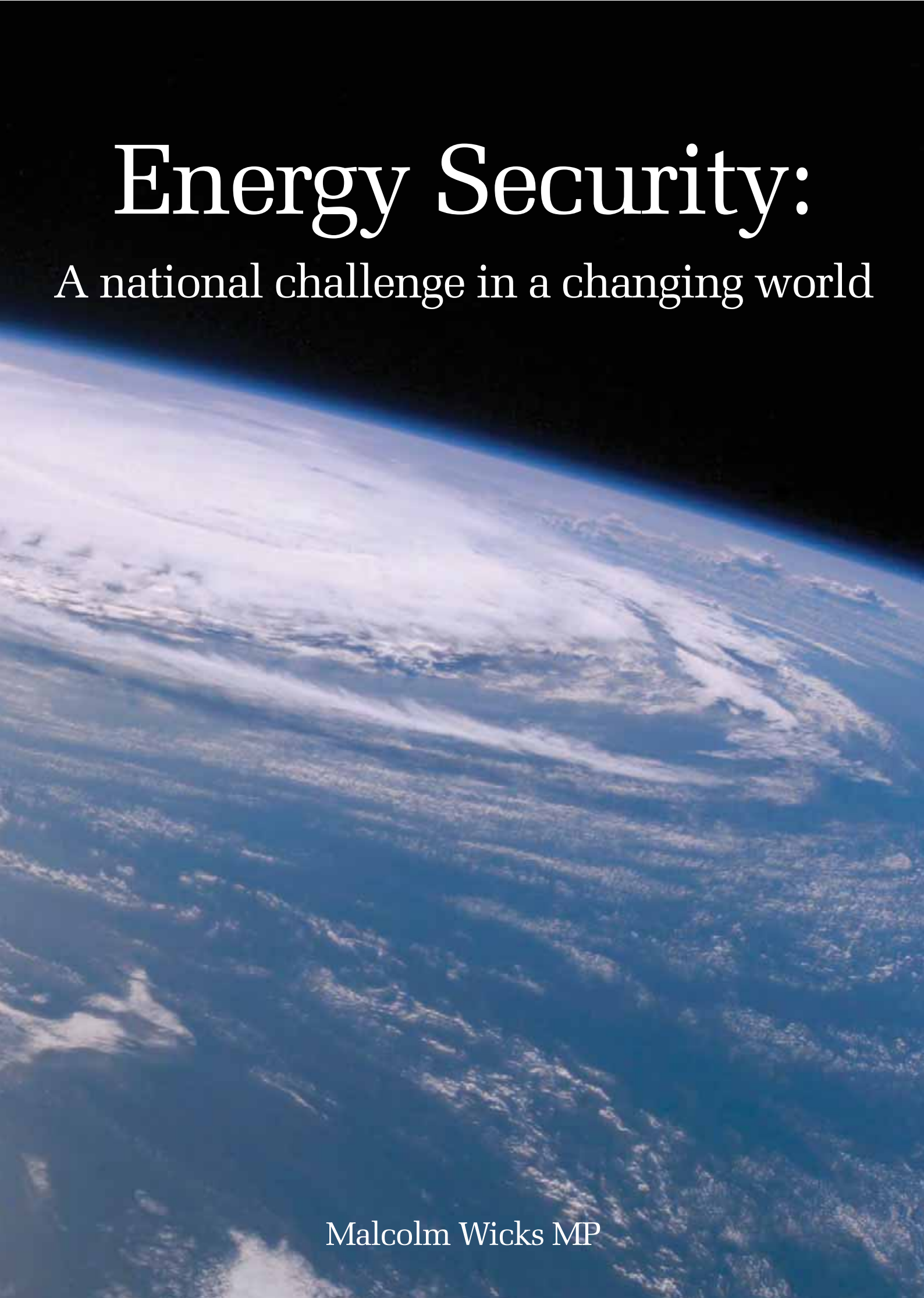
Energy Security:

A national challenge in a changing world



Malcolm Wicks MP

Biographical note

Malcolm Wicks is the MP for Croydon North. Between 2005-6 and 2007-8 he was Minister of State for Energy in the UK Government, serving as Science Minister in the interim. In October 2008 he was appointed by the Prime Minister as his Special Representative on International Energy.

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August 2009

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Introduction

The geopolitics of energy insecurity will be a key theme for the 21st century. Securing Britain's energy supply must therefore be a national priority as we transition to a low carbon economy. We have entered a decade or more of dramatic transition, heralding a century of serious energy uncertainty. We are moving from a position of relative energy independence to one of significant dependence on imports. Gas is critical, given its importance to industry, electricity generation and home heating. In recent years Britain was self-sufficient; today we are net importers of over 25 per cent of our annual demand; and by 2020 this proportion will be considerably higher. Estimates of import dependence by 2020 range from 45 per cent to much higher, 70 percent or more.

There is no crisis. Indeed we are doing many of the things that are important. The build-up of renewables to a target of 15 per cent of all energy by 2020; the decision to facilitate a new generation of civil nuclear plants; and a number of energy efficiency programmes all help to produce a better balance between home-grown energy and imports. I welcome the UK Low Carbon Transition Plan, which sets out in detail how we will achieve the challenging climate change targets we have adopted. It is a major contributor to our future energy security.

But there is no room for complacency. As the world comes out of global recession, the global grab for energy will return to something like its pre-recession trajectory, with demand forecast to increase substantially by 2030. Oil and gas prices can be expected to increase, perhaps very significantly. More nations will flex their muscles in the pursuit of energy resources.

This presents new challenges. There is no exact science on this, more a question of risk assessment and judgement. But the loss of relative energy self-sufficiency takes place at a time of rapid energy change and challenge. My conclusion is that the era of heavy reliance on companies, competition and liberalisation must be re-assessed. The time for market innocence is over. We must still rely on companies for exploration, delivery and supply, but the state must become more active – interventionist where necessary. This is critical in Europe, when, despite progress, full liberalisation of energy has not been achieved, and when key states are strong players in energy decision-making. Moreover, internationally, independent private-sector oil companies control smaller proportions of global oil and gas reserves, as nation states use national companies to develop these national resources. Many countries use political influence to gain access to energy supplies.

With supplies of gas from the North Sea in decline, we will need more gas storage. If commercial projects are not installed at the predicted rate, or access to storage on the Continent does not materialise, the Government

should consider very carefully the case for strategic storage, reserved for emergencies as an insurance policy in an uncertain world. In my judgement, obligations on gas suppliers to ensure that they do supply customers with whom they have contracts also need to be strengthened.

For the UK we conclude that total energy independence is not feasible and, indeed, there are advantages through interdependence. However, we must do much more to develop indigenous and alternative energy resources, ranging from new nuclear to renewables, to a rigorous look at exploring anew Britain's own coal reserves, in innovative and clean ways. I recommend that an aspiration that nuclear should provide some 35-40 per cent of our electricity beyond 2030 should be considered by Government. We must also attack vigorously energy inefficiencies with the clear aim of reducing overall energy demand in the United Kingdom. This will also bring significant business opportunities and potentially new skilled employment. All Departments must be seized by the national priority of pursuing urgently these objectives.

Notwithstanding such measures, Britain will continue to be heavily reliant on imports in the medium term. We are already relatively well-placed and diversity of supply is crucial. There can be no over-reliance on any one region, country, energy source or pipeline. Building up relationships with key countries is important and the EU needs to be far more proactive in developing specific pipeline infrastructures and electricity connection that will benefit Europe as a whole.

Government has recognised the importance of energy for our country's national security in the National Security Strategy 2009. It needs to ensure that energy security is treated with the same focus as other national security issues. To enable this, I recommend that the Government consider setting up an Office of International Energy, bringing together more closely those working across Government on these issues.

During my review I was pleased to have been able to meet a wide range of experts in the energy field and, in particular to draw on the suggestions, ideas and wisdom of my "Expert Group", the role and participants in which are listed at Annex A. I also visited Oslo, Washington, Aberdeen, Brussels and the International Energy Agency (IEA) in Paris in the course of my review and am very grateful to those I met, too numerous to list here, who were so generous with their time and candid with their views. I was supported, most ably, by a small team of officials in the Department of Energy and Climate Change[1] (DECC) and also benefited from advice from across Whitehall, in particular the Foreign Office. All views and recommendations expressed in the pages that follow, except where clearly attributed to someone else, are of course my own.

Malcolm Wicks MP
Special Representative of the Prime Minister

[1] Paul Bailey, Claire Ball, Colin Cushway, Andrew Dobbie, Ashley Ibbett, Sansel Smith, Kristen Tiley and Lynsey Tinios. Thanks also to Louise Szpera in my Parliamentary office.

Executive summary

Scope

This review of the implications of developments in international energy markets for the UK's future energy security has been written at the request of the Prime Minister.

It takes as a starting point the UK's commitment to tackle dangerous man-made climate change. It identifies the considerable synergies between actions needed to reduce emissions and those which enhance the security of our energy supplies but also points out where there might be tensions.

We are entering a period where the UK will become increasingly reliant on imports to meet its energy needs, during the transition to a low-carbon economy. In the longer term, depending on the technologies which provide our future energy, this import reliance may fall again. Relying on imports is not new for the UK – we were for example heavily reliant on imports in the years before the exploitation of North Sea oil and gas – but the energy security challenges presented by a dramatically changing global economic, geopolitical and energy landscape, combined with the urgent need to tackle climate change, are new and require us to re-assess our approach.

The changing UK and global energy picture

Once the global economy recovers, global demand for energy, including for both oil and gas, looks set to rise for at least the next decade, even if there is an ambitious agreement tackling the causes of global climate change in the international negotiations in Copenhagen later this year. The growing populations and economies of developing countries, particularly China and India, are the main cause of this increase. More people will want to drive cars, and there will be increased demand for electricity for both household and industrial use.

Drawing on the analysis by the International Energy Agency, we see much of this demand being satisfied using existing technologies – the combustion engine for cars, and coal and gas use in power stations, and gas for heating. Though alternative technologies have rich promise to provide more of the world's energy needs, and there is scope for all countries to use energy more efficiently, world fossil fuel demand is likely to grow over the next decade and remain a significant part of the global energy mix in the longer-term.

There are clear risks that global supply of oil and gas will not keep pace with demand. Remaining reserves of both are increasingly concentrated in a

limited number of countries, are becoming increasingly more expensive and (geologically) difficult to exploit (particularly in the OECD), and supplies from existing fields are declining at increasing rates.

Many resource-rich countries restrict the involvement of foreign companies in producing oil and gas, which increases the possibility that investments will not be made in an efficient and timely manner to enable a smooth matching between supply and demand, thus artificially restricting the production of oil and gas, causing supply constraints. States will have a wide range of investment and spending priorities, and some state-owned companies are less technically capable than those which compete in the global marketplace. If supply cannot keep pace with demand, the consequence will be increasing prices for both oil and gas and, because of physical rigidities around the supply of gas, the potential for supply shortages in particular parts of the world.

These risks are compounded by the effect of the world economic downturn, which has delayed investment projects. Demand can be expected to recover strongly as and when normal global economic growth resumes. There is a clear danger that lack of investment in production and exploration across the world the near term could lead to a "tight" supply situation in the years to come.

The concentration of production in fewer countries brings with it other risks. Crisis affecting production in a particular part of the world or significant producing country has greater global impact where there are fewer significant producing alternatives. Increasing proportions of world energy supplies will go through critical transport nodes, including the Straits of Hormuz, Malacca Straits and the Suez Canal.

Imported oil and gas will account for an increasing proportion of demand in the years to 2030, as indigenous production declines. As a result of the measures set out in the recent White Paper (The UK Low Carbon Transition Plan) to boost renewables and energy efficiency, DECC's central projection is that our consumption of gas in 2020 will be around 66 billion cubic meters (bcm) a year, about 30 bcm lower than without the measures. In turn, this is forecast to keep our net imports down to 2010 levels for the whole of the following decade. This would mean that our net imports would be around 45% of demand in 2020, compared with up to 80% projected at the time of the 2006 Energy Review. However, such projections are inevitably uncertain, and others have estimated higher levels of import dependence. A great deal will therefore depend on successful delivery of the renewables and energy efficiency measures.

With the uncertain prospects for supply, we will increasingly be exposed to price and (particularly for gas) supply risks. Having been for many years well favoured for gas supply, with ample UK production and limited opportunities to export this, we are now increasingly integrated into the European gas market.

Given this outlook, what should the Government do? This review proposes a framework in relation to both international and domestic policy of first, acting to reduce total energy demand; secondly, promoting the adoption of technologies that reduce reliance on oil and gas and simultaneously reduce carbon emissions; and, finally, acting to mitigate the international energy security risks inherent in the use of fossil fuels.

International strategy

In its international relations, the Government should use its membership of international institutions to promote further and more effective energy efficiency measures. Bilateral contacts with countries with significant potential to improve their energy efficiency should also be maximised. This is particularly relevant to producer and transit states, because their resource abundance has often led to wasteful energy use, and because there is a direct relationship between their energy use and the amount of energy they have available for export.

There is also the potential to use the Government's multilateral and bilateral activity to increase development and deployment of technologies using alternative energy sources. This will help to reduce future demand pressure on international fossil fuel supplies and therefore energy security risks for the UK. We need to be a leading player supporting European action to encourage the low-carbon economy, including concerted and ambitious regulation of product and building standards.

But the world will still be reliant on fossil fuels for much of its power, heating, industrial, agricultural and transport needs. We in the UK will need reliable, reasonably priced energy supplies. Global growth is strongly correlated with oil prices, which drive gas and coal prices as well through indexing and the ability to switch between fuels in some applications. So we need to do what we can to work for better functioning oil markets, which match supply and demand at reasonable, stable prices. We need to support the work of the International Energy Forum to examine how dialogue between producer and consumer countries can be enhanced to tackle volatility in this market, and to continue to press for more data and transparency in this market. It is also important to ensure financial trading in oil is properly regulated.

Our increasing integration with EU energy markets means that we need to ensure that they function effectively. We need to ensure the effective, cross-Europe implementation of the "Third Package" of energy markets liberalisation, to ensure that companies operating in the UK and those operating on the Continent are operating under similar rules and can have reciprocal access to key infrastructure. We need too to support the building of key infrastructure enabling energy and fuels to move around Europe in response to need. And we need to support European attempts to diversify sources and routes of energy imports, including the "Southern Corridor" project for gas imports to Central Europe from the Caspian and Central Asia.

What we can do in the UK to support our energy security?

We need to supplement a strategic directed approach to our relations with other states with equally thought-through, effective policies within our own borders if we are to maximise our energy security in the way that best tackles climate change. Here again, the review proposes an approach of acting first to minimise energy use, acting to diversify our energy mix, and then taking action to minimise any residual risks arising from our continuing oil and gas use, and growing import dependence.

The Government has made considerable progress in improving our energy efficiency. There is scope to go further. More programmes enabling people to use less energy within their own homes, progressively increasing requirements on businesses to reduce their energy use, and progressively tighter regulatory requirements for both buildings and products are key to achieving further progress. The Government needs to show leadership, ensuring that reducing the energy used in its own activities is seen as a priority by all Departments and Agencies.

The Government has also done much to encourage a more diverse energy mix, in particular through its Renewables Obligation, its encouragement of a new generation of nuclear power plants, and its announcement of support for the building of coal-fired power stations with carbon capture and storage (CCS) technology attached. It also deserves credit for its support for the development of new transport technologies including no and low-emission cars, as well as for encouraging public transport.

Achieving 15 per cent of energy use from renewables by 2020, to which the Government has committed, is very ambitious and this review does not believe that it is feasible to set a higher target in this period, though we should not see 2020 as a destination, after which we can reduce our ambition. There is scope for greater connection with sources of 'green energy', and for an increased contribution from marine and tidal technologies, which need and are receiving the Government's support.

Nuclear power is a proven, large-scale, low-carbon way to generate electricity. To enhance energy security and reduce our reliance on imports, a range between, say, 35-40 per cent of electricity from nuclear could be a sensible aspiration beyond 2030.

Even with improved energy efficiency and effective diversification measures, declining UK production means our import dependency for oil and gas will still grow. Our energy security demands that we reduce the risks to which this exposes us.

Gas is particularly important in this context. We need to ensure that we maximise production from the UK's own, still considerable reserves and this requires continuing attention to the tax and regulatory regime for producers. But we cannot expect this to reverse the decline in our own production

though. We will need more gas storage to enable demand to be met should there be a supply disruption or a prolonged period of high demand, perhaps in a very cold winter, as well as better arrangements to enable effective moderation of demand at times of supply difficulty.

The review concludes that we also need to review regulatory structures designed in good times, where we were broadly self-sufficient and had limited export capacity, to establish if these still provide sufficient assurance of secure supply when we are increasingly import-dependent and connected to continental markets.

How Government tackles the energy security challenge

The Government needs to track energy security risks and challenges in a coherent way, and to regularly to assess their seriousness in relation to other sources of national security risk. It needs to ensure that international engagement across the range of issues affecting energy security is well co-ordinated, and gets sufficient attention and priority at the most senior levels.

Scope and aims of this Report

Following some three years of Ministerial engagement in energy policy, I was asked by the Prime Minister to carry out this review of international energy security and how developments internationally are likely to affect our own energy security in the coming decades. It is timely to consider afresh our approach to energy security against the backdrop of the development of the global recession, and the growing realisation of the urgency of tackling the challenge of dangerous man-made climate change.

Energy security and tackling climate change

We must not pursue energy security at the expense of achieving our climate change objectives. As our own natural resources decline and we become more dependent on imported fuels we need to find solutions to our energy security anxieties that also deliver on climate security. In this regard, the creation of DECC to champion in one place these twin challenges is timely.

In this review, I am concerned to propose an approach to energy security which recognises the synergies between reducing energy security concerns and tackling climate change. I am convinced that the twin imperatives push us in the same directions. For this reason, my recommendations are based on an approach of, first, acting to reduce total energy demand, second, adopting technologies that reduce emissions of greenhouse gases and, finally, acting to deal with residual risks associated with our use of fossil fuel and our growing import dependency.

One early question when I began my review was to define energy security. There are many definitions, focusing on different aspects of this issue. I have decided to define it broadly. I believe energy policy must aim at achieving:

- Physical security: avoiding involuntary interruptions of supply;
- Price security: providing energy at reasonable prices to consumers; and
- Geopolitical security: ensuring the UK retains independence in its foreign policy through avoiding dependence on particular nations.

According to the Centre for Strategic and International Studies[2], a secure energy system will tend to be characterised by:

- A diverse mix of different energy sources and fuels, with the capability to switch between these when necessary;

[2] http://csis.org/files/media/csis/pubs/090130_evaluating_energy_security_implications.pdf

- Diversity of suppliers of energy, without excessive reliance on imported supplies, which have a risk of disruption beyond the host country's control;
- Diverse routes of imported supply, avoiding excessive reliance on particular "supply corridors";
- Reducing "energy intensity": the amount of energy required to produce a unit of national output;
- Reliable and well-managed physical infrastructure;
- Stable and affordable energy prices;
- Feasible and commercially-viable plans for technological improvement for the future.

The cost of energy insecurity

Failing to achieve energy security would have serious impacts on our national prosperity. The costs of supply disruptions in global energy markets can impact the UK in two ways:

1. A physical supply disruption of any fuel could impact on economic activity in the UK.. For example, Oxera previously estimated that the costs of an expected gas supply disruption could cost the UK economy up to £600 million in terms of lost output[3]; and;
2. Even if there is no physical impact on the UK energy system, supply disruption in global energy markets would lead to higher energy prices in the UK. Higher energy prices could have adverse economic impacts such as inflation and high consumer prices, particularly affecting poorer citizens. Oxford Economics[4] indicated that the high oil prices experienced in 2008 cost the global economy about $150 billion or 0.3 per cent of global GDP.

