be tight, price and profit expectations will rise, thus limiting demand and encouraging new build. This chart shows how the capacity margin might develop under various scenarios.

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36 A fuller discussion of the contribution of intermittent generation to security of supply can be found at <http://www.ukerc.ac.uk/Downloads/PDF/06/0604Intermittency/0604IntermittencyReport.pdf>

Chart 4.8: Modelled levels of capacity margin under different scenarios



Source: Redpoint<sup>37</sup>

Note: The scenarios explored here are: a “Status Quo” under which no Government action is taken other than that already set out in the 2007 Energy White Paper; variations on this changing the assumptions about fuel prices (“high fuel” and “low fuel”) and demand (“low demand”); and a case in which the Government extends the Renewables Obligation to 32% (“RO32”). It should be noted that this does not include any impact from the implementation of the Industrial Emissions Directive (paragraph 4.4.6 refers).

- 4.7.5 All scenarios suggest an increase in the capacity margin over the next few years, followed by a decline to levels broadly comparable to today’s as plant closures begin to take place. However, uncertainty increases and so does the range of possible outcomes as time goes on.
- 4.7.6 This is a more favourable outlook for the capacity margin than those suggested by the same consultants’ modelling for the 2007 Energy White Paper. Reasons for this include: the fact that construction work has already started on some projects which were not anticipated in the previous model; incorporation into the model of Energy White Paper measures for energy efficiency; and higher fuel price expectations, the latter of which are likely both to reduce

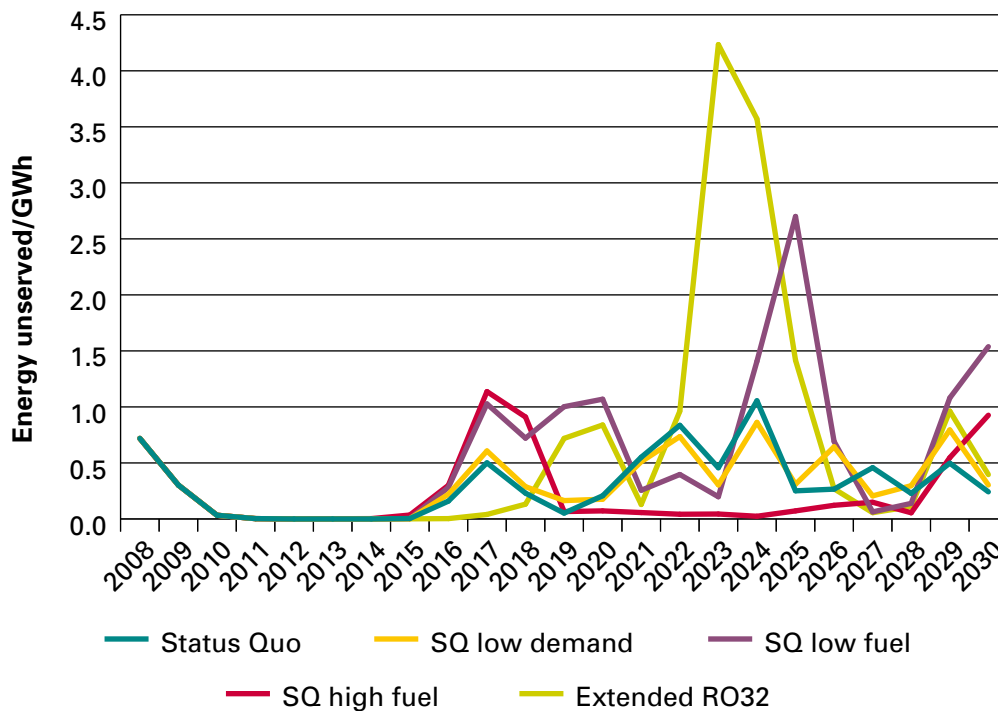
<sup>37</sup> “Implementation of the EU 2020 renewable target in the UK Electricity Sector: Renewable support schemes” Redpoint et al (2008) available at [http://renewableconsultation.berr.gov.uk/related\\_documents](http://renewableconsultation.berr.gov.uk/related_documents)



demand and to encourage the construction of new electricity generating capacity. This is because high fuel prices increase the cost advantages of more efficient new plant compared to old. Very high fuel costs would also be likely to bring forward the closure of older plant, hence the early downturn under the “Status Quo with high fuel prices” scenario included in the chart above.

4.7.7 The correlation between capacity margin and security of supply is demonstrated by comparison with the chart of “expected energy unserved”, an indicator of probability-weighted average level of energy demand which would not be met under these different scenarios. It shows that where the capacity margin is below what it would be under the Status Quo, for example 2019 – 2021 under the “RO32” case in which the Government targets a renewables penetration level of 32% by extending the Renewables Obligation, security of supply levels are also lower and the amount of energy unserved rises. Conversely, where the capacity margin is higher, for example 2020 – 2029 in the Status Quo high fuel case, security of supply levels are also higher and the amount of energy unserved is lower.

Chart 4.9: Modelled levels of energy unserved under different scenarios



Source: Redpoint<sup>38</sup>

38 “Implementation of the EU 2020 renewable target in the UK Electricity Sector: Renewable support schemes” Redpoint et al (2008) available at [http://renewableconsultation.berr.gov.uk/related\\_documents](http://renewableconsultation.berr.gov.uk/related_documents)

- 4.7.8 By way of context, a loss of 4 GWh in a single year, as is shown for 2024 under the “RO 32” case, compares with some 372 TWh demand modelled for the same year in the same scenario. It thus equates to about 0.001% of annual energy demand.
- 4.7.9 Also worth noting is that the factor which has the most strongly positive influence on the capacity margin over the longer term and on security of supply, is a high fossil fuel price. This encourages reduction in demand and increase in supply as it becomes more worthwhile to build new capacity which is less fuel-hungry than existing plant, either because it is more efficient or because it does not use fossil fuels at all.

## **4.8 Security of electricity supply: Network reliability**

- 4.8.1 Electricity transmission and distribution network owners are subject to price controls set by Ofgem. The price controls are designed to provide the companies with an efficient level of investment, whilst ensuring that customers receive value for money. In addition to the core price controls, the transmission and distribution network operators are subject to incentives which complement these provisions.
- 4.8.2 The three transmission network operators in Great Britain face regulatory incentives 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 the seven years commencing 2000, the National Grid transmission network in England and Wales experienced an average loss of unsupplied energy of only 533MWh p.a. This equates to a transmission reliability of approximately 99.99983% over the period, measured in terms of the index of unsupplied energy to energy actually delivered. It compares favourably with other European countries, as the majority of the GB transmission system is built to a higher level of security than its counterparts, at an efficient level of cost.
- 4.8.3 The operators of electricity distribution networks in Great Britain also face incentives to reduce the number and 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.

## Distributed electricity and security of supply

The emergence of electricity generating technologies which are less dependent on economies of scale and can more easily be sited near to or in population centres suggests that we are likely to see a growth in generating capacity which feeds into local distribution networks rather than into the national transmission system. This would offer significant economic and efficiency benefits, particularly where heat as well as electricity can be put to commercial use, and reduce pressure for expansion of the national transmission system.

However, this is unlikely to lead to an entirely decentralised system in which all demand is met from local sources via separate, isolated networks. Interconnection at a national or even larger scale via a high voltage transmission system enables the pooling of both generation and demand, which in turn offers a number of economic and other benefits.

An interconnected transmission system provides a more efficient bulk transfer of power from generation to demand centres; and, by linking together all participants across the transmission system, makes it possible to select the cheapest generation available. It enables surplus generation capacity in one area to be used to cover shortfalls elsewhere on the system, resulting in a reduction of the total installed generation capacity required to provide sufficient generation security for the whole system.

Without transmission interconnection, each separate system would need to carry its own back-up capacity to respond instantaneously to meet demand variations, but with interconnection the net response requirement only needs to match the highest of the individual system requirements to cover for the largest potential loss of power (generation) rather than the sum of them all.

While we expect to see an expansion in locally-connected generating capacity, therefore, this is expected to complement rather than replace existing larger-scale infrastructure, which will nevertheless need to adapt and evolve to meet changing demand and supply conditions.

- 4.8.4 It is National Grid's responsibility as System Operator to ensure real-time balancing of the transmission system. National Grid is able to procure services well ahead of real time, as well as a range of ancillary services that it can call upon at short timescales. It can also accept bids and offers in the Balancing Mechanism, and has a range of mandatory service provisions and technical characteristics that generators must be capable of providing if they are to be connected to the transmission system. Not only does National Grid contract with generators, it also contracts with adjustable loads on the demand side, to be prepared to adjust offtake at short notice.
- 4.8.5 The transmission system is also built to accommodate major contingencies including the loss of the largest single source of power on the system, Sizewell B (1320 MW); and National Grid has already dealt with instantaneous demand side fluctuations of up to 2900 MW (the TV pick-up effect). No system can be immune to every contingency, however, as was demonstrated on 27 May 2008 when near-simultaneous outages at two large power stations led to widespread if short-lived interruptions to electricity supply in some parts of Great Britain<sup>39</sup>. Resilience measures on the grid system operated successfully to stabilise and recover the situation; nevertheless, work is under way to identify any lessons which can be learned from that experience and the subsequent response to it.

## Future development of electricity networks

- 4.8.6 Ofgem and its academic partners are looking at a range of future scenarios for electricity networks that could arise as a consequence of market and policy developments and have initiated the long-term electricity network scenarios (LENS) project.
- 4.8.7 The project facilitates the development of a range of future electricity network scenarios for Great Britain for 2050. This provides a framework for discussion between stakeholders on longer term electricity network development issues. Whilst assisting strategic thinking amongst stakeholders in industry and Government within various contexts, the project is not aimed at developing or prescribing particular investment strategies for electricity network companies.

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<sup>39</sup> National Grid's preliminary report of the incident and the electricity industry's response to it is available at <http://www.nationalgrid.com/NR/rdonlyres/D680C70A-F73D-4484-BA54-95656534B52D/26917/PublicReportIssue1.pdf>

4.8.8 The LENS project has identified three main drivers of change. First, “environmental concern”, or the level to which the environment affects the decision-making of individuals, communities, private companies, public institutions and the Government (on a UK and global basis). Second, “institutional governance”, or the extent to which institutions will intervene in the energy market and the development of the electricity networks. Finally, “consumer participation”, or the level to which all types of consumers (commercial, industrial, domestic and public) are willing to participate actively in the energy/electricity market and to drive greater energy efficiency. Based on a consideration of the plausible evolution of these drivers, the Final Report sets out five scenarios for the future development of GB electricity networks:

- **Big Transmission and Distribution**, in which the transmission system operators (TSOs) are at the centre of networks activity. Network infrastructure development and management continues as expected from today’s patterns, while expanding to meet growing demand and the deployment of renewable generation;
- **Energy Service Companies**, in which energy service companies (ESCOs) are at the centre of developments in networks, doing all of the work at the customer side. Networks contract with such companies to supply network services;
- **Distribution System Operators**, in which distribution system operators (DSOs) take on a central role in managing the electricity system. Compared to today, distribution companies take much more responsibility for system management including generation and demand management, quality and security of supply, and system reliability, with much more distributed generation;
- **Microgrids**, in which customers are at the centre of activity in electricity networks. The self-sufficiency concept has developed very strongly in power and energy supplies. Electricity consumers take much more responsibility for managing their own energy supplies and demands. As a consequence, microgrid system operators (MSOs) emerge to provide the system management capability to enable customers to achieve this with the new technologies;
- **Multi Purpose Networks**, in which network companies at all levels respond to emerging policy and market requirements. TSOs still retain the central role in developing and managing networks but distribution

companies also have a more significant role to play. The network is characterised by diversity in network development and management approaches.

- 4.8.9 These scenarios suggest a range of plausible outcomes for GB electricity networks that is perhaps wider than is often acknowledged in recent debates about energy policy and network investment. They imply that radical change for the electricity sector, including networks, and related sectors (such as transport and heat) is both possible and, depending on how key underlying driving forces play out, conceivable.
- 4.8.10 The breadth of the scenarios suggests that regulatory policy will need to be sufficiently flexible and adaptable to accommodate uncertainty and potentially radical change. For several scenarios, stakeholders may need to develop strategies and act on them in relatively short timeframes. It will be important that Ofgem and other policy makers do not inadvertently close off options for the development of the networks and the wider sector they serve.
- 4.8.11 In addition, National Grid, in conjunction with the two Scottish Transmission owners, is undertaking a study on the various investment options that would help facilitate the UK meeting its renewable and CO<sub>2</sub> targets. The results of this work will be made available in early 2009.

## **4.9 Conclusions**

- 4.9.1 In the near term, there is a relatively large amount of new plant under construction. However, in the medium term as plant start to close, the electricity generating industry faces a substantial challenge in ensuring delivery of the new generating capacity that will be needed if Britain is to maintain security of supply at similar levels to those so far enjoyed. There is considerable uncertainty and hence a wide range of possible out-turns around future levels of electricity demand and new electricity build, as well as the exact timing and sequence of plant closures. In any scenario, improvements in energy efficiency and demand-side responsiveness would help to underpin continued security, as well as limiting the need to invest in new generating capacity. This is an area which the Energy Markets Outlook will continue to monitor closely.
- 4.9.2 In the longer term, of course, uncertainty – for example, as to relative fuel prices, environmental regulation and the

development of global supply chains – becomes far greater; and the possibility of currently unforeseen technological advances in generation, transmission and distribution and demand side management enters into the equation. Government policy will need to evolve to ensure that these uncertainties do not prevent the necessary development of new generating capacity.

- 4.9.3 This is already happening in a range of areas from the Planning Act 2008 to moves to establish a market framework that will bring forward new renewables, new nuclear and clean coal plant. The Energy Act has also updated the legislative framework to reflect the availability of new technologies, such as carbon capture and storage, which would enable coal fired generation to be deployed in a way consistent with the transition to a low carbon economy, and emerging renewable technologies. The Government is also determined to take appropriate action to support the development of CCS technology.
- 4.9.4 The Government is also ensuring there are no unnecessary barriers to the deployment of new nuclear power, and the appropriate regulatory frameworks are in place for nuclear new build. In January 2008 the Government published a White Paper on nuclear power setting out the Government's policy on nuclear power development. The White Paper also set out the timetable of facilitative actions necessary to enable energy companies to begin construction of the first new nuclear power station in 2013 – 2014, to start operation in 2017 – 2020.
- 4.9.5 The Government has set aggressive targets for the deployment of renewables, to implement the EU's target of delivering 20% of energy demand from renewable sources by 2020, and for emissions as set out in the Climate Change Act 2008. Its 2008 consultation sought views on how to achieve the level of deployment of renewable energy in the UK at the speed and scale required. This will help to shape the UK's Renewable Energy Strategy which will be published in first half of 2009.
- 4.9.6 Energy efficiency is an important strand to the Government's approach, offering the possibility of a reduced need for new generation and gas supply infrastructure in the future.

## Electricity supply and demand in Northern Ireland

There are three power stations in Northern Ireland (NI), two of which are gas fired and one which is coal/oil fired and which has 'opted in' to the Large Combustion Plants Directive. Northern Ireland has current total installed generation capacity of 2,793MW (including renewables). Allowing for availability of generation plant, the current peak demand which can be met is around 2,172 MW with an estimated peak electricity demand expected during 2008/09 of around 1,702 MW. Indigenous renewables currently account for around 5% of electricity output. Forecast estimates of future generation capacity margins in NI can be found in the System Operator for Northern Ireland (SONI) 'Generation 7 year Capacity Statement'<sup>40</sup>. There are currently proposals to construct a new 450 MW CCGT and two 40MW OCGT (Open Cycle Gas Turbine) peaking units.

Around 400MW of wind generation will shortly be connected, and a further 1.2GW is currently in the planning process. Governments in Northern Ireland and the Republic of Ireland recently completed a study into how the electrical grid on the island could accommodate increased levels of renewable generation. The study concluded that it was technically feasible for up to 42% of generation by demand to be from renewable sources, mainly on-shore wind. The study implications, in relation to grid strengthening in particular, are being taken forward in conjunction with the Regulator SONI, and NIE, the electricity grid owner.

Introduction of the all-island Single Electricity Market ("SEM") for trading in wholesale electricity on 1 November 2007 has brought greater competition in generation and substantially increased the potential generation mix available for supplying Northern Ireland customers. The retail electricity supply market in NI was fully opened from the same date.

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40 [www.soni.ltd.uk/upload/Gen\\_SYS\\_2004\\_Final.pdf](http://www.soni.ltd.uk/upload/Gen_SYS_2004_Final.pdf)



## Interconnection

The Moyle interconnector links NI with Scotland and has a capacity of 450 MW. The North-South interconnector linking the NI and Republic of Ireland ("RoI") networks has a capacity of 600MW. However, net transfer capacity is limited to some 300 MW, North to South, mainly because of transmission constraints in RoI.

It is planned to build a second North-South interconnector by late 2012 which will more than double North-South trading capacity. The second interconnector will provide benefits to Northern Ireland, including:

- improved security of supply through network stability and access to additional power supplies;
- greater grid support to allow for additional wind power generation;
- scope for improved competition in the SEM with the opportunity for cost savings to NI and RoI consumers; and
- access for NI generators to a larger market for export opportunities.

Following the installation of the second North-South interconnector, it is proposed to replace the separate generation adequacy standards in Northern Ireland and the Republic of Ireland with a combined all-island generation security standard.

## 5. Gas

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### 5.1 Introduction

- 5.1.1 The UK has benefited from indigenous reserves of gas for many years but, as North Sea reserves decline, we will become increasingly dependent on imported gas. Gas imports are already meeting around a third of the UK's total annual gas demand, potentially rising to around 80% by 2020, although measures to maximise economic recovery of remaining gas reserves from the UK Continental Shelf may help to reduce that proportion.
- 5.1.2 Higher levels of import dependence bring new risks. These are not necessarily any greater than the risks to indigenous supplies (which may arise, for example, due to technical difficulties, adverse weather conditions or problems with industrial relations) and they cannot be avoided altogether. They therefore need to be managed. Options for doing this, all of which are under way, include:
- Facilitating and encouraging investment in gas storage and import infrastructure to maximise the diversity of options available for gas supply;
  - Improving the effectiveness and transparency of UK and EU gas markets so as to enable gas to be delivered more efficiently to where it is needed;
  - Working with international partners to improve the functioning of global energy markets. This includes work at EU level, in particular in the context of the EU's Strategic Energy Review, and the ongoing oil consumer-producer dialogue which was established at the Jeddah energy meeting in June;
  - Facilitating and encouraging flexibility on the demand side; and
  - Through a focus on the more efficient use of energy, ensuring that our gas import requirement is no greater than it needs to be.
- 5.1.3 This diversity of options increases the likelihood that gas demand will be met, but also increases uncertainty as to the balance of sources. The demand outlook is also particularly uncertain given likely forthcoming changes in

the electricity generation sector and possibly also in domestic heating. This chapter looks at recent developments and projections and the implications for security of supply.

- 5.1.4 Where this chapter presents data and projections from National Grid covering the National Transmission System<sup>41</sup>, drawing on analysis for their report *Transporting Britain's Energy 2008*, these refer to the supply-demand balance in Great Britain. DECC's own data and projections<sup>42</sup> refer to the UK as a whole, but these focus on annual (or, for historic data, at best monthly) periods. There are other views on a range of issues such as the level of UK gas production or where our gas imports will come from<sup>43</sup>.

## 5.2 Demand

- 5.2.1 The UK is the largest gas consumer in Europe with demand representing close to a fifth of the EU total and 3% of the global total. In addition to meeting domestic gas demand, supplies to Great Britain are also needed to meet demand from Northern Ireland and the Republic of Ireland and for (gross) exports to the Continent through the Bacton–Zeebrugge Interconnector. Irish gas import demand is currently met through pipelines from Scotland; in future some Irish demand might be met by direct importation of LNG<sup>44</sup>.
- 5.2.2 Peak monthly demand has fallen in recent years as a result of milder winters and, especially, higher prices; but there remains a very strong seasonal pattern, with much lower demand in summer. Household demand is much more seasonal than industrial demand, which is more sensitive to price. Demand for gas for electricity generation is sensitive to the price of gas and also to the coal–gas price differential, which is in turn influenced by the level of the carbon price which affects the cost of generating electricity from coal and gas-fired power stations to differing extents.
- 5.2.3 The principal issue for security of supply purposes is the ability to deliver enough gas to meet demand both throughout the year and on the coldest days of the year.

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41 <http://www.nationalgrid.com/uk/Gas/OperationalInfo/TBE/> chapter 3 sets out the rationale behind the Base Case supply forecast for all supply sources and storage.

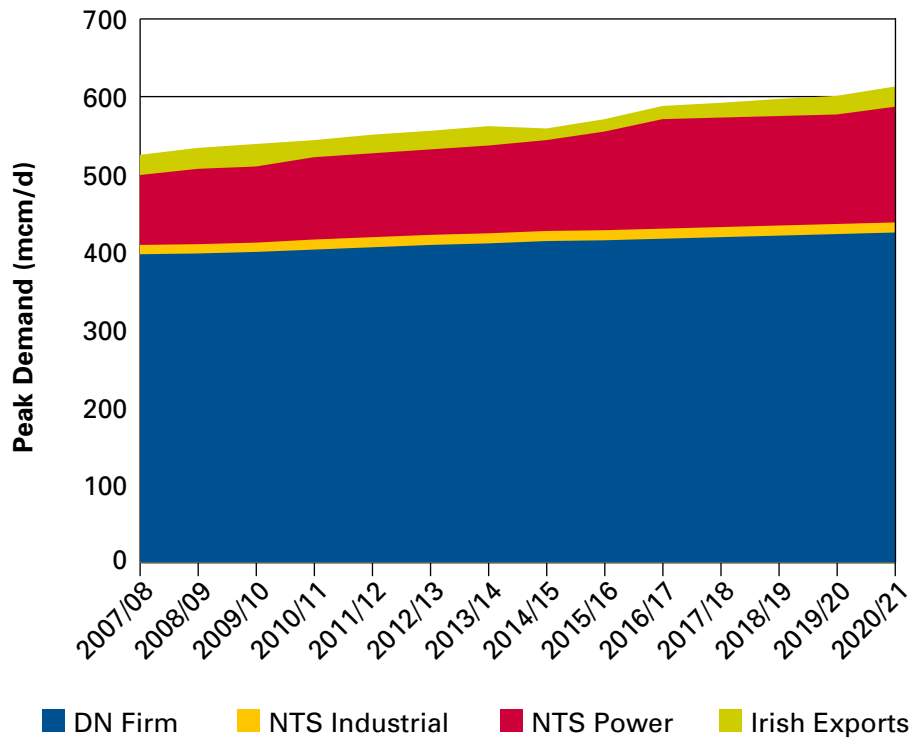
42 Chapter 4 in and Annex F to the *Digest of UK Energy Statistics 2008* (DUKES 2008, <http://www.berr.gov.uk/whatwedo/energy/statistics/publications/dukes/page45537.html>) provide background information on the production, transmission and consumption of natural gas in the UK.

43 <http://www.berr.gov.uk/files/file41820.pdf>

44 <http://www.shannonlngplanning.ie/>

We therefore show National Grid’s Base Case projections for peak and annual gas demand illustrated in the next two charts<sup>45</sup>. National Grid is expecting both peak and annual demand to grow, with the main growth in both cases coming from the electricity generating sector.