Oil price volatility has also been a significant concern for the global economy over the last 18 months. Oil prices peaked at $147 per barrel in July 2008, dropped below $40 by the end of the year, and then rose again to $70 in June 2009. Oil prices drive gas prices and, to a lesser extent, coal prices as well. As long-term gas contracts are predominantly indexed to oil and as long-term contracts tend to dominate gas markets, gas prices generally follow any oil price trends quite closely, albeit with a lag. Coal prices do not diverge dramatically from gas prices as they are very close substitutes in power generation. Hence, fossil fuel prices tend to increase/decrease together unless

[3] An assessment of the potential measures to improve gas security of supply – Oxera May 2007 (http://www.berr.gov.uk/files/file38980.pdf).
[4] Oxford Economics (December 2008): 'Oil, energy and the world economy'.

there are specific factors in the individual markets that could cause a short-term divergence.

There are of course costs to many of the things we could do to improve energy security. Some things, like using energy more cleverly and efficiently, are "no pain" measures benefiting both the energy consumer and our energy security. Others, like building additional infrastructure such as gas storage facilities, would entail extra costs to consumers or energy firms, but these costs would potentially be offset by the benefits of enhanced energy security.

Structure of this Report

This report is structured as follows:

- Chapter 1 discusses UK energy in its historical context.
- Chapter 2 analyses global energy trends, including forecast future patterns of energy supply and demand.
- Chapter 3 analyses the likely effect of these trends on the UK's energy security.
- Chapter 4 considers the implications of these trends on the UK's energy security.
- Chapter 5 makes recommendations for international action arising from this analysis.
- Chapter 6 makes recommendations about actions we can take ourselves, within our own borders, to reduce the risks involved in our engagement with international energy markets.

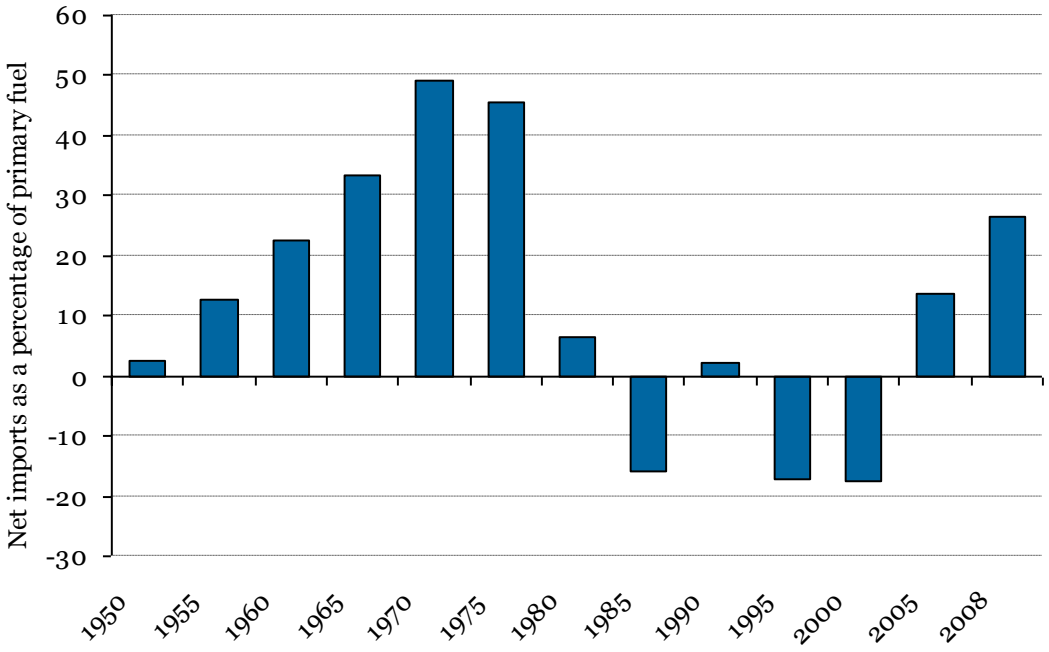
Chapter 1: UK energy in its historical context

Historic context

1.1 The UK's overall degree of reliance on imported energy has fluctuated in recent history according to shifts in the amounts and mix of fuels consumed and produced. After being largely self-sufficient in energy (first wood, and then coal) for most of its pre-World War II history, the UK became increasingly reliant on imported energy, mainly oil, during the 1950s, 60s and 70s. In energy value terms (oil equivalents) net imports accounted for nearly 50 per cent of the UK's energy consumption by 1970 (see Figure 1).

1.2 The discovery of North Sea oil and gas from the late 1960s and subsequent development of fields resulted in the UK becoming a net exporter of energy for most of the 1980s and 1990s. In more recent years, declining North Sea production has again made the UK a net importer of energy. Net imports accounted for 26.5 per cent of total UK primary energy consumption in 2008.

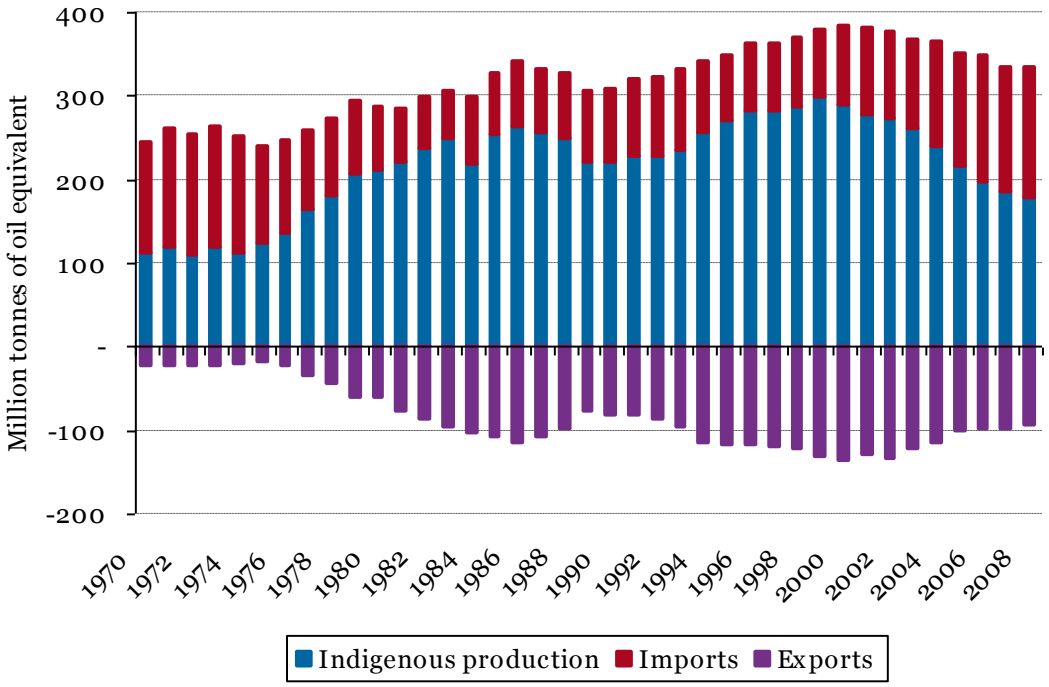
Figure 1: UK import dependency: Net imports as a percentage of gross inland deliveries of primary fuels



Source: DECC Energy Statistics

1.3 However, as shown in Figure 2 and expanded on below, the overall balance between the UK's imports and exports of energy masks the different underlying trends for different fuels. It also does not give a complete picture of the UK's reliance on imports, or its interaction with global energy markets. Despite periods of producing more energy in total than it consumes, at no time in the last few decades has the UK not relied on imports of oil, gas or coal to meet some of its energy consumption needs. In the past few decades UK policy has been to rely on appropriately regulated markets (both domestic and international) to meet its energy needs. In general, therefore, where the market participants have seen advantage in importing their energy supplies, they have mostly been free to do so.

Figure 2: UK aggregate energy balance 1970-2008



Source: DECC Energy Statistics

UK energy consumption, exports and imports over the decades

Before the age of electricity

1.4 Archaeological remains reveal that coal has been used as a fuel for at least 3000-4000 years – there is evidence of coal burning in Britain from the Bronze Age.

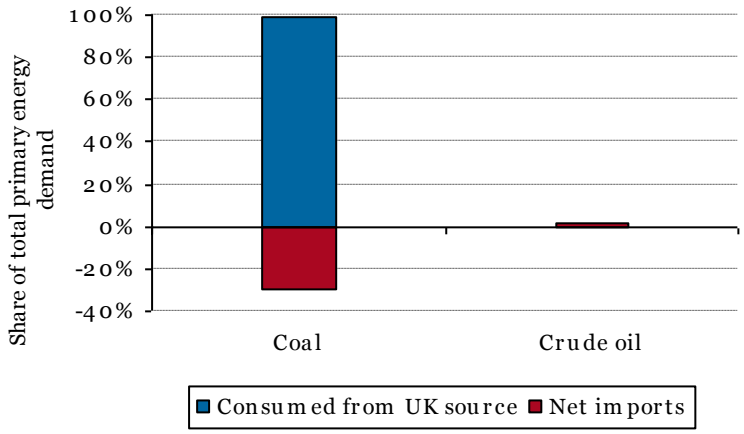
1.5 Most people in the pre-industrial period depended on simple open fires to meet their heating and cooking needs, while water mills were used

from the 13th century onwards to power production activities including food processing and metal-working. Until the 17th century wood was Britain's main fuel source. Then coal began to be widely used in cities; it was extracted from the North East of England from surface bed and coastal deposits, hence the name 'sea coal'. By the 18th century, developments of oil and kerosene lamps had replaced some of the uses of coal but it was still the dominant fuel and was to become even more important to the UK economy as the Industrial Revolution dawned.

Era of domestic coal: 1800-1950

1.6 There is much debate about the initial causes of the Industrial Revolution but clearly inventions such as the steam engine, the growing mechanisation of industry and the use of coal gas to light streets and buildings led to a much higher demand for energy. In the 1880s mains electricity became available. Most of this electricity was initially produced in coal-fired power stations. Coal became the dominant source of energy with annual UK coal production increasing from 10 million tonnes in 1800 to 220 million tonnes by 1935, by which time almost one quarter was being exported. The UK remained a coal-based country until the 1950s, when the UK's reliance on indigenous deep-mined coal began to go into a steady decline. In 1954, production peaked at 227 million tonnes from around 900 pits employing some 700,000 miners. By 2008, a deep-mine workforce of 3,660 produced some 8 million tonnes from 18 underground mines.

Figure 3: 1935 coal fuelling almost all our energy needs*



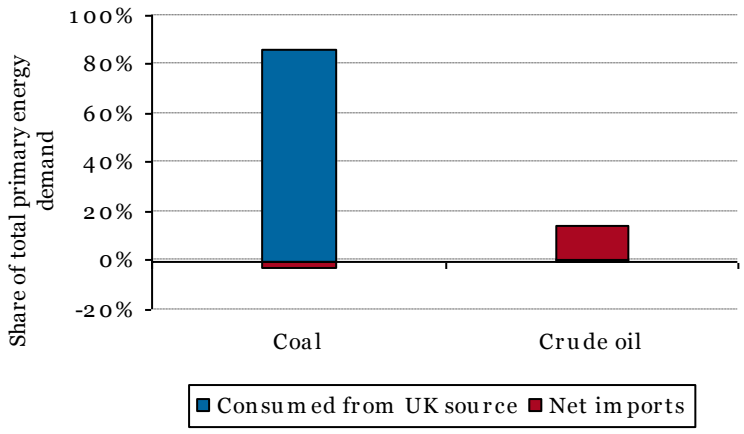
Source: DECC Energy Statistics. *Negative figures represent UK net exports

A growing thirst for oil: 1950-70

1.7 After World War II car ownership in the UK began to accelerate and oil consumption grew rapidly, with an average increase of over 10 per cent a year between 1950 and 1970. This was a key factor in the transformation of the UK from a net energy exporter to a net importer.

Already by 1955 oil imports accounted for 14 per cent of the UK's energy consumption (see Figure 4).

Figure 4: 1955 foreign oil increasingly part of the mix*

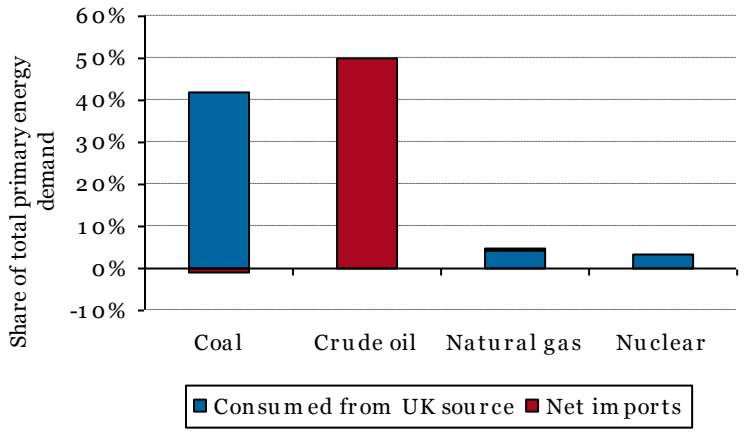


Source: DECC Energy Statistics. *Negative figures represent UK net exports

Oil import dependence: 1970-79

1.8 By 1970 oil had exceeded coal as the main fuel in the UK's energy mix, accounting for 50 per cent of consumption (see Figure 5). With North Sea oil still to be developed, virtually all of this oil was imported (mainly from the Middle East) and the UK's energy import dependence peaked at 52 per cent in 1974. This dependence on imported oil coincided with the oil price shocks of 1973 and 1979.

Figure 5: 1970 dependence on foreign oil grows as coal demand diminishes*

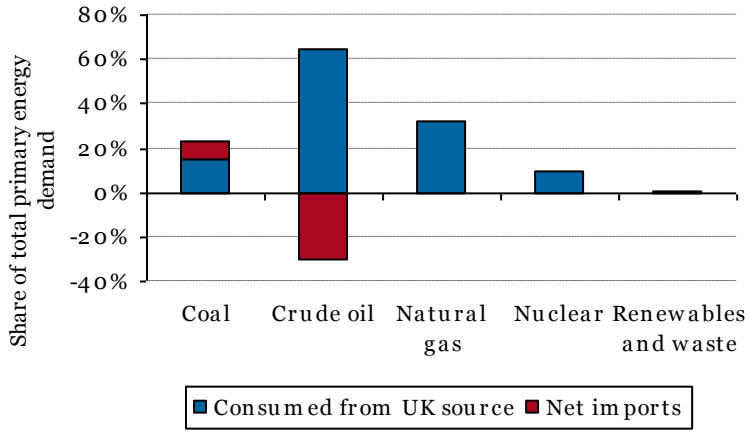


Source: DECC Energy Statistics. *Negative figures represent UK net exports

North Sea oil and gas: 1980-2003

1.9 Increasing North Sea production meant that by 1981 the UK was again a net energy exporter – a status which, apart from the period between 1989 and 1992 when North Sea oil production dipped in the aftermath of the Piper Alpha disaster, lasted through to 2003. Net exports peaked at 21 per cent of consumption in 1999. However, during this period, the UK was technically still not "self-sufficient" in energy. It relied on imports to meet some of its coal needs and imported uranium to fuel its nuclear power stations, while the oil it consumed was traded and priced in an international market.

Figure 6: 1995 energy self-reliance, exporting oil from the North Sea*



Source: DECC Energy Statistics. *Negative figures represent UK net exports

Box 1: North Sea storyline

There is no doubt that, since the early days of exploration, the North Sea has been an incredible success story for the UK – providing a major input to our economy *and* energy needs. The first significant discovery – the West Sole gas field – was made in 1965 and paved the way for more exploration in the Southern Basin of the North Sea. Four years later, in 1969, we saw the first major oil discoveries. Since then there has been a vast amount of activity on the UK Continental Shelf, massive financial investment by the industry, and continual technological breakthroughs to overcome the tough operating conditions which the North Sea presents. There have been large fields, such as Forties in the 1970s, which continue producing oil to this day.

Since those early days, a vast network of fields and pipelines has been developed. And there is a wealth of knowledge and expertise running throughout the industry which has been built up over the years. However the province is maturing. Combined oil and gas production peaked in 1999 and is now declining at between 5 and 8 per cent a year. There are different challenges now for Government and industry to meet to maximise the economic recovery of remaining UK reserves.

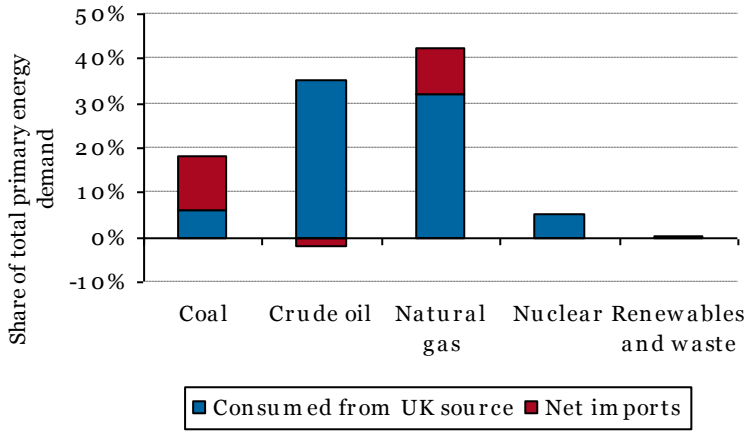
It is important from a security of supply perspective to realise the full potential of our indigenous resources. So far around 40 billion barrels of oil equivalent (boe) have been produced in the UK with potential remaining reserves of around 20 billion boe. These hydrocarbons continue to make a key contribution towards the UK's economy and energy needs, currently supplying around 60 per cent of UK primary energy demand. The UK oil and gas industry annually invests around £5 billon, generates over £10 billion in tax revenue and directly or indirectly supports around 450,000 UK jobs. Supply chain turnover is over £10 billion (including £5 billion from exports of goods and services).

In recent years Government and industry have brought forward a range of initiatives to maximise exploration and investment - including innovations to the licensing system, increased emphasis on brown field stewardship, unlocking fallow acreage and industry Codes of Practice. All this has led to strong levels of interest and activity. 2007 saw the highest number (111) of offshore exploration and appraisal wells drilled since 1996. 2008 saw almost as many (105), with a strong emphasis on exploration. Over the past three years this strong drilling has resulted in more than 400 million boe being discovered each year. And the latest licensing round produced, at 171, the highest number of licences ever offered, to 99 companies. However, there is no room for complacency.

Growing fossil fuel import dependence after 2004

1.10 UK oil and gas production reached a peak in 1999 and has been declining since. As a result the UK once again became a net importer of gas in 2004 and by 2008 net imports of energy (mainly coal and gas) accounted for 26.5 per cent of the UK's primary energy consumption (see Figure 7).

Figure 7: 2008 looking globally once again for our energy needs*



Source: DECC Energy Statistics. *Negative figures represent UK net exports

Box 2: The history of UK electricity and gas markets

Electricity

In the 1880s mains electricity became available on a commercial scale. In these early days, the generation of electricity was essentially a local affair with entrepreneurs providing electricity to customers within a 2km range. This led to a multitude of different supply voltages and frequencies. By 1926 the Government set up a committee to review 'the national problem of the supply of electrical energy' and recommended that a central electricity board be created and given the job of interconnecting the most efficient generating stations in Great Britain by a National Grid of high transmission lines. The Central Electricity Board (CEB) would have the role of specifying the levels of generation of the selected and privately owned generators to achieve the overall lowest production costs. This led to an inherent tension between the independent generators and the Government's centralised control.

The National Grid was completed in 1934 and after nationalisation in 1947 and the Energy Act of 1957, electricity supply in England and Wales became a vertically integrated system which meant that the generation of electricity was carried out by state-owned monopoly, the Central Electricity Generating Board (CEGB).

By the 1980s the then-Government was keen to regard electricity as a totally free market commodity and in 1989 the electricity industry was privatised. A centrally controlled power pool is required to operate such a system and in England and Wales this is overseen by the Office of Gas and Electricity Markets (Ofgem) with National Grid acting as system operator.

Until April 2005 the electricity wholesale market in Scotland operated under different arrangements from those in England and Wales and the transmission system was operated by Scottish Power and Scottish and Southern Energy who were the major generator and supply companies. However, the British Electricity Trading and Transmission Arrangements (BETTA) introduced a single wholesale electricity market for Great Britain with National Grid becoming the single transmission system operator independent of generation and supply.

Gas

In the 1840s gas companies charged for gas on the basis of the number of gas lamps in a house. As soon as other uses such as gas heating and cooking became widespread it became necessary to develop proper gas meters and legislate that gas be sold by its energy content. By the mid-1930s there were some 11 million gas customers, supplied with town gas (manufactured mainly from coal) by over 1,000 private companies and municipal undertakings.

In 1949 gas supply companies and undertakings were nationalised and amalgamated into 12 vertically-integrated Area Boards. Until the 1960s gas was produced from coal in coke ovens ('town gas'), and later also through oil used as a feedstock. There was no long-distance transmission system and gas was supplied by the companies involved to their local areas. However this began to change with the discovery of North Sea gas in 1965 which required modifications to users' apparatus, and the construction of a national long-distance transmission system.

In 1972 the industry was reorganised under the Gas Act. This established the British Gas Corporation (which took over the operations of the 12 separate Area Boards) as the vertically-integrated gas supply monopoly. As with electricity, gas was privatised in the 1980s, through the 1986 Gas Act.

The Utilities Act 2000 amalgamated the regulatory regimes for gas and electricity and created Ofgem.

1.11 There are four key points to take away from this brief look at the history of energy use in the UK:

- The UK was a net importer for a substantial amount of its energy needs during the 1960s and 1970s.
- Its market arrangements were mostly developed in the period when it was largely self-reliant.
- In the post-World War II period, the UK's energy security has never been completely "insulated" from events in international energy markets. Even in those periods where the UK produced more energy than it consumed, it still imported some energy – for example, to meet demand for a particular fuel type that could not be met through indigenous supply – and remained exposed to movements in international energy, particularly oil, prices.
- Developments in global energy markets have therefore always had an influence on the UK's energy security and UK energy prices, although to differing degrees over the decades.

Chapter 2: The global energy context

2.1 As the UK increasingly sources its energy from the global energy markets, it is important to consider how these markets may develop over the medium and longer term. In particular, are there potential risks to the UK's energy supplies or prices? This chapter reviews how the future global energy picture may look in the medium and longer term as the UK moves towards greater import dependency. It draws out the implications of these future trends for global energy security.

2.2 The future is uncertain. Global events, some unforeseeable and others on the horizon, but whose implications and development are still unknown, will profoundly influence how the world changes. The recent global economic crisis has had a major impact on the global energy markets. The international negotiations on climate change, among other events, also have the potential to influence significantly how global energy markets develop.

2.3 This chapter starts with a description of the reference scenario developed by the International Energy Agency (IEA) for its latest (2008) World Energy Outlook, which this review uses as a base case projection. It is prudent to use this as the base case as this represents the world continuing broadly on its present course, with some sensible assumptions about deployment of new technologies. It then shows through an alternative scenario how changes consequent on international agreement on ambitious climate change goals could impact on the future. Following this, the rest of the chapter is dedicated to drawing a picture of how the demand and supply patterns are expected to look out to 2030, taking as its basis the IEA reference scenario, but examining the consequences of the economic downturn.

Where is the global fuel mix going?

2.4 Figures 8, 9 and 10 show projections for the future global energy mix, based on the IEA "reference scenario" and an alternative "450 Policy Scenario" which presumes international agreement on measures necessary to stabilise global greenhouse gas (GHG) emissions at a level that would avoid the most dangerous man-made climate change.

2.5 The "reference scenario" establishes trends for future energy demand taking into account government policies and measures enacted or adopted by mid 2008. These include the European Commission's Energy and Climate Change package, which sets a binding renewables target of 20 per cent renewable energy in total EU energy consumption by 2020 as well as energy efficiency and biofuels targets; the US Energy

Independence and Security Act; and laws in other countries committing them to improve energy efficiency and increase use of renewable energy. It assumes the development of major new technologies including commercially viable carbon capture and storage (CCS) after 2020, and second generation biofuels by 2020. This scenario makes a number of assumptions about effective deployment of new technology and the successful implementation of renewable energy and energy efficiency measures across a range of countries, so it is possible that future energy use including of fossil fuels, will exceed the projections made in it.

2.6 The alternative 450 Policy Scenario presents a view of future energy demand with a fuel mix that is compatible with stabilising the level of greenhouse gases at 450ppm (parts per million) of CO_2 equivalent in the atmosphere, with a temperature rise of around 2 degrees Celsius. It assumes participation by all Organisation for Economic Cooperation and Development (OECD) countries[5], all other EU countries and other major economies including China, Russia, India, Brazil, South Africa, Saudi Arabia, Iran and Indonesia in cap and trade systems, and sectoral agreements – international agreements committing participating countries to adopting common processes or objectives in order to reduce GHG emissions from a specific sector[6] – in addition to national policies and measures to reduce emissions.

Box 3: Global climate change: the issue

Climate change is the greatest environmental challenge facing the world today. The effects will be felt globally, as rising sea levels threaten the very existence of some small island states and put millions of people at risk. Temperature increases, drought and flooding will affect people's health and way of life, and cause the irreversible loss of many species of plants and animals.

Climate refers to the average weather experienced over a long period. This includes temperature, wind and rainfall patterns. The climate of the Earth is not static, and has changed many times in response to a variety of natural causes. The Earth has warmed by 0.74 degrees Celsius over the last hundred years. Around 0.4 degrees Celsius of this warming has occurred since the 1970s.

The recent assessment of the Intergovernmental Panel on Climate Change (IPCC) leaves us in no doubt that human activity is the primary driver of these observed changes in climate. According to the IPCC, mean global temperatures are likely to rise between 1.1 and 6.4 degrees Celsius above 1990

[5] Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.

[6] Definition of a sectoral agreement as defined for the purposes of modelling in the WEO 2008 alternative climate change scenario p.427.

levels by the end of this century, depending on our emissions. This will result in a further rise in global sea levels of between 20 and 60cm by the end of this century, continued melting of ice caps, glaciers and sea ice, changes in rainfall patterns and intensification of tropical cyclones.

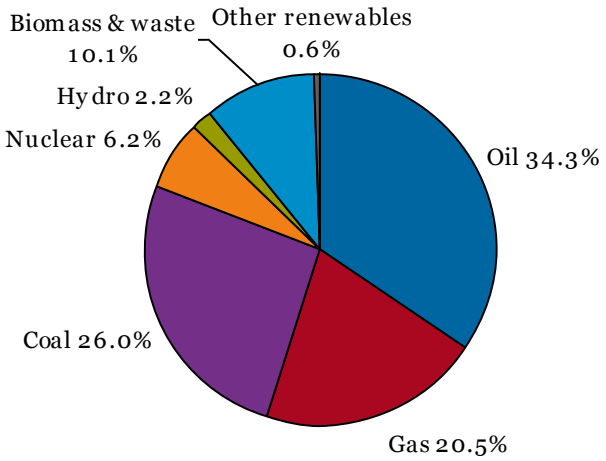
The main human influence on global climate is emissions of the key greenhouse gases - carbon dioxide (CO_2), methane and nitrous oxide. The accumulation of these gases in the atmosphere strengthens the greenhouse effect. At present, just over 7 billion tonnes of CO_2 is emitted globally each year through fossil fuel use, and an additional 1.6 billion tonnes are emitted by land use change, largely by deforestation. The concentrations of these gases in the atmosphere have now reached the highest levels for tens of thousands of years.

However effective the policies to reduce emissions of greenhouse gases are, the world will now experience a significant degree of climate change. This is likely to have far-reaching effects on all aspects of the world's environment, economy and society.

The UK is therefore arguing, with its European partners, that climate change needs to be limited to an increase in global mean surface temperature of no more than 2 degrees Celsius since pre-industrial times. Global temperature rises of more than 2 degrees Celsius would result in huge impact on water availability, food security and ecosystems. For the first time, at the recent G8 Summit in L'Aquila, world leaders of both developed and developing countries recognised that the increase in global average temperature above pre-industrial levels ought not to exceed 2 degrees Celsius. This sets a strong lead in advance of the climate change negotiations in Copenhagen in December 2009.

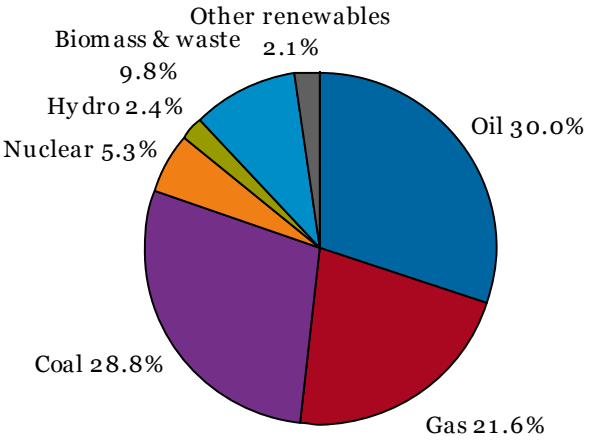
2.7 Figures 8, 9 and 10 illustrate how the fuel mix in 2030 differs from that today in these two different scenarios. In the reference scenario, global energy demand increases by 45% between 2006 and 2030 - a growth rate of 1.6 per cent per annum. By contrast, demand increases by 22 per cent (0.8 per cent per annum) in the 450 Policy Scenario. The major differences in the global fuel mix in 2030 under the 450 Policy Scenario compared with the reference scenario relate to the levels of coal demand, and use of nuclear and renewables. Coal demand is cut drastically. In the reference scenario, coal demand to 2030 grows faster than that for oil and gas, but in the 450 Policy Scenario it falls as a result of a cap and trade system introducing a carbon price in the heavily consuming Asian nations. In the 450 Policy Scenario, nuclear expands by over half compared to the reference scenario, while renewable energy grows at more than 10 per cent per annum. The much faster deployment in renewables, including biomass, leads to a share of 40 per cent in total electricity generation by 2030.

Figure 8: Global fuel mix 2006



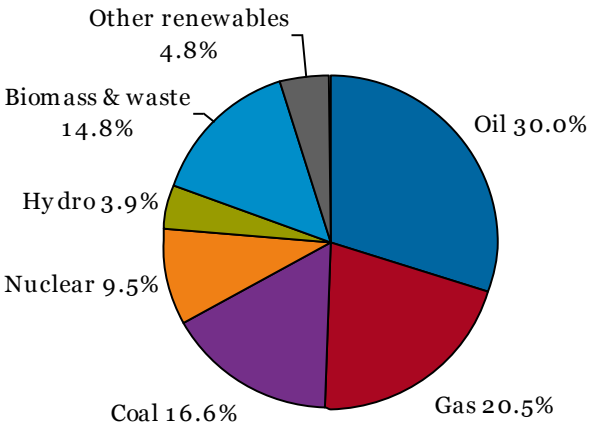
Source: IEA World Energy Outlook 2008

Figure 9: Global future mix 2030 – reference scenario



Source: IEA World Energy Outlook 2008

Figure 10: Global fuel mix 2030 – 450 Policy Scenario



Source: IEA World Energy Outlook 2008

2.8 What is striking in comparing these quite different energy futures is the continuing dominance of fossil fuels in the energy mix and the relative stability of the shares of oil and gas in both. Despite the decline in the share of fossil fuels resulting from the reduction in coal use in the 450 Policy Scenario, these fuels still account for 67 per cent of primary energy demand in 2030, compared to the 80 per cent today, and the 80 per cent they are estimated to still account for in 2030 under the reference scenario. Moreover, in the 450 Policy Scenario coal is the only fuel expected to be used less in 2030 than today. Although demand for oil and gas begin to decline after 2020, demand for both fuels is still higher in 2030 than today.

2.9 Renewables have the potential to start to make a significant impact but there are challenges in deploying these on a large scale in the short and medium term. In the long term the shares of all types of renewable energy in overall energy demand do increase fairly considerably, leading them to be the source of almost one quarter of energy consumed in 2030, from under 15 per cent today.

2.10 The rest of this chapter looks in greater detail at potential future energy trends in demand and supply for each of the fossil fuels. The focus on fossil fuels is because these will remain the most important fuels in the global energy mix up to 2030. And these fuels are at the centre of global competition for resources. The UK and EU are becoming increasingly import dependent for them. Securing enough of these fuels to ensure they fulfil that part of energy demand which still comes from them is less within our own control. Who the potential suppliers are, where the substantial investment is needed to ensure supplies are produced, and whether these will be delivered, are key questions in analysing our energy security. Of course, the continuing dependence on a large share of fossil fuels in the global, EU and UK energy mix raises serious questions as to how to ensure their use is consistent with climate change objectives. Chapters 5 and 6 of this review propose measures to address energy security issues while also enabling dangerous man-made climate change to be tackled.

2.11 The outlooks and trends presented in what follows are based on the IEA's reference scenario. This may be interpreted as a baseline scenario for the future fuel demand and supply outlooks. Factors such as more ambitious global policies to tackle climate change or the impact of the global downturn on global demand may alter this. It is evident, however, from the comparison of the scenarios above that fossil fuels will continue to be of crucial importance to the global energy mix. In addition, the overall trends in terms of who will need to be supplying these markets presented subsequently in this chapter do not change. Paragraphs 2.12-2.17 analyse the implication for the IEA reference scenario of the current economic downturn due to its potential impact on investment and developments in global energy markets over the medium term.

The impact of the current economic downturn on the medium term outlook, and longer term implications

2.12 The current financial and economic downturn has already had a major impact on the energy sector. Global energy demand has fallen in response to the rapidly slowing world economy. Oil demand declined in 2008 and is expected to fall again in 2009. These would be the first two consecutive years of demand decline since 1982 and 1983. The downturn in demand coupled with the credit crunch is adversely affecting investment in the sector. Oil prices (and linked prices for other forms of energy) crashed in the second half of last year. Though they have since increased substantially, investment remains at risk in the continuing uncertain global climate.

2.13 The IEA, in analysis prepared for the Group of 8 (G8) Energy Ministers' Meeting in May 2009, has indicated that upstream oil and gas investment budgets have already been cut by 21 per cent in 2009 compared with 2008 budgets, a reduction of almost $100 billion. Between October 2008 and the end of April 2009 almost 2 million barrels per day (mb/d) of oil production increases have been cancelled or delayed indefinitely while 35 projects involving 4.2 mb/d have been delayed by at least 18 months. These cancellations and delays equal around 7 per cent of global oil demand. Canadian oil sands projects account for most of the postponed capacity.

2.14 In its Medium-Term Oil Market Report,[7] the IEA also significantly reduced its previous assessment of likely future oil demand. Oil demand in 2009 is estimated to be around 3 per cent or 2.6 mb/d less than in 2008. This decline in demand has led to a significant increase in spare capacity in the oil market. Spare capacity is already around 6.8 mb/d[8], 60 per cent higher than the IEA forecast in July 2008. How quickly this spare capacity will be employed depends on how quickly the global economy recovers, how much more investment is delayed or cancelled in the coming months and how quickly investment responds to a return in demand growth. Should the world economy quickly resume previous growth patterns this spare capacity could be substantially eroded in the next three to four years., falling to less than 4mb/d by 2014. However, more moderate growth assumptions could see spare capacity remaining above 6mb/d out to 2014, and possibly beyond.

2.15 Investment in upstream gas markets has also suffered in the economic downturn, but to a lesser extent than in the oil market, while demand has plunged. In the OECD demand was down 9.7 per cent in April compared to April last year while for Europe gas demand was down 20

[7] Medium-Term Oil Market Report June 2009, IEA.
[8] Effective OPEC spare capacity (excluding Iraq, Nigeria and Venezuela) equals 5.28mbd.

per cent despite one of the coldest winters for two decades.[9] Around 94 million cubic metres per day of growth in gas capacity (3 per cent of global demand) has been cancelled or delayed by at least 18 months. Gas can be transported either in pipelines (pipeline gas) or turned into a liquid, shipped in tankers and regasified at the destination (liquefied natural gas – LNG). Because of lower demand for gas associated with the global economic downturn, it is likely that the market will be well-supplied for the next several years thanks to LNG capacity already under construction which will be completed, albeit with the risk of some delays. However, it is unlikely that new LNG or pipeline projects will be agreed before 2010 given the uncertain outlook for demand and prices. Hence, given the long lead times in building new plants, the IEA suggest that LNG markets could tighten once again beyond 2013-2014.

2.16 Investment in the coal sector is expected to decline by around 40 per cent between 2008 and 2009. However, this decline is from high levels of investment seen in 2007. Although growth in coal production capacity is likely to slow given this scaling back of investment, coal markets are likely to be adequately supplied in the near future. Moreover, coal projects can be producing within two to five years of an investment decision should high growth in coal demand resume.

2.17 Financing problems and lower energy prices are particularly discouraging investment in low-carbon technologies – both on the supply and demand sides – as a result of high up-front costs, greater risk, and the greater exposure of small renewables companies to financial risk and high credit costs. Compared to year-on-year increases in global clean energy investment of 60-70 per cent between 2004 ($35 billion) and 2007 ($148 billion), investment slowed significantly in 2008 (to $155 billion), growing by only 5 per cent overall, and has declined sharply in recent quarters. The IEA estimate that investment in renewables could drop by as much as 38 per cent in 2009.

2.18 In summary, therefore, reduced global demand for energy has created spare capacity in global energy production, helping to alleviate the tight market conditions and high energy prices seen over recent years. However, the sharp decline in investment across the energy sector creates the risk that tight markets will return once global economic growth, and with it energy demand, recovers.

[9] "The Impact of the Financial and Economic Crisis on Global Energy Investment IEA" Background paper for the G8 Energy Ministers' Meeting 24-25 May 2009.

Longer-term expectations

Emerging economies will drive increasing global demand for energy

2.19 The implications of the financial crisis on the medium term outlooks for all fossil fuels are not reflected in this section. The longer term demand and supply projections to 2030 presented in this section are based on the IEA's World Energy Outlook 2008 yet the economic situation and fuels prices have changed significantly since. However, the trend to 2030 for strongly increasing demand and the patterns in where supplies are expected to come from will remain. The timelines and the speed of recovery for the global economy are uncertain but in the longer term it is expected that economic growth will resume the trajectory seen before the global economic slowdown. In line with such a recovery, world energy demand is expected to resume its upward trend driven by growth from emerging and developing countries – most notably, China, India and the Middle East. By contrast, energy demand in the OECD group of wealthier countries is likely to remain constant and possibly even decline in the period to 2030. In the IEA's reference scenario, China, India and the Middle East account for over 60 per cent of the growth in global energy demand to 2030.

2.20 Population growth in developing and emerging countries, urbanisation of their populations, and significant growth in gross domestic product (GDP), with associated changes in lifestyles such as increasing rates of car use, are the main drivers of increasing global demand for energy. Table 1 illustrates the forecast evolution of these factors in China, India and the Middle East compared to the US and EU.

Table 1: Emerging economies and future energy demand

Country	Population growth	Population		GDP growth	Vehicle use millions		Energy consumption per person	
	Per annum	2005	2030	Per annum	2005	2030	Urban (mtoe)	National (mtoe)
China	0.4%	1310m	1460m	6.1%	23m	230m	2.6	1.4
India	1.1%	1100m	1450m	6.4%	10m	125m	n/a	n/a
Middle East	1.7%	190m	300m	4.3%	18m	75m	n/a	n/a
US	0.8%	303m	370m	2.1%	160m	225m	7.6	7.6
EU	0%	489m	505m	1.8%	225m	295m	3.5	3.7

Source: WEO 2008; population figures based on UNDP

2.21 The world's population is projected to grow from 6.5 billion today to 8.2 billion by 2030, with 35 per cent of this growth in China and India.