*Chart 5.1: Base Case Peak Gas Demand Forecast*



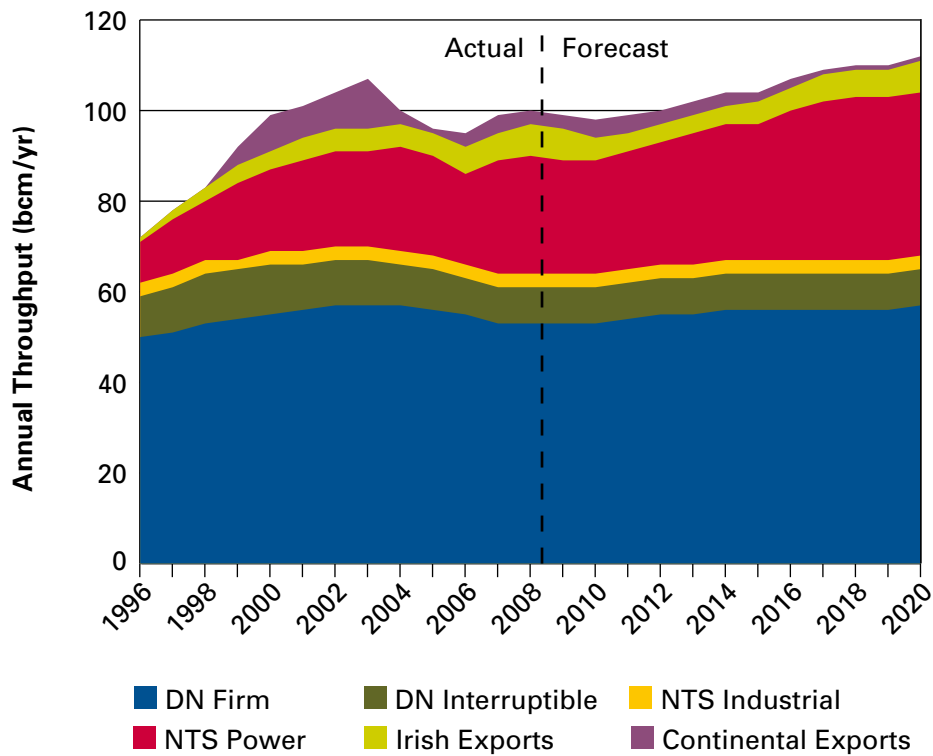
*Source: National Grid*

*Note: DN Firm: Distribution Networks – broadly, domestic, commercial and smaller industrial demand. NTS Power: Electricity generation. NTS Industrial: Large industrial consumers who take delivery direct from the national transmission system.*

*Note: This is peak day demand in a 1-in-20 cold winter and thus very much higher than peak day demand actually observed in recent winters.*

<sup>45</sup> Further details of National Grid’s gas demand methodology and the range of factors leading to variations in demand – such as the rate of economic growth, developments in energy efficiency and the degree of success of the Renewable Energy Strategy – are available in a National Grid paper on the Energy Markets Outlook gas page on the BERR website. <http://www.berr.gov.uk/whatwedo/energy/energymarketsoutlook/page41839.html>

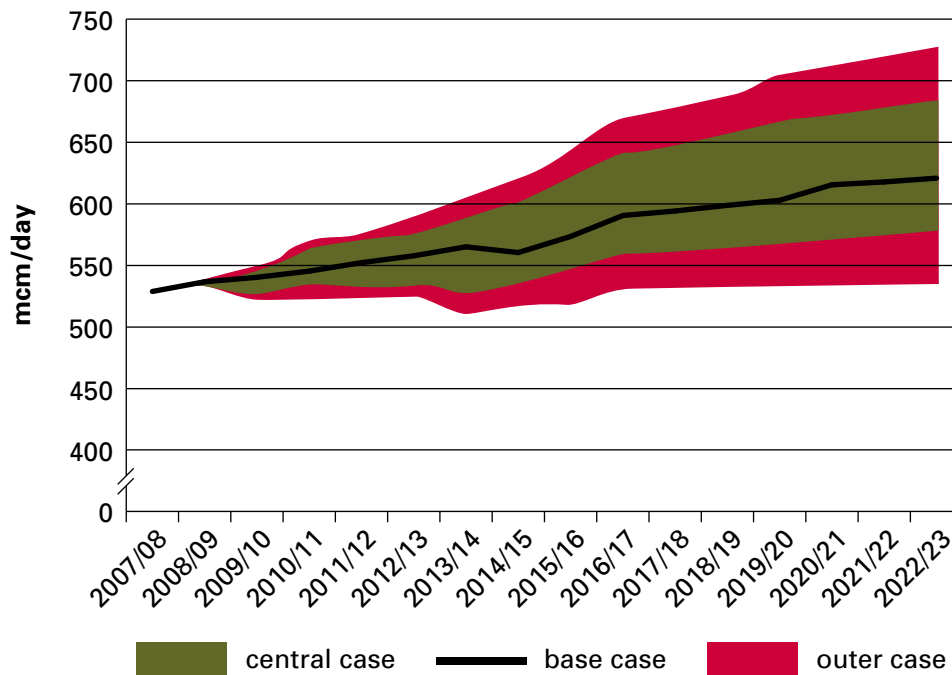
Chart 5.2: Actual (historic) and Base Case Forecast Annual Gas Demand



Source: National Grid

5.2.4 There is significant uncertainty around these Base Case forecasts. Factors such as the gas price, the success of energy efficiency policies, general economic conditions and the deployment and use of gas-fired electricity generating capacity may all have an effect in one direction or another.

**Chart 5.3: Sensitivities around base case peak day demand forecast**

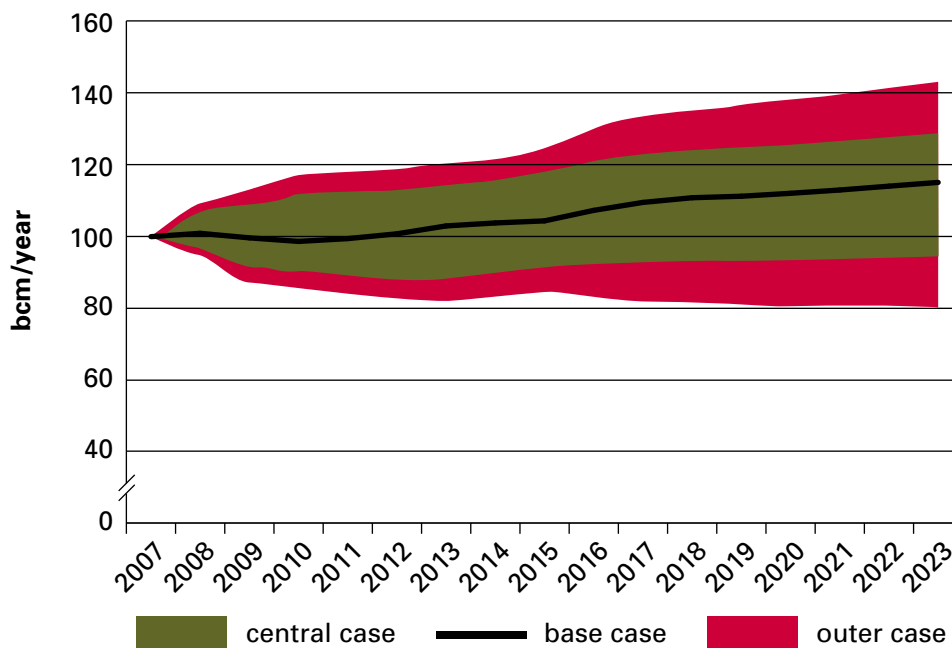


Source: National Grid

Note: This is peak day demand in a 1-in-20 cold winter and thus very much higher than peak day demand actually observed in recent winters.

5.2.5 In the case of annual demand, weather trends are also a significant factor.

**Chart 5.4: Sensitivities around annual forecast**



Source: National Grid

5.2.6 The UK Government's Renewable Energy Strategy<sup>46</sup> requires a ten-fold increase in the level of renewable energy in the UK over the next 12 years. On the Government's central assumptions this would see a reduction in annual UK gas consumption in 2020 of around 10 per cent from the level previously projected. On the chart above that would be towards the lower part of the range shown, below the "base case". Given the high level of import dependency expected then, the reduction in net annual imports would be a slightly greater percentage, perhaps 12 – 14% in 2020 compared to what it would otherwise have been<sup>47</sup>. Peak daily consumption, however, may not be very much affected; if a cold day coincides with still weather, wind generation will not be able to contribute very much to reducing the pressure on gas demand from the electricity generating sector.

### 5.3 Sources of Supply

5.3.1 There are a number of potential sources of supply to meet UK gas demand. These include: production from the UK Continental Shelf (UKCS), which peaked in 2000 and is expected to continue to decline; imports by pipeline directly from Norway (currently via Vesterled, Langeled and the Tampen Link); imports from the Continent through the (Interconnector and BBL) pipelines to Bacton in Norfolk from Zeebrugge in Belgium and Balgzand in The Netherlands; and imports of Liquefied Natural Gas (LNG) by tanker (to the Isle of Grain, Teesside, soon Milford Haven and in future potentially elsewhere). Gas storage facilities also provide a role in matching supplies from these sources and demand.

5.3.2 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 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 are intended to ensure that the proposed Infrastructure Planning Commission can handle applications for development consent for gas supply infrastructure in England comprising

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46 <http://www.berr.gov.uk/whatwedo/energy/sources/renewables/strategy/page43356.html>

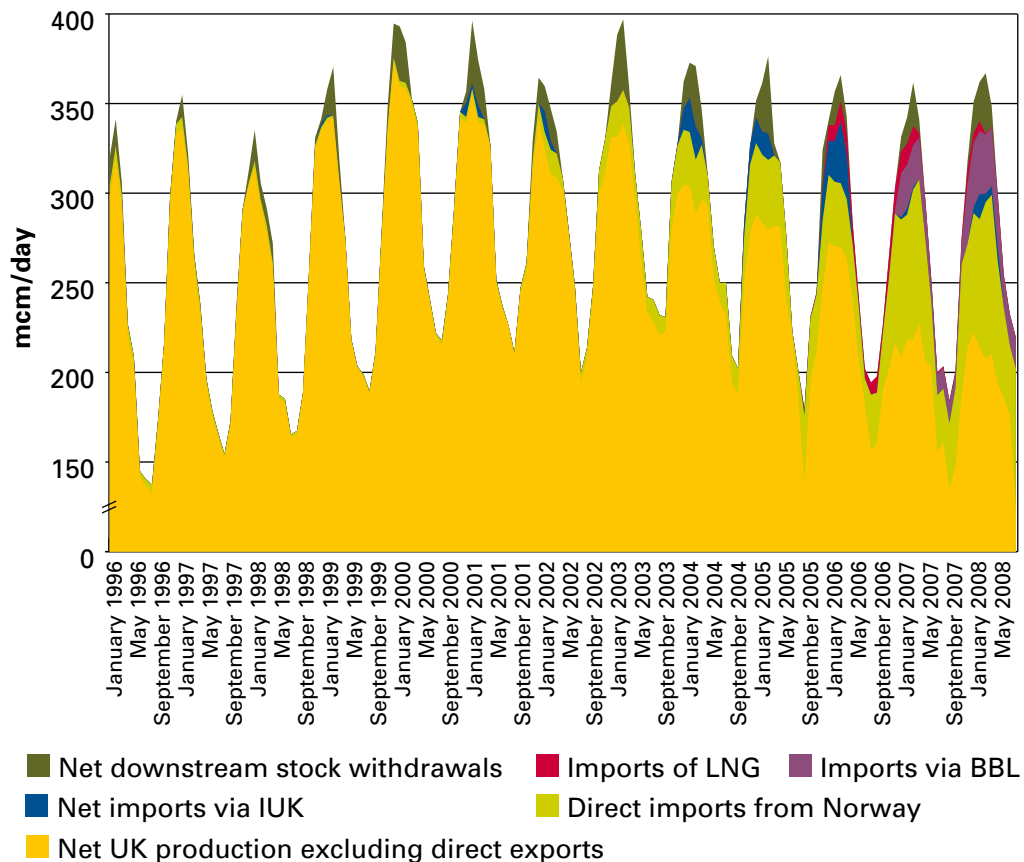
47 Paragraph 10.4.5 of the Renewable Energy Strategy

gas storage facilities, LNG import facilities, gas reception facilities and connection pipelines.

5.3.3 Each of these sources will deliver a greater or lesser proportion of total demand depending on several factors which vary daily or seasonally and with varying levels of predictability/manageability e.g. price, production conditions and contractual arrangements.

5.3.4 The chart below illustrates the monthly variation in the principal sources of UK gas supply<sup>48</sup>. The much-reduced level of seasonal flexibility in supply from UK production is evident, partly reflecting a greater share of production from associated gas fields<sup>49</sup> and less from dry gas fields and partly also because there are now no demand constraints. Also evident is the rapid increase in imports, especially from Norway, as UK production continues to decline. On a monthly basis, the use of storage does not appear to have grown in line with the growth of imports, having been broadly stable relative to total demand since winter 1999/2000.

Chart 5.5: UK Monthly Gas Supply



Source: DECC

48 <http://www.berr.gov.uk/whatwedo/energy/energymarketsoutlook/gas/page41850.html>.

49 About 60% of UKCS production is associated with oil production.

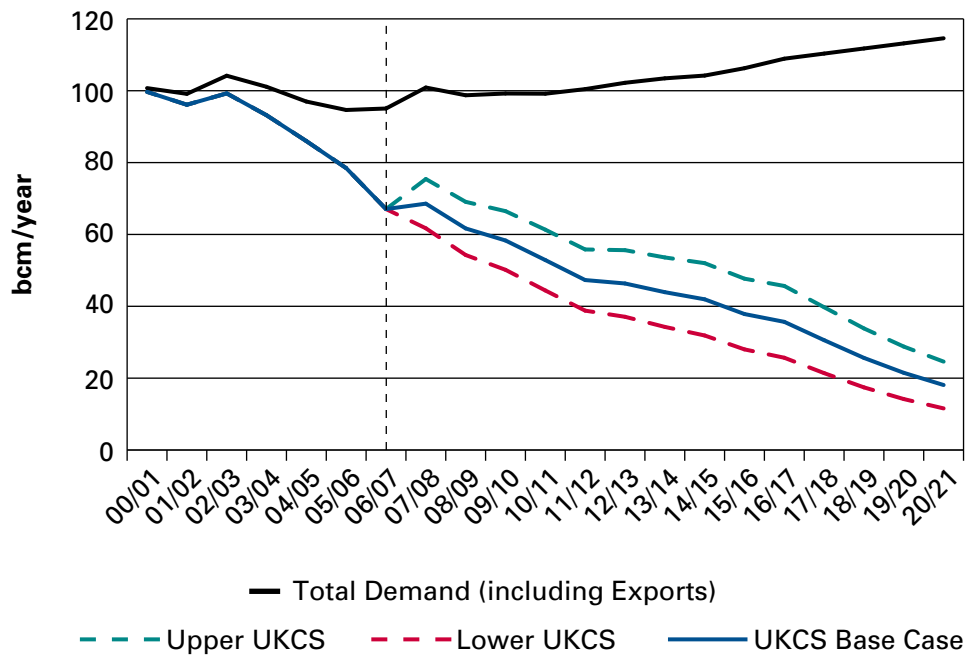


- 5.3.5 The constitution of future gas supply for both annual and peak analyses is subject to considerable uncertainty. This is due to numerous reasons, notably:
- supply capacity generally exceeds supply availability;
  - because of demand seasonality, supply availability generally exceeds demand;
  - for numerous supplies there are options to supply gas to alternative markets;
  - the role of storage in meeting demand.
- 5.3.6 National Grid's Base Case supply forecast is based on declining United Kingdom Continental Shelf (UKCS) production and increasing import dependency. In constructing their Base Case, National Grid break down supply into three main components, namely UKCS, imports and storage. For imports they further assess by supply type (Norway, Continent and LNG) and import routes (i.e. Vesterled, Langeled, BBL, IUK, LNG terminals).
- 5.3.7 As all supplies have a degree of uncertainty associated with them, supply ranges are considered for all supply types. Whilst these can be readily illustrated individually, it is difficult to show the interaction between supply types.

## 5.4 UK Production

- 5.4.1 UK gas production peaked in 2000 and has been declining since. That trend is generally expected to continue, as shown in the chart below which compares National Grid's range of forecasts of annual UKCS gas production with their Base Case forecast of annual UK gas demand. As with projections of demand, projections of UK gas production are inherently uncertain and should be treated as indicative rather than definitive. One particular area of uncertainty is whether and, if so when, significant volumes of gas from West of Shetland will be developed and brought to market; if this is not the case, the rate of decline will be greater.

Chart 5.6: Annual UKCS Gas Production Actual, Base Case and Range and Demand



Source: National Grid

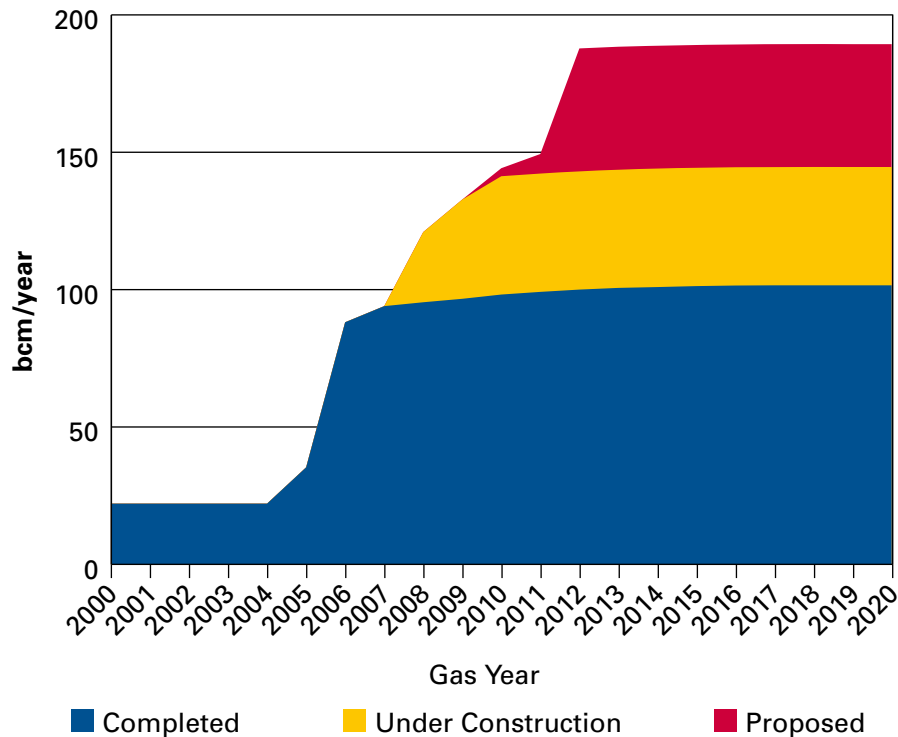
5.4.2 Supplies from the UKCS are considered as the first source of supply in determining National Grid’s supply forecasts, based on the following considerations:

- currently, the UKCS remains the major supply component;
- most UKCS fields are already in production;
- there are very limited options for UK production to supply alternative markets;
- low production/transportation costs.

## 5.5 Imports

5.5.1 UK gas import demand is set to rise to a significant scale in terms of global and, in particular, European gas demand. Notionally, as shown in the following chart, annual gas import capacity is already sufficient to meet annual UK gas demand and it is expected to grow significantly in the next few years.

Chart 5.7: Annual Import Capacity Build-up



Source: National Grid

5.5.2 Import reliance, although neither new to the UK nor uncommon around the world, can bring additional risks of disruption to supply sources. These risks may include, for example, lack of access to pipeline infrastructure outside UK borders or low market liquidity or competitiveness. Liquid, competitive markets can facilitate the transportation of gas to where it is valued most and investment in interconnection, import facilities and source development; their absence can prevent gas from being produced and delivered as and when needed<sup>50</sup>.

5.5.3 While the UK gas market is one of the most liquid markets in the world and the most liquid in Europe, there is a relative lack of liquidity and competitiveness in some of the markets from which we import gas supplies. This needs to be borne in mind when we consider the likely responsiveness of the international marketplace to price signals from the UK. In the winter of 2005 – 2006, for example, imports from the Continent proved difficult to obtain despite a very strong price signal, due to a combination of regulatory, commercial and infrastructure constraints; some of these are in the process of being addressed through EU market liberalisation.

50 <http://www.berr.gov.uk/files/file41845.pdf>

- 5.5.4 Nevertheless, the UK market now enjoys a wider diversity of supply sources and supply routes and this should increase our resilience to interruptions to, or reductions in, flows from individual supply sources, whether domestic or external.
- 5.5.5 The world's gas reserves are relatively concentrated, with 41.3% of the world total held in the Middle East (15.7% in Iran, 14.4% in Qatar) and 30.2% in the former Soviet Union (25.2% in the Russian Federation)<sup>51</sup>. 1.7% of the reserves are in Norway.

## Imports from Norway (direct by pipeline)

- 5.5.6 Norwegian flows to Europe (Germany, France and Belgium) in the past two winters have been close to, but not at, the capacity of the pipelines through which the gas flows. Norwegian supplies direct to the UK have, broadly, been a residual after they met their contractual commitments under long-term supply contracts to those markets. At times of peak supply they have nevertheless approached the import capacity of the pipelines direct from Norway to the UK. Additional supplies from Norway may arrive in the UK via one or both of the pipelines from the near Continent to Bacton (see below) or possibly, in future, by tanker, since some Norwegian production (from the Snøhvit Field) is now exported as LNG. Any significant additional Norwegian production would be likely to require new export capacity.
- 5.5.7 The next chart shows National Grid's forecasts of Norwegian pipeline export capacity and flows to the UK. Supplies from Norway are considered as the second source of supply in determining National Grid's supply forecasts, based on the following considerations:
- in terms of the UK supply mix, Norway is an important and growing supply component;
  - an expectation of increasing Norwegian production;
  - though the offshore Gassled network is extensive, flows through existing pipelines to the Continent are close to capacity; with limited options to supply extra gas to the Continent the UK is expected to receive much of any increased production;
  - relatively low production costs.

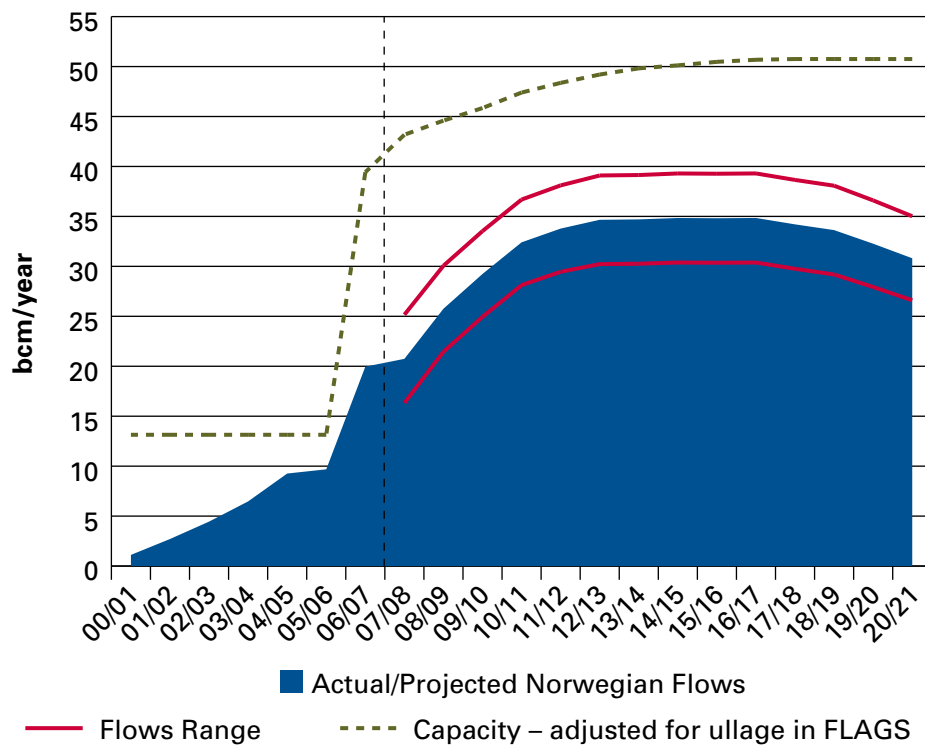
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<sup>51</sup> BP Statistical Review of World Energy 2008, available at <http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622>

5.5.8 National Grid’s Norwegian forecast is based on limited information received through consultation with the UK energy industry<sup>52</sup>, commercially available Norwegian field data and interpretation of aggregated Norwegian production forecasts from Norwegian agencies. To determine flows to the UK, National Grid assess Norwegian production against pipeline capacities to the UK and Continent. They have also assumed no new major Norwegian export pipelines are built in the near future.

5.5.9 Assessment of historic utilisation rates for the pipelines transporting Norwegian gas to the Continent has enabled National Grid to create a range for Norwegian import flows to the UK. These are typically  $\pm 4.5$  bcm/year.

*Chart 5.8: Actual/Projected Annual Norwegian Import Capacity and Flows*



Source: National Grid

## Imports from Europe

5.5.10 There are two pipelines between the UK and the near Continent, importing gas from the rest of the EU. This will include gas produced within the EU, for example in the Netherlands, as well as gas imported from outside the EU,

52 <http://www.nationalgrid.com/uk/Gas/OperationalInfo/TBE/>

for example from Russia (which supplies some 25% of the EU's gas) and Norway (9%).

5.5.11 The Bacton–Zeebrugge Interconnector<sup>53</sup> from Belgium was commissioned in October 1998. Its import capacity has since been expanded progressively and, at 25.5 bcm/year, now exceeds its export capacity of 20.0 bcm/year. However, despite the expansion of import capacity since 2006, recent flows have been much reduced.

5.5.12 BBL (the Balgzand–Bacton Line) from The Netherlands<sup>54</sup> was commissioned in December 2006 with a capacity of 25 mcm/day and expanded from November 2007 to 40 mcm/day by additional compression. The decision in August 2008 to add a fourth compressor is expected to expand the capacity to 46.7 mcm/day from December 2010 and further expansion is possible in the years ahead. BBL is also now offering interruptible forward flow and non-physical reverse flow capacity on the pipeline.

5.5.13 The next two charts show National Grid's forecasts of the capacity and flows of IUK and BBL. Supplies from the Continent are considered as the third source of supply in determining National Grid's supply forecasts, based on the following considerations:

- increased options to flow gas to alternative markets;
- uncertainty of market liberalisation, access to transmission pipelines and use/role of storage within the rest of the EU market.

5.5.14 National Grid's Continental forecast of flows to the UK assumes that the current basis for IUK and BBL will remain broadly unchanged, namely that BBL will tend to import at reported contract rates and that IUK will continue to respond to market conditions, thus operating seasonally.

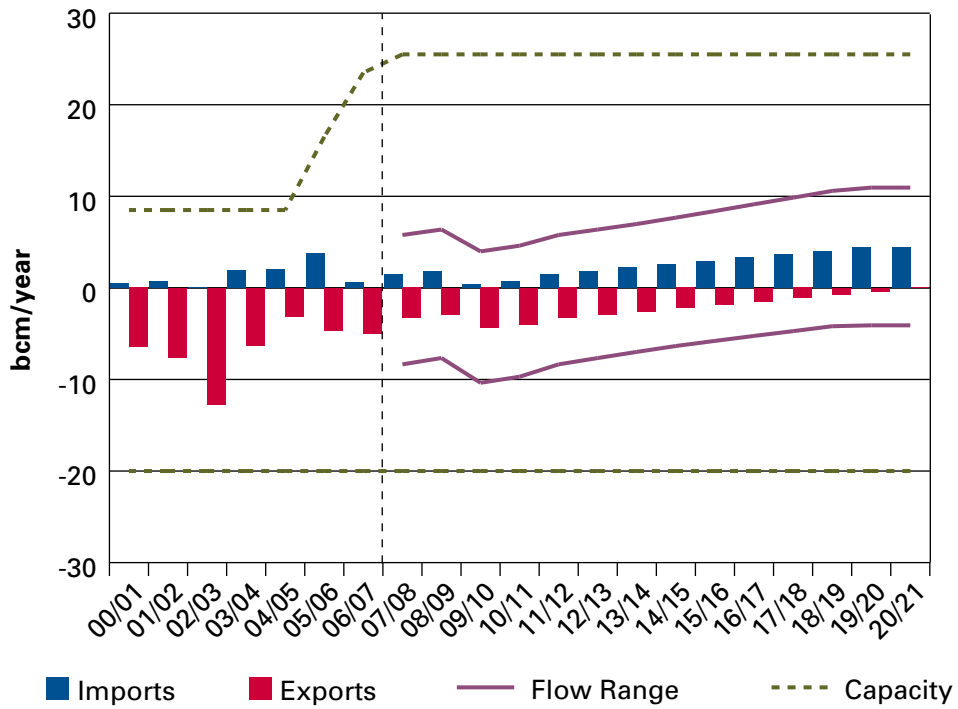
5.5.15 Longer term, National Grid anticipates higher Continental imports as the UK's level of import dependence increases. Due to the uncertainty associated with Continental imports National Grid have assumed a relatively high range of approximately  $\pm 3.5$  bcm for BBL and  $\pm 5$  bcm for IUK.

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53 <http://www.interconnector.com/>

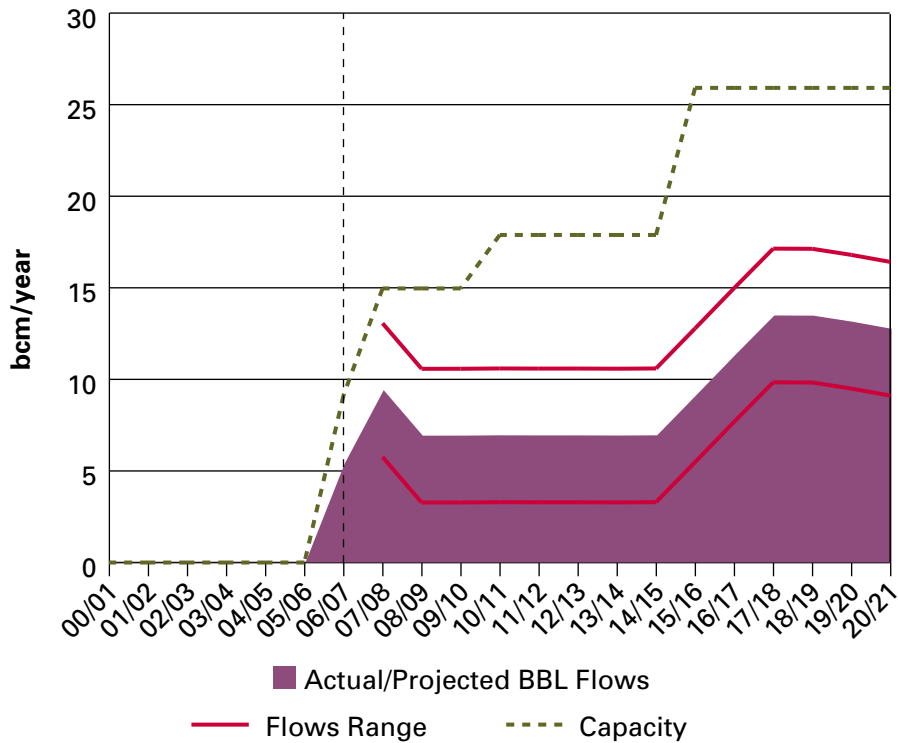
54 <http://www.bblcompany.com/>.

Chart 5.9: Bacton–Zeebrugge Interconnector Annual Capacity and Actual/Base Case Forecast Flows



Source: National Grid

Chart 5.10: Balgzand–Bacton Line Capacity and Imports



Source: National Grid

5.5.16 The UK's ability to import gas from this source will depend in part on whether the EU market as a whole is well supplied with gas; and in part on the extent to which the internal EU market functions to ensure efficient distribution of the gas that it has.

## European security of gas supply

5.5.17 The EU as a whole is about 25% dependent on gas for its energy supply and about 60% dependent on imports for its gas supply; this latter figure is expected to rise to over 75% by 2020. Its main external suppliers are Russia, Norway and Algeria. Historically these have all been consistently reliable suppliers and the EU has been working to develop its relations further with these, and other, important supplier countries. There are, however, growing concerns about the security of the EU's gas supply among EU Member States. These include the risk that not enough is being invested in production capacity by some suppliers to meet future demand, and that energy supply and supply routes might be used for political ends.

5.5.18 In March, European Leaders underlined the need for more work to improve security of supply. These calls were repeated at an extraordinary European Council in September at which Heads of State and Government discussed the impacts of the crisis in Georgia. They called in particular for more work to diversify the routes and sources of the EU's energy supplies.

5.5.19 The European Commission published its Second Strategic Energy Review on 13 November. The Government is working with the Commission and other Member States to ensure a thorough debate about the EU's energy security, leading to practical actions to improve security of supply. The UK is keen, for example, to see more political and economic engagement with countries along the Southern Corridor (the route which would bring gas from the Caspian region, through Turkey, to the EU).

## The European internal gas market

5.5.20 The UK Government has long argued that competitive energy markets are the best way of maintaining secure and sustainable energy supplies, increasing efficiency and



improving services for customers<sup>55</sup>; and so welcomes the significant steps that have already been taken to develop a competitive internal gas market, in particular the 2003 Gas Directive. A third package of EU legislation<sup>56</sup> is expected to be adopted early in 2009. This will strengthen the regulatory framework and remove structural barriers to discrimination with the goal of establishing a properly functioning and transparent internal energy market that encourages cross-border trade and investment in infrastructure.

- 5.5.21 Under the new legislation, regulators in all Member States will have strong powers, including powers to impose tough penalties (up to 10% of company turnover) if companies do not comply with their obligations in the package. Moreover, an agency composed of national regulators will be set up so that regulatory regimes are more consistent across the whole of the EU, which will encourage investment and trade across borders.

## Imports of Liquefied Natural Gas<sup>57</sup>

- 5.5.22 There are currently two LNG import facilities in the UK with more under construction or planned. The principal existing facility is at the Isle of Grain. The other facility, at Teesside, has to date received only one cargo and even that was only partly unloaded for commissioning purposes. Two large import facilities at Milford Haven are expected to begin operation during early 2009 and to be expanded in stages in the years ahead. Of these, the South Hook facility is expected to import gas from a large new liquefaction facility in Qatar while the Dragon facility is not tied to any particular import source.

- 5.5.23 The next chart shows National Grid's forecasts of LNG import capacity and flows to the UK. LNG imports are considered as the fourth and final source of supply in determining National Grid's supply forecasts, based on the following considerations:

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55 A study commissioned from Ernst and Young, "The case for liberalisation", was published in January 2006 and is available on the BERR website at <http://www.berr.gov.uk/whatwedo/energy/markets/liberalisation/page28403.html>.

56 There is a fuller account, by the International Energy Agency, of the development of EU energy markets at [http://www.iea.org/textbase/papers/2008/gas\\_trading.pdf](http://www.iea.org/textbase/papers/2008/gas_trading.pdf)

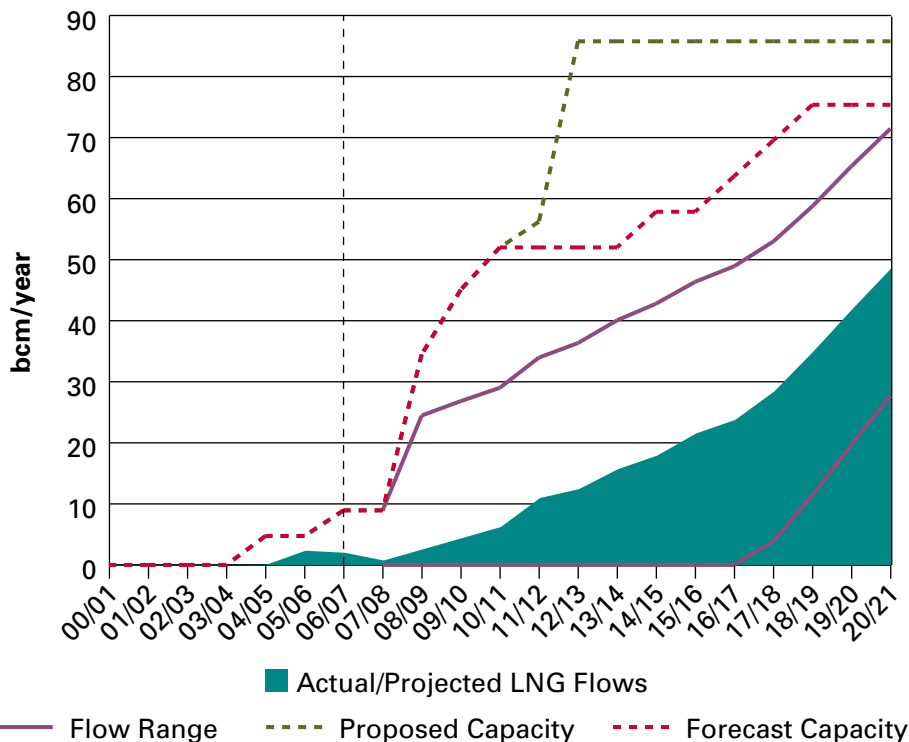
57 The LNG market – globally now to 2025 and the implications for the UK, available on the Energy Markets Outlook gas page on the BERR website (<http://www.berr.gov.uk/whatwedo/energy/energymarketsoutlook/gas/page41850.html>); Energy Modeling Forum Working Group (September 2007, EMF Report 23 *Prices and Trade in a Globalizing Natural Gas Market, Volume 1* – accessible via <http://www.stanford.edu/group/EMF/publications/index.htm>).

- limited operational experience to date;
- global options to deliver gas to alternative (higher priced) markets;
- delays in commissioning dates of new import facilities and delays in the construction of new production facilities;
- a view that there is limited LNG currently contracted to UK players.

5.5.24 Hence National Grid’s forecast for LNG imports to the UK is primarily driven by the import requirement after consideration of alternative import sources. Nevertheless, over time the UK’s requirement for LNG grows considerably.

5.5.25 To create a range for LNG, National Grid has aggregated the supply ranges for the three other sources of supply. This creates a large range commensurate with the uncertainties associated with LNG imports.

Chart 5.11: Actual Annual LNG Flows and Base Case Flow Forecasts



Source: National Grid

5.5.26 The availability of LNG to the UK market will depend on the development of the global LNG market.

- 5.5.27 A report commissioned from Global Insight in 2007<sup>58</sup> considered various scenarios, concluding broadly that the global LNG market is likely to change from consisting primarily of bi-lateral trades to a much more flexible market with an increasing proportion of gas not contractually committed to one specific destination. This would increase the responsiveness of supplies to price differentials between different potential import markets. However, the report also identified several areas of risk, notably delays in worldwide LNG liquefaction projects.
- 5.5.28 Similarly, the International Energy Agency<sup>59</sup> sees an “irreversible” trend towards regional gas markets converging into globalisation, encouraged by the emergence of more producing and consuming countries, growing European dependence on external imports, tighter balances, increasing volumes of spot and short-term LNG and higher prices. The IEA calls for more transparency on prices and flows and more competitive internal markets to enable interregional competition to improve global gas security.

## Storage Withdrawals

- 5.5.29 Storage is one means of managing seasonal price fluctuations and also one option for dealing with short-term demand fluctuations/supply disruptions. The charts below show storage space and deliverability in terms of existing facilities, those under construction and those proposed<sup>60</sup>. The charts also show storage space since 2000/01 and National Grid’s Base Case forecasts of capacity/deliverability.
- 5.5.30 Inclusion of all proposals for UK storage could increase storage deliverability from approximately 130 mcm/d to above 550 mcm/d (hence higher than our current peak day demand). For their Base Case, however, National Grid assume that not all of the storage proposals will proceed as planned and many of those that are developed may slip in terms of their delivery dates.

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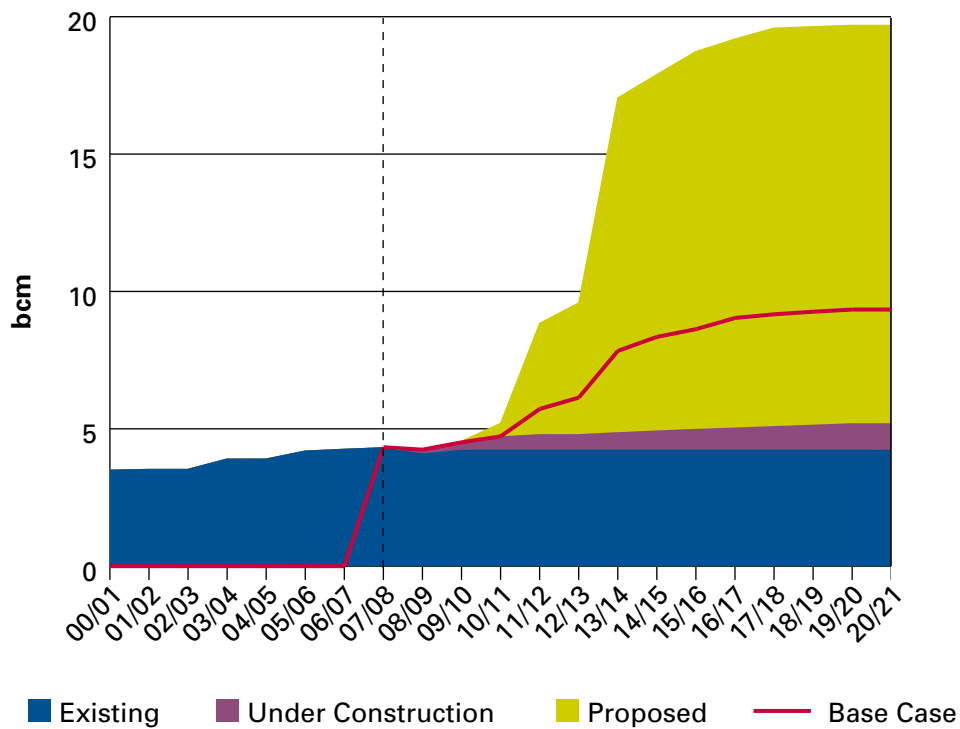
58 <http://www.berr.gov.uk/files/file41844.pdf>

59 Natural Gas Market Review 2008; executive summary available at <http://www.iea.org/w/bookshop/add.aspx?id=341>

60 There is a full list of existing, under construction and publicly announced proposals for gas storage facilities at table A2 in National Grid’s report *Transporting Britain’s Energy 2008* available at <http://www.nationalgrid.com/uk/Gas/OperationalInfo/TBE/>

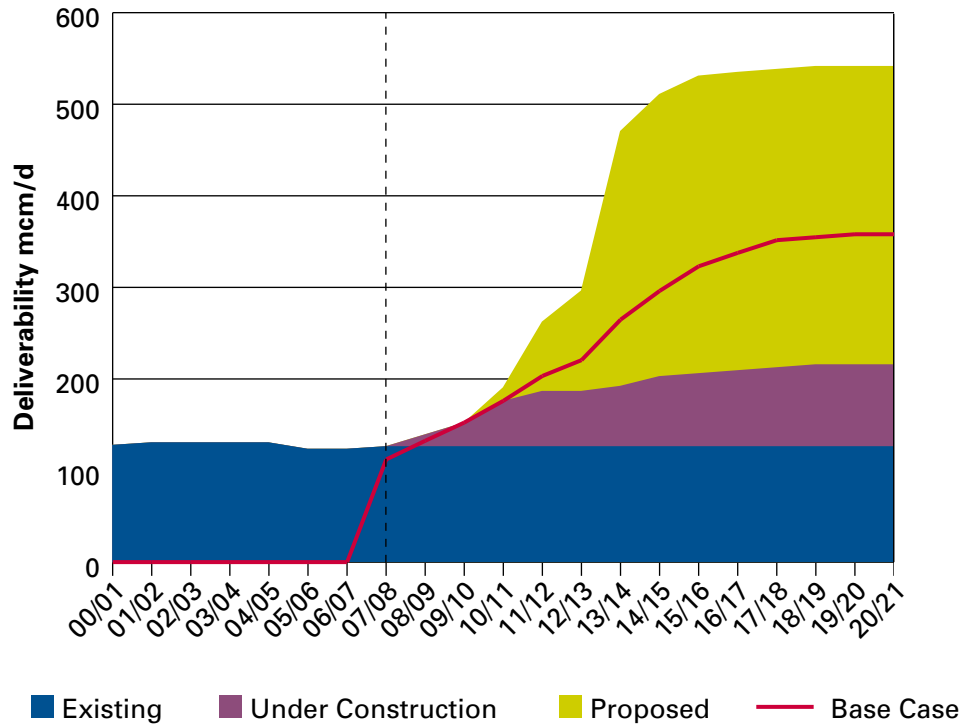
5.5.31 Gas from storage does not make a net contribution to annual gas demand since, broadly, summer inputs into storage equal winter offtakes. That said, stored gas is expected to play an increasingly important role in meeting winter demand as the UK's import requirement grows. Under the base case the UK is expected to be able to store about 10% of its expected annual demand by 2020/2021.

Chart 5.12: UK Storage Space Projections



Source: National Grid

Chart 5.13: UK Storage Daily Deliverability Projections



Source: National Grid

5.5.32 Storage capacity is often described in terms of 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.

5.5.33 Under the base case, then, by 2021 the UK is expected to have the capacity in theory to meet nearly 60% of its expected peak daily demand from stored supply, but such a delivery pattern would not be sustainable for long.

## 5.6 Composition of Supplies

5.6.1 The existence of import capacity is a necessary but not a sufficient condition to ensure that import flows are able to meet import requirements. As far as import capacity goes,

we have shown that, based on existing import facilities and those under construction, there is expected to be more than enough import capacity to deliver the UK's expected requirement for gas imports for the period covered by this report. It can also be shown<sup>61</sup> that any two of Norwegian, Continental or LNG gas supply capacity are large enough to deliver sufficient gas to meet the UK's import requirements to 2010 or even longer (even assuming no additional flows from the UKCS or use of storage supplies). For example, Norwegian flows at about 70% and Continental flows at about 25% of capacity could meet demand even with no LNG supply in 2010.

- 5.6.2 Thereafter, and noticeably by about 2015, the increasing level of import dependency means that a loss of one type of supply would result in a need for significant additional flows from alternative import sources. For example, if no new import capacity were available, the loss of Norwegian supply would require flows from the Continent at about 60% and LNG flows at over 50% of expected capacity as early as 2011/12, while the loss of Continental gas would require both Norwegian and LNG flows at around 80% by 2015. These levels of capacity utilisation indicate that more import capacity would need to be available by then if the UK is to maintain the position of being physically able to meet demand even in the absence of one of the import supply routes.
- 5.6.3 However, the existence of capacity is not a guarantee that gas will flow through it. 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 considerable uncertainty deriving from a range of factors – commercial, technical, weather-related, geopolitical, seismological, industrial relations-led, for example. Nevertheless, the extent to which any individual issue can affect the overall availability of gas to the UK reduces, as the diversity and overcapacity of delivery routes increases.
- 5.6.4 In the UK, gas suppliers have a responsibility to ensure that their customers' demand is 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

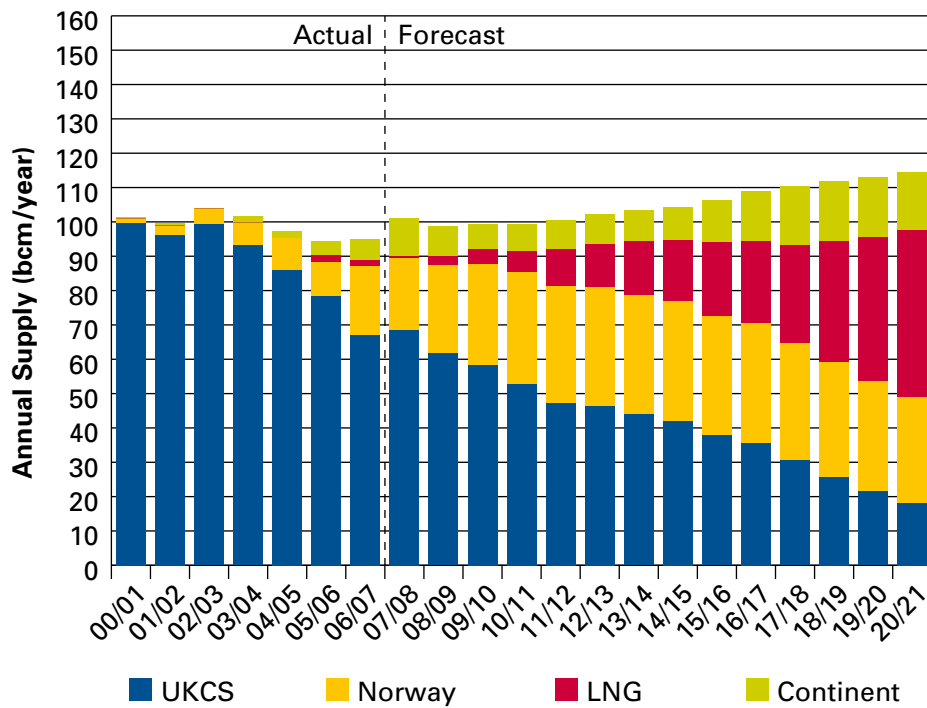
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61 Chapter 5 of *Transporting Britain's Energy: Development of NTS Investment Scenarios* (National Grid) available at <http://www.nationalgrid.com/NR/rdonlyres/B5C10071-4CEE-4BDB-B2EE-67B6BEED3040/27054/DevelopmentofInvestmentScenarios2008.pdf>

their inputs into the National Transmission System with their customers' offtakes on a daily basis. The suppliers have an incentive to 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.

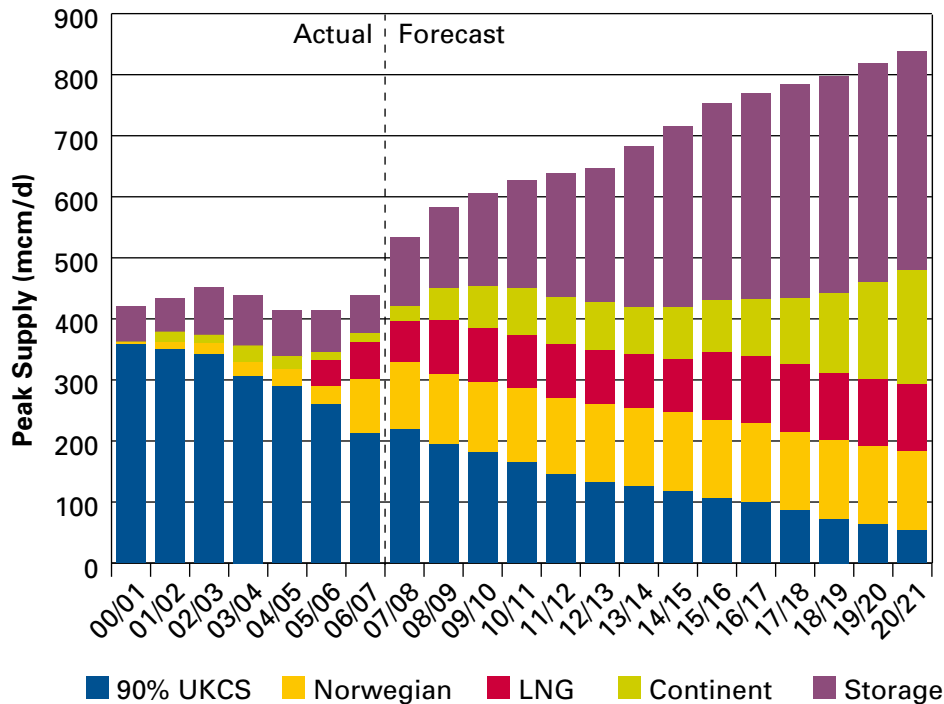
5.6.5 There is therefore scope for a wide range of possibilities as to the extent to which the different supply source will be used to meet the UK's gas demand out to the medium term. We show here the National Grid base case for annual and peak day supply.

Chart 5.14: Annual Gas Supply Forecast (Base Case)



Source: National Grid

Chart 5.15: Peak Gas Supply (Base Case)



Source: National Grid

Forecasts are for peak demand in a 1-in-20 winter, which is why they are higher than actual supply in previous years.

## 5.7 Conclusion

5.7.1 For the medium and longer term, further investment in additional import and storage capacity will be required. Delivery of additional storage capacity in the short and medium terms is likely to reduce some of the current uncertainty around availability of supplies at times of peak winter demand. Under a central scenario of demand, additional infrastructure would also be needed from around the middle of the next decade to ensure secure supplies. Significant additional investment is taking place in such infrastructure, including through the new terminals currently under construction at Milford Haven.

5.7.2 The Energy Act 2008 will enable a fit for purpose regime for certain types of offshore gas infrastructure including gas storage. Also, the Planning Act 2008 should facilitate delivery of onshore storage. Although there are widely differing views on the actual future sources of gas, there is expected to be increasing diversity of the sources of supply. There may also be a beneficial effect of further liberalisation in Europe.



## Northern Ireland<sup>62</sup>

Since 1 January 2007, the supply of natural gas to non-domestic and domestic consumers in the Greater Belfast licensed area in Northern Ireland has been open to competition. The natural gas market in Northern Ireland is concentrated in this area, where gas is supplied to around 120,000 consumers, principally by Phoenix Natural Gas. Firmus Energy is engaged in ongoing work to develop the gas market in ten towns outside Belfast and presently has around 4000 customers.

### Gas Demand

The Northern Ireland Authority for Utility Regulation (the energy regulator) prepares an annual report, the NI Gas Pressure Report, which details current and future gas demand for power generation, business, and domestic users.