All of the growth is expected to occur in urban areas. Around 60 per cent of Chinese are expected to live in urban areas in 2030, compared to around 40 per cent today. This urbanisation is significant because most energy is consumed in or close to towns or cities; two thirds of the world's energy is consumed in cities whilst only half of the world's population live in cities. In China, India and the Middle East, per capita urban energy consumption is much higher than in rural communities, whilst for developed economies energy consumption is often slightly higher in rural areas. This is because the early stages of economic development are accompanied by urbanisation. The much higher rates of economic growth forecast in the emerging economies over the period to 2030 (reaching more than 6 per cent per annum compared to 2 per cent for the developed economies), drive higher incomes in urban areas. With economic growth and higher incomes comes greater demand for energy services and relative luxuries such as cars. China is estimated to have over 200 million more cars by 2030; India, 100 million. US and EU car use is expected to increase too but, there, consumers are expected increasingly to use more fuel- and energy-efficient vehicles, perhaps including substantial numbers of electric cars by 2030.

2.22 The expected large growth in demand for cars in emerging countries, combined with the relative difficulty of replacing oil for transport use with alternatives over the timeline to 2030, helps to explain why oil is projected to remain the largest fuel in the global fuel mix to 2030, under both the reference scenario and the 450 Policy Scenario. The next three sections present the outlooks for demand and supply by fuel, based on the IEA reference scenario.

The global outlook for oil

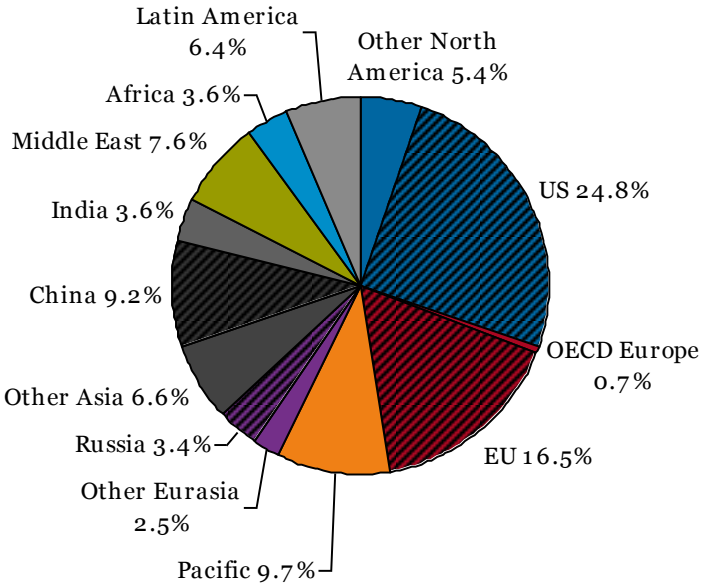
Who will be consuming the world's oil resources?

2.23 Oil demand worldwide is estimated to expand by one quarter from 85 mb/d in 2007 to 106 mb/d in 2030. This would reduce the share of oil in world primary energy demand from 34 per cent today to 30 per cent in 2030. The amount of oil used per unit of GDP ("oil intensity of GDP") has been declining, particularly in richer countries as service sectors have become more important in their economies, and at an accelerating rate in the last few years, where high oil prices have favoured fuel conservation and switching to alternative fuels. This decline is set to continue with the oil intensity of GDP for non-OECD countries converging to the lower OECD levels as they use oil more efficiently. However, large increases in demand for transport in less developed countries still lead to a growing demand for oil overall. Around three-quarters of the projected increase in oil demand worldwide is expected to come from the transport sector, the sector least responsive, in the short term, to price changes.

2.24 All the increase in world oil demand is likely to come from non-OECD countries whose consumption is expected to be two thirds higher in 2030, at nearly 60 mb/d due to their stronger GDP growth and large increases in vehicle ownership. China alone accounts for 40 per cent of this increase, more than doubling its consumption to 16.6 mb/d, with India and the Middle East also experiencing large rises. China's share of total global oil consumption is forecast to increase from 9 per cent today to 16 per cent. OECD consumption is expected to fall, with North America, the EU and Japan and Korea all consuming less oil in 2030 than in 2007.

2.25 Despite falling shares, in 2030 North America and the EU are expected to remain important consumers of oil, with North America accounting for one quarter and the EU 12 per cent of all consumption. The Asian region will become the heaviest oil consuming region by 2030, responsible for 30 per cent of world oil consumption. The US will remain the single largest consumer (see Figure 12).

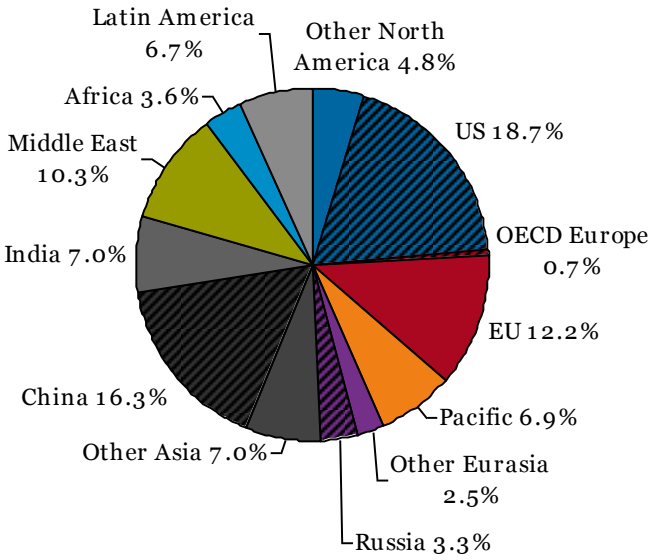
Figure 11: Shares of global oil demand 2007



Source: IEA World Energy Outlook 2008[10]

[10] To include the EU as a category and maintain the overall global demand, the share for the EU has been subtracted from the OECD Europe grouping. This is approximate as the OECD Europe category does not include all EU member states – notably the smaller Central and Eastern European member states and Cyprus and Malta (these are also included within the Other Eurasia region). OECD Europe here consists of Iceland, Norway, Switzerland and Turkey.

Figure 12: Shares of global oil demand 2030 – reference scenario



Source: IEA World Energy Outlook 2008

Who will be supplying these needs?

2.26 Production to meet the increase in global demand is likely to be concentrated in non-OECD countries, in particular in countries belonging to the Organization of the Petroleum Exporting Countries (OPEC). Oil production has already peaked in most non- OPEC countries and will peak in most others before 2030. OECD production will decline through to the middle of the next decade, managing to grow from 2015 onwards only due to the production of non-conventional oil reserves, in particular Canadian oil sands. Timely investment, which remains quite uncertain, will be critical to ensuring the availability of supplies of oil to meet the forecast levels of demand.

Box 4: Organization of the Petroleum Exporting Countries (OPEC)

OPEC is a permanent, inter-governmental organization, founded in 1960, by Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. The five Founding Members have subsequently been joined by nine other Members: Qatar, Libya, United Arab Emirates, Algeria, Nigeria, Ecuador, and Angola. Gabon and Indonesia have also been members of OPEC but have currently suspended membership.

The stated aim of OPEC 'is to coordinate and unify the petroleum policies of Member Countries and ensure the stabilization of oil markets in order to secure an efficient, economic and regular supply of petroleum to consumers, a steady income to producers and a fair return on capital to those investing in the petroleum industry'.

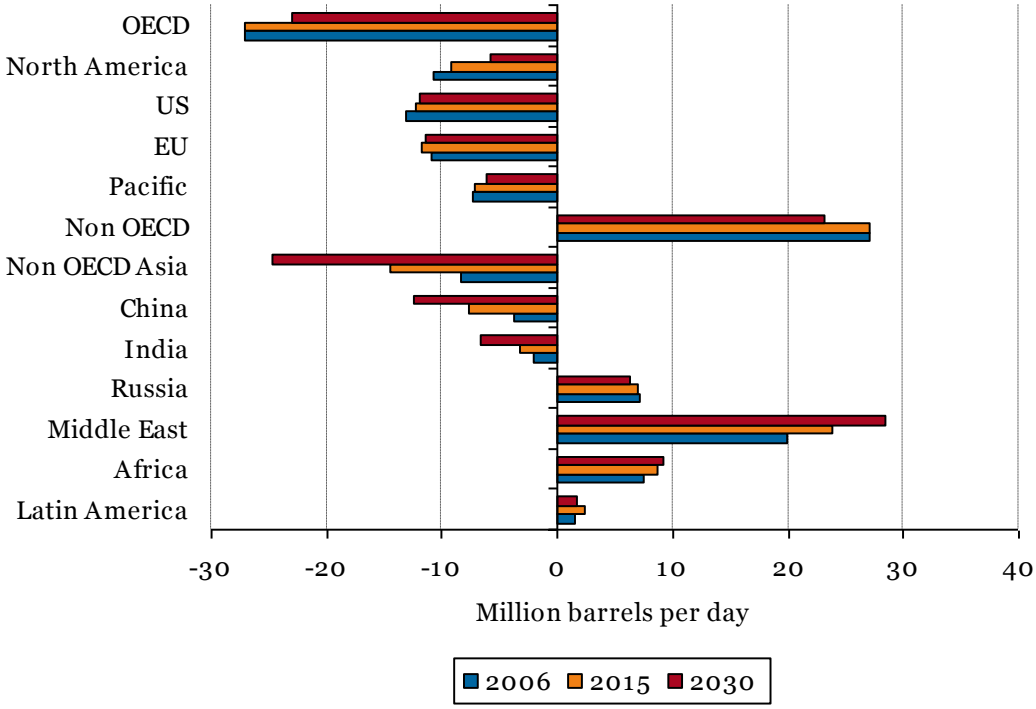
OPEC countries account for more than 40 per cent of total oil production and holds over 70 per cent of the world's proven oil reserves, making it the dominant player within the oil market. Its main mechanism for influencing the global oil market is to agree crude production levels ("quotas") for each member to adhere to.

Reaching a common position between members is difficult in any multilateral organisation as each member will always have different interests and objectives. In addition, there are competing interests between maximising short-term profits and having a stable revenue stream in the long-term. Moreover, OPEC's influence over the market is not constant but varies over time. This change in influence is induced by market conditions and can occur in both weak and tight market conditions. For example, when the majority of members are producing at or close to their maximum capacity, OPEC has less downward influence on prices, as in summer 2008.

Under all IEA future scenarios, OPEC's share of oil production will grow so it will continue to play a major part in the global oil market.

2.27 It is expected that over half of all the oil consumed in the world in 2030 will be traded across national borders. Figure 13 shows import and export trends of oil today and those expected in 2015, and 2030. Today, the OECD members including those in the EU, the US and Japan are quite large importers of oil, as is non-OECD Asia because of Chinese and Indian imports. The EU and the Asian countries are expected to become even more dependent on imports in the future. Asian net imports increase dramatically by almost 200 per cent to equal 24.7mb/d; by 2030, non-OECD imports will be of the same magnitude as total OECD imports. In contrast North America becomes much less dependent on imports, dropping by almost a half, as production from Canadian oil sands increases. Net imports into OECD countries decline as a share of total oil demand, resulting in import dependency falling from 58 per cent to 52 per cent mainly because of increasing North American production. Additionally, the fall in net imports from the Pacific region outweighs the increase in net imports demanded in Europe.

Figure 13: Oil net imports and exports by key countries and regions* – reference scenario



Source: IEA World Energy Outlook 2008. * Negative figures are volumes of net imports, positive figures imply net exports

2.28 The largest volumes of exports are likely to come from the Middle East. Net exports from the Middle East represented 48 per cent of global oil trade in 2007. This proportion is forecast to increase to 52 per cent by 2030. African net exports are projected to increase by over 20 per cent over the period while Russia's net exports are expected to decline. By 2030, African net exports will be greater than those of Russia.

The potential of non-conventional oil resources

2.29 Oil sands and biofuels have the potential to alter supply and demand trends significantly in the future.

Oil Sands

2.30 The ultimate potential of the oil sands is immense, estimated at 1.7 trillion barrels of potentially recoverable oil or 60 per cent of all total non-conventional resources and one quarter of all potentially recoverable global oil resources. The estimated future increase in demand for oil and the need to replace falling production from rapidly depleting oil fields imply that oil sands are likely to play an important role in meeting the world's future energy needs. However oil sands reserves have only recently been considered to be part of the world's oil

reserves, as higher oil prices and new technology enable them to be profitably extracted and upgraded to usable products.

2.31 Oil sands, also known as tar sands, or extra heavy oil, are naturally occurring mixtures of sand or clay, water and an extremely dense and viscous form of petroleum called bitumen. They are found in large amounts in many countries throughout the world, but are found in extremely large quantities in Canada and Venezuela. In particular, the Alberta province in Canada plans to increase oil sands production significantly and given that Canada has an open, transparent and competitive oil market, there is a real potential for oil sands to make a significant contribution to global security of supply.

2.32 However there are significant environmental concerns around the impact of their commercialisation as large amounts of energy (usually natural gas) are required to extract and upgrade oil sands. This means that significant GHG emissions are associated with production. Some estimates state that the current production process could contribute up to three times the GHG emissions of conventional oil production – although the exact impact on emissions varies depending on the extent of transportation involved from the source of production to the end consumer. In addition oil sands production requires a large amount of water for production and the tailings ponds of polluted water created by the production are an environmental problem. There are also biosphere concerns relating to wildlife and river welfare.

Biofuels

2.33 Biofuels have experienced fast growth over the last few years with demand growing on average 23 per cent per year between 2000 and 2006. But they still only represented around 1.6 per cent of road transport fuel demand in 2006. Growth in the use of these fuels, which consist of ethanol as a petrol substitute and biodiesel for diesel, is expected to remain strong, spurred by ambitious targets in the US, China and the EU to encourage their use.

2.34 The US is now the biggest consumer of biofuels, overtaking Brazil – the largest exporter accounting for 45 per cent of global biofuels trade. The North American market is set to remain the most significant between now and 2030, when it is estimated to consume 40 per cent of total world production. The EU's market however is expected to equal that of Latin America by 2030, with each accounting for 20 per cent of the global share of biofuels consumption. Asian consumption is expected to grow by over 10 per cent a year but still account for less than 20 per cent of global consumption by 2030.

2.35 The IEA estimates that the increase in biofuels supply to 3.2mb/d in 2030 up from 0.6mb/d in 2006, will increase their contribution to total road transport fuel demand to 5 per cent. This assumes the EU will succeed in meeting its target of 10 per cent of biofuels in road

transport demand by 2020 and China will attain its target[11] . The IEA assumes however that the US will achieve only 40 per cent of its target. But concerns about the sustainability of biofuels due to their landuse impacts as well as their impact on food production have led to some countries scaling back their plans for biofuels, and the EU is currently reviewing its policies to ensure that biofuels meet sustainability criteria.

2.36 For biofuels to be a viable part of the fuel transport sector, these concerns need to be resolved. So-called second generation biofuels, which are derived from non-food biomass feedstocks, are expected to present a solution but they will not be commercially competitive for some time. The IEA assumes they will start to make an impact after 2020. How the market for second generation biofuels develops over the interim will be an important factor in the future growth of the biofuels market.

The global outlook for gas

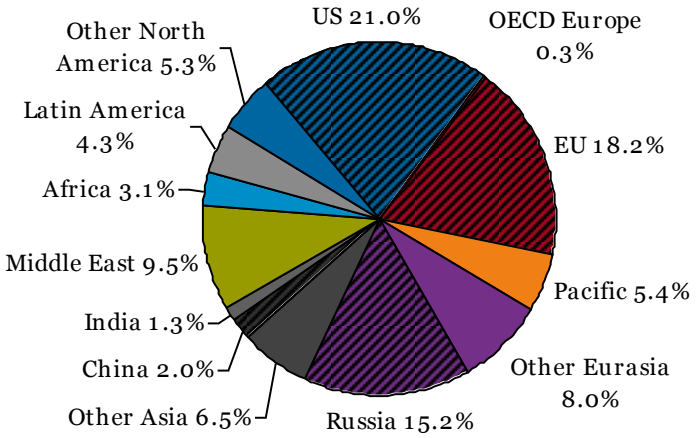
Who will be consuming the world's gas resources?

2.37 The IEA reference scenario forecasts that global demand for natural gas will increase 52 per cent between 2006 and 2030, from 2916 billion cubic metres (bcm) to 4,434 bcm, marginally increasing the share of gas in total world primary energy demand. This rate of growth would be slower than that seen in the last twenty five years. Three quarters of the increase in global gas use over 2006-2030 is expected to be in non-OECD countries, particularly the Middle East and Asia.

2.38 Non-OECD countries are expected to account for the majority of global gas demand by 2030, unlike in 2006. The OECD region of North America is expected to remain the largest consumer, accounting for around one fifth of the global demand and the EU the third largest with just over 15 per cent of the global share. The US share of total demand is forecast to fall from 21 per cent to 14 per cent, though it will remain the single largest national user of gas. The non-OECD region of Eurasia is forecast to be the second largest global consumer of gas. Russia accounts for the majority of this consumption, second only to the US in absolute volumes consumed (524 bcm).

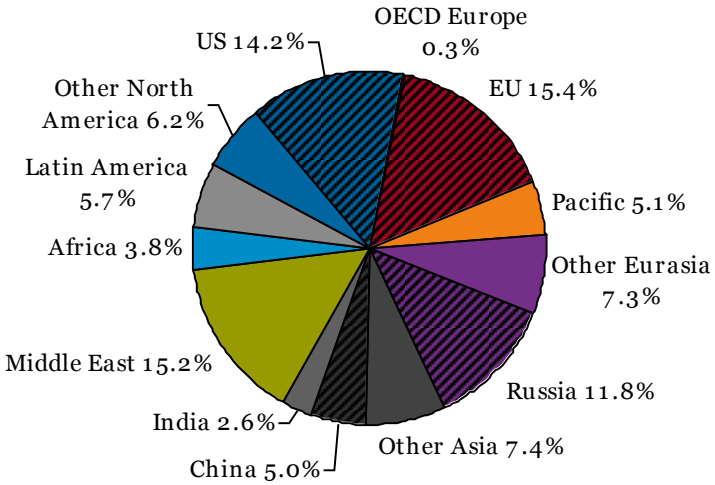
[11] China's Medium and Long-Term Development Plan for Renewable Energy sets targets of 2 million tonnes by 2010 and 10 million tonnes by 2020 for non-grain fuel ethanol use. A target for biodiesel use has been set for 200 000 tonnes by 2010 and 2 million tonnes by 2020.

Figure 14: Shares of global gas demand 2006



Source: IEA World Energy Outlook 2008

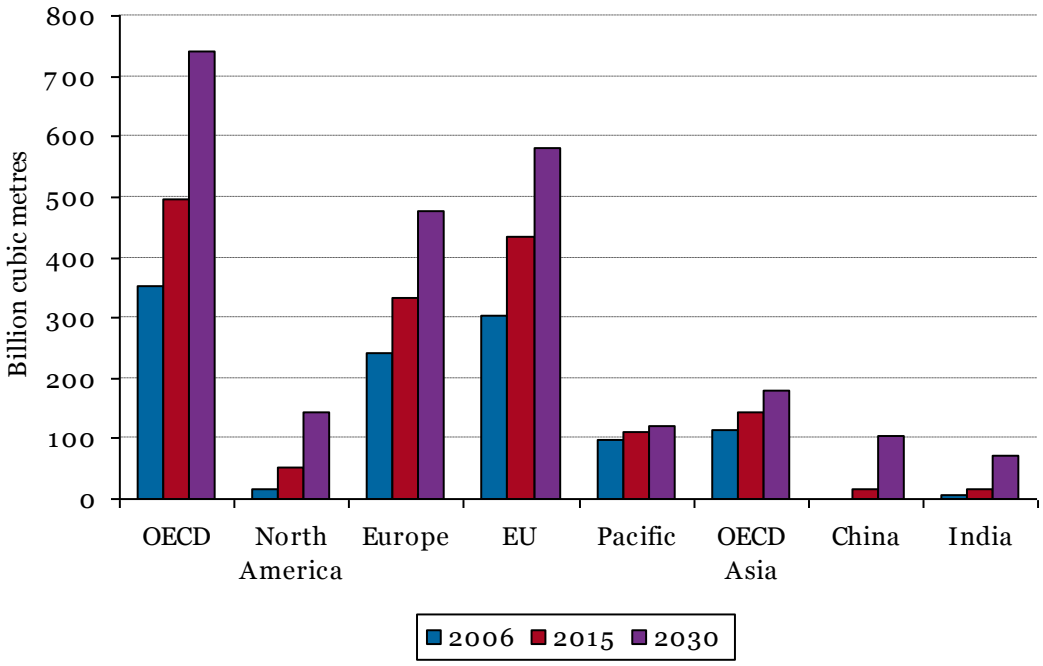
Figure 15: Shares of global gas demand 2030 – reference scenario



Source: IEA World Energy Outlook 2008

2.39 With demand growing in all regions but production already in decline in Europe and until recently expected to decline in North America, these regions will become increasingly dependent on imports. However, the future gas production potential in North America is currently very uncertain due to the potentially significant impact of "unconventional" sources of gas – gas reserves which new technologies make it possible to exploit. Chinese and Indian demand growth is expected to outstrip production increases. The EU requires, by a considerable amount, the largest increase in imports in absolute terms. The net imports of the region are forecast to almost more than double by 2030, raising the import dependency of the region from just under 60 per cent today to over 80 per cent, the largest import dependency of any part of the world with the exception of OECD Asia (Japan and Korea).