### Gas Delivery

Northern Ireland has no indigenous sources of natural gas, and is therefore reliant on gas supplies from Great Britain. While there is gas interconnection with the Republic of Ireland, which has some indigenous sources of natural gas, it too receives the bulk of its gas from Great Britain.

In order to get to Northern Ireland, gas is piped by National Grid to Moffat, in southern Scotland. From there it passes through the Scotland–Northern Ireland Pipeline (SNIP) to near Stranraer and then under the sea to Islandmagee. At Islandmagee, much of the gas is used by Ballylumford power station, but the remainder is transported to Torytown near Carrickfergus and into the main distribution system. In addition, the South-North gas transmission pipeline, completed in October 2006 between Dublin and Antrim, provides additional security of supply to Northern Ireland by providing access to gas from the Republic of Ireland.

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62 Information on the gas market in Northern Ireland is available from the Department of Enterprise, Trade and Investment (<http://www.detini.gov.uk>) and the Northern Ireland Authority for Utility Regulation (<http://ofreg.nics.gov.uk/index.html>)

There has been renewed interest in developing underground gas storage in caverns created by solution mining of salt strata in the East Antrim area. While Northern Ireland benefits from the additional security of supply which will result from ongoing investment in gas storage and other supply infrastructure in Great Britain, establishing gas storage in East Antrim would provide significant additional security of gas supply for Northern Ireland.

## 6. Coal

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### 6.1 Introduction

- 6.1.1 In this chapter we report scenarios that have been 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) are likely to have a significant impact on both in years to come. Linked to EU legislative proposals, the Government consulted on the regulation of storage of CO<sub>2</sub> as a preparation for Carbon Capture and Storage and on its preliminary stage Carbon Capture Readiness (CCR)<sup>63</sup> during 2008; the outcomes are expected shortly.
- 6.1.2 Here we also set out scenarios for future indigenous production of coal. As indigenous production is unlikely to be able to meet demand, we also 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 inputs from the UK Coal Forum, the Confederation of UK Coal Producers, and the Association of UK Coal Importers, Coallmp. We also draw on the Government's Updated Emissions Projections<sup>64</sup> and analysis carried out by Redpoint<sup>65</sup> to underpin the Government's consultation on meeting the Renewable Energy Target.

### 6.2 UK Demand

- 6.2.1 A significant proportion of demand for coal in Great Britain (around 83% in 2007) comes from the electricity sector and so is closely linked to the level of generation by coal-fired power stations. Of the remaining 17% of demand, 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

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63 <http://www.berr.gov.uk/files/file46810.pdf>

64 <http://www.berr.gov.uk/files/file26377.pdf>

65 [http://renewableconsultation.berr.gov.uk/related\\_documents](http://renewableconsultation.berr.gov.uk/related_documents)

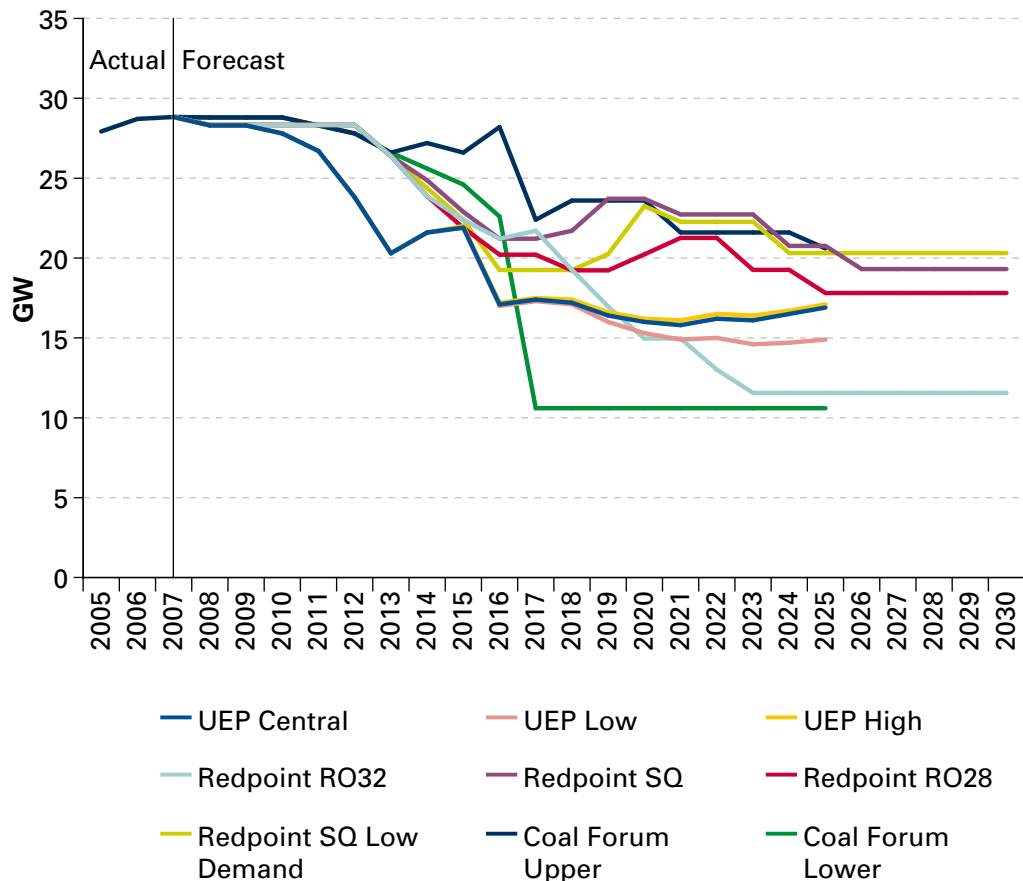
power generation, but also includes estimates of total coal demand, and implications for import requirements.

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

6.2.3 Chart 6.1 below shows a range of scenarios for coal-fired generation capacity. These scenarios are based on:

- BERR Updated Emissions Projection (a high, central and low case for coal fired generation in the mix);
- scenarios developed as part of the Redpoint analysis carried out to underpin the BERR consultation on meeting the Renewable Energy Target. (Three scenarios are shown – Status Quo, RO 28 and RO32 in which the Government targets different levels of renewable electricity through extension of the Renewables Obligation);
- upper and lower scenarios developed by the Coal Forum Generation Sub-Group.

Chart 6.1: Generation Capacity, GW (Existing + New)



6.2.4 It should be noted that these three sets of scenarios have been developed for distinct purposes, and reflect different sets of assumptions, as set out below. Most significantly:

- the BERR Updated Emissions Projections provide a set of estimates of future carbon emissions and reflect only measures that are already in place. They do not take into account the impact of the Renewables Target;
- the Redpoint scenarios model the impact on the generation mix of a range of incentives to encourage the market to deliver renewable generation to meet the Renewables Target;
- the Coal Forum has presented high and low-case scenarios for delivery of coal generation.

6.2.5 It will be seen that most scenarios show a reduction in coal fired generation around 2015-2016, due to the closure of opted out plant under the Large Combustion Plants Directive. Thereafter, there are a range of scenarios, showing capacity of between 10 and 20 GW, with the current level being about 30GW.

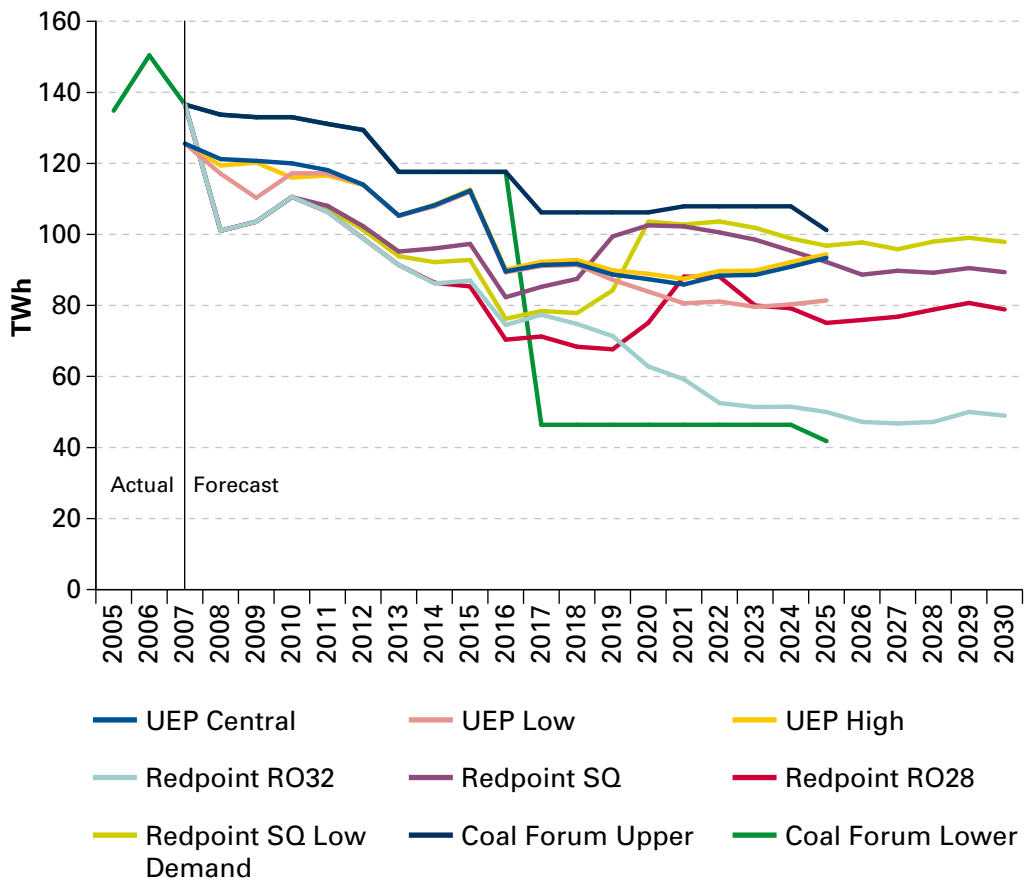
- 6.2.6 The following general points may be noted regarding the impact of Carbon Capture and Storage (CCS) and other clean coal technologies. The development and successful deployment of CCS will provide an option for coal fired generation to continue as an important part of the mix, while significantly reducing emissions. A consultation on some regulatory aspects of CCS as well as on the preliminary stage of Carbon Capture Readiness (CCR) was undertaken by BERR over summer 2008. This consultation was intended to help to ensure that the UK has a regulatory regime for CCS storage which is safe, effective and enables investment in this important technology. It should be noted that the individual components of CCS (capture, transport, and storage) have all been successfully demonstrated individually but the full chain of technologies has yet to be demonstrated and then upscaled to commercial scale. It is this lack of first generation demonstration that has been identified as a barrier for CCS deployment, and in turn, a potential barrier to the longer term delivery of new coal fired generation. The Government last year launched a competition to support one of the world's first commercial scale demonstration projects on a coal plant.
- 6.2.7 There is also potential for further long term improvements in other cleaner coal technologies, as well as improvements in the thermal efficiency of coal power stations through development of advanced supercritical boilers and improved turbines and gasifiers. These advances are expected to lead to emission reductions of about 20%, even before the introduction of CCS technology, and thus reduce coal's environmental impact. With CCS, this may lead to coal fired generation having an enhanced role in the energy mix.

### **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 (e.g. on plant which has opted out of the higher standards imposed by the Large Combustion Plants Directive – paragraphs 4.4.2 – 4.4.7 refer) and fuel price relativities, particularly the price of coal and gas relative to each other and to the electricity price.

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

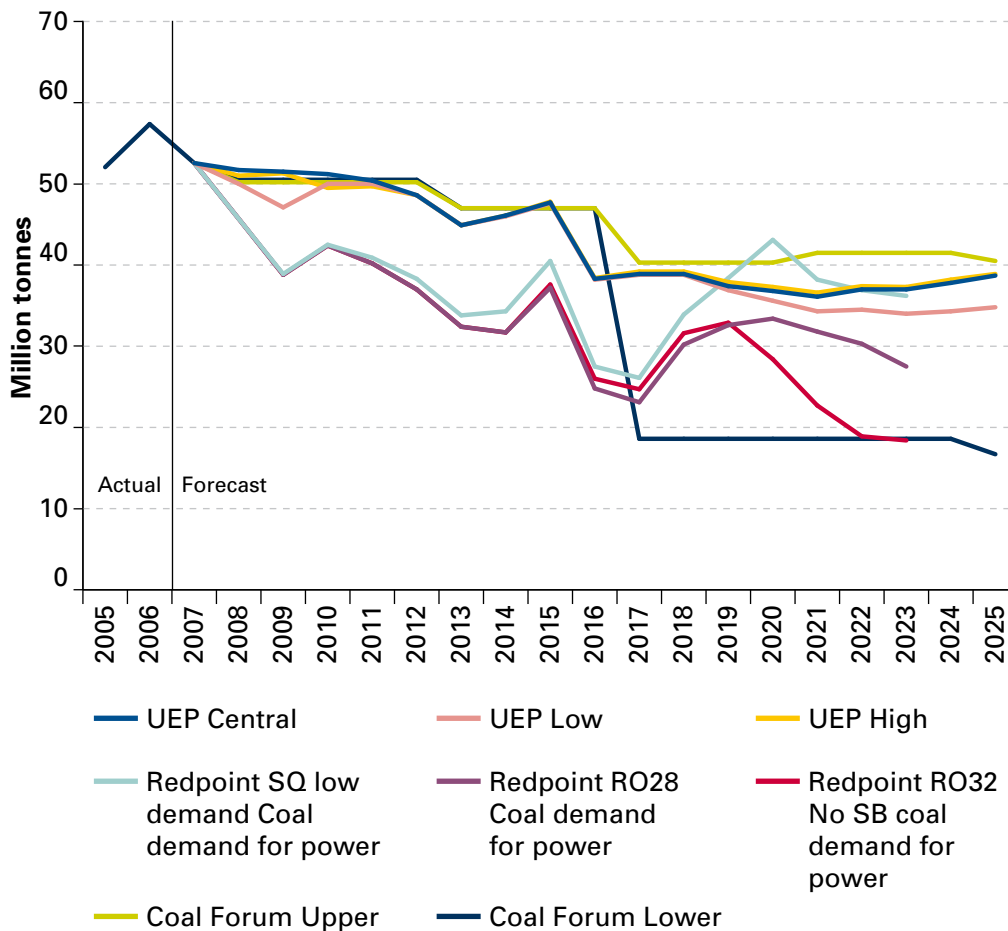
Chart 6.2: Generation output from coal



## 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); over time, older, less efficient plant would be expected to close first, increasing the average efficiency of the remainder of plant.

Chart 6.3: Coal demand for power generation



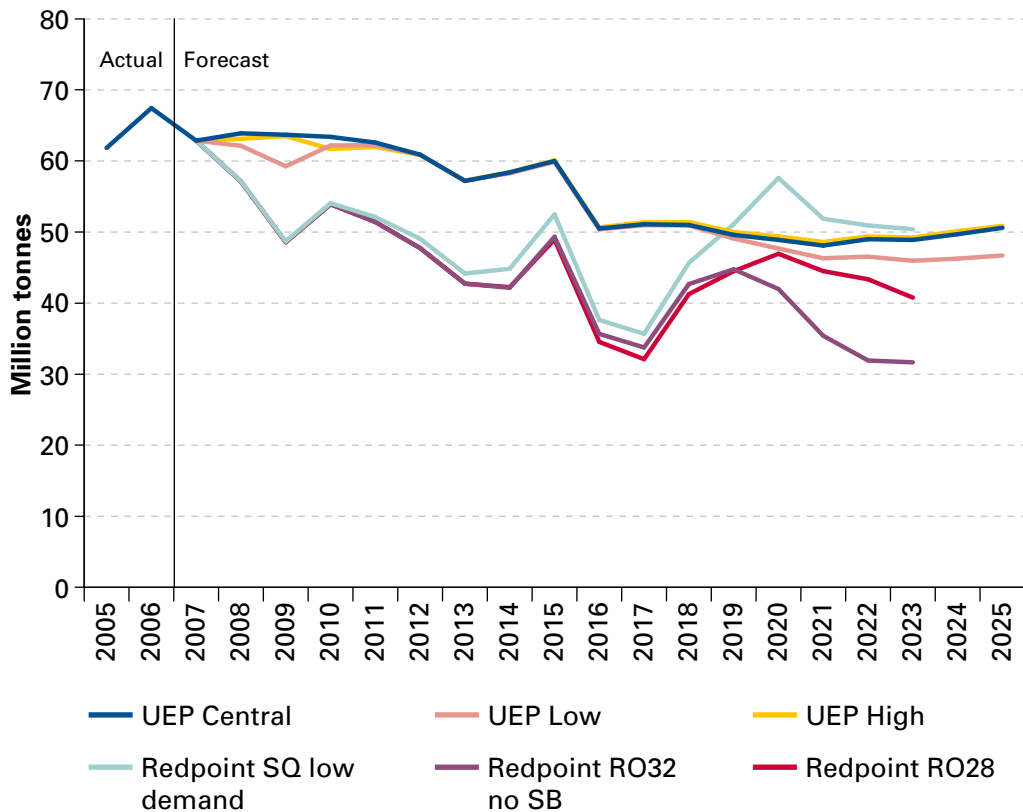
6.4.2 The analysis presented here considers aggregate demand for coal. In practice, account would also need to be taken of requirements for particular types of coal, for example in terms of sulphur content and NOx profile, which affect emissions of sulphur oxides (SOx) and nitrogen oxides (NOx) respectively. Typically, low sulphur coal would be needed for the opted out fleet (8.2 GW of capacity, for which the Coal Forum has estimated coal usage of 6 – 12 mtpa for the period 2008 to 2015). 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.)

## 6.5 Total demand for coal

6.5.1 Coal is also required for non-power uses, including coking and smelting. Chart 6.4 below incorporates data from the BERR Updated Emissions Estimate to provide scenarios for total UK coal demand.



Chart 6.4: Total demand for coal



## 6.6 UK Supply: Indigenous production

6.6.1 A number of factors affect levels of production of coal in the UK, of which just over half still comes from deep mines and the remainder from surface (opencast) mines.

### Deep mines

6.6.2 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. Hatfield, Harworth);
- potential for investment in new deep mines.

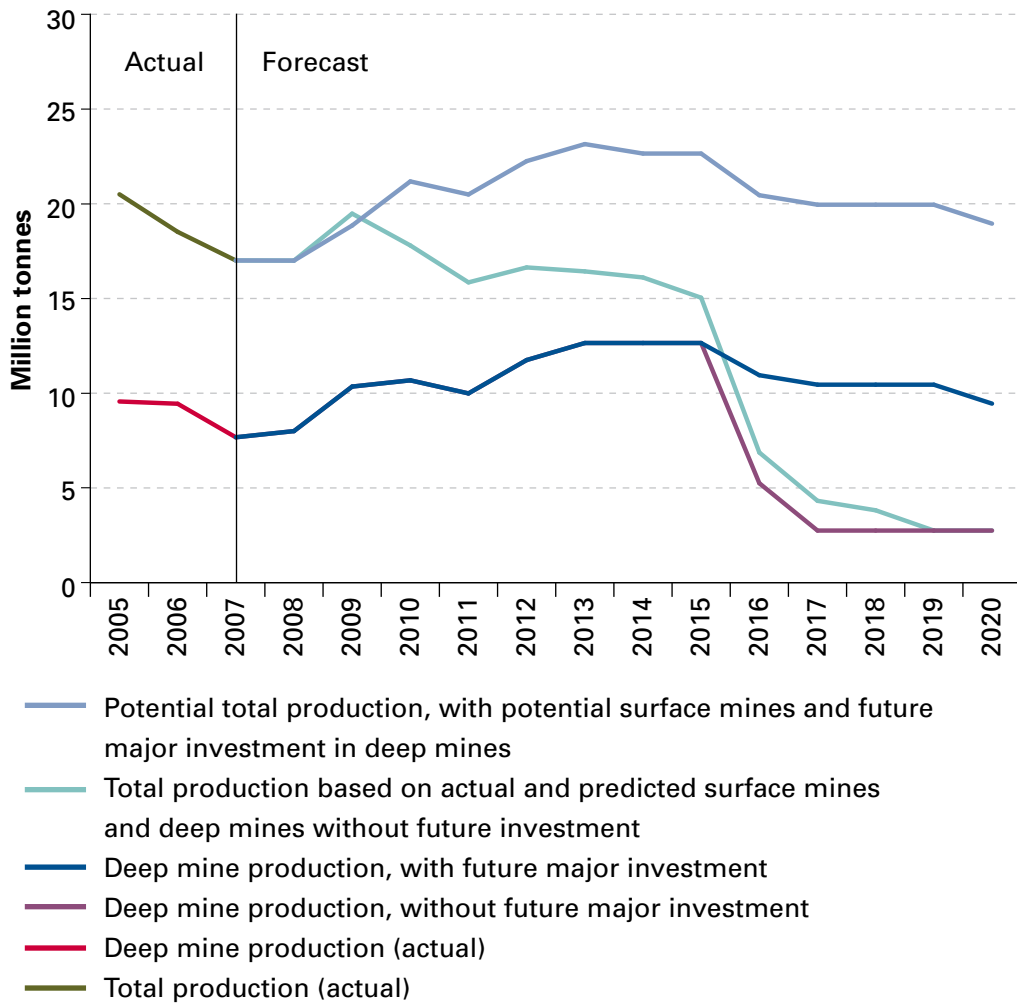
6.6.3 Most of the UK's existing deep mines have investment programmes in place which should allow them to maintain current production levels until at least 2015. Thereafter, further tranches of investment would be needed if production levels were to be maintained at these mines. Recent increases in the coal price have made the economics of re-opening closed or mothballed mines more attractive. Greater certainty around continuing demand for

coal beyond 2020 could also help the case for such projects, as could significantly higher confidence in continuing demand and forward price levels.

## Surface mines

- 6.6.4 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.
- 6.6.5 The Confederation of UK Coal Producers (CoalPro) estimates that surface mining could potentially provide production of 8,500 to 10,500 mtpa to at least 2015. The chart below, which has been provided by CoalPro, shows a central forecast for UK deep mine steam coal production, both with and without additional investment for 2016 onwards. It also shows potential production with a contribution from surface mines.

Chart 6.5: Coal production forecasts



## 6.7 UK Supply: Stocks

6.7.1 Generators collectively held about 11.5 million tonnes of coal stocks at the end of 2007<sup>66</sup>. Assuming that the average production rate is 2.55 GWh per kilo-tonne of coal burn, then this amount is equivalent to 29.3TWh of electricity generation – or approx 7% of total electricity supplied in 2007<sup>67</sup>. Based on National Grid data<sup>68</sup>, there is 29 GW of (transmission-connected) coal-fired generating capacity in Great Britain, so it follows that the fleet could run on stocks alone for about 42 days continuously. This is for illustrative purposes only; in reality coal-fired power stations would be very unlikely to operate non-stop for this length of time.

66 DUKES table 2.7 at <http://www.berr.gov.uk/whatwedo/energy/statistics/source/coal/page18529.html>

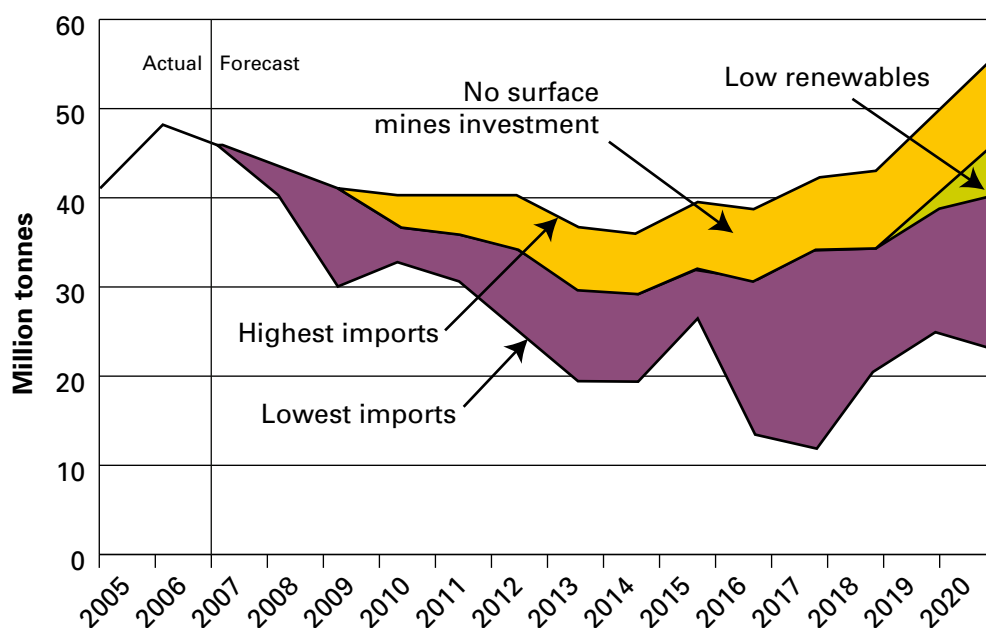
67 <http://www.berr.gov.uk/whatwedo/energy/statistics/publications/dukes/page45537.html>

68 Table 3.5 [http://www.nationalgrid.com/uk/sys\\_08/print.asp?chap=3](http://www.nationalgrid.com/uk/sys_08/print.asp?chap=3)

## 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 6.6, which shows the upper and lower boundaries of the ranges for these scenarios.
- 6.8.2 The trend for volumes of imported coal to fall from 2005 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 6.6: Possible range of coal imports



## 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<sup>69</sup>. 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. 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 resources were reported in 2007 as totalling 8,710 billion tonnes coal equivalent<sup>70</sup>, suggesting that proven, recoverable, reserves are around 10% of total resources.

## 6.10 Supply and Demand: international hard coal trade

6.10.1 In 2007, coal was the fastest growing fuel in the world for the fifth consecutive year.<sup>71</sup> Global consumption rose by 4.5%, to around 3,400 mtoe (million tonnes of oil equivalent). Two thirds of this increase was accounted for by Chinese coal consumption, growing by 7.9%. Indian consumption rose by 6.6% and OECD consumption rose by 1.3%.

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. Forecasting of future global supply and demand is beyond the scope of this document. However, the charts below, as published by the IEA in 2006, show hard coal trade in 2005, and a projection for 2030. These show that, over this period, exports from Australia, Russia and South Africa are expected to increase.

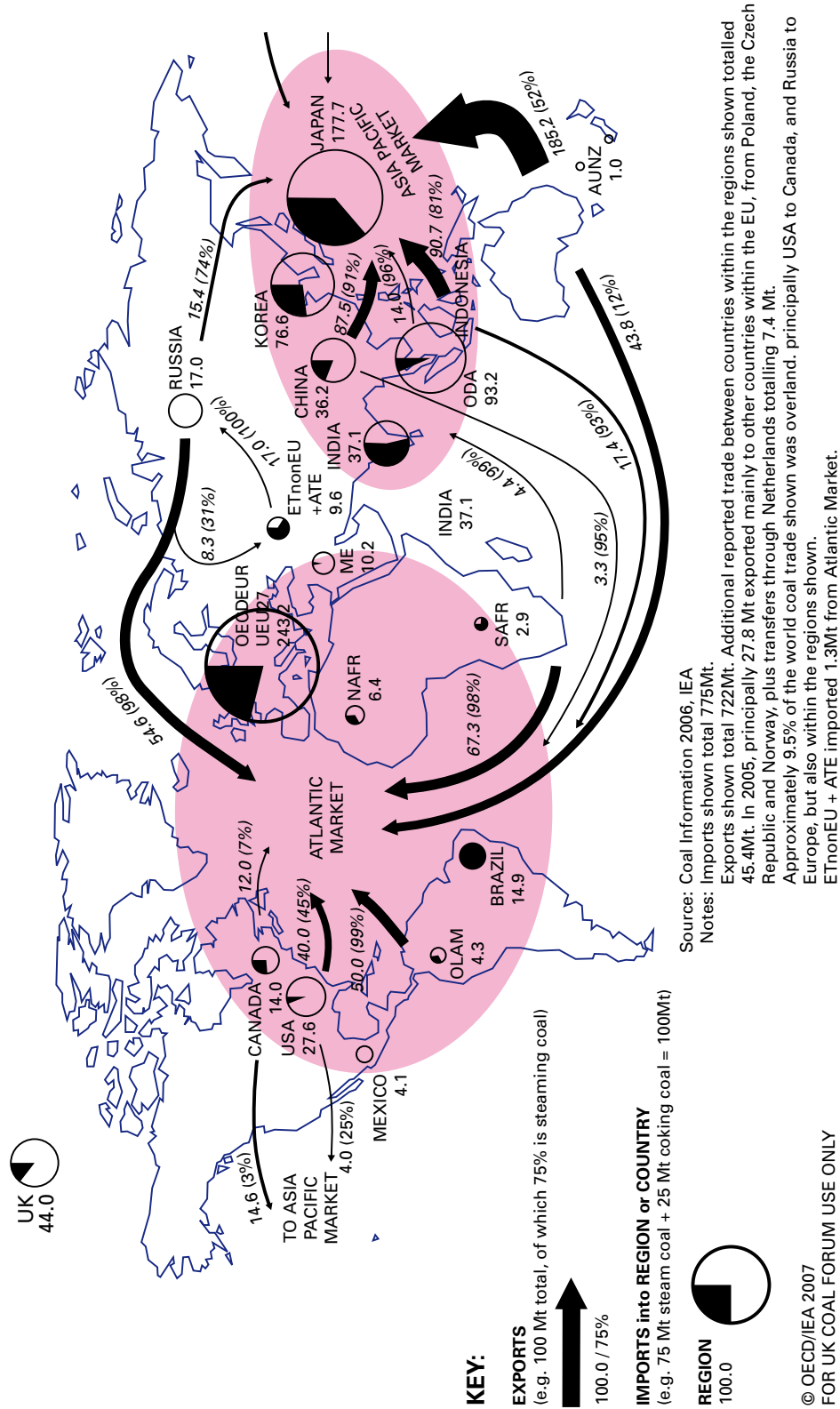
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69 The World Energy Council's 2007 Survey of Energy Resources [http://www.worldenergy.org/documents/ser2007\\_final\\_online\\_version\\_1.pdf](http://www.worldenergy.org/documents/ser2007_final_online_version_1.pdf)

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

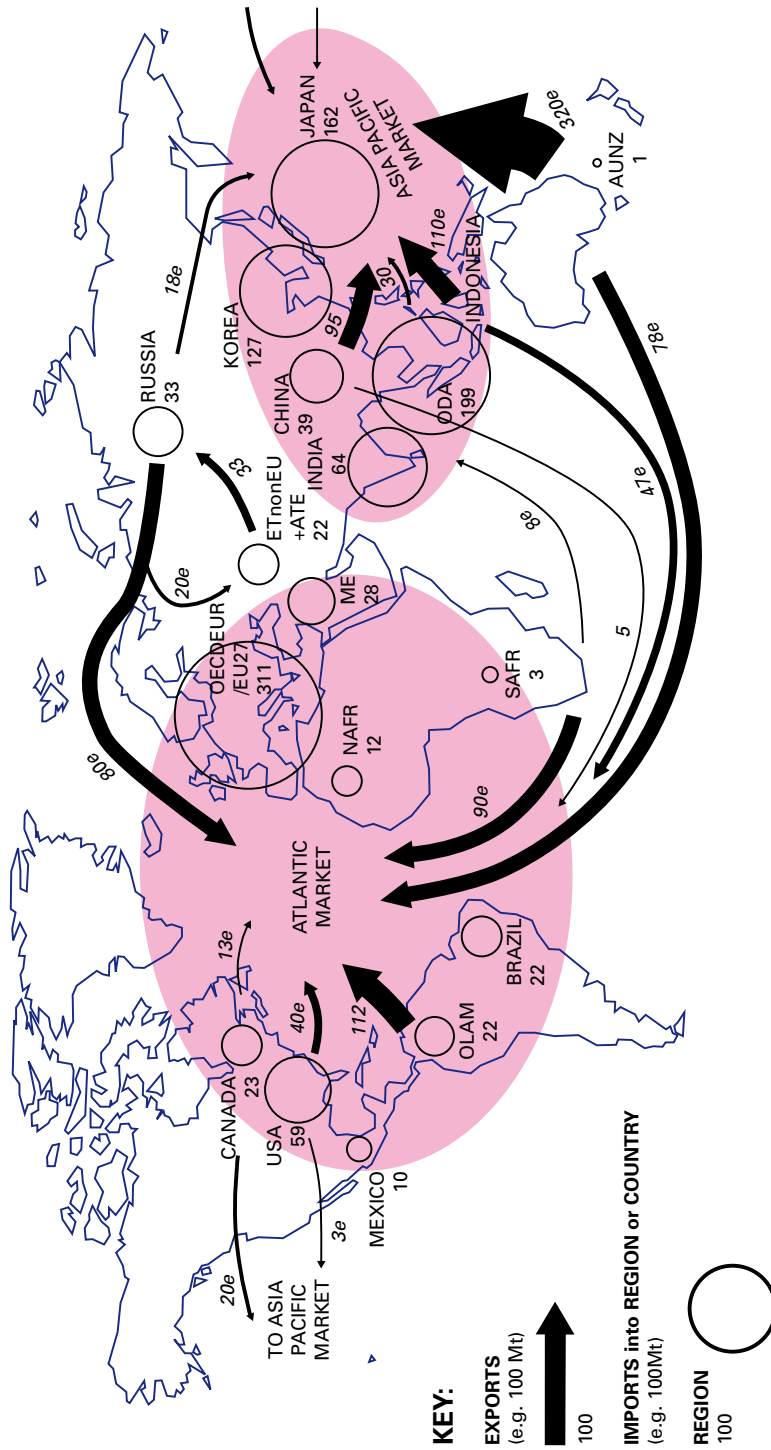
71 BP Statistical Review of World Energy – June 2008 [http://www.bp.com/liveassets/bp\\_internet/globalbp/globalbp\\_uk\\_english/reports\\_and\\_publications/statistical\\_energy\\_review\\_2008/STAGING/local\\_assets/downloads/pdf/statistical\\_review\\_of\\_world\\_energy\\_full\\_review\\_2008.pdf](http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2008/STAGING/local_assets/downloads/pdf/statistical_review_of_world_energy_full_review_2008.pdf)

Chart 6.7: International hard coal trade, 2005 (million tonnes)



Source: IEA Coal Information 2006

Chart 6.8: International hard coal trade, 2030 (million tonnes)



NOTES: "e" after tonnage means an estimated split between Atlantic and Pacific markets since WEO model balances at the world market level

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Source: IEA Coal Information 2006

## 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;
- 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), such as considered in the IEA Alternative Policy Scenario<sup>72</sup>. A major fuel-switch to gas or other alternative forms of electricity generation would be likely to depress international prices.

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72 <http://www.worldenergyoutlook.org/>



## 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 (SO<sub>x</sub>) and nitrogen oxide (NO<sub>x</sub>) 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 2015 as an alternative to fitting flue gas desulphurisation (FGD) equipment to remove SO<sub>x</sub> 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. It is noted that the draft Industrial Emissions Directive (IED), which is currently under discussion within the EU, could result in revised emissions limits. This in turn could impact on the performance required from the FGD equipment fitted to power stations to allow opted in plant to run.
- 6.12.2 Limits on NO<sub>x</sub> emissions are also a constraint on types of coal suitable for both opted in and opted out plant. Depending on the outcome of discussions on the draft Industrial Emissions Directive (IED), at least some plant is likely to fit NO<sub>x</sub> abatement equipment such as Selective Catalytic Reduction (SCR). Once SCR is fitted, the NO<sub>x</sub> constraint on types of coal that can be used is removed. Progressive fitting of NO<sub>x</sub> abatement equipment up to 2016 may therefore open up the range of coals that can be used in the intervening period.
- 6.12.3 A significant issue for the sector will be the economics of fitting these abatement technologies, and how they will perform, and therefore the economic viability of a coal fleet. Along with the outcome of the development and deployment of Carbon Capture and Storage technology, this would be expected to have an influence on the resulting size of the coal fleet.

## 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 NO<sub>x</sub> emissions). There has been a significant increase in the use of Russian coal in the last few years. High overall demand for coal imports into the UK has led to greater use of smaller ports, which are suited to Russian supply. In addition, the relatively short shipping times to the UK has meant that Russian coal has a particular market advantage.
- 6.12.5 Alternative sources of coal are available, principally from Colombia, Indonesia and Venezuela. However, these coals are currently more expensive than Russian coal. This is on account of higher freight rates for shipping (especially 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. Production of Venezuelan coal is limited. South African coals are available but are currently less attractive in terms of NO<sub>x</sub> emissions.
- 6.12.6 It was announced earlier this year that the state-owned Russian gas companies, Gazprom and SUEK (Russia's largest coal producer) were withdrawing from their proposed joint venture, but there would be strategic cooperation between the two companies. Such an arrangement would allow Russia to direct more coal towards domestic power generation. This could provide more gas for export markets, but in the absence of an increase in coal production, could reduce the amount of coal available for export.
- 6.12.7 The main Russian coalfields are a long way from port and supply interruptions have been caused over the past year 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.

## 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. These demand scenarios provide an opportunity for indigenous production of coal, although issues such as planning consents in particular for surface mines would also need to be considered. In all scenarios described here, there is a requirement for imports. However, only under one scenario would import requirements be at 2006 levels of 50 mtpa and under all other scenarios they would be lower.
- 6.13.2 Given the abundance of proven reserves of coal globally, the future use of coal is unlikely to be limited by resource availability, but there are a number of international issues and risks that could affect future prices. A particular issue for the UK for the medium term could be availability of Russian low-sulphur coal if this coal is increasingly used for domestic power generation within Russia. This would not be expected to raise a security of supply issue, since alternative sources are available, but alternative sources are currently more expensive.

## 7. Oil

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### 7.1 Introduction

7.1.1 The UK is already heavily involved in the global oil market, as both an importer and exporter, with the balance moving towards increased import dependency over the medium and long term. As a result, both the demand and the supply side of the UK oil industry face new challenges. This chapter, therefore, focuses on both UK and global supply and demand conditions, as these are the main determinants of oil availability and prices.

### 7.2 UK Oil Demand

7.2.1 The UK's oil intensity, at around 0.2 to 0.3 bbl/\$1000, is around half that of the US and the world average<sup>73</sup>, one of the lowest amongst the G7 countries, and is in further decline. Demand for oil in the transport sector is still robust (approx 70% of total UK oil consumption) and projected to increase in the short to medium term. However, demand in the industry and domestic sectors is declining.

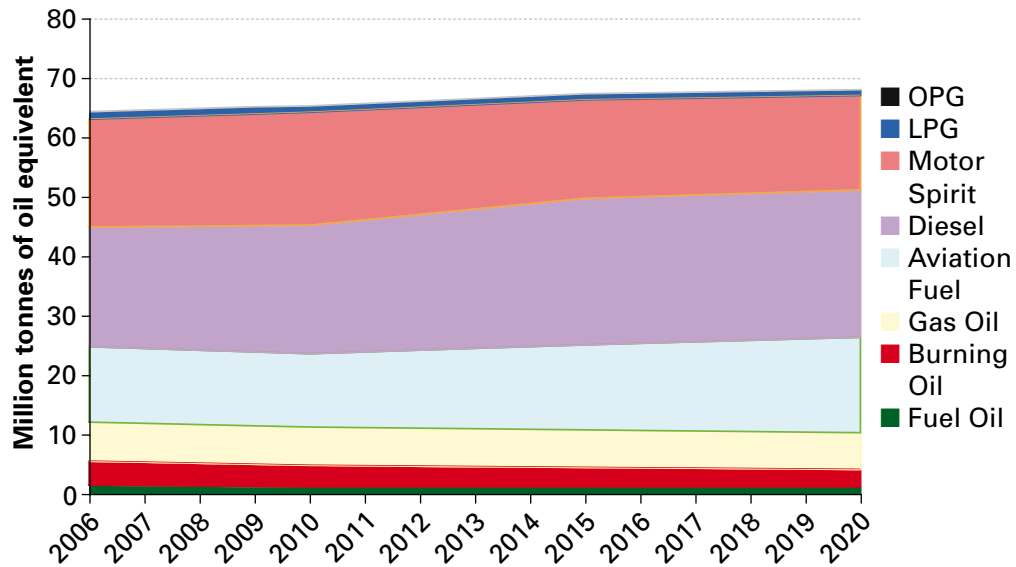
7.2.2 As seen in Chart 7.1, while consumption of petrol in the UK is forecast to fall, demand for diesel and aviation fuel is expected to continue to rise, as is total oil demand, in absolute terms.<sup>74</sup>

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<sup>73</sup> Figure obtained from DECC analysis of IEA and IMF data (2007).

<sup>74</sup> *IEA Medium-Term Oil Market Report*, July 2008.

Chart 7.1: Forecast UK oil demand by petroleum product type



Source: BERR forecast model

7.2.3 Consumption of diesel fuel steadily increased from 2001 to surpass deliveries of motor spirit in 2005, while consumption of motor spirit in 2006 was 25% lower than the peak of 24m tonnes in 1990. The increase in UK demand for diesel is expected to continue to be driven by improvements in diesel engine technology, which have encouraged motorists to switch to more fuel-efficient diesel powered cars.

7.2.4 Developments are also expected in the market for marine fuel oil. The International Maritime Organization (IMO) has recently proposed amendments to the MARPOL Annex VI regulations to reduce harmful emissions from ships. The main changes are to:

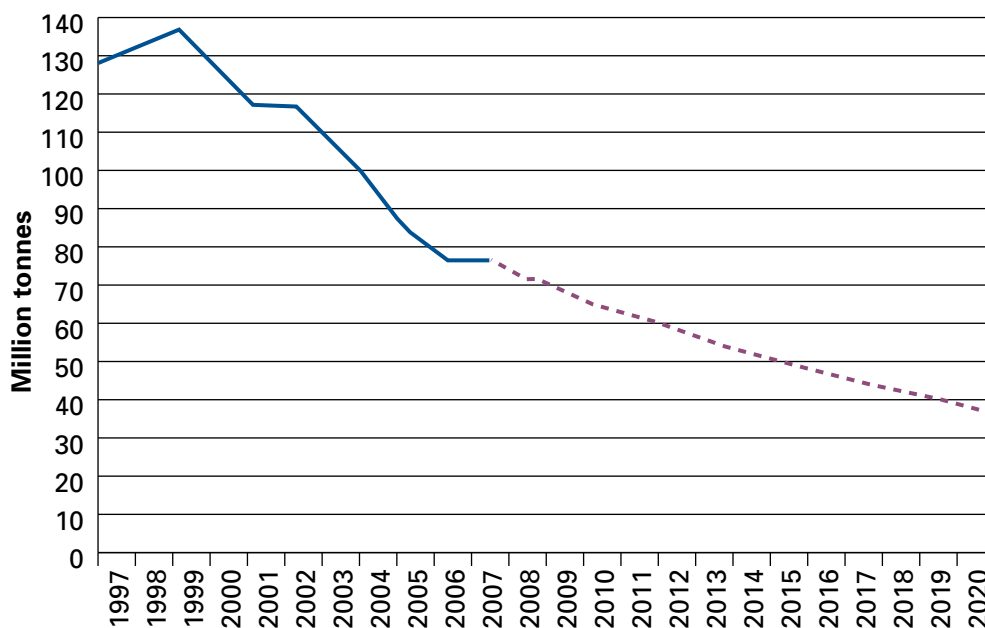
- mandate a progressive reduction in sulphur oxide emissions, with stepped reductions in permitted sulphur levels for marine fuel oil to 3.5% (from the current 4.5%), effective from 1 January 2012; with a further reduction to 0.5%, effective from 1 January 2020, subject to a feasibility review to be completed no later than 2018; and
- reduce limits applicable in Sulphur Emission Control Areas (SECAs) to 1%, beginning on 1 March 2010 (from the current 1.5%), being further reduced to 0.1% from 1 January 2015. In the current Annex VI, there are two SECAs designated; the Baltic Sea and the North Sea area, which includes the English Channel.

The effect of these changes is likely to reduce fuel oil demand from 2015 onwards, with a corresponding increase in demand for marine gas oil. With UK refineries configured to meet historic demand for petrol and fuel oil, more investment will be required to realign production with demand for middle distillate products.

## 7.3 UK Supply: Indigenous Production

7.3.1 Oil production from the UK continental shelf peaked in 1999. Buoyed by production from the large Buzzard Field, UK oil production rose slightly in 2007, but the decline of previous years is expected to resume, albeit at a slower rate given the high levels of investment. The chart below is based on DECC's latest published projections of UK oil production<sup>75</sup> through to 2013 with an assumption of a decline rate of 5.5% per annum thereafter.

Chart 7.2: UK crude oil and natural gas liquids production 1997-2020



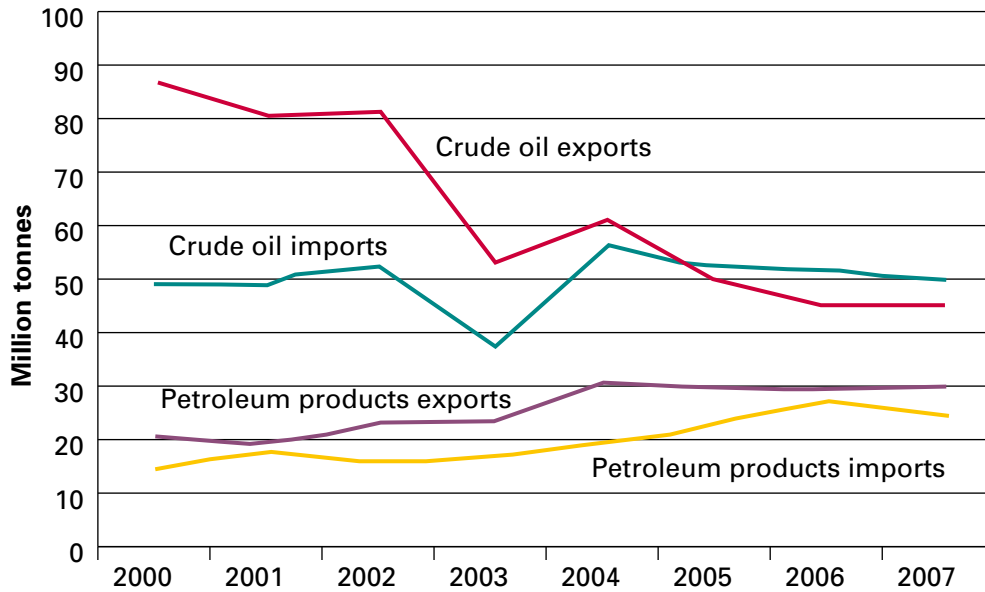
Source: DECC

## 7.4 UK supply: UK Imports

7.4.1 While the UK has become a net importer of crude, we still remain and expect to continue to be net exporters of petroleum products.

<sup>75</sup> Further information available at [https://www.og.berr.gov.uk/information/bb\\_updates/chapters/Section4\\_17.htm](https://www.og.berr.gov.uk/information/bb_updates/chapters/Section4_17.htm)

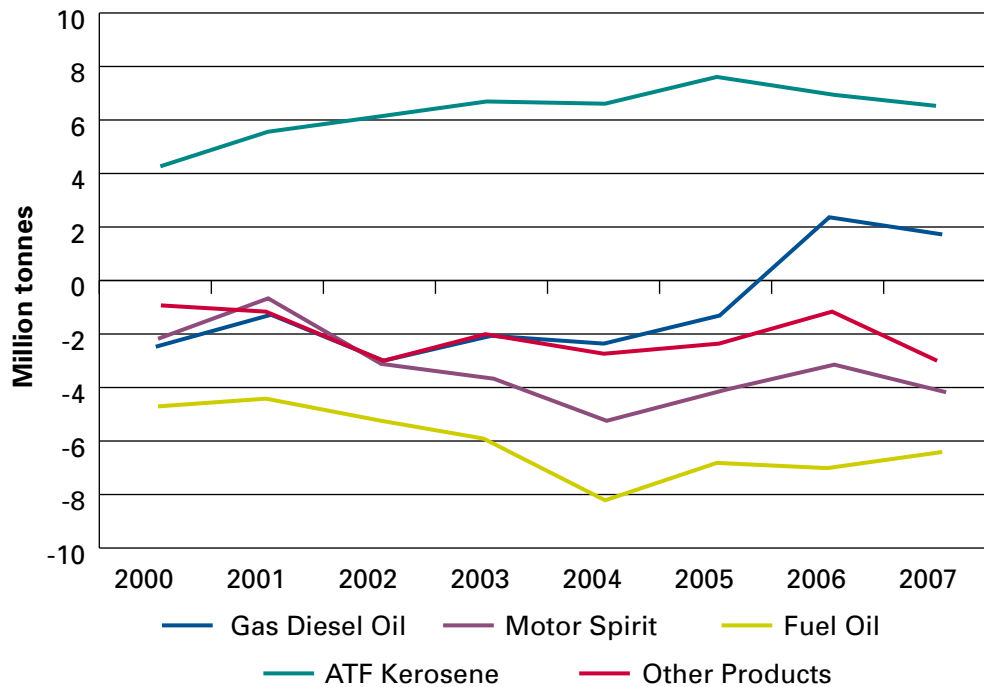
Chart 7.3: Imports and exports of crude oil and petroleum products



Source: BERR: DUKES Chart 3.4

7.4.2 In 2007, nearly 33% of total UK product demand was met through imports, an increase of 13% from 2000 levels. Demand differences between product types explain why the UK imports petroleum products when there is an overall surplus available for export. For instance, gas/diesel oil exports from the UK tend to be of lower grades for use as heating fuels in countries with less stringent sulphur restrictions, while imports tend to be of higher-grade gas/diesel oil with low sulphur content. The UK imports jet fuel (mainly from the Middle East) and diesel (mainly from Russia) to cover a deficit in these products, and exports surplus petrol (mainly to the USA) and fuel oil. The US remains one of the key markets for UK exports of oil products, accounting for 19% of total UK exports of oil products in 2006.

Chart 7.4: Net UK Imports of Petroleum products



Source: BERR Digest of UK Energy Statistics

7.4.3 With increasing dependency on imports of aviation turbine fuel (ATF) and gas/diesel oil, a number of import terminals are reaching capacity, and additional investment will be required in import terminals and related storage and distribution infrastructure. There is currently a shortage of middle distillates (ATF, heating oil, diesel and gas oil) in North West Europe. Although product is currently available from Russia, the Middle East and India, North West Europe competes for these imports with demand from rapidly developing markets such as China and India, and the market is anticipated to remain tight, with prices remaining robust and with increased risks to supply security.

## 7.5 UK Refining and Distribution: Key Challenges

### Investment

7.5.1 UK refineries face the twin challenges of changes both in product demand and in crude oil supply. On the demand side, there is a declining market opportunity to export petrol to the United States. Figures from the US Department of Energy show a waning demand due to the economic downturn and the higher petrol prices experienced over the last few years. In June 2008, miles



driven in the U.S. were down 4.7 % from the same period in the previous year. Further, demand for jet and diesel/gas oil is increasing with the UK competing with the rest of Europe for imports. Significant changes in demand for marine fuels are also anticipated following changes in IMO regulations to reduce harmful emissions from ships. This will pose a challenge to the industry, with the potential requirement for significant investment to adapt the existing product mix to process more low sulphur products.