Figure 16: Net gas imports for major importing regions and countries – reference scenario



Source: IEA World Energy Outlook 2008

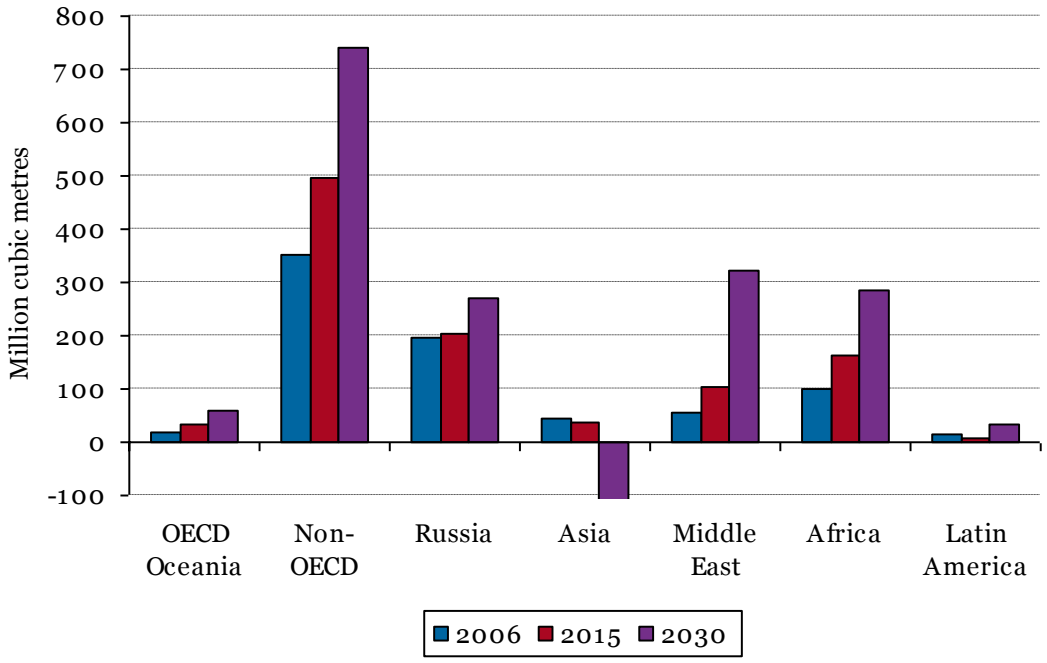
Box 5: Republic of Korea

Korea imports 97 per cent of the energy it uses. Its policies have for many years emphasised stability of supplies and diversification. It is one of the world's largest importers of LNG, with a mixture of long-term contracts and short-term procurement. It has sought to increase the security of gas imports by preliminary agreement on a pipeline deal with Russia and signing a Memorandum of Understanding with East Timor for supplies from a new development there. Nuclear power already accounts for 40 per cent of power generation, with plans to expand this to 60 per cent by 2035. More recently, the Government has adopted policies aimed at improving energy efficiency, and its recent fiscal stimulus very strongly emphasised green measures, including increased support for renewables, which it aims should account for 11 per cent of the energy mix by 2030.

Which countries will be supplying these needs?

2.40 The Middle East is forecast to become the greatest exporting region by 2030, with a rise in net exports from 55 bcm to 323 bcm over the period 2006 to 2030. Whereas Russia is the single largest net exporter today, with 198 bcm in 2006, net export growth is forecast to be relatively modest to 2030, due to small increases in production over the period, though the Russian Government plans higher levels of exports. African exports are forecast to be larger than Russia's by 2030.

Figure 17: Net gas exports of major exporting regions and countries



Source: IEA World Energy Outlook 2008

2.41 Export destinations have traditionally been determined largely by the pipeline transport infrastructure. Shipping times are a major factor in determining the destination of LNG exports. Most African exports go to Europe whereas the destination for Middle Eastern exports is more diverse, covering all the main markets except China. By 2030, the Middle East may be supplying the Chinese market through LNG but there is generally a large degree of uncertainty surrounding the Middle East region's prospects for gas exports due to domestic supplier obligations and moratoria in some countries on exports. Russia and the Caspian/Central Asian countries have potential to increase exports to Europe and are likely soon to start exporting to China and OECD Asia.

2.42 Producing countries vary in their strategies for production and export. Most Middle Eastern exports, for example, are from Qatar with LNG exports driving fast-growing production over the period. The region's biggest producer, Iran, plans to expand exports but this has been delayed for technical and political reasons in recent years. Heavy domestic needs have been a key factor here. Saudi Arabia is the region's second biggest producer behind Iran, but operates a policy of zero exports of natural gas to satisfy domestic needs; this is unlikely to change unless Saudi Arabia is certain that its increasing future domestic demand can be satisfied.

2.43 Algeria and Nigeria are expected still to be significant exporters to Europe in 2030. The Algerian Government aims to achieve gas exports of 85 bcm in 2012 and 100 bcm in 2015 by pipeline to Europe and as LNG. Algeria, Niger and Nigeria have also recently signed an Inter Governmental Agreement on the construction of a trans-Saharan

pipeline, which the Nigerian Government hopes to use to transmit 20-30bcm to Europe from 2015, gassifying the north of the country at the same time, though many commentators see these as ambitious objectives and point to security difficulties in the Sahel region. Nigeria is already a big LNG exporter and has substantial gas reserves, though security in the Delta region is a significant concern and may be a limiting factor. Egypt, while potentially a significant contributor to the region's gas production, requires most of its gas to meet growing domestic demand.

2.44 Russia is the most important supplier for EU imports of gas from the Eurasian region and has the potential to continue to be so for the foreseeable future owing to its vast reserves. There are anxieties over Russia's capacity to maintain its levels of exports in view of large infrastructure investments required over the next few years and competing State objectives for its energy sector (see Box 13 for more details). The other countries in this region produce much smaller quantities of gas but their limited domestic demand and openness to trade their gas mean they are another potentially useful source of exports. Uzbekistan exports principally to Russia, but there is potential for further exports, by pipeline to other countries. Azerbaijan and Turkmenistan are also potential export markets of interest, with Azerbaijan planning to make 20 bcm of gas available for export to Turkey and the rest of Europe from the middle of the next decade. Kazakhstan currently consumes most of its gas locally but has the potential to export in the medium term. EU countries are concerned that Russia uses energy as a political tool. Russia may also be seeking to prevent EU access to Caspian gas exports to preserve its dominant position as a gas supplier to the EU.

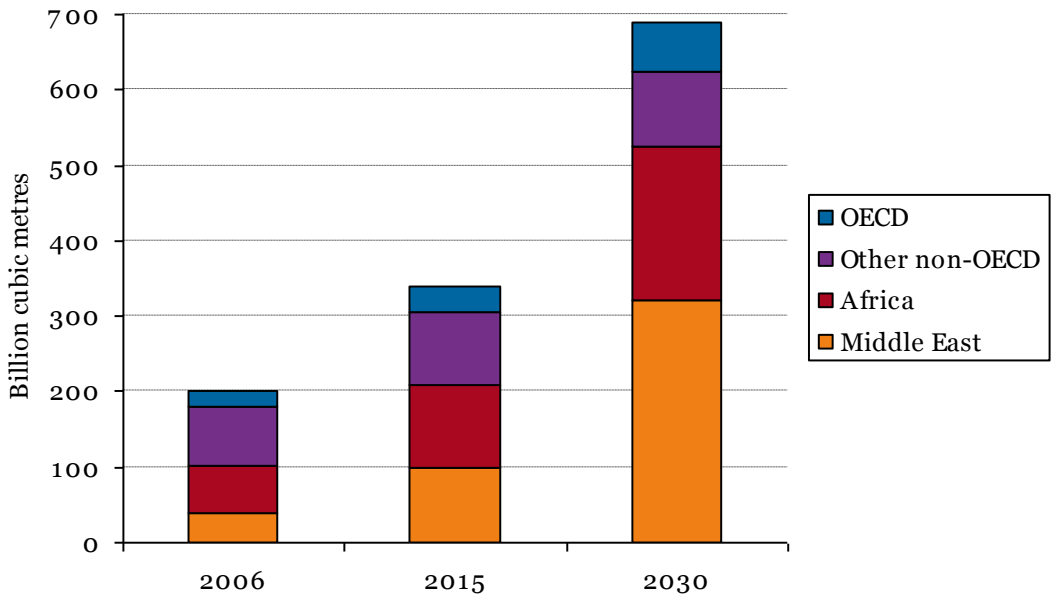
2.45 Gas trade is set to expand considerably faster than demand over the next two decades owing to growing geographical mismatch between the main gas consuming and producing regions. LNG will grow in importance, as it is very expensive to build gas pipelines over very long distances and advances in liquefaction and shipping technologies continue to gain economies of scale. LNG also enables producers to have flexibility over the destination of their exports.

2.46 LNG currently meets around 7.5 per cent of world demand for natural gas[12]. World LNG production stood at 233 bcm in 2007, having grown 9 per cent on the previous year and by 53 per cent in five years. The volume of LNG trade is forecast to increase to 340 bcm by 2015 and 680 bcm by 2030. While project delays for LNG liquefaction capacity and reduced demand owing to the economic downturn may reduce traded volumes in the medium term, LNG will continue to grow to be a key component of a global gas market. Spot and short-term imports are growing fast, representing 13 per cent of trade in 2005. But regional and long term trades with destination restrictions (through pipelines or LNG contractual obligations) will continue to be the dominant model

[12] BP Statistical Review of World Energy June 2009

of gas trading. Gas is not likely to be a completely free traded commodity like oil, at least in the medium term.

Figure 18: Inter-regional exports* of LNG by source in the reference scenario



Source: IEA World Energy Outlook 2008. *Net exports of LNG from major WEO regions, not including international trade within each region

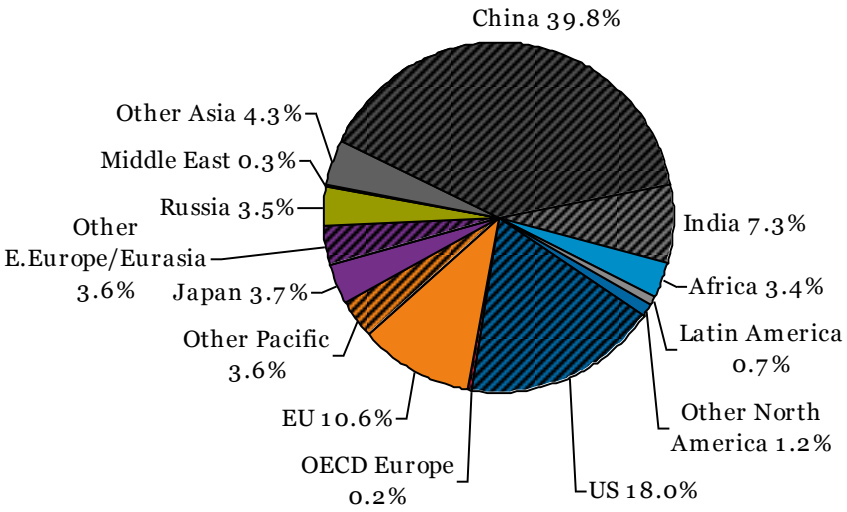
The global outlook for coal

Who will be consuming the world's coal reserves?

2.47 Since 2000, coal consumption has grown faster than demand for any other fuel, at 4.9 per cent per annum. It is the second most important fuel after oil in the global energy mix, accounting for a quarter of global energy demand. The pace of coal growth up to 2030 is projected to slow, to an average of 2 per cent annually. However, this consists of two distinct phases, with coal growth averaging 3.1 per cent per year until 2015 and 1.3 per cent thereafter as policies to reduce carbon emissions act to constrain demand. Over the period 2006-2030 coal consumption is estimated to increase by 61 per cent reaching 7,011 million tonnes of coal equivalent (mtce) up from 4,362 mtce today. Switching to lower carbon technologies contributes to this slowdown in growth, since coal is the most carbon intensive of fuels, yet coal demand still grows faster than overall energy demand. Energy consumption as a whole is therefore set to become more carbon intensive. The share of coal in total energy supply in the IEA's reference scenario rises from 26 per cent in 2006 to 29 per cent by around 2025 where it then levels off.

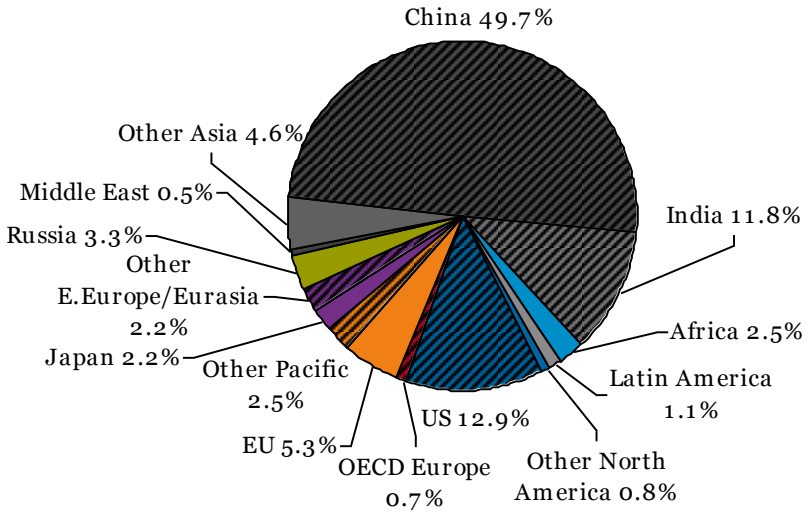
2.48 Five countries, China, the US, India, Japan and Russia, account for almost three quarters of all coal consumed. Within this, China is the single most important consumer of coal. In 2006, China's consumption at 1,734 mtce was greater than that of all the OECD nations combined. China accounts for around 40 per cent of total global coal demand. The US is the second largest consumer with 18 per cent of the total global share (787 mtce) with the three remaining countries making up a further 15 per cent.

Figure 19: Share of global coal demand 2006



Source: IEA World Energy Outlook 2008

Figure 20: Share of global coal demand 2030 – reference scenario



Source: IEA World Energy Outlook 2008

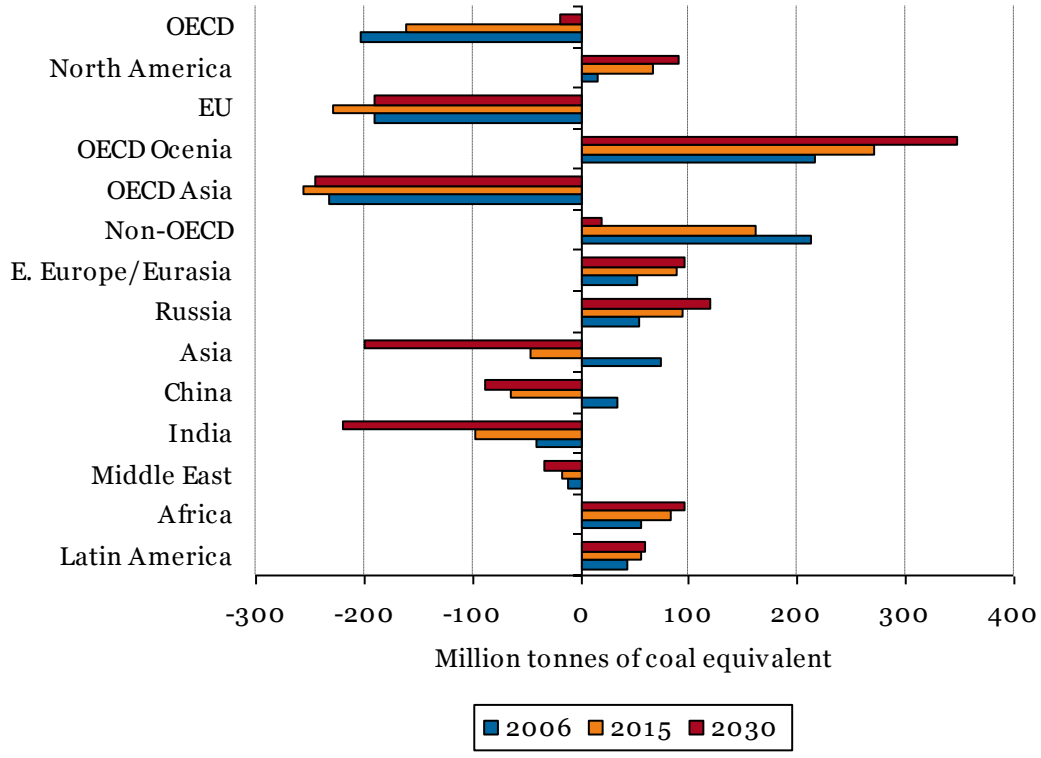
2.49 Growth over the last few years has been driven by non-OECD countries and this trend is set to continue with non-OECD member countries' demand growing 2.8 per cent annually compare to just 0.2 per cent in OCED countries.

Which countries will be supplying these needs?

2.50 The main net importers of coal[13] are OECD Asia consisting of Japan and Korea (232 mtce) and the EU (191 mtce). For Europe, coal imports amount to 43 per cent of its total coal consumption whilst OECD Asia imports all of its coal requirements from Pacific regional producer Australia, also the largest global coal producer.

2.51 Falling production throughout the 2006-2030 period raises the import dependency of coal for the EU considerably, up to around 60 per cent from 40 per cent today, although policies to reduce carbon emissions could limit the increased dependence on imported coal to 50 per cent. For the OECD as a whole net imports fall to just 1 per cent of total OECD coal demand by 2030 from 12 per cent in 2006 due to a combination of falling demand in EU countries thanks to climate change policies and increased production in North America and the Pacific.

Figure 21: Coal net imports and exports by key countries and regions* – reference scenario



Source: IEA World Energy Outlook 2008. *Negative figures are volumes of net imports, positive figures imply net exports

2.52 While net imports in OECD regions are restricted over the period due to the impact of environmental legislation, non-OECD net importing

[13] Hard coal including steam and coking coal, and coke. Excludes brown coal (lignite) and peat.

regions experience a continuing upward trajectory. The Asian region moves from being a net exporter in 2006 to a net importer by 2015 with net imports continuing to rise through to 2030. This change is driven by China and India's increasing coal needs over the period. China remains largely self sufficient in coal, however, with net imports accounting for only 3 per cent of total coal demand by 2030.

2.53 Between 2006 and 2030 coal production is projected to rise by 60 per cent. Over 90 per cent of this increase in production could come from the non-OECD regions.