- 7.5.2 Falling North Sea oil production will mean that UK refiners will increasingly have to source their supplies from elsewhere. The closest alternative major supply source is from Russia, whose oil is of lower quality than present sources and so would require refiners to invest in adapting existing or acquiring new processing equipment in order to process significant quantities of crude oil from this source. Alternatively, they can source crude similar in grade to the North Sea from Africa and the Mediterranean, entailing higher delivery costs.

## Competitiveness

- 7.5.3 The UK refineries face the challenge of improving their competitiveness in the European refining market. They are presently mid to low performers<sup>76</sup> within the EU peer group, so do not attract discretionary investment. UK refiners are also challenged by an ageing workforce and shrinking pool of available talent to replace those scheduled to retire from the sector. The sector has experienced problems recruiting domestically and has had increasingly to look overseas for qualified workers.

## Biofuels

- 7.5.4 The recent introduction of the Renewable Transport Fuels Obligation (RTFO) requires companies selling transport fuels into the UK market to ensure that a certain percentage of their total sales are renewable fuels (paragraph 9.2.8 discusses biodiesel supply). These changes will impact the UK future product balance by:

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<sup>76</sup> Review of UK oil refining capacity, Wood Mackenzie, May 2007. [www.berr.gov.uk/files/file39390.pdf](http://www.berr.gov.uk/files/file39390.pdf)

- increasing the petrol surplus; the future UK petrol product surplus is likely to increase by the amount of ethanol being introduced into the UK market, 0.77 mt of ethanol in 2015. The additional surplus petrol will need to be exported, increasing the market challenge faced by UK refiners who will increasingly need to target other markets, or invest in the production of alternative products – such as middle distillates, where Europe is expected to be in deficit;<sup>77</sup>
- delaying the UK entering a net deficit in the diesel/gas oil balance from 2008 until 2011 and then assisting the UK to return to a net surplus position once again in 2017 (see Chart 1.4 above).

## 7.6 UK supply: Oil Stocks

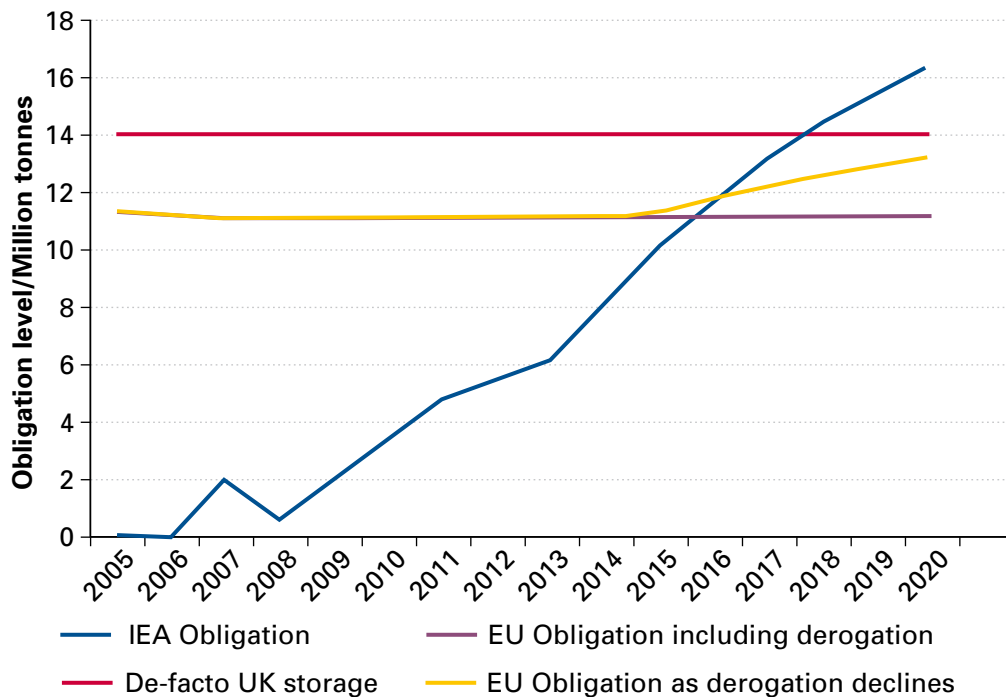
- 7.6.1 Both the International Energy Agency and the European Union require their member states to hold stocks of oil, but the same stocks can be used to meet both obligations. To meet these obligations, the UK directs companies to hold stocks of oil for use in the event of disruption to global supplies.<sup>78</sup>
- 7.6.2 The EU obligations are based on consumption and the IEA obligations are based on net imports. Currently, the EU requirements are above the IEA requirements; however, the UK's obligations under the IEA requirements are set to increase further as the UK increasingly becomes a net-importer of oil.

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77 Review of UK oil refining capacity, Wood Mackenzie, May 2007 [www.berr.gov.uk/files/file39390.pdf](http://www.berr.gov.uk/files/file39390.pdf)

78 Further details about the IEA's emergency responses procedures can be found at [http://www.iea.org/textbase/nppdf/free/2007/fs\\_response\\_system.pdf](http://www.iea.org/textbase/nppdf/free/2007/fs_response_system.pdf).

Chart 7.5: Modelled forecast of UK Oil Stocking Obligations



Source: DECC

7.6.3 Between about 2016 and 2018 the IEA obligation is expected to overtake the EU obligation. Thereafter, the UK obligation for stock holdings will begin to increase steeply from its current level of 67.5 days’ consumption to an eventual total of 99 days’ consumption. At the same time the total UK obligation is likely to exceed the UK storage capacity available to hold these stocks.<sup>79</sup> More stocks and storage capacity will therefore be required to meet the overall UK stocking obligation.

7.6.4 In February 2007 and following an extensive stakeholder consultation, the Government announced changes to the operation of the UK’s industry-based compulsory stocking regime<sup>80</sup>. One aspect of this decision was judicially reviewed in February 2008, when the High Court found in the Government’s favour. However, permission to appeal was granted and the Court of Appeal heard the case in December 2008.

7.6.5 In late April 2008, the EU Commission launched a public consultation on modernising the emergency oil stock regime. The consultation suggested closer alignment and

79 Further information is available at <http://www.berr.gov.uk/whatwedo/energy/international/oil-stocking/page28385.html>

80 Further information is available at <http://www.berr.gov.uk/whatwedo/energy/international/oil-stocking/page28385.html>

co-ordination between the EU and IEA stocking systems together with changing data reporting requirements and strengthening government control. The consultation closed in mid June and stakeholder responses can be viewed on the Commission's website<sup>81</sup>.

## **7.7 The Global Oil Market**

- 7.7.1 The UK acts as both buyer and seller in the global market, where prices and availability are determined by global supply and demand conditions; it is expected to become increasingly reliant on imports in the medium term.
- 7.7.2 Although prices have fallen significantly in recent months, 2008 saw oil prices hitting all-time highs, even in real terms. Unlike previous spikes, rising prices over the past year were largely the result of rapid demand growth, led by emerging economies like China and India, which caused tightness in both crude and product markets and raised concerns about the degree to which global supplies of crude oil and oil products are growing in line with global demand. Since their peak in July however, oil prices have fallen in excess of \$100/bbl as global demand for petroleum products has collapsed in the wake of economic slowdown.
- 7.7.3 The year's dramatic events have fostered considerable international efforts to improve the functioning of the oil market and, in June, Saudi Arabia hosted a meeting which brought together major producing and consuming countries, together with the IEA, IEF and OPEC. This meeting identified a number of areas where further work should be taken forward as part of an enhanced dialogue between producers and consumers to improve the functioning of the oil market and increase understanding. The UK is hosting a follow up meeting – The London Energy Meeting – on 19 December 2008 to continue this process and address the impact of the financial crisis on both demand and investment.
- 7.7.4 The rest of this chapter examines key risks to the future global supply of oil, particularly barriers to investment, both in the upstream and the downstream global oil markets, that may hinder the ability of the oil industry to respond to future demand trends.

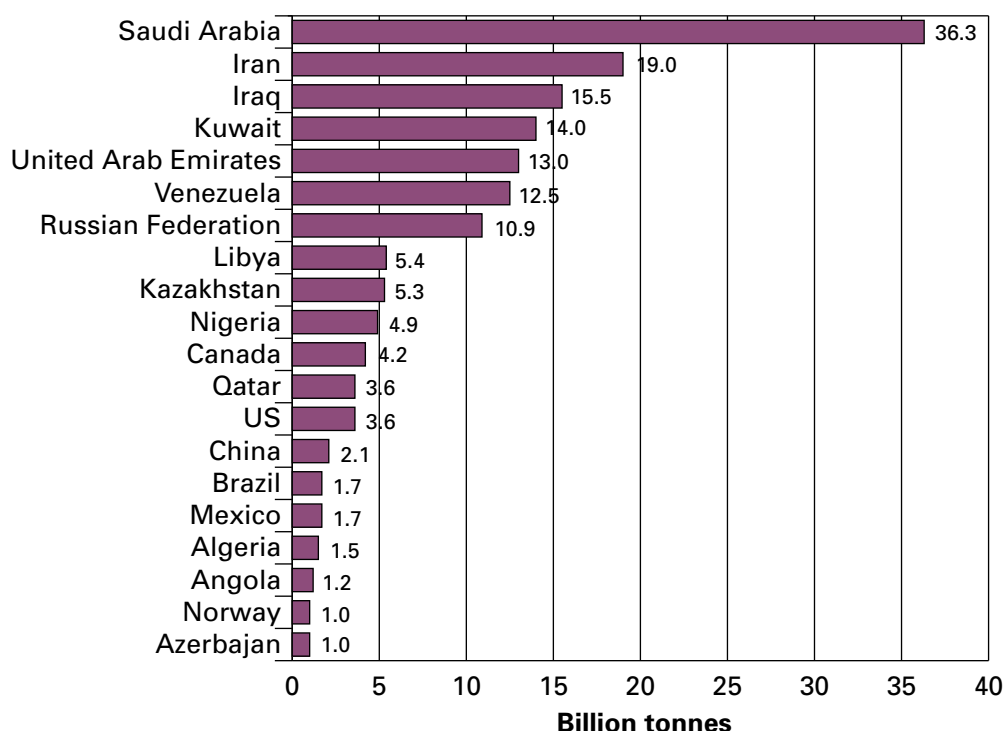
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81 Further details are available at [http://ec.europa.eu/energy/oil/consultation/oil\\_stocks\\_en.htm](http://ec.europa.eu/energy/oil/consultation/oil_stocks_en.htm)

## Global Resources and Reserves

7.7.5 Although estimates of economically recoverable reserves vary, the physical existence of oil is not the major concern.<sup>82</sup> According to the *BP Statistical Review of World Energy 2008*<sup>83</sup>, the world's proven reserves<sup>84</sup> of oil amounted to 193 billion tonnes (or 1390 billion barrels)<sup>85</sup> at the end of 2007, equivalent to 41.6 years of current production. The Middle East accounts for 54% of the world total, with Saudi Arabia alone accounting for 19%; while the UK ranks 28th globally in terms of its proven oil reserves.

Chart 7.6: Top twenty countries' proven oil reserves, end 2007



Source: *BP Statistical Review of World Energy 2008*

7.7.6 However, incentives for oil companies to invest significant sums in upstream exploration and development are constrained, particularly in regions affected by regulatory instability and security and political risks, and have been blunted by recent market volatility. Recent experiences in Venezuela and Russia, and continuing uncertainty within Iraq and Nigeria, underline the importance of stable and predictable regulatory frameworks, stability and security to provide a sound basis for investment.

82 See sub-section on Peak Oil at the end of this chapter.

83 Further details are available at <http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622>

84 Proven Reserves of oil are generally taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions.

85 Total includes Canadian oil sands, remaining established reserves not under active development.

## Resource Nationalism

- 7.7.7 The share of reserves that are now under the control of National Oil Companies<sup>86</sup> (NOCs) has been increasing since the 1970s and is expected to continue to do so. This has significantly limited the ability of International Oil Companies (IOCs) to develop new reserves, constraining the flow of both capital and technology into oil production.
- 7.7.8 In some cases, NOCs face constraints on both the level and complexity of production they can undertake, including competing domestic socio-economic priorities, which reduce the productive efficiency of the supply chain. A desire to save oil for future generations may also motivate slower investment in some countries, though this assumes that oil will act as a store of value over time, which may not be the case given the development of alternative energy sources. More generally, wider regulatory barriers such as obtaining planning permission and licences can also impact investment by preventing it, slowing it down, or increasing its cost.
- 7.7.9 The range of factors limiting access to low-cost reserves has increasingly led IOCs to focus on development of marginal fields, characterised by increasing geological complexity, and non-conventional sources of oil, both involving increased technological challenges and higher costs.

## Demand Uncertainty

- 7.7.10 Oil-producing nations often refer to uncertainties over future oil demand in light of ongoing global climate negotiations, which act as a disincentive for further investment in oil supply. The lack of credible demand projections and robust and timely data on key oil market data, such as demand, supply, inventories, investment and reserves, exacerbates this uncertainty. The Joint Oil Data Initiative (JODI) is an international initiative between producers and consumers to improve transparency via routine publication of production and consumption data. Around ninety countries participate in JODI, representing well over 90 per cent of global supply and demand.<sup>87</sup>

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<sup>86</sup> Companies under the direct control of national Governments and often managed on a political rather than commercial basis

<sup>87</sup> For further details see <http://www.jodidata.org/>.

7.7.11 Furthermore, in a number of countries, administered prices for petroleum products have helped insulate consumers from price changes and therefore prevented demand from responding effectively to market price signals. Currently, half of the world's population experiences fuel subsidies, with around a quarter of the world's supply of petrol being sold below free market prices.<sup>88</sup> Whether these policies prevail or not is even more important given the growing share of transport demand in global oil demand, which is price-inelastic, and therefore makes the fiscal cost of subsidies increasingly variable. This increasing variability makes the timing, extent and impact of any change in subsidisation policy far less easy to predict and manage, rendering decisions about investment in new production and refining capacity much more difficult.

## Cost inflation

7.7.12 In the recent past, productive capacity has not kept pace with the rise in demand. Key reasons for the slow response in supply are the time lag it takes to bring new supply to market, up to ten years in most instances, and rising production costs due to global shortages in skilled labour and specialist equipment. The cost of developing a new oil field is estimated to have doubled in the last four years.<sup>89</sup> As a result, the real value of investment into oil production has been eroded, reducing the number of barrels produced per dollar of investment. The cost increase and skills shortage is often related to rapidly increasing demand for construction materials and commodities from developing nations such as, for example, China and India.

7.7.13 In addition, there is an increasingly significant mismatch in the quality of global crude oil supply, which is becoming increasingly heavier, and existing refinery capacity, which at the global level is mostly designed to handle lighter crudes. To address this, investment in upgrading existing refining facilities and building new refineries will be needed.

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<sup>88</sup> "Crude measures", *The Economist*, 29 May 2008.

<sup>89</sup> Upstream Capital Cost Index, Cambridge Energy Research Associates <http://www.cera.com/asp/cda/client/knowledgeArea/serviceDescription.aspx?KID=178>

## 7.8 Conclusions

- 7.8.1 Although the UK only recently became a net oil importer, we have long been active in the global oil market and therefore already have in place much of the infrastructure, contractual arrangements and commercial relationships needed to ensure the continued security of oil supplies for the UK from external sources. The UK also has a well-developed refinery sector to process crude oil, even though it is unlikely that domestic production will ever fully match consumption of the different oil products.
- 7.8.2 The UK has primary storage and transport infrastructure to distribute oil and oil products to end users. However, further investment will be required in some localities, such as the South-East, where storage and distribution disruptions have occurred in the past and demand for petroleum products, particularly aviation fuel, still maintains a high rate of growth. Finally, in case of supply emergencies, the UK, including through its membership of international institutions, has well established procedures in place to deal with disruptions. One example of this was the release of IEA stocks in the event of Hurricane Katrina and Rita. The downstream oil industry itself also has the flexibility to respond to a short-lived disruption of the UK oil supply.
- 7.8.3 Going forward, there are significant uncertainties as to whether the necessary investment in upstream and downstream supply capability will be forthcoming, with recent price volatility adding to the risk of a supply crunch. Both spare capacity and inventories provide important buffers to deal with supply shocks or swift increases in global oil demand, mitigating the risk of a physical supply disruption to consumers and price volatility while the supply-demand balance adjusts. Although the recent downturn in demand has already reduced pressure on supply and will lead to rising spare capacity in the immediate future, this trend is set to reverse before 2015. Without the required investment taking place in supply, refining and spare capacity, the risk of higher prices and greater price volatility increases.



## Peak Oil

Some analysts and scientists believe that the peak in global oil production is going to happen soon, with views ranging from imminently to within the next 10–15 years. They argue that there is relatively little oil left to be discovered, that reserves are overstated and that we have already nearly produced half of the world's original endowment of ultimately recoverable reserves.

While the amount of oil physically existing in the world is fixed by geology, the proportion of that total that is economically recoverable is not; it can be increased, for example, by technological developments and by increases in the price of oil that will make more reserves economical to recover.

Global proven reserves<sup>90</sup> (including Canadian oil sands) have more than doubled since 1980 despite production in the interim. Global proven reserves are also larger than the cumulative production needed to meet rising demand until at least 2030. However, more oil will need to be added to the proven category if global oil production is not to peak before then. In this respect, undiscovered resources, reserve growth from existing fields and technological developments will all help to increase the amount of oil that is ultimately recoverable. For example, the UK's remaining oil resources that might be ultimately recoverable are estimated to be between 1.0 and 3.3 billion tonnes, compared to current proven reserves of 0.5 billion tonnes.

However, the issues surrounding 'peak oil' are not restricted to the existence of resources and reserves, but also depend on the world's ability to convert these reserves into production now and in the long run. Thus, there are a number of other factors that also have an influence, such as:

- the level of investment that takes place in the energy supply chain;
- the extent to which open markets enable access to resources, reserves and the requisite capital;
- ongoing geo-political tensions and lack of security.

Maintaining growth in production capacity is a significant challenge given escalating costs of production as remaining reserves become more technologically challenging to extract (e.g. deep-sea reserves, oil sands), and other investment

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<sup>90</sup> Proven Reserves of oil are generally taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions.

constraints such as the increasing costs of materials and decreasing availability of skilled labour in the sector. In 2008 the International Energy Agency (IEA) estimated that the oil industry needs to invest a total of \$6.3 trillion in 2007 dollars over the period 2007–2030 to deliver the growth in production capacity necessary to meet projected increases in demand levels<sup>91,92</sup>.

Meanwhile, investment plans may change; projects may be cancelled, delayed or accelerated for various reasons. The opportunities and incentives for private and publicly-owned companies to invest are particularly uncertain. In addition, environmental policies could increasingly affect opportunities for building upstream and downstream facilities and their cost, especially in OECD countries.

Hence the timing of 'peak oil' in global oil production also crucially depends on turning reserves through investment into new production.

In any case, whatever the cause, the approach to oil production peaking is most likely to manifest itself in a tighter oil market, resulting in higher and volatile prices. However, high and volatile prices are likely to result in some demand destruction and increased elasticity of oil demand in the medium to long run leading to a more flexible market. In the short term, however, demand is relatively inelastic and unresponsive to high prices due both to lack of short-term alternatives in the transport sector and to crude prices only constituting a relatively low proportion of the final product price.

The UK may be in a better position to cope with higher oil prices than its international counterparts because, among the G7 countries and despite being an oil producer, the UK consumes the least amount of oil per \$1000 worth of output. Further, many of the policies currently being pursued in order to reduce the UK's CO<sub>2</sub> emissions from the transport sector, such as the Renewable Transport Fuel Obligation (RTFO), EU standards on vehicle emissions, research into electric and hybrid vehicles, etc. are likely to encourage the development and deployment of technologies that provide an alternative to petrol and diesel. As such, they are likely to improve the UK's resilience against "peak oil".

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91 International Energy Agency *World Energy Outlook 2008*

92 International Energy Agency, *World Energy Outlook 2008, Upstream Investment Prospects*

## 8. Nuclear Fuel

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### 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 considered in paragraph 4.6.5.
- 8.1.2 The analysis in this chapter draws heavily on the most recent reports published by the Organisation for Economic Co-operation and Development's Nuclear Energy Agency and the International Atomic Energy Agency<sup>93</sup> (OECD/IAEA), and the Euratom Supply Agency<sup>94</sup> (ESA).

### 8.2 Demand for nuclear fuel in the UK

- 8.2.1 The UK currently has nineteen operating reactors at ten nuclear power stations. The UK's nuclear power stations provided 57.25 TWh of electricity, around 15 per cent of the UK's electricity supply, in 2007<sup>95</sup>.
- 8.2.2 As explained in paragraph 4.4.8 a number of these stations are due to close over the next few years. However, since the last Energy Markets Outlook was published there have been significant developments in Government policy and these are summarised in paragraph 4.6.6 above.

### 8.3 Uranium supply in the UK

- 8.3.1 The majority of nuclear fuel is made from enriched uranium. Uranium in the form of uranium ore concentrate (commonly known as yellowcake, U<sub>3</sub>O<sub>8</sub>) is readily available on the world market where commercial demand for uranium is principally determined by the requirements of nuclear electricity generation. The UK is not a uranium producer, but uranium ore may be stockpiled. The stockpiling of fuel in the UK is the responsibility of the

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93 Uranium 2007: Resources, Production and Demand. OECD Nuclear Energy Agency and the International Atomic Energy Agency. June 2008.

<http://www.oecdbookshop.org/oecd/display.asp?sf1=identifiers&st1=9789264047662>

94 Euratom Supply Agency: Annual Report 2007. June 2008. <http://ec.europa.eu/euratom/ar/last.pdf>

95 Digest of United Kingdom Energy Statistics 2008.

<http://www.berr.gov.uk/whatwedo/energy/statistics/publications/dukes/page45537.html>

utilities concerned and the actual fuel stock levels held by commercial companies are confidential. Fuel costs make up only a small proportion (around 10%) of overall plant running costs, with uranium ore accounting for approximately 1.5% of total generation costs<sup>96</sup>.

8.3.2 There are fuel fabrication and enrichment facilities located in the UK with the capability to manufacture fuel for all major designs of nuclear reactors. The first step in producing fuel for the UK's Advanced Gas-cooled Reactors (AGRs) and Pressurised Water Reactors (PWR) is to convert uranium into uranium hexafluoride which, for AGR and PWR fuel (Magnox stations use natural (un-enriched) uranium) is then enriched to increase the proportion of Uranium 235<sup>97</sup> (U235) from approximately 0.7% to typically between 2.5 and 5.0%. The enriched material is then converted into either AGR or PWR ceramic (UO<sub>2</sub>) fuel pellets which are then packed into stainless steel tubes for AGRs to form fuel pins or zirconium alloy tubes for PWRs to form fuel rods. A number of these pins or rods are then assembled into a fuel element. A fuel assembly remains within an AGR for a period of typically four to eight years, and PWR fuel elements remain within the reactor for typically three to five years.

8.3.3 A report<sup>98</sup> published by the Nuclear Decommissioning Authority (NDA) in June 2007, examined the uranium and plutonium stocks held by the Authority. The report provided an economic analysis of potential future disposition options for the significant stock of nuclear materials held by the NDA and concluded that they could be immobilised and disposed of, stored over the long-term, sold and/or converted to fuel to be re-used in nuclear power stations. Table 8.1 presents the inventory of nuclear materials held by the NDA.

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96 Meeting the Energy Challenge: A White Paper on Nuclear Power. Department for Business, Enterprise and Regulatory Reform. January 2008. <http://www.berr.gov.uk/whatwedo/energy/sources/nuclear/whitepaper/page42765.html>

97 The isotope found in uranium that is readily fissionable in a nuclear reactor is U-235, but only 0.7% of natural uranium is U-235, the remainder being U-238. By enriching uranium the U-235 content can be increased to typically around 2.5 – 5%. Enriched fuel is capable of reaching much higher temperatures in a nuclear reactor and is more efficient in generating electricity.

98 Uranium and Plutonium: *Macro-Economic Study*. Final Report. Nuclear Decommissioning Authority. June 2007. <http://www.nda.gov.uk/documents/upload/Uranium-and-Plutonium-Macro-Economic-Study-June-2007.pdf>

Table 8.1: Inventory of nuclear materials<sup>99</sup> held by the NDA

Source	Quantity (tonnes) of heavy metal
Tails Uranium Hexafluoride <sup>100</sup>	25,000
Magnox Depleted Uranium <sup>101</sup>	30,000
Thorp Product Uranium <sup>102</sup>	5,000
Plutonium Dioxide <sup>103</sup>	100
Total	60,000

8.3.4 The report stated that the inventory held by the NDA could be used to fuel up to three modern 1000MW PWR reactors over a period of 60 years. However, the decision on what option will be followed to manage the NDA's inventory in the future has yet to be made by the UK Government.

## 8.4 Import requirement

8.4.1 The UK nuclear industry currently sources the majority of its uranium from Australia<sup>104</sup>. The supply of uranium is carried out in accordance with the procedures stipulated by the Euratom Supply Agency<sup>105</sup> (ESA). The ESA's Annual Report 2007<sup>106</sup> presents information on the countries of origin for the supply of uranium to the EU. Chart 8.1 draws on the supplier country information given in the ESA Report.

99 These materials (Uranium and Plutonium, in a variety of physical and chemical forms) have arisen principally from uranium enrichment, nuclear fuel manufacture and used nuclear fuel reprocessing.

100 This is residue from enrichment of natural uranium for fuel manufacture. This material has a lower U-235 content (typically in the range 0.2-0.4%) than natural uranium.

101 Material obtained from Sellafield reprocessing of used fuel from Magnox reactors. The recovered uranium from reprocessing contains around 0.4% U-235.

102 Material obtained from Sellafield reprocessing of used fuel from AGR reactors in Thermal Oxide Reprocessing Plant (Thorp). This material typically contains a higher percentage of U-235 (around 0.9%) than natural uranium.