Table 2: Major coal importers and exporters

Major coal importers: 2007			Major coal exporters: 2007		
Country	Million tonnes	Proportion of total	Country	Million tonnes	Proportion of total
Japan	182.300	20.4%	Australia	243.600	26.6%
Korea	88.300	9.9%	Indonesia	202.200	22.0%
Taiwan	68.900	7.7%	Russia	100.200	10.9%
India	54.100	6.1%	Colombia	67.200	7.3%
UK	50.300	5.6%	South Africa	66.700	7.3%
PR of China	47.600	5.3%	PR of China	53.700	5.9%
Germany	46.300	5.2%	US	53.400	5.8%
US	32.900	3.7%	Canada	30.400	3.3%
World	892.027	-	World	917.264	-
OECD	577.749	64.8%	OECD	357.394	39.0%
Non-OECD	314.278	35.2%	Non-OECD	559.870	61.0%

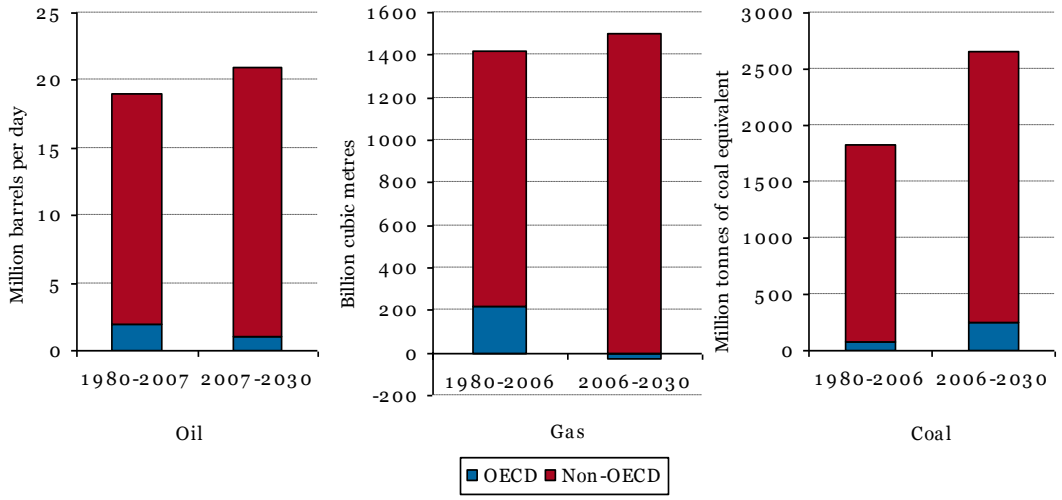
Source: IEA Coal Information 2008

2.54 The Asian regions alone have the potential to account for around 80 per cent of the increase in production, for the large part responding to their own consumption requirements. Increased Russian production is expected to make quite a significant contribution to global production, accounting for 5.7 per cent of the total increase. Latin American and African production is expected to expand with each region contributing between 2 and 3 per cent of the global increase. However, Table 2 shows the diversity of regional exporters of coal in 2007. This diversity combined with vast geographically spread global reserves for coal and their relative ease to access and produce means that concerns around risks to supply of coal are less than those relating to oil and gas.

Implications of increasing OECD dependency on imported energy

2.55 The global demand and supply outlooks for fossil fuels reveal the likely shift in the volumes and patterns of global production and trade. The overall global energy picture is one of massively increasing demand in non-OECD countries driven by the huge appetites of the Asian nations but also Middle Eastern countries. At the same time, energy demand in the OECD is set to expand, albeit to a much lesser degree. Almost all the increase in global energy supply is likely to come from non-OECD regions.

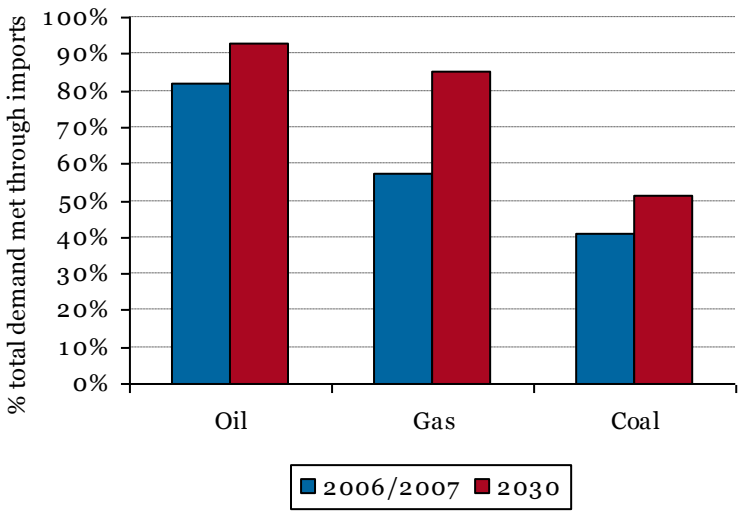
Figure 22: Future global energy supplies – reference scenario



Source: IEA World Energy Outlook 2008

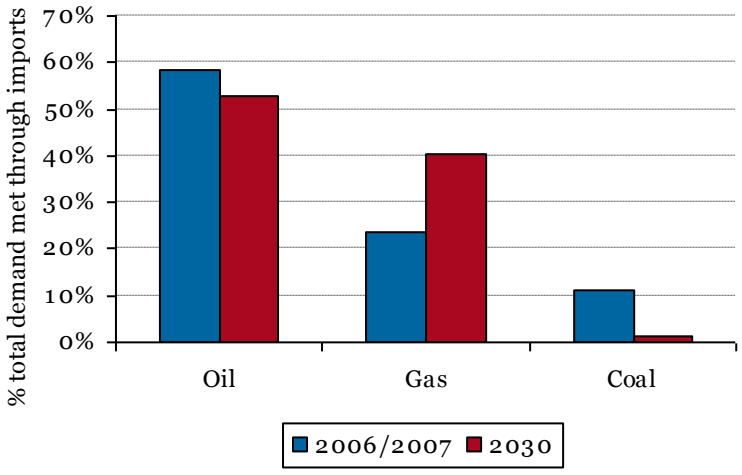
2.56 Figures 23 and 24 illustrate what these global trends in demand and supply imply for the OECD and the EU's reliance on foreign imports. The EU experiences a stark increase in import dependency for all fossil fuels. Though only gas consumption is expected to rise to 2030, as coal and oil consumption falls, production of all three fossil fuels will decline sharply within the region. This contrasts with the situation for OECD countries as a whole that experience falling reliance on foreign imports of oil and coal, although for oil the level of dependency remains high.

Figure 23: EU import dependency: 2006 and 2030 – reference scenario



Source: IEA World Energy Outlook 2008

Figure 24: OECD import dependency: 2006 and 2030 – reference scenario



Source: IEA World Energy Outlook 2008

Risks

2.57 Satisfying anticipated global demand for all the fossil fuels will require extensive additional production of oil, gas and coal over the next two decades. There are geological, geopolitical and/or economic risks to the achievement of such supply.

2.58 For all three fuels, physical supply risk due to geological constraints may be effectively ruled out as a serious concern since there are

sufficient proven reserves and even larger remaining resources. However, the geopolitical and economic risks are such that the large sums of investment needed to exploit these reserves may not be made or may not be timely, meaning some markets are potentially left undersupplied or prone to volatile or high prices. In addition, as resources become more concentrated, supply disruptions in certain regions may have a larger impact on physical availability.

2.59 The consequences of a supply disruption for oil are generally considered less grave than for gas delivered by pipeline since in the event of a disruption of one source, the liquid nature of oil - both literally and figuratively in terms of the global oil market - mean that supplies can be shipped from other regions and purchased from sellers with relative ease on the spot market. In addition, there is spare capacity in the form of shut-in OPEC production and there is the IEA emergency response mechanism in the form of stock release. Gas transported by pipelines on the other hand cannot easily be redirected, if at all, and more of the volumes traded are tied in by long-term contracts. There are also concerns about concentration of LNG production in a few countries. However, gas demand is more responsive as it can more easily be substituted by other fuels, for example by coal in the power sector. Given that there are few substitutes for oil in the transport sector, oil demand is less responsive. Nevertheless, the UK economy is likely to suffer significant negative economic impacts from disruptions in either oil or gas supplies.

2.60 Chapter 3 considers the risks to UK energy security associated with the future global energy trends.

Reserves, resources and key supplier regions

2.61 Global proven reserves, those that can economically be extracted today, are estimated at around 40 years at current production rates for oil, 60 years for gas and 140 years for coal. While this may give rise to, for oil and gas at least, fears that resources are limited, the actual potential resources in the ground and which are ultimately recoverable are far greater. It is the geographical concentration of the resources and the supplying regions that are of greater interest when assessing potential risks to security of supply.

2.62 Coal may be viewed somewhat differently to oil and gas. It is the most abundant and geographically dispersed of the fossil fuels. The US has the greatest quantity of proven reserves, followed by Russia and China, together holding 61 per cent of the world's proven reserves. For oil and gas, reserves are heavily concentrated in the Middle East and Russia, which contain 66 per cent of global gas and 60 per cent of global oil reserves (67 per cent excluding Canadian oil sands).

Box 6: Peak oil

Oil's finite nature means that production will inevitably peak. The term 'peak oil' refers to oil production peaking at reaching its all-time high and the subsequent decline in production. This relatively simple concept is complicated both by the use of different definitions of the word 'oil' and by the range of factors that affect oil production. Firstly, the peak oil debate tends to focus on conventional oil production and often excludes natural gas liquids (NGLs) and other unconventional sources such as oil sands, and oil shales. Secondly, the fundamental constraint on production is typically considered to be the geological scarcity of oil, leaving out other important factors such as technological progress, future demand for oil and its link to the oil price, access to and investment in the development of existing resources, and political instability or resource nationalism that limits the amount of recoverable oil.

In 1956, the American geophysicist M. King Hubbert presented a prediction of when US oil production would peak and kicked off what would became known as the 'Hubbert peak theory'. In a nutshell, he said that as oil is a finite resource, the rate of oil discoveries will rise at first before eventually falling off to nothing as remaining undiscovered reserves become increasingly scarce, and the production profile will follow a similar pattern, albeit with a lag. Graphed over time, the rate of oil production will therefore appear to be an approximately bell-shaped curve. Hubbert's theory implied that oil production could fall away fairly steeply as discoveries declined and gave rise to concerns that the world would have to move quickly to alternative sources of energy when oil production reached its peak.

Hubbert's predication of when oil production in the United States (in the lower 48 states) would peak proved remarkably accurate, but his projections for life after the peak have proved less than reliable. In 2005, US production was 66 per cent higher than Hubbert's projections, due in large part to technological improvements that increased the amount of oil recovered from existing fields. As resource estimates on a global level are less reliable and change over time, and are influenced by the oil price, changing technology and governments' policies on total recoverable reserves, it is not possible to predict accurately the timing of peak oil.

In the literature, the estimates of when oil production will peak vary from 'imminently' to 'not before 2030'. Few authors advocating an imminent peak take account of factors such as the role of prices in stimulating exploration, investment, technological development and changes in consumer behaviour. Proponents of a late peak tend to underplay the risks of insufficient investment and the significant rigidities that disrupt the oil market's efficient operation.

In the IEA's latest assessment the world's ultimately recoverable conventional oil resources, including natural gas liquids, amount to 3.6 trillion barrels, including the 1.1 trillion barrels that have been produced to date. Of the more

than 2.4 trillion barrels remaining, around 1.2-1.3 trillion barrels are proven reserves, meaning that they have been discovered.[14] These proven reserves are equal to over 40 years of current production. However, as noted above, the immediate risk to oil production is not the level of resources and reserves, but the world's ability to convert these reserves into production now and in the long run, which is essential for the UK's security of supply.

2.63 Historically, however, the countries with the largest reserves have not always been the largest producers. In the case of coal, Australia, the world's largest coal exporter, has 9 per cent of the world's proven reserves, while Indonesia, the second largest producer, has just 1 per cent. Similarly, Table 3 shows for gas and oil how the regional shares of production compared with proven reserves may differ widely.

2.64 Both Europe and North America produce significant amounts of their gas reserves. North America produces 26 per cent of the world's gas and Europe around 10 per cent whilst these regions have less than 5 per cent of world reserves. Conversely, the Middle East, with around 30 per cent of the world's reserves, is responsible for only 11 per cent of the world's gas production. The picture is similar for oil. The Middle East does account for a larger share of production at around 30 per cent but its share of total oil reserves is even greater than for gas at 60 per cent. Again, the US, with just 7 per cent of global reserves, produces a significant proportion more, accounting for 18 per cent of global production.

2.65 The low production-to-reserves ratio of the Middle East compared to the high ratio in Europe and North America is not a cause for concern to the extent that production of their resources can increase to ensure sufficient supply to meet global demand, as reserves elsewhere are run down. Figure 23 on EU import dependency and the global demand and supply outlooks in the previous sections reveal that the EU will be particularly reliant on this increased production taking place, due to its own declining resources and production potential.

2.66 Where the increased production will occur and, more importantly, who will be supplying the export market is therefore key for the EU. The geopolitical risk factors that may accompany these trends and their implications for security of supply are considered next.

Geopolitical risk factors

2.67 A number of risks to supply can be associated with geopolitics, covering the spectrum of the supply chain. These include failure by national energy companies to produce enough fuel to satisfy global demand, physical supply disruptions caused by political interference in transit routes, and market dominance by producers who manipulate both price and quantities supplied. These obstacles to open markets can impact on the speed and efficiency with which supply responds to

[14] International Energy Agency (IEA), World Energy Outlook 2008, pp. 202-205.

demand, creating uncertainty for consumers and producers in the global energy markets and impacting negatively on investment.

2.68 Geopolitical risks are less significant in relation to coal. Firstly, quite significant declines in EU demand for coal mean that, despite shrinking indigenous production, the demand to supply balance remains relatively better and coal import dependency rises less dramatically than for oil and gas (see Figure 23). The region faces, therefore, less exposure to potential supply risks in coal markets. Secondly, the large global reserves of coal and their geographic dispersion reduce the risk that resources will not be produced. As Figure 24 shows, OECD import dependency for coal falls quite significantly through falling demand in some regions but also due to increased production. OECD North America and the Pacific are expected to be making available volumes for export of the same order as the import needs of the EU. While there is a potential for competition for resources due to large increases in Asian consumption, most of this extra demand is satisfied through exploitation of China and India's own large resources of coal. The geographical dispersion also reduces the impact of any one regional supply disruption or that supplies will not be available for export.

2.69 Despite facing different trajectories, with oil demand declining and gas demand increasing in the EU to 2030, EU import dependency for both fuels could reach over 80 per cent by this time. The potential supply risks for these two fuels are similar, given the similarity in the geographical location of reserves and resources and structures around resource ownership and the market operators for producing these. However, as discussed earlier there are differences in the operation of the two markets that will lead to them responding differently to these risks.

2.70 Table 3 summarises the key players supplying the global market for oil and gas through to 2030 and beyond. It is clear-that the OPEC countries, in particular the Middle Eastern OPEC members, and Russia, dominate in terms of oil and gas reserves. From the OECD, only Canada for oil and to a lesser extent the US for gas hold substantial reserves. Canada's oil reserves consist primarily of the, as yet more difficult and thus costly to produce, oil sands. The potential for gas production from the US given recent gas shale discoveries is uncertain. The Middle East and Russia are large producers of oil, with Saudi Arabia, Russia, Iran and the UAE making considerable amounts available for export. While the North American countries produce a lot of their oil reserves, much of this satisfies domestic demand. Key emerging players are Kazakhstan and Nigeria which have the potential to expand oil production considerably with most additional production available for export, although security and other concerns remain limiting factors at present. Iraq is expected once again to become one of the most important oil suppliers to the global market by 2030.

2.71 For gas, despite large reserves, the Middle Eastern OPEC countries are not key exporters. The majority of production comes from Russia and North America but Norway and Algeria are also important exporters. Qatar and Nigeria are expected to experience considerable production growth. Given Qatar's relatively high exports to date and Nigerian export potential, these will also be important in supplying the global market in 2030.

Table 3: Reserves, production and net exports of key oil and gas producers

Oil	Reserves (Billions barrels)	Production (1000's barrels daily)				Net exports (1000's barrels daily)	
	2008	2008	Rank	2030	Rank	2008	Rank
Saudi Arabia	264.2	10846	1	15600	1	8622	1
Canada	178.6	3238	6	1900	16	943	12
Iran	138.2	4325	4	5400	5	2595	3
Iraq	115	2423	12	6400	4	*	-
Kuwait	101.5	2784	9	3300	12	2484	5
UAE	97.8	2980	8	3900	7	2513	4
Venezuela	99.4	2566	10	3600	9	1847	7
Russia	80.4	9886	2	9500	2	7089	2
Libya	43.7	1846	17	2200	17	*	-
Kazakhstan	39.8	1554	17	4300	6	1325	9
Nigeria	36.2	2170	13	3700	8	*	-
US	30.5	6736	3	6500	3	-12683	-
Qatar	27.4	1378	18	2500	15	1274	10
China	16.1	3795	5	3500	10	-4204	-
Angola	13.5	1875	16	2600	14	*	-
Brazil	12.6	1899	15	3400	11	-498	-
Mexico	12.2	3157	7	3000	13	1118	11
Algeria	12.2	1993	14	2300	16	1682	8
Norway	8.2	2455	11	1300	18	2245	6

Gas	Reserves (billion cubic metres)	Production (billion cubic metres)				Net exports (billion cubic metres)	
	2008	2008	Rank	2030	Rank	2008	Rank
Russia	43.3	601.7	1	794	1	181.5	1
Iran	29.61	116.3	4	313	3	-1.3	-
Qatar	25.46	76.6	8	169	4	56.8	5
Saudi Arabia	7.57	78.1	7	-	-	0	-
UAE	6.43	50.2	18	-	-	-7.9	13
US	6.73	582.2	2	515	2	-75	-
Nigeria	5.22	35	19	127	7	*	
Venezuela	4.84	31.5	24	70	11	-0.9	-
Algeria	4.5	86.5	6	142	6	61.1	4
Indonesia	3.18	69.7	10			31.7	8
Iraq	3.17	n/a	n/a	n/a	n/a	n/a	n/a
Norway	2.91	99.2	5	127	7	94.8	2
Turkmenistan	7.94	66.1	13	-	-	47.1	6
Australia	2.51	38.3	21	96	10	14.8	10
Malaysia	2.39	62.5	14	-	-	31.8	7
Egypt	2.17	58.9	16	-	-	18	9
China	2.46	76.1	9	115	9	-4.6	14
Kuwait	1.78	12.8	38	-	-	0	-
Canada	1.63	175.2	3	164	5	75.2	3
UK	0.34	69.6	11	10	12	-24.2	-

Source: BP Statistical Review 2009 for 2008 production and exports; and IEA World Energy Outlook for 2030 production estimates – reference scenario

2.72 Future traded oil and gas will largely originate from the Middle East, other OPEC member states and Russia. Non-OPEC exporters of potential importance include Kazakhstan for oil and Norway and Canada for gas.

2.73 Many countries on which the global markets, and especially the European market, will be dependent for their imports of gas, present geopolitical risks to supply discussed in Table 4.