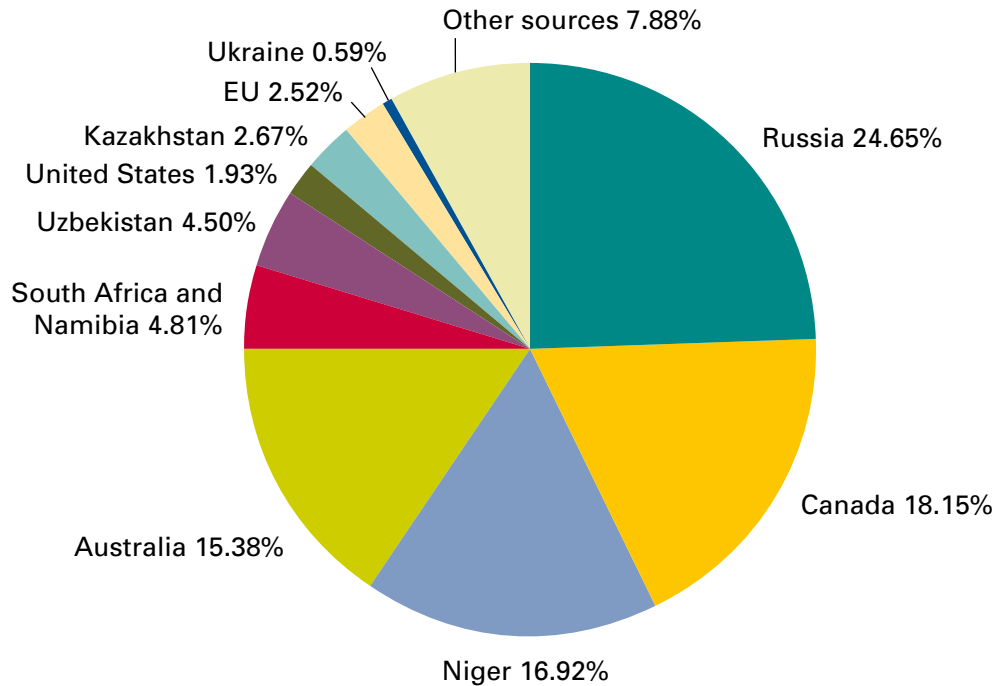
103 This is plutonium recovered from Sellafield reprocessing (Magnox and Thorp) of used fuel.

104 Uranium Asset Management Ltd.

105 [http://ec.europa.eu/euratom/index\\_en.html](http://ec.europa.eu/euratom/index_en.html)

106 Euratom Supply Agency: Annual Report 2007. June 2008. <http://ec.europa.eu/euratom/ar/last.pdf>

Chart 8.1: Major suppliers of uranium to the EU



Source: ESA

8.4.2 The only European states that supplied uranium to the EU were the Czech Republic and Romania, but they supplied only a very minor part of the total EU needs.

8.4.3 The ESA Annual Report also notes that *for the second time since 2006, uranium deliveries to EU utilities were higher than the amount of uranium loaded into reactors. Thus inventories are being rebuilt in response to security of supply concerns and rising prices.*

## 8.5 Global uranium demand

8.5.1 Over the next 20 to 30 years (assuming an operating lifetime for older type nuclear reactors to be between 40 to 50 years) around 285GW (electricity), which equates to almost 77% of current global nuclear capacity, is expected to retire. There is great interest throughout the world in new nuclear capacity, as a means of securing electricity supplies and tackling carbon emissions. There are currently 34 reactors under construction. Table 8.2 gives the countries and number of reactors being constructed<sup>107</sup> as of June 2008.

<sup>107</sup> Power Reactor Information System. International Atomic Energy Agency. <http://www.iaea.org/programmes/a2/>

Table 8.2: Reactors under construction globally

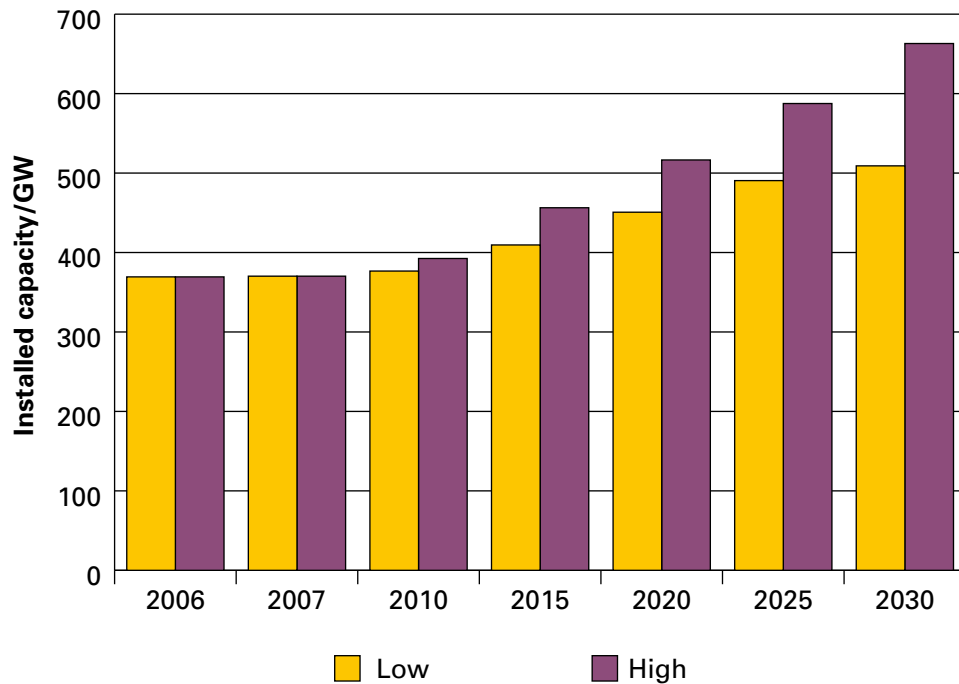
Country	Number of reactors	Total capacity MW (electricity)
China	6	5220
India	6	2910
Russian Federation	6	3639
Rep. of Korea	3	2880
Bulgaria	2	1906
Taiwan	2	2600
Ukraine	2	1900
Argentina	1	692
Finland	1	1600
France	1	1600
Islamic Rep. of Iran	1	915
Japan	1	866
Pakistan	1	300
United States	1	1165
<b>Total</b>	<b>34</b>	<b>28193</b>

Source: IAEA

- 8.5.2 The OECD/IAEA has produced projections<sup>108</sup> covering low and high case scenarios for global installed nuclear capacity and future global uranium requirements. The OECD/IAEA forecast significant growth in nuclear capacity and in turn higher demand for nuclear fuel.
- 8.5.3 The OECD/IAEA have stated that *installed nuclear capacity is projected to grow from about 370 GWe net at the beginning of 2007 to about 509 GWe net (low case) or 663 GWe net (high case) by the year 2030. The low case represents growth of 38% from current capacity, while the high case represents a net increase of about 80%.* Chart 8.2 provides graphical representation of the OECD/IAEA projected low and high case scenarios for installed capacity.

108 Uranium 2007: Resources, Production and Demand. OECD Nuclear Energy Agency and the International Atomic Energy Agency. June 2008.  
<http://www.oecdbookshop.org/oecd/display.asp?sf1=identifiers&st1=9789264047662>

Chart 8.2: Projected world installed nuclear generating capacity to 2030



Source: OECD/IAEA<sup>109</sup>

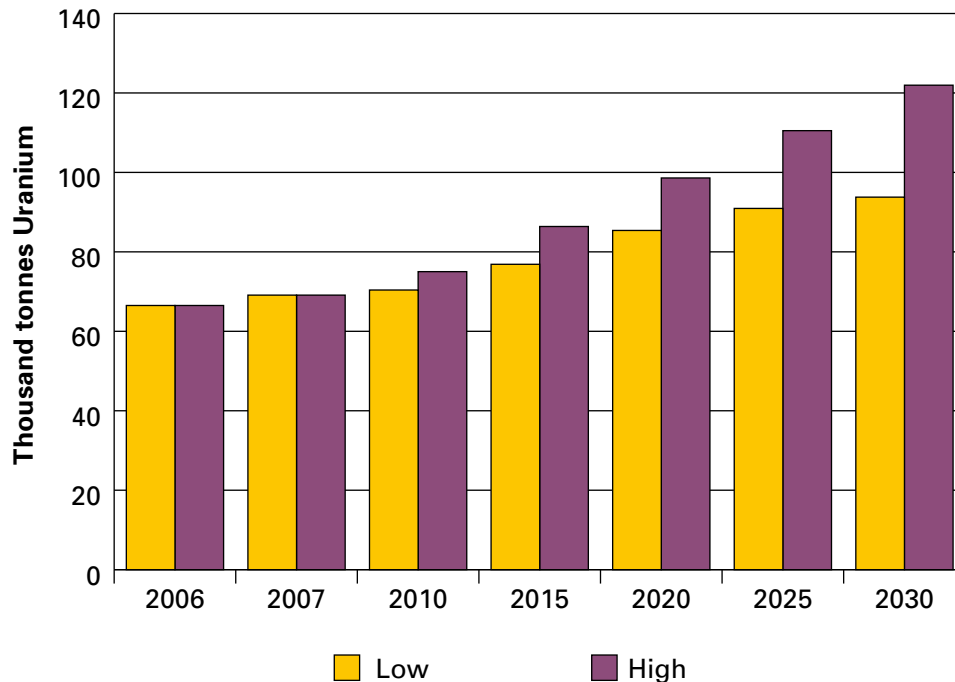
8.5.4 The OECD/IAEA have stated that *world reactor-related uranium requirements by the year 2030 (assuming a tails assay<sup>110</sup> of 0.3%) are projected to increase to between 93 775 tU/year in the low case and 121 955 tU/year in the high case, representing about 41% and 83% increases respectively, compared to 2006.* Chart 8.3 provides a graphical representation of the OECD/IAEA projected demand for uranium out to 2030.

109 Forty Years of Uranium Resources, Production and Demand in Perspective, Sept 2006. Uranium 2007 Resources, Production and Demand, June 2008.

110 Tails assay – This is the quantity of fissile uranium (U-235) that is contained in the waste material following the uranium enrichment process.



Chart 8.3: Projected world uranium requirements to 2030



Source: OECD/IAEA<sup>111</sup>

8.5.5 The OECD/IAEA<sup>112</sup> have stated that there could be an even greater increase in the growth of nuclear energy due to increasing concerns about longer-term security of supply of fossil fuels and the extent to which nuclear energy is seen to be beneficial in meeting greenhouse gas reduction targets.

## 8.6 Uranium supply: resources

8.6.1 Nuclear energy benefits from having a diverse supply of fuel in 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.

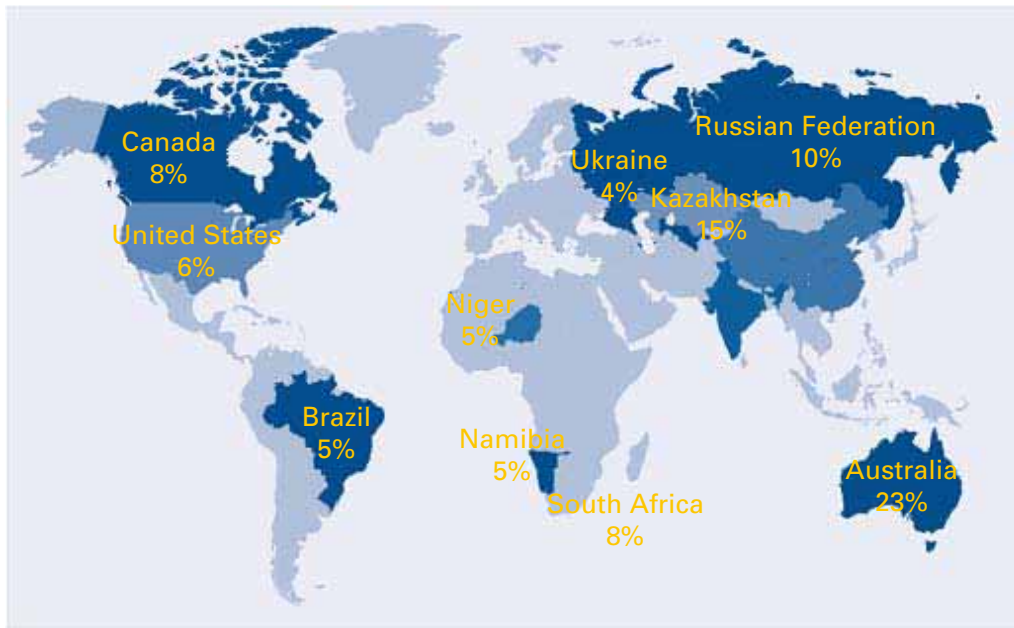
8.6.2 The identified global uranium resource base is spread throughout 43 countries and is listed in the OECD/IAEA *Red Book*. The ten countries with the largest resources are given in chart 8.4.

111 Forty Years of Uranium Resources, Production and Demand in Perspective, Sept 2006. Uranium 2007 Resources, Production and Demand, June 2008.

112 Uranium 2007: Resources, Production and Demand (*Red Book*). OECD Nuclear Energy Agency and the International Atomic Energy Agency. June 2008.

<http://www.oecdbookshop.org/oecd/display.asp?sf1=identifiers&st1=9789264047662>

Chart 8.4: The ten countries with the highest identified uranium resources



Source: OECD/IAEA

8.6.3 The OECD/IAEA and the ESA have both stated that sufficient global uranium resources exist to accommodate future nuclear power expansion. The latest figures available from the OECD/IAEA state that at 2006 estimated rates of uranium consumption in nuclear power reactors, identified uranium resources would be sufficient for about 100 years of reactor supply. They also state that *given the limited maturity and geographical coverage of uranium exploration worldwide, there is considerable potential for discovery of new resources of economic interest.*

## 8.7 Uranium supply: exploration and production

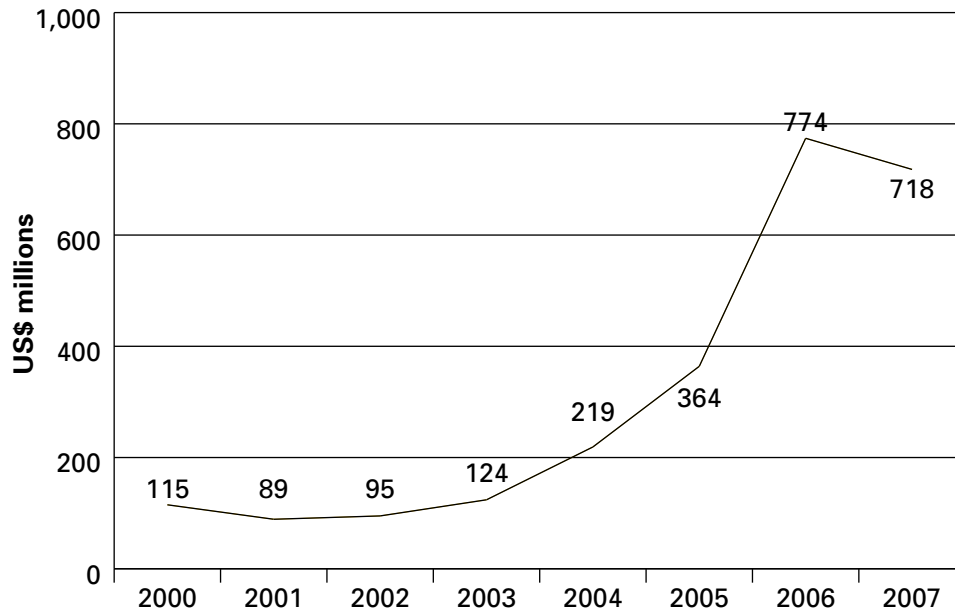
8.7.1 The development of mines and the increase of uranium production are necessary to ensure that the uranium resources continue to be available to the market. The *Red Book* acknowledges that *a continued strong market and sustained high prices will be necessary for resources to be developed within the timeframe required to meet future uranium demand.*

8.7.2 The recent renewed interest in nuclear power generation and the rises in uranium prices have delivered substantially increased expenditure on exploration for new uranium resources, including in several EU Member States. The

OECD/IAEA<sup>113</sup> has reported that exploration activities are being conducted in *countries which explored and developed uranium deposits in the past and also in many countries where exploration for uranium had not been conducted for many decades.*

8.7.3 Chart 8.5 below shows how exploration expenditure has increased over the years.

*Chart 8.5 Uranium exploration expenditure*



Source. OECD/IAEA.

Note: for 2007 this is an estimated figure.

8.7.4 Exploration expenditure has increased more than seven fold since the early part of this decade.

113 Uranium 2007: Resources, Production and Demand. OECD Nuclear Energy Agency and the International Atomic Energy Agency. June 2008.  
<http://www.oecdbookshop.org/oecd/display.asp?sf1=identifiers&st1=9789264047662>

## 8.8 Conclusion

- 8.8.1 The UK Government has concluded that nuclear should have a role to play in the generation of electricity, alongside other low carbon technologies. The Government is taking the steps set out in the Nuclear White Paper<sup>114</sup> to facilitate the development of new nuclear power stations in the UK.
- 8.8.2 Following analysis and wide consultation the UK Government reached the conclusion, with respect to uranium fuel, in the 2008 White Paper that *...there should be sufficient reserves to fuel any new nuclear power stations constructed in the UK.*
- 8.8.3 There is a growing interest globally in constructing new nuclear generating capacity in response to security of supply and climate change concerns. The OECD/IAEA predicts an increase in nuclear power to take place over the coming years. The OECD/IAEA and the ESA nevertheless estimate that there are sufficient uranium resources to meet future demand.

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114 Meeting the Energy Challenge: A White Paper on Nuclear Power. Department for Business, Enterprise and Regulatory Reform. January 2008.  
<http://www.berr.gov.uk/whatwedo/energy/sources/nuclear/whitepaper/page42765.html>

## 9. Renewable Energy

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### 9.1 Introduction

- 9.1.1 Security of supply is often associated with national self sufficiency and hence (inversely) with import dependency. The increasing dependency of the EU as a whole on fossil fuel imports which may be subject to interruption, for political, criminal, geological, commercial or meteorological reasons which are outside the EU's control, is cited in the Renewables Directive as one of the main drivers of the EU objective of increasing the proportion of its energy needs to be met from renewable sources. Increasing international competition for energy resources, as increased demand from growing economies coincides with increasing scarcity and difficulty of accessing and extracting fossil fuel reserves, has been identified as one of the main threats to the UK's overall security.
- 9.1.2 The UK has previously chosen to address this mainly through diversification, ensuring that we do not become over-exposed to any one supply source, supply route or import point, and market liberalisation to encourage an efficient and flexible market response to changes in the supply-demand balance. However, there are limits to the extent to which diversification of geographical fossil fuel supply sources is feasible. For example, the world's gas and oil reserves are concentrated in a limited number of countries, as are uranium reserves; and increasingly stringent emissions standards are likely to reduce the number of sources of coal as some types of coal will become unsuitable for use.
- 9.1.3 Greater use of renewable energy therefore offers another means of diversification and should help to reduce our dependency on imported fossil fuels on an annual basis. For example, the Government's Consultation on the UK Renewable Energy Strategy<sup>115</sup> indicates that increased investment in the UK to meet a 15% renewable energy target in 2020 will reduce *annual* UK gas imports by 12 – 14% in 2020, although the *peak day* import requirement may increase – for example, if a cold day coincides with low wind availability so that electricity demand has to be

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<sup>115</sup> <http://renewableconsultation.berr.gov.uk/>

met with increased output from gas-fired generating capacity. The impact on electricity supply of a higher proportion of renewable generating capacity is considered in the box on the impact of increased renewables penetration in chapter 4.

- 9.1.4 Even without carbon considerations it is clear that in the longer term fossil fuel reserves are ultimately finite and will become increasingly harder and more expensive to obtain. Activity now to develop renewable energy generating technology, and ways of ensuring that it meets our need for secure, reliable energy supply, will smooth the path towards an eventual transition away from fossil fuels.
- 9.1.5 A Renewable Energy Strategy will be developed in the light of responses to the consultation exercise<sup>116</sup> and published in the first half of 2009. This chapter considers the possible future supply-demand balance of the various renewable resources which the UK is likely to draw on in reaching the target.

## 9.2 Renewable resources: Supply

- 9.2.1 The total amount of renewable energy resource available in the UK is high.

### Wind

- 9.2.2 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<sup>117</sup>.

### Intermittency

- 9.2.3 However, this power source is not always available. While no energy generating technology capacity delivers all the time, wind power raises particular difficulties in this regard. Wind turbines operate at maximum capacity where wind

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<sup>116</sup> Responses were not available for analysis as this report was being prepared and so information and conclusions from that source are not reflected here.

<sup>117</sup> *Quantification of Constraints on the Growth of UK Renewable Generating Capacity*, Sinclair Knight Merz 2008 (Table 1). Available from [http://renewableconsultation.berr.gov.uk/related\\_documents](http://renewableconsultation.berr.gov.uk/related_documents)

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; and at wind speeds of 25 m/s or above, wind turbines become unstable and stop working.

- 9.2.4 Individual wind sites are likely to experience wind speeds below 4 m/s about 15% – 20% of the time. However, such effectively-no wind events very rarely affect the whole country (one hour per year where over 90% of the UK experiences wind speeds of less than 4 m/s) and widespread high-wind events are even rarer. For 85% of the time, half or more of the UK experiences some wind. 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<sup>118</sup>.
- 9.2.5 On average, and on both an annual and a daily basis, wind availability varies with electricity demand; it is higher during winter months, and during daylight hours, than it is during the summer and at night.

## Variability

- 9.2.6 Changes in wind speed can have a significant impact on output from wind turbines; for example an increase from 5 to 6 m/s will more than double the output, and an increase from 5 to 10 m/s will multiply it twelvefold. This can present a significant challenge to the requirement to maintain an instantaneous balance between electricity supply and demand. However, such large changes are unlikely to happen very rapidly, with hourly changes of 2.5% the most likely and 99.98% of hourly changes less than 20%<sup>119</sup>; and can usually be forecast some hours ahead.

## Biomass/biofuel

- 9.2.7 Landfill gas is currently the most significant source of biomass-based renewable generation in the UK but the potential for growth is small in the short term as most large landfill sites are already being exploited and may decline in future as sites are depleted. Exploitable resources of sewage gas are expected to plateau after 2020. Further

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118 Environmental Change Institute, University of Oxford: Wind power and the UK wind resource, 2005

119 ECI *ibid*

growth in biomass electricity generation is likely to be sourced from waste or energy crops<sup>120</sup>.

- 9.2.8 Total annual capacity for biodiesel production in the UK could reach 1600 million litres per year by 2010 if all planned plant were to become operational and existing plant operates at full capacity, equivalent to just under 6% of the UK's diesel consumption in 2007. However, this level of production would require significant imports of vegetable oils<sup>121</sup>.
- 9.2.9 Total annual capacity for bioethanol production in the UK could reach 600 billion litres per year by 2011 if all planned plant were to become operational, equivalent to around 2.4% of the UK's petrol consumption in 2007. However, this level of production would require significant imports of wheat<sup>122</sup>.
- 9.2.10 A review<sup>123</sup> of biofuel sustainability published in July 2008 concluded that there is probably sufficient land for food, feed and biofuels but recommended that the introduction of biofuels should be significantly slowed down until adequate controls to address displacement effects are implemented and demonstrated to be effective. The Government accordingly stated in the consultation document on the Renewable Energy Strategy that it would not agree to any increase above current biofuels targets unless it is clear that this can be done in a sustainable way.
- 9.2.11 Biomass is currently the basis of the most important renewable heat technologies in use in the UK. The main types of biomass in use are woody biomass and waste with a high biomass content, such as municipal "black bag" waste.

## Wave and tidal power

- 9.2.12 The potential energy resource from wave and tidal generation in the UK is significant. Because of the direction of the prevailing winds and the size of the Atlantic Ocean, the UK has wave power levels which are among the highest in the world<sup>124</sup> and the tidal range in the Severn Estuary is the second highest in the world. The level of this resource

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120 Renewables consultation document para 3.2.11

121 DUKES 2008 para 7.30

122 DUKES 2007 para 7.31

123 [http://www.dft.gov.uk/rfa/db/documents/Report\\_of\\_the\\_Gallagher\\_review.pdf](http://www.dft.gov.uk/rfa/db/documents/Report_of_the_Gallagher_review.pdf)

124 DUKES 2008 para 7.42



which could practicably be exploited is limited by the accessibility of suitable sites, but the Carbon Trust has nevertheless estimated that between 15% and 20% of current UK electricity demand could be met from marine and tidal energy<sup>125</sup>, including 5% of the UK's electricity demand from the Severn alone<sup>126</sup>.

9.2.13 Tidal flows are entirely predictable for many years in advance, but wave strength and speed is correlated with wind speeds and so would be affected by the same issues of intermittency and variability as power from wind turbines.

## Hydro

9.2.14 There have been few large hydro schemes constructed in the UK since the 1980s and there are few sites left that would permit the construction of large hydropower schemes. The untapped resource for further hydropower generation in the UK is that from micro and small-scale schemes. Such plants are presently mostly used for domestic or farm purposes or for local sale to electricity supply companies.

## Other

9.2.15 Renewable distributed energy includes a range of technologies including solar thermal, air-source heat pumps, ground-source heat pumps, solar voltaics, micro-wind and micro-hydro to deliver heat and/or electricity to nearby sites or into the local electricity distribution network. It makes 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 clear that community distributed energy has the potential to make a significant contribution to renewable energy and carbon reduction targets<sup>127</sup>.

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125 "Future Marine Energy", The Carbon Trust 2006

<http://www.carbontrust.co.uk/publications/publicationdetail.htm?productid=CTC601>

126 "Turning the Tide: Tidal Power in the UK" Sustainable Development Commission 2007

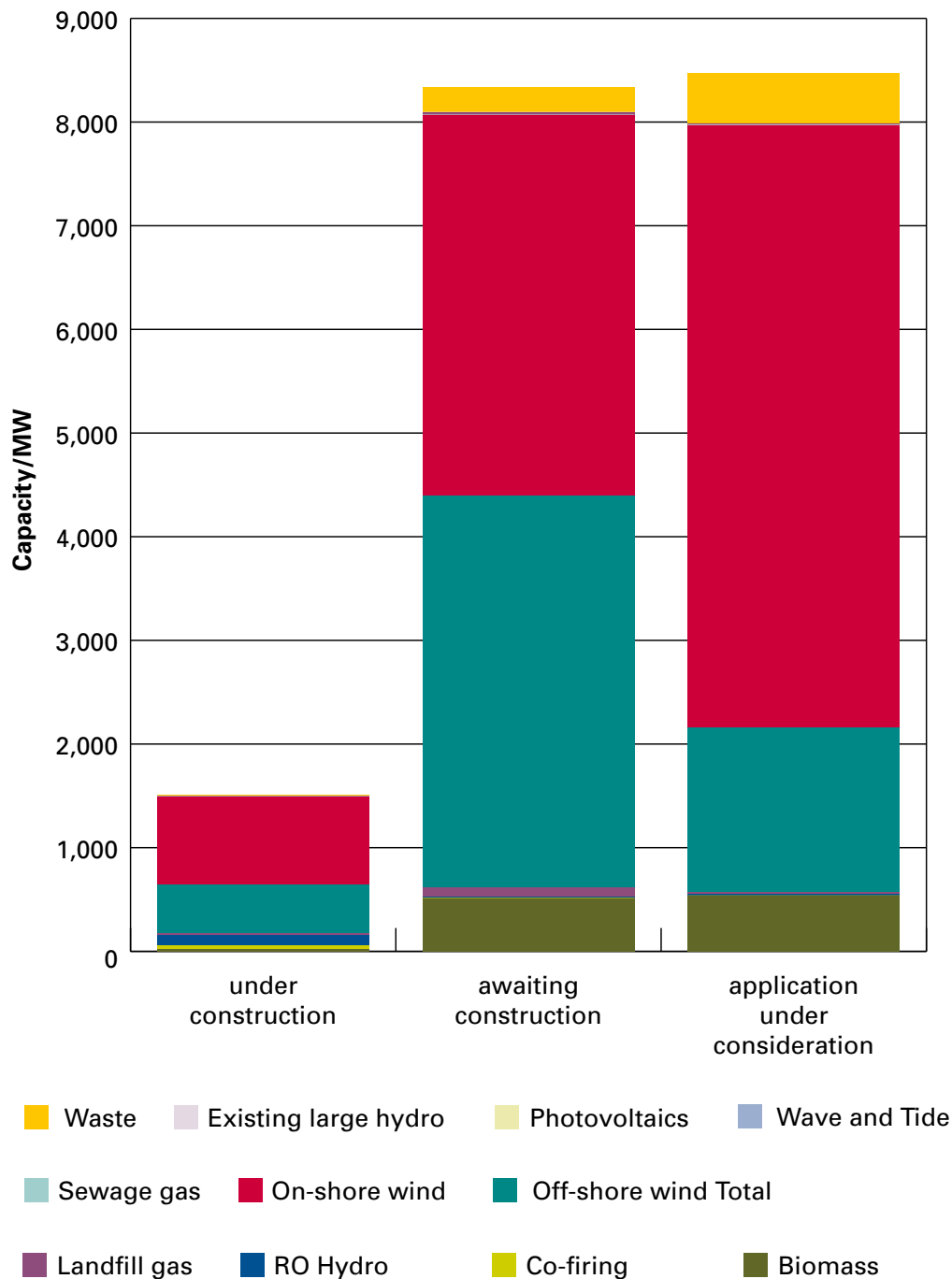
<http://www.sd-commission.org.uk/pages/tidal.html>

127 Renewables consultation document para 5.1.3

## 9.3 Renewable resources: Demand

9.3.1 The extent to which these resources will actually be used, will depend on the extent to which renewable generating capacity is deployed.

*Chart 9.1: Renewable electricity generating capacity under development*



Source: RESTATS<sup>128</sup> progress datasheet of September 2008

128 [http://www.restats.org.uk/2010\\_target.htm](http://www.restats.org.uk/2010_target.htm)

- 9.3.2 As at September 2008 there was some 1.5 GW of renewable electricity generating capacity under construction, of which slightly more than 60% was contributed by projects larger than 50MW which therefore required the Secretary of State's consent under section 36 of the Electricity Act 1989. A further 8.3 GW had consent from the Secretary of State or from the Local Planning Authority; and applications from a further 8.4 GW were being considered.
- 9.3.3 As with plans for conventional capacity, it is likely that not all of the capacity presently at early stages of the planning and development process will actually be built. Conversely, in due course it is likely that capacity which is not presently included within these totals will be built.
- 9.3.4 The construction of new renewable electricity generating capacity faces similar pressures to those confronting conventional generating capacity, as discussed at paragraph 4.5.4 above. These pressures are examined in detail in a report<sup>129</sup> published alongside the Renewable Energy Strategy consultation. Of the supply chain constraints, this identifies in particular:
- the availability of wind turbine generators;
  - the availability of specialist vessels for their installation offshore;
  - the supply of high voltage AC and DC cables to connect offshore wind farms to the onshore electricity infrastructure;
  - other plant equipment such as transformers and switchgear;
  - biomass fuel supply;
  - skilled engineering resources.
- 9.3.5 The consultants identified also that many of these gaps represent a commercial opportunity for new manufacturing capacity in the UK.
- 9.3.6 We examine here two cases from the Redpoint consortium's modelling<sup>130</sup> of the impacts of various possible policy approaches to delivering a higher level of renewable electricity in pursuance of the EU renewables target, which

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129 *Quantification of Constraints on the Growth of UK Renewable Generating Capacity* Sinclair Knight Merz 2008. Available at [http://renewableconsultation.berr.gov.uk/related\\_documents](http://renewableconsultation.berr.gov.uk/related_documents)

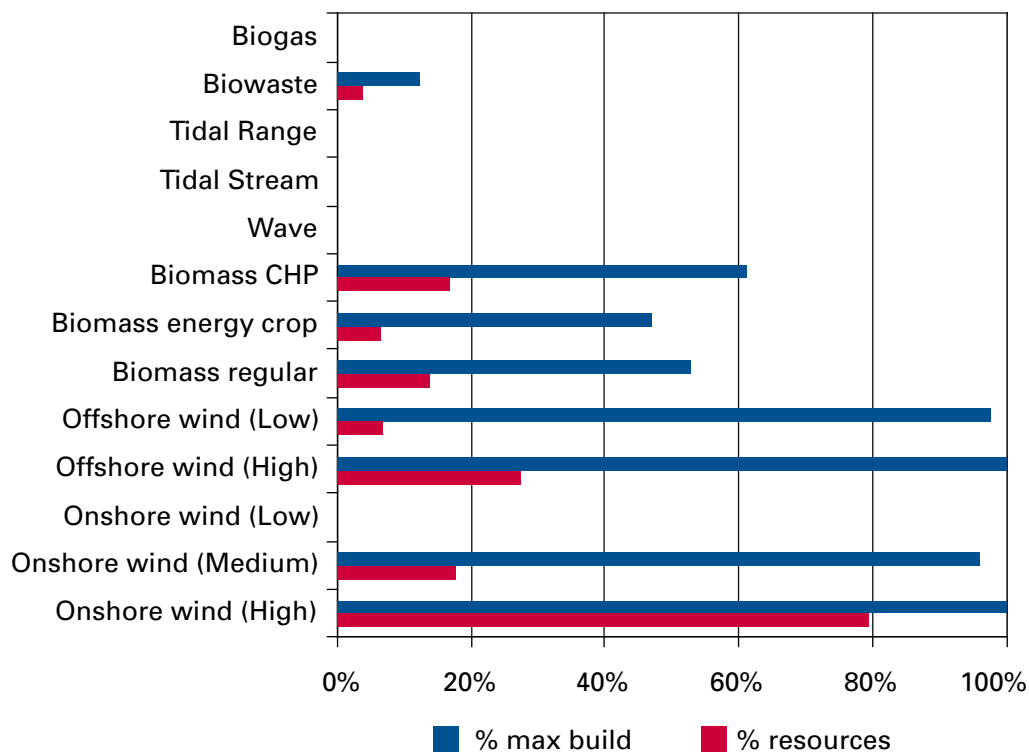
130 *Implementation of EU 2020 Renewable Target in the UK Electricity Sector: Renewable Support Schemes* Redpoint *et al* 2008. Available at [http://renewableconsultation.berr.gov.uk/related\\_documents](http://renewableconsultation.berr.gov.uk/related_documents)

takes into account the constraints on the deployment of new capacity identified above.

9.3.7 Under the status quo case, under which no action is taken beyond that already under way, nearly 12 GW of new renewable electricity generating capacity, the vast majority of it onshore and offshore wind, is expected to be deployed by about 2020. This would be a four-fold increase over present levels but still within the maximum possible build rate for several technologies and also well short of utilising all the available resource.

9.3.8 For example, the chart below shows that under this scenario, offshore wind is built at or close to the maximum rate possible under a business-as-usual case, but only about half as much regular biomass capacity is built as would be possible (blue bars). Also under this scenario, about 80% of the UK's onshore high-wind potential but only about 30% of its offshore high-wind potential is exploited (red bars).

*Chart 9.2: Exploitation of the UK's renewable resource potential under the Status Quo scenario*

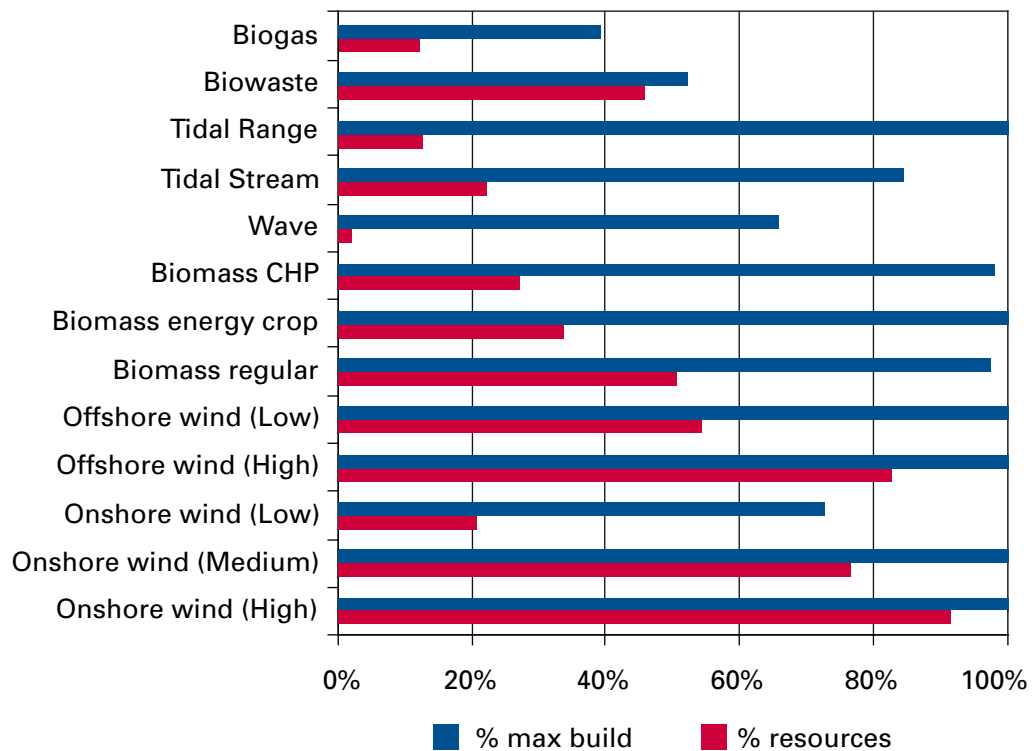


*Source: Redpoint*

9.3.9 This shows that there will still be plenty of unexploited renewable resource by 2020 except in the area of onshore high-wind potential.

9.3.10 In a case where the Government seeks to deliver the UK's share of the EU renewables target by extending the Renewables Obligation to deliver 32% of electricity from renewable sources by 2020, the market is modelled to respond by delivering as much new capacity as is possible, under an optimistic scenario regarding constraints on new build, in several sectors. However, the red bars again show that there remains plenty of potential resource still to be tapped.

*Chart 9.3: Exploitation of the UK's renewable resource under the RO32 scenario*



Source: Redpoint

## 9.4 Conclusions

9.4.1 The UK has excellent renewable resources but converting this energy into usable heat, electricity and transport to deliver the UK's share of the EU's target of delivering 20% of energy demand from renewable sources by 2020 presents a major challenge. The Government's 2008 Renewables Consultation sought views on how to drive up the use of renewable energy in the UK, and will help to shape the UK's Renewable Energy Strategy. This is due to be published in the first half of 2009.

## 10. Carbon

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### 10.1 Introduction

10.1.1 This chapter summarises the current position on the EU Emissions Trading Scheme, considers the impact on security of supply of the introduction of a carbon price and sets out some pointers as to likely future directions in the emerging carbon market.

### 10.2 How it works<sup>131</sup>

10.2.1 The electricity generation sector in the UK and EU, along with other carbon-intensive industries such as steel, glass and paper production, now faces a price for emitting carbon dioxide under the EU Emissions Trading Scheme<sup>132</sup>. This covers the emissions from all generation plants above 20MW in the EU, and requires the owners of such plants to monitor and report their emissions of CO<sub>2</sub> on an annual basis. Plant owners must also ensure that at the end of each year they surrender to the regulators one EU ETS allowance (EUA) for each tonne of CO<sub>2</sub> (tCO<sub>2</sub>) emitted in that year.

10.2.2 Each installation (including large electricity generation plant) is allocated allowances for each phase of the EU ETS. Phase I ran from 2005 – 2007; Phase II began on 1 January 2008 and runs until 31 December 2012. The number of allowances allocated for Phases I and II have been determined through National Allocation Plans, which each Member State produces.

10.2.3 EUAs can be traded between participants in the scheme throughout the EU. Because EUAs are the same in every EU country, and can be freely traded between them, there is a single EU carbon price<sup>133</sup>. If the cost of reducing carbon emissions for an individual EU ETS participant is less than the cost of EUAs in the market place, it is economically rational for a participant to reduce carbon emissions and either sell allowances on the market or avoid having to buy

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131 <http://www.defra.gov.uk/environment/climatechange/trading/eu/index.htm>

132 The Directive is available in several languages from [http://ec.europa.eu/environment/climat/emission/implementation\\_en.htm](http://ec.europa.eu/environment/climat/emission/implementation_en.htm)

133 Current prices can be found on a number of websites, including <http://www.pointcarbon.com/>

allowances. As a result, market participants now have a strong commercial incentive to consider the costs of emissions in their investment and production decisions; and carbon emissions will be reduced where it is least costly to do so.

10.2.4 As well as using EUAs, companies can also make some use<sup>134</sup> of carbon credits from the Clean Development Mechanism<sup>135</sup> and Joint Implementation<sup>136</sup> processes set up under the Kyoto protocol. These credits come from emission reduction projects in so called Annex B countries (mainly developing countries), or in the case of Joint Implementation, outside the UK (mainly Eastern European countries). Buying carbon credits under these processes pays for carbon reductions outside the EU, so helping to transfer funds and clean technology to developing nations.

10.2.5 The EU ETS Directive was reviewed during 2008 in order to establish a revised set of rules for Phase III (2013-2020). A proposal<sup>137</sup> was made by the European Commission on 23 January 2008 and is currently making its way through the European legislative process.

### 10.3 Impact on security of supply

10.3.1 The introduction of an explicit commercial price for emitting carbon is intended to influence decisions as to what kind of electricity generating capacity to invest in and deploy. Carbon-intensive forms of generation, such as coal-burning generators, become relatively less competitive compared to lower-carbon technologies, such as renewable or nuclear generation. To the extent that the cost of carbon is passed through to the final consumer, the existence of a carbon price should also have an impact on demand for electricity (as well as other products that use carbon-intensive industrial processes).

10.3.2 The introduction of a carbon price should also encourage investment in new, low carbon and more efficient electricity generating capacity. This is because the carbon price increases the difference between the cost of running efficient new plant and the cost of running less efficient, and therefore more carbon-intensive, older plant. In a

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134 In the UK, up to 7%

135 <http://cdm.unfccc.int/about/index.html>

136 <http://ji.unfccc.int/>

137 The full proposal can be found at: [http://ec.europa.eu/environment/climat/emission/ets\\_post2012\\_en.htm](http://ec.europa.eu/environment/climat/emission/ets_post2012_en.htm)

competitive generation market, the wholesale price of electricity at any one time is set by the short-run marginal costs of the most expensive generator which is running at that particular time.

- 10.3.3 The difference between the running costs of the marginal plant and the cost of less expensive plant represents profit for the latter. Increasing this profit therefore enables quicker recovery of the capital costs of investment and so increases the attractiveness of building new plant. It may also bring forward the closure of less efficient older plant. This would be beneficial in terms of the Government's climate change objectives, but the net impact on security of supply is less clear-cut.
- 10.3.4 Uncertainty as to the future of carbon policy could make it more difficult for investors to assess the long-term costs and likely returns from investment in different forms of generating capacity. If this uncertainty leads to delay in the construction of new plant while investors wait for a clearer picture to emerge, this could lead to supply tightness as demand rises and supply does not; and consequent higher prices and greater risk of inadequate generating capacity.

## 10.4 Experience in practice

- 10.4.1 The ETS started on 1 January 2005. The first phase ran from 2005-2007 and the second phase runs from 2008-2012 to coincide with the first Kyoto Commitment Period. The UK's plan for 2008-2012<sup>138</sup> includes a total allocation of 246 million allowances per year. 107 million allowances per year<sup>139</sup> will be distributed to the electricity generating industry, which equates to some 70% of this industry's projected CO<sub>2</sub> emissions over the same period.
- 10.4.2 While there was an excess of supply of EUAs in Phase I, the European Commission and individual Member States have taken a more stringent approach to allocation in Phase II and this has so far been reflected in the price of EUAs. Additionally, with banking for future phases being allowed in the 2008-2012 trading period, expectations of rising carbon prices support the Phase II price.

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138 The full UK allocation plan is available from <http://www.defra.gov.uk/environment/climatechange/trading/eu/operators/phase-2.htm>

139 The UK will allocate 246 million allowances per annum in the second phase of the EU ETS (2008-2012), including those to be auctioned or sold. This equates to a cap of 1230 million allowances over the whole period. This figure includes 219 million allowances per annum for activities that were covered by the Scheme in Phase I, 9 million allowances to cover emissions from expansion of scope in Phase II and 17million allowances to be auctioned or sold in Phase II.



## 10.5 Future directions

10.5.1 The EU already has the following targets:

- 8% reduction in greenhouse gas emissions by 2008-2012 compared to 1990 levels (from the Kyoto protocol<sup>140</sup>);
- at least a 20% reduction of greenhouse gas emissions by 2020 compared to 1990, and the objective of a 30% reduction by 2020 compared to 1990 as its contribution to a global and comprehensive post-2012 agreement;<sup>141</sup>
- 20% of the EU's energy to be from renewable sources by 2020.

10.5.2 The UK already has the following targets:

- 12.5% reduction in greenhouse gas emissions by 2008-2012 compared to 1990 levels (from the Kyoto protocol);
- A 20% reduction in carbon dioxide emissions by 2010, compared to 1990 levels.

The Government has also signalled its commitment to delivering the UK's share of the EU target for 20% of the EU's energy to be from renewable sources by 2020.

10.5.3 The Climate Change Bill<sup>142</sup>, which received Royal Assent on 26 November 2008, will commit the UK to achieving reductions of at least 26% in CO<sub>2</sub> emissions by 2020, compared to 1990 levels. This corresponds to a reduction in greenhouse gas emissions of around 32-37% by the same date.

10.5.4 All of these factors tend in the same direction, indicating continuing political, regulatory and commercial pressure for significant reductions of carbon emissions in the EU. At the June 2007 Environment Council, the Conclusions on the Review of the ETS underlined the importance of the EU ETS in achieving significant emissions reductions as an essential part of an integrated climate and energy policy.

10.5.5 The UK Government has also signalled its commitment to carbon trading as a crucial mechanism for delivering that reduction, en route to a low carbon economy. The UK's vision<sup>143</sup> for the future of the ETS (i.e. the structure from

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140 <http://unfccc.int/resource/docs/convkp/kpeng.html>

141 Provided that other developed countries commit themselves to comparable emission reductions and economically more advanced developing countries contribute adequately according to their responsibilities and respective capabilities

142 <http://www.official-documents.gov.uk/document/cm70/7040/7040.asp>

143 [http://www.hm-treasury.gov.uk/d/environment\\_emissionstrading301006.pdf](http://www.hm-treasury.gov.uk/d/environment_emissionstrading301006.pdf)

2013 onwards) was set out in October 2006, following the publication of the Stern Review<sup>144</sup>. It emphasised a more harmonised, transparent scheme with a move towards greater predictability and more auctioning of allowances. UK industry, working with Government and NGOs, has also produced a manifesto with its view on the future of the scheme<sup>145</sup>.

10.5.6 The UK Government is actively engaged in the European Commission's current review of the EU Emissions Trading Scheme. The European Commission's legislative proposal for amending the EU Emissions Trading scheme was published on 23 January 2008, and negotiations have already begun. The UK published its public consultation on the Commission's proposals on 7 May 2008<sup>146</sup>. The Government Response<sup>147</sup> was issued on 6 November.

10.5.7 The Government's key priorities for the future EU ETS include an EU-wide central cap that creates real scarcity in the carbon market and drives emissions reductions; and increased certainty in the scheme through longer-term carbon price signals and clarity over the policy.

10.5.8 The future structure of EU ETS will become clearer with the Directive being agreed. The proposals will help to meet the UK's priorities:

- An EU-wide cap, set out to 2020 with a predictable, downward trajectory.

The proposal is for a cap in 2020 that is 21% below 2005 emissions for those sectors covered by the EU ETS. To get there, the cap will decrease in a linear manner from 2013-2020. Access to Clean Development Mechanism/Joint Implementation (CDM/JI) credits will be reduced and the number of EUAs auctioned to industry will increase. Under this proposal, the supply of EUAs would decrease over time and a higher price than that seen in Phases I and II might be expected.

- The proposals afford a longer-term carbon price signal.

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144 [http://www.hm-treasury.gov.uk/sternreview\\_index.htm](http://www.hm-treasury.gov.uk/sternreview_index.htm)

145 <http://www.defra.gov.uk/news/latest/2007/climate-0306.htm>

146 <http://www.defra.gov.uk/corporate/consult/euets-2013amendments/index.htm>

147 <http://www.defra.gov.uk/corporate/consult/euets-2013amendments/government-response.pdf>

The European Commission have set out proposed annual caps from 2013-2020. In addition, it is proposed that the downward trajectory seen in Phase III would continue beyond 2020, giving some indication of cap levels even further into the future.

- 10.5.9 Other countries such as New Zealand<sup>148</sup> and Australia<sup>149</sup> are also starting to consider introducing emission trading schemes, and the current proposal allows for the EU ETS to link to such schemes. This would clearly have implications for the price of carbon in the EU.

## 10.6 Conclusions

- 10.6.1 The reform of EU ETS and business confidence that there will continue to be a meaningful carbon price are key to future investment decisions. The current proposals for reforming the EU ETS go some way towards providing a longer-term carbon price signal and increased certainty for investors. They point to increasing scarcity in the carbon market (due to reduced supply) as the EU moves towards its 2020 emissions reduction target. This should support the carbon price, thus encouraging research, development and investment into innovative low-carbon energy technologies to take an increasingly large place in the UK's overall energy supply mix.

DECC  
OFGEM  
December 2008

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<sup>148</sup> Details at: <http://www.climatechange.govt.nz>

<sup>149</sup> Details at: <http://www.greenhouse.gov.au/emissionstrading/index.html>

## Glossary of Acronyms

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BBL:	Balgzand-Bacton Line- Gas import pipeline
BCM:	Billion Cubic Metres
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 Mechanisms
CHP:	Combined Heat and Power
DECC:	Department of Energy and Climate Change
DN:	Distribution Networks
EEU:	European Economic Union
ESA	Euratom Supply Agency
GEMA:	Gas and Electricity Markets Authority
GW:	GigaWatt
IAEA:	International Atomic Energy Agency
IEA:	International Energy Agency
IMO:	International Maritime Organisation
IUK:	Gas interconnected import pipelines
JI:	Joint Implementation
JODI:	Joint Oil Data Initiative
LNG:	Liquefied Natural Gas
LPG:	Liquefied Petroleum Gas
MCM/d:	Million Cubic Metres per day
MW:	MegaWatts
MWh:	MegaWatt hours
NGO:	Non-Government Organisations

NOx: Nitrogen Oxide

NIAUR: Northern Ireland Authority for Utility Regulation

NTS: National Transmission System

OCGT: Open Cycle Gas Turbine

OECD: Organisation for Economic Co-operation and Development

OPEC: Organisation of Petroleum Exporting Countries

OPG: Other Petroleum Gases

RO: Renewable Obligation

RTFO: Renewable Transport Fuel Obligation

SEM: The Irish Single Electricity Market

SUEK: Siberian Coal Energy Company – Russia’s largest coal business

TBE: Transporting Britain’s Energy

TSO: Transmission System Operator

TWh: TeraWatt hours

UEP: Updated Emissions Projections

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

## Glossary of technical terms

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**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 Emission Trading Scheme EU-ETS:** A policy introduced across Europe to tackle emissions of Carbon Dioxide and other greenhouse gases.

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

**Gas Year:** The year running from 1 October to 30 September.

**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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