Table 4: Impacts associated with geopolitical risks

	Description	Impacts	Countries potentially demonstrating risk
Geopolitical factors that could constrain/delay investment			
Depletion policies	Policies to preserve resources over time. Choice to deplete resources more slowly in order to provide a wealth fund for future generations or simply through belief that in a context of rising prices, resources are worth more left in the ground for extraction in the future.	Less willingness to supply export market; higher prices .	Saudi Arabia; Kuwait; Mexico; Venezuela; Qatar.
Resource nationalism	Lack of access to reserves for IOCs and/or risk of appropriation.	Reliance on NOCs often less technologically advanced leads to inefficient exploitation of resources; less supply to global market.	Reserves inaccessible to IOCs: Saudi Arabia; Iran; Iraq; Kuwait; Mexico. Access restricted: UAE; Venezuela; Russia; Libya; Nigeria; Kazakhstan; Qatar; Algeria, Libya.
Political instability and terrorism	Military conflict or terrorist activity.	Acts as a deterrent to foreign investment and/or makes operations difficult.	Nigeria; Algeria; Libya; Iraq; Iran; Saudi Arabia.
Physical supply risks			
Transit risks	Disputes among supplier and transit nations prevents supplier's consumer obligations from being met. Transit routes in potential conflict zones.	Supply shortages through political interference or physical infrastructure damage.	Russia; Ukraine; Turkey; Georgia; Straits of Hormuz; Gulf of Aden; Malacca Straits; Suez Canal.
Uncompetitive markets			
OPEC and potential development of a Gas Cartel	Explicit or implicit collusion between producer countries to influence market outcomes. Price manipulation through quotas to maximise group revenue rather than prices determined by market forces for demand and supply.	Prevents a transparent and competitive market; supply and price uncertainty.	For OPEC see Box 4. Members of the Gas Exporting Countries Forum, which has potential to develop into a future Gas Cartel over the longer term.

Source: DECC

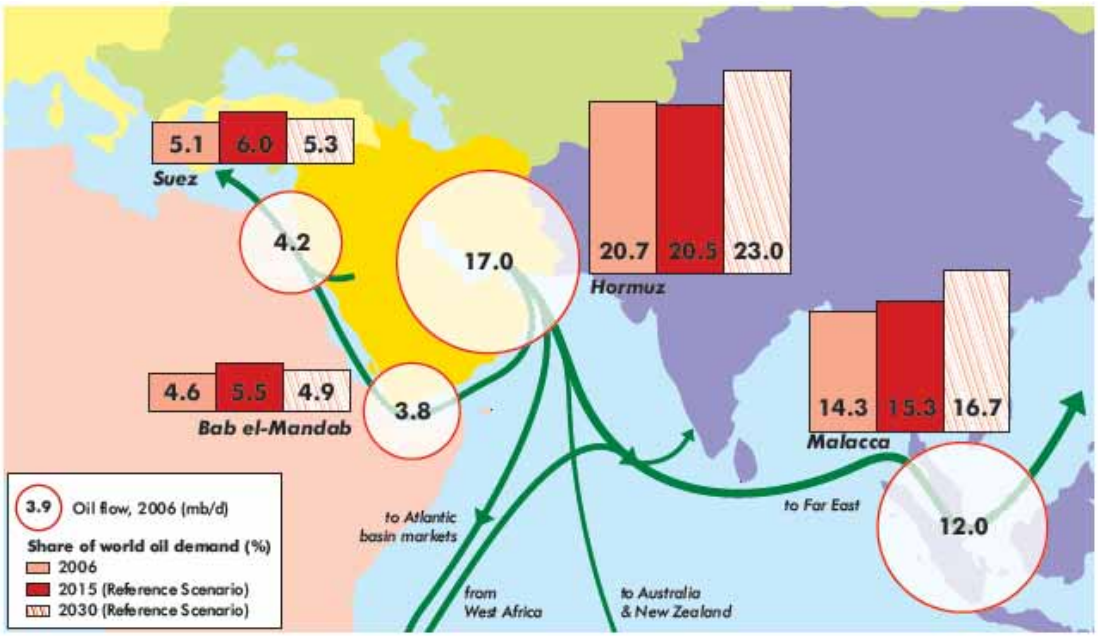
Transit risks

2.74 The forecast increase in trade in oil and gas exposes these markets to increased transit risks. Figure 25 shows the concentration of supplies coming through the Straits of Hormuz which is set to equal around one

third of world oil demand in 2030 as well as the UK's future gas supplies from Qatar; any disruption to that particular supply route would have more serious consequences than in the past.

2.75 Recent events have highlighted the reality of transit risks for the European gas market. The Russia-Ukraine gas dispute had serious consequences for a number of European countries relying on the transit route through Ukraine for all their pipelined gas. Europe currently imports 28 per cent of its gas from Russia and will continue to rely on its vast reserves of gas for the foreseeable future. This episode demonstrated the seriousness for European countries of regional disputes between this key supplier to the European market and transit nations. A potential difference between gas and oil, which could be argued to make transit risk more of a concern, is the speed with which a dispute translates into a potentially grave security of supply problem, because of the lack of flexibility in sourcing supplies elsewhere given the physical constraints and the relatively small size of the LNG market.

Figure 25: Oil export flows from the Middle East



Source: IEA World Economic Outlook 2008

Investment risk

2.76 For the large additional volumes of fossil fuels to be produced in order to satisfy the substantial demand growth, the IEA have estimated that investment of over $5 trillion is required in the oil sector and $3.3 trillion[15] in the gas sector over 2007-2030. In addition, most of the investment required to meet oil demand growth is to compensate for

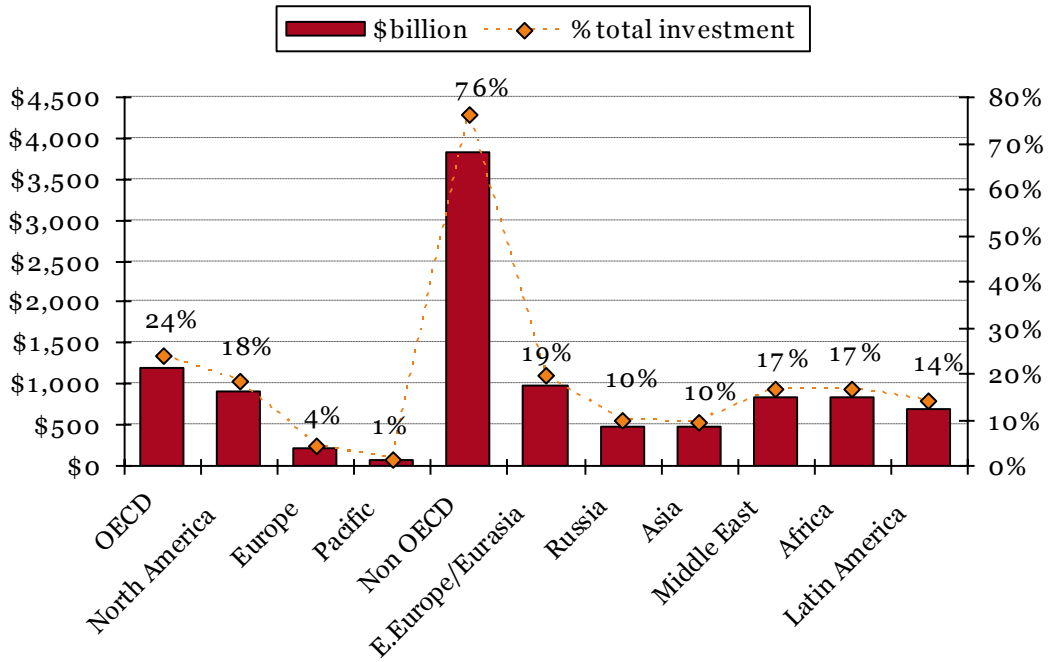
[15] In year 2007 dollars.

the loss of output from the decline in existing fields. The IEA have estimated that the rate at which existing fields are depleting will rise from an average 6.7 per cent in 2007 to 8.6 per cent in 2030. This means that additional production equivalent to 4 Saudi Arabias will be needed to maintain oil production at existing levels and 6 Saudi Arabias to enable supply to match the increase in demand likely to materialise by 2030. Investment required in the coal sector is much lower at $730 billion. There are significant challenges to the level and timeliness of energy investment. Paragraphs 2.12-2.18 highlighted how the current credit crunch may have impacted on the investment picture, concluding overall that the credit crunch and global downturn have led to delays and postponements in investment, creating the risk that, should the global economy make a strong cyclical recovery, gas and oil markets may again become tight. This section focuses on the longer term risk to meeting the projected investment requirements.

Resource nationalism and depletion policies impact on investment

2.77 The expected shift in future oil and gas production to the Middle East and Africa will require an increase in investment in these regions. For example, in the gas sector, to date 70 per cent of upstream investment has taken place in OECD regions, compared to just 6 per cent in Middle Eastern OPEC countries. The picture for historic oil investment is similar.

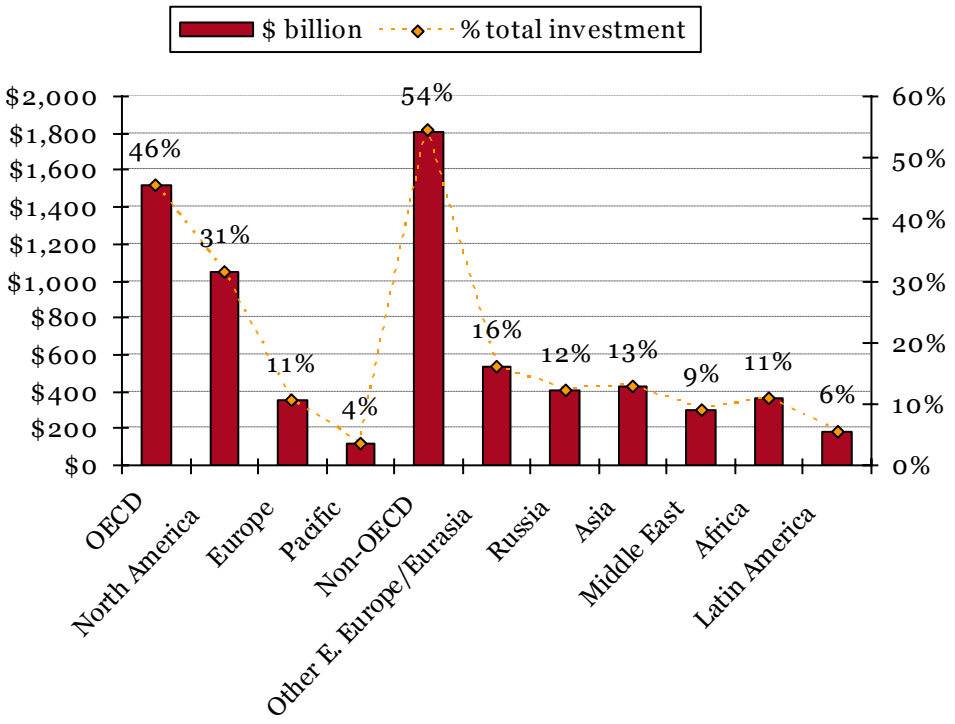
Figure 26: Investment requirements to meet estimated oil demand in 2030 – reference scenario in $ 2007



Source: IEA World Energy Outlook 2008

2.78 Figure 27 shows the necessary investment shares in the different regions of the world that are consistent with meeting the gas production required in 2030.

Figure 27: Investment requirement to meet estimated gas demand in 2030 – reference scenario in $ 2007



Source: IEA World Energy Outlook 2008

2.79 As a consequence of the shift in where production is expected to come from, almost 80 per cent of the projected increase in output needed for both oil and gas is expected to come from countries where production is controlled by national oil companies (NOCs). The change in the structure of the global oil and gas industry has important implications for investment, making it less certain that all the investment will be made or be made efficiently. The future prevalence of NOCs in oil and gas production may not lead to the prioritising of investment for future production as NOCs' resources may be diverted to other sectors of their country's economy. Sustainable depletion policies in some countries, which involve reserving a country's resources to enable production to last for longer, also reduce the availability of resources in the short term. Keeping resources in the ground in this context is seen as a way of preserving wealth for future generations.

2.80 Policies of "resource nationalism" which either completely prohibit or restrict access to reserves for International Oil Companies (IOCs) could also undermine investment due to the financial and technical limitations of many state-owned NOCs compared with the IOC super majors. Often NOCs are poorly managed and rely on outdated

technologies and production methods which can result in the inefficient exploitation of reserves at greater cost and not in a timely manner. The end consequence is higher prices for energy. There is, however, a large diversity among NOCs with some having made progress in improving their technical and management capabilities and beginning to internationalise their activities. Companies such as Brazil's Petrobras and Malaysia's Petronas are comparable to the larger international oil companies. Saudi Arabia's Aramco, the most technically advanced of the Middle Eastern NOCs, is also an efficient producer.

2.81 The regions at risk from failing to meet the investment requirements to supply the global market are also those where the production costs for developing reserves are the lowest. There is a risk therefore that should investment fall short in the Middle Eastern region for example, costs for meeting global demand for oil, particularly, and gas would rise considerably as investment and production would have to move to higher cost regions, such as North America for the Canadian oil sands. This could potentially lead to higher oil and gas prices than would have been necessary.

Skills

2.82 The upstream oil and gas industry as a whole faces wider problems of skills and equipment shortages. The skills issue in the industry is particularly acute. There is a risk that investment capacity in the oil and gas industry will be limited by shortages of highly qualified specialised workers. The long lead times associated with training these types of worker, design engineers for example, mean that in North America and Europe the shortfall is expected to exceed 15 per cent of demand by 2012. The lack of skilled labour leads to higher wages and higher production costs. In addition, the skill shortage has limited the degree to which production costs have fallen in light of the economic slowdown, further reducing the incentive to invest given falling energy prices.

Uncompetitive and non transparent markets: uncertainty over future trends

2.83 Oil and gas markets display a number of characteristics which complicate the normal functioning of transactions between producers and consumers. These can undermine investment and ultimately supply to the global market. Characteristics such as future demand and supply uncertainty and price volatility caused by interdependence between fuel demand and economic growth or due to supply disruptions (man-made or natural) can be attributed to the nature of the products themselves, namely the way they are produced and used. Similarly, investment risk is higher than it would be in some other markets due to the long term and expensive nature of the investment projects and consequent high sunk costs.

2.84 To incentivise investment, uncertainty should be minimised for both producers and consumers. Producers need to be confident about the potential size of the market for their oil and gas; consumers need assurance about the availability of sufficient supplies and at affordable prices.

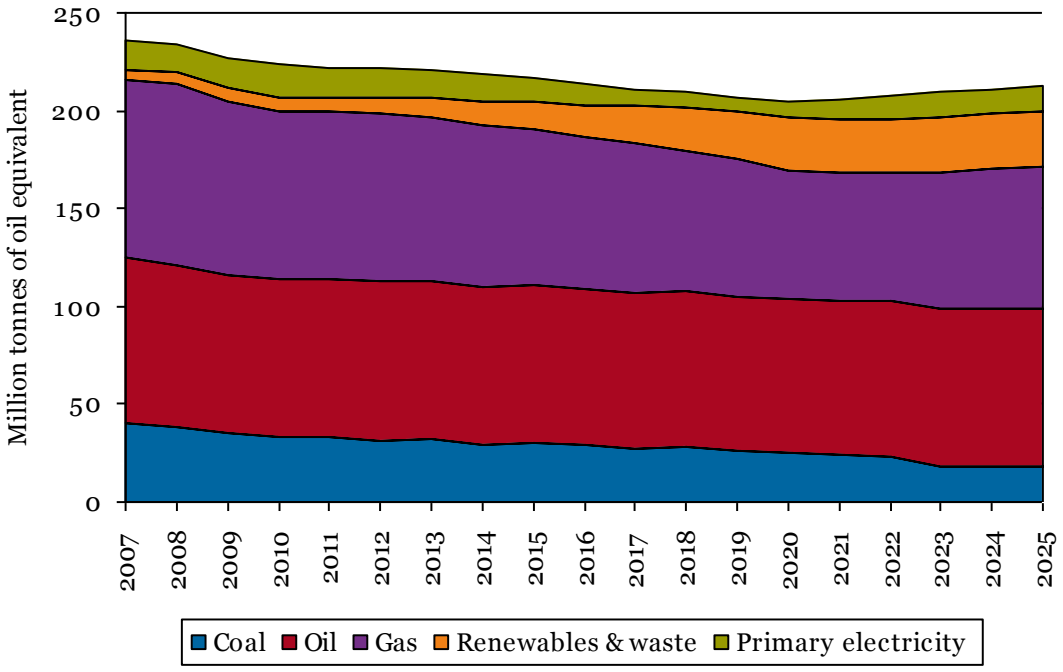
2.85 As well as trading physical quantities of oil, oil market participants can also trade oil as a financial product through trading on the futures market. Liquid, well operating futures markets are an important element to the functioning of oil markets through more effective oil price discovery and the opportunity they provide for market players to hedge production or consumption against future oil price fluctuations. However, the growth in the volumes of oil–based financial products traded over the last couple of years has raised questions over the extent to which activity in financial markets has been contributing to the oil price volatility recently experienced. In order to reduce the risk of any adverse impact financial markets trading could have on commodity price volatility, including oil, the International Organisation for Securities Commissions (IOSCO) has recently made recommendations that will enhance the oversight and regulation of commodity derivative markets, thus increasing transparency in the financial aspects of oil trading as well.

Chapter 3: What the global trends imply for the UK's medium- and longer-term energy security

3.1 Primarily driven by declining indigenous production of oil and gas, the nature and extent of the UK's dependence on imported energy and its exposure to international energy markets has changed quickly in recent years and will continue to do so over coming decades, at a time when the global energy market is itself undergoing fundamental change.

3.2 The evolution of future UK energy demand and production will depend on a number of uncertain factors including: international energy price movements, the rate of technological development, the evolution of energy and climate change policies, the energy choices of consumers and firms and economic growth. Moreover, of course, the outlook becomes more uncertain the further out one looks. However, it is possible to construct some scenarios to demonstrate a plausible range for the UK's future reliance on imported energy.

Figure 28: The UK's current and projected demand for primary energy



Source: DECC Energy Projections

3.3 Notwithstanding declining gas production, DECC forecast that the impact of the measures in the UK Low Carbon Transition Plan will be that the volume of gas we need to import in 2020 will be little changed compared to 2010, mostly due to the impact on gas demand of energy efficiency measures and increasing use of renewable technologies. At certain times of peak demand, for example on very cold, still days, where wind generation cannot contribute much electricity to the grid, and there is need for high levels of gas-fired generation, import requirements on a short-term basis will be much higher than today. Import requirements for oil will significantly increase as UK production also declines.

3.4 The overall level of UK energy import dependence (net imports as a proportion of total demand) will depend on the extent to which some of the renewable energy (biomass and biofuels) is imported but net imports of energy are likely to be in a range between 39-43 per cent of total UK energy consumption in 2020, and 47-50 per cent in 2025.

Box 7: Germany

The potential for an electricity supply gap is the key issue facing Germany. With no public backing for nuclear, and an ambitious renewables target of 25-30 per cent for electricity generation by 2020, gas is expected to close the supply gap. Enhancing security of supply for gas has become a dominant theme in Germany's multilateral and bilateral relations. Russia is a key bilateral relationship for Germany. German Ministers have advocated Russia as a reliable gas supplier which would remain so in the future, and have sought to improve this relationship through the EU, arguing the need for an energy chapter within the Partnership and Cooperation agreement with Russia.

The Russia/Ukraine gas dispute highlighted Germany's exposure to a high level of dependence. Gas storage sites are privately owned and the system was proved in the crisis as Germany was able to cover all its gas demand as well as supply those Eastern European countries facing difficulties. Strategic gas storage has been considered but rejected on the grounds of being too expensive. Germany has prioritised diversifying both gas suppliers and routes in the EU's Strategic Energy Review. It has focussed on promoting new gas supplies by forging relations with the Caspian region and improving LNG capacity to gain access to African and Middle Eastern resources are also a focus.

3.5 As set out in Box 8, the long-term is more uncertain, but it looks likely that in 2050 the UK will still be significantly reliant on imported energy. Even taking into account action to reduce emissions, imported fossil fuels could still account for 40-60 per cent of the UK's energy consumption in 2050, with virtually all oil and gas needs imported. Moreover, while increasing action to curb emissions would help to reduce reliance on imported fossil fuels, it would entail increasing reliance on imports of other sources of energy such as uranium (for

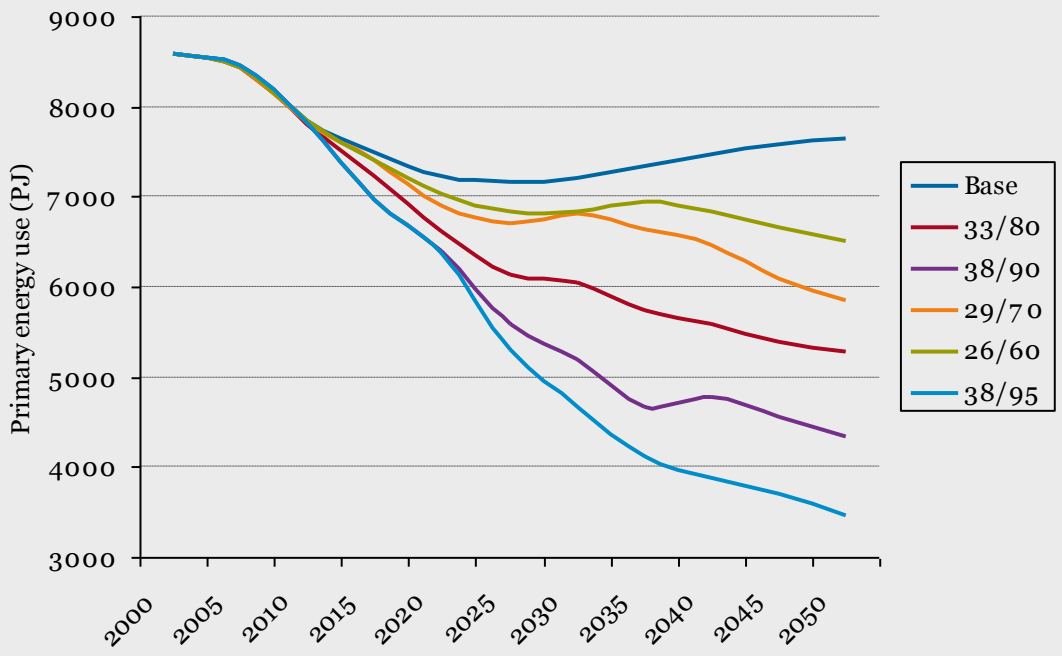
nuclear power), hydrogen, biomass and biofuels – although, as discussed later, the security of supply risks associated with the import of these fuels is expected to be lower than that for fossil fuels.

Box 8: Scenarios for the UK's import dependence in 2050

UK energy consumption

Research commissioned by the Committee on Climate Change (CCC) for its report *"Building a low-carbon economy – the UK's contribution to tackling climate change"* sets out a number of scenarios for the UK's energy mix in order to achieve various reductions in greenhouse gas (GHG) emissions by 2050 relative to 1990 levels – the Government has committed to a reduction of at least 80 per cent in the Climate Change Act 2008.

Figure 29: Primary energy demand, core trajectory scenarios (PJ)



Source: Figure 2.1, AEA (2008) MARKAL-MED model runs of long term carbon reduction targets in the UK for the Committee on Climate Change report "Building a low-carbon economy – the UK's contribution to tackling climate change", December 2008

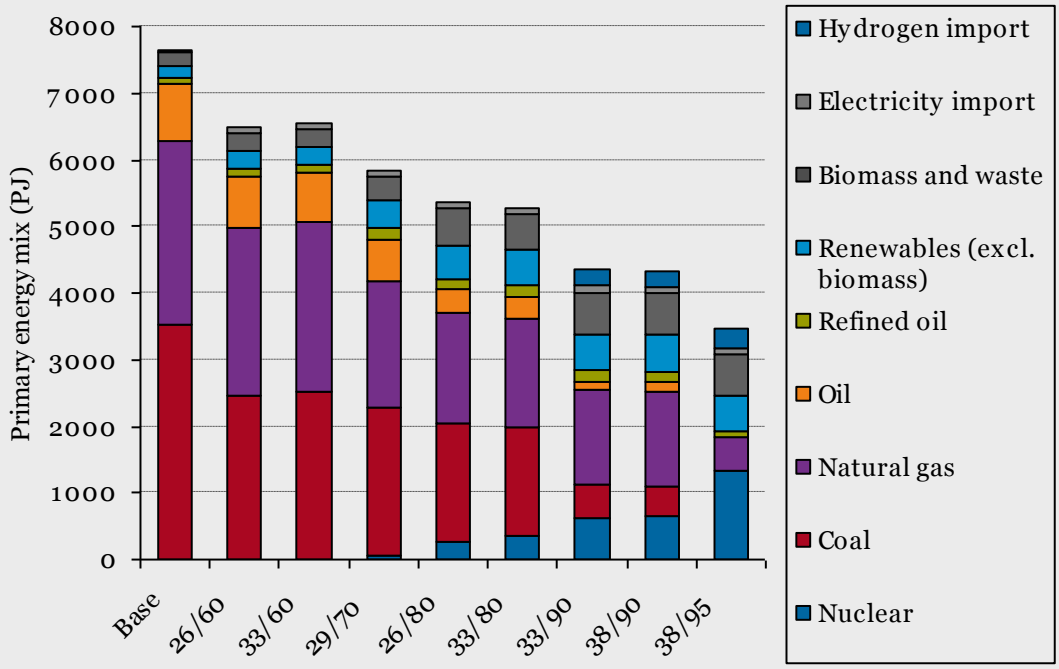
Notes: Legend series headings refer to emissions reductions in 2020 and 2050 relative to 1990. For example, "26/60" refers to a trajectory where emissions are reduced by 26 per cent by 2020 and by 60 per cent by 2050.

The level and type of energy consumed changes significantly under increasingly tighter emissions constraints. Figure 29 gives an indication of the changes in overall primary energy demand for different emissions reduction trajectories. In the base case energy demand declines to 2030, primarily as a result of vehicle efficiency improvements. Under a 60 per cent emissions

reduction scenario ("26/60") in 2050, total primary energy use decreases (relative to 2005 levels) by 23 per cent. Under an 80 per cent constraint scenario ("33/80"), the reduction is over 37 per cent, and 49 per cent under a 90 per cent constraint scenario ("38/90").

A comparison of the types of energy used in 2050 is given in Figure 30. Although the share of fossil fuels is reduced from today's level of over 90 per cent they continue to play a significant role (around 70 per cent of total energy demand) in the 80 per cent constraint scenarios, and even in the 90 per cent constraint scenarios they remain important (around 50 per cent). As emissions constraints tighten, the importance of nuclear energy, biomass and other renewables all increase, with hydrogen imports also becoming important in the 90 per cent constraint scenarios. As a consequence, levels of oil and coal use get increasingly lower, with their use reduced to just 17 per cent of consumption in the 95 per cent constraint scenario.

Figure 30: Primary energy demand in 2050 (PJ)



Source: Figure 2.2, AEA (2008) MARKAL-MED model runs of long term carbon reduction targets in the UK for the Committee on Climate Change report "Building a low-carbon economy – the UK's contribution to tackling climate change", December 2008

UK energy production

Barring unanticipated discoveries of major new reserves of oil and gas in UK territories and/or significant technological progress, UK oil and gas production will continue to decline, reaching a negligible amount by 2050. While the UK has significant reserves of surface mineable coal, production is likely to decline in the long-term to around 3-6 million tonnes of oil equivalent or 125-250 peta joules (PJ) by 2050, reflecting the difficulty there would then

be in finding sites which would be environmentally acceptable under present legislation. Longer term, technically production of the UK's biomass resource could be expanded to as much as 6 per cent of the UK's overall energy demand.

UK import dependence

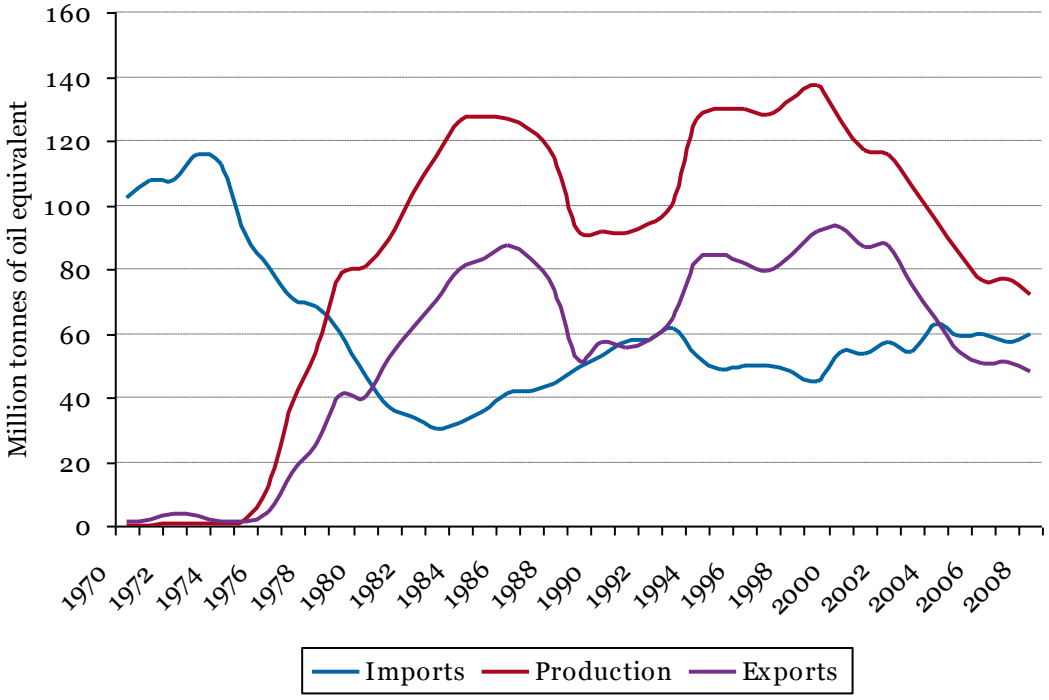
Despite a reduction in the share of fossil fuels in the energy mix, the UK is likely to be significantly dependent on imported fossil fuels in 2050 as a result of a lack of domestic production potential. In a scenario where the UK's emissions are reduced by 80 per cent by 2050, imported fossil fuels (mostly gas and coal) could still account for nearly 70 per cent of the energy mix, with virtually all oil and gas needs imported. This compares to over 85 per cent reliance in a scenario where emissions are only reduced by 60 per cent. Were emissions to be reduced by 90 per cent, then reliance on imported fossil fuels (mostly gas) falls to around 40 per cent. However, while the reliance on imported fossil fuels declines with increasing emissions reductions, the UK's reliance on imported uranium, hydrogen, biomass and biofuels increases. For example, in the scenario where emissions are reduced by 95 per cent, nuclear (fuelled by imported uranium) and hydrogen imports account for around 45 per cent of the UK's energy mix.

Oil

3.6 In 2008 oil accounted for around one-third of the UK's inland energy consumption, with around 70 per cent of refined oil used in the transport sector. As previously noted, the UK has long been exposed to conditions in the international oil market. Although indigenous production exceeded consumption for most of the 1980s and 1990s, the UK still imported crude oil to meet demand by refiners for different types of oil to North Sea crude, and to take advantage of pipeline infrastructure shared with some Norwegian fields (see Figure 31). Moreover, the prices of both indigenous and imported supplies were (and remain) set by conditions in the international market. Since 2005 the UK has moved to become a consistent net importer of crude oil. In 2008, net imports accounted for 14 per cent of the crude oil refined in the UK.

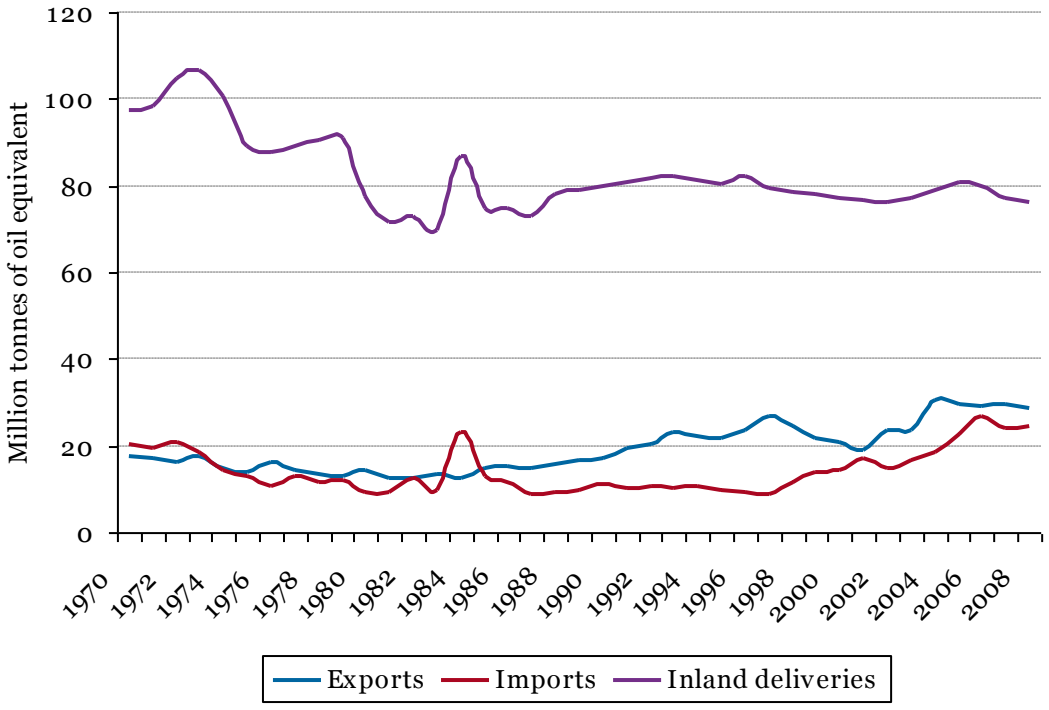
3.7 However, the UK produces more refined petroleum products than it consumes and is therefore a net exporter of refined products (see Figure 32). As a result, net imports of total oil (primary oils plus petroleum products) accounted for around 8 per cent of the UK's oil consumption in 2008.

Figure 31: UK production, imports and exports of primary oils: 1970-2008



Source: DECC Energy Statistics

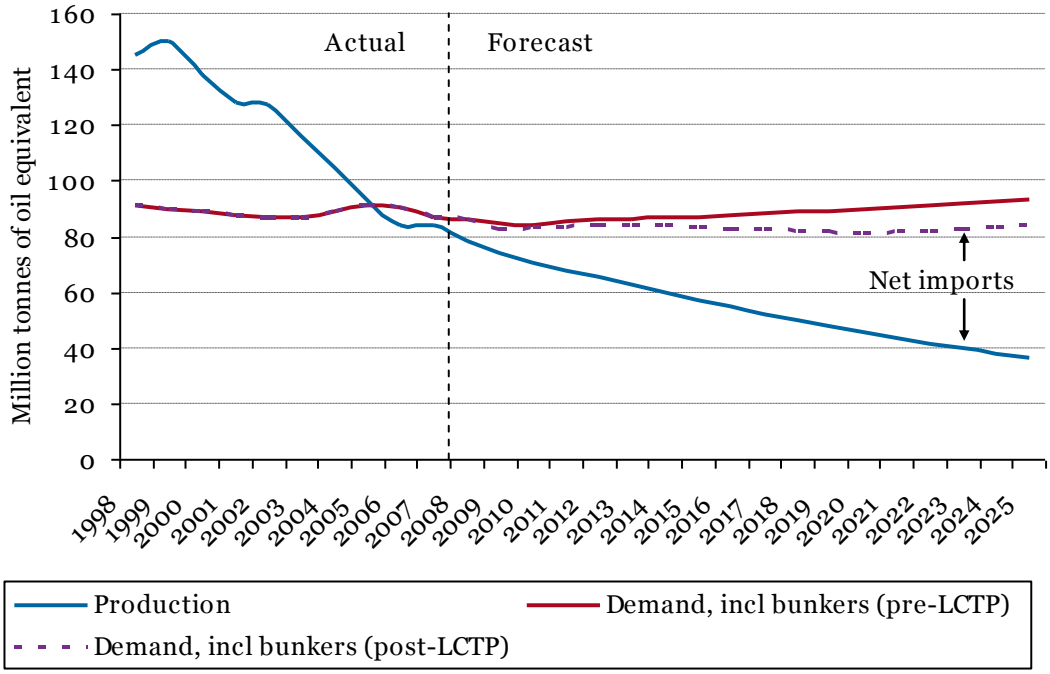
Figure 32: UK consumption, imports and exports of petroleum products: 1970-2008



Source: DECC Energy Statistics

3.8 Looking forward, Figure 33 shows that the UK's net imports of oil are expected to increase over the next two decades, as indigenous production continues to decline. Government measures set out in the Low Carbon Transition Plan designed to improve the efficiency of the vehicle fleet, increase the use of alternative transport fuels (e.g. biofuels and electricity) and change transport behaviour (e.g. greater use of public transport, eco-driving etc) will help limit the extent of reliance on imported oil but will not be sufficient to prevent the UK becoming significantly more import-reliant over the next two decades. Imported oil could be accounting for around 44 per cent of the UK's consumption of oil by 2020 and 57 per cent by 2025. In the absence of the impact of the measures set out in the Low Carbon Transition Plan these figures would respectively be 50 per cent and 61 per cent.

Figure 33: UK production and consumption of oil: 2000-25



Source: DECC Energy Statistics and Projections

3.9 Most (81 per cent in 2007) of the UK's crude oil imports are sourced from Norway, with the majority of the remaining imports sourced from Russia, Algeria and Venezuela. Over the past few years the share of the Middle East has fallen, accounting only for 0.4 per cent of imports in 2007 compared to 5 per cent in 2000. The global nature of the oil market and the fact that oil can easily be transported around the world by tanker means that it is difficult to predict exactly from which countries the UK will import from in the future. Geographical proximity (and hence lower transportation costs) means that Norway, Russia and, increasingly, Africa, the Middle East and the Caspian region are likely to be the most significant direct suppliers to the UK in the future but the UK's extensive infrastructure will give it the flexibility to source imports from a range of suppliers across the global

oil market. It is, therefore, developments in the global oil market, rather than with individual supply countries that are likely to supply the UK, that will have the biggest implications for the security of the UK's future oil supplies.

3.10 The UK is currently a net exporter of refined petroleum products and, based on its current level of refinery capacity, has the potential to remain so for the next two decades. However, a mismatch between the UK's refinery mix and its petroleum product demand means that the UK is currently a net importer of aviation turbine fuel – around half of which is imported from the Middle East – and gas/diesel oil – the majority of which come from EU and FSU countries - while it is a net exporter of fuel oil and petrol. In the future, aviation fuel and diesel are likely to increase their share of the UK's oil mix. The UK petroleum industry will face a decision as to how much to invest in altering its refining capacity to meet this trend and how much to rely on imports. This is also a matter for Government given the strategic importance of the refining sector.

3.11 In the longer-term, UK consumption of oil is expected to decline significantly with increased penetration of alternative fuels in the transport sector. By 2050, UK consumption of oil could account only for 5-10 per cent of the UK's energy consumption, and in some scenarios could be almost completely replaced by alternative fuels (biofuels, electricity and hydrogen). However, given the lack of domestic production potential (based on current reserves and technology), the oil the UK does consume in 2050 is likely to be almost entirely imported. By 2030, global production of oil is likely to be dominated by Middle East countries and unconventional sources in Canada.

3.12 Increased reliance on imported oil from the global market will increase the UK's exposure to the risks outlined in Chapter 2. While remaining a low but increasing likelihood, this increases the risk of international oil supply shortages impacting on the UK. More likely, however, is that the UK economy will become more exposed to increasing periods of high and volatile international oil prices due to the potential tightness in the global oil market caused by the difficulties in achieving the required levels of investment.

Box 9: Emergency oil stocks

The UK has international obligations as a member of the International Energy Agency and the European Union to hold oil stocks of crude oil and oil products for use in the event of disruption to global oil supplies. The same stocks can be used to meet both obligations. To meet these obligations, the UK directs companies (largely refiners and importers of oil products) to hold stocks of oil ensuring regular turnover of product and closeness to consumers. In order to release stocks under either the EU and IEA obligation, agreement is required by all members of each organisation.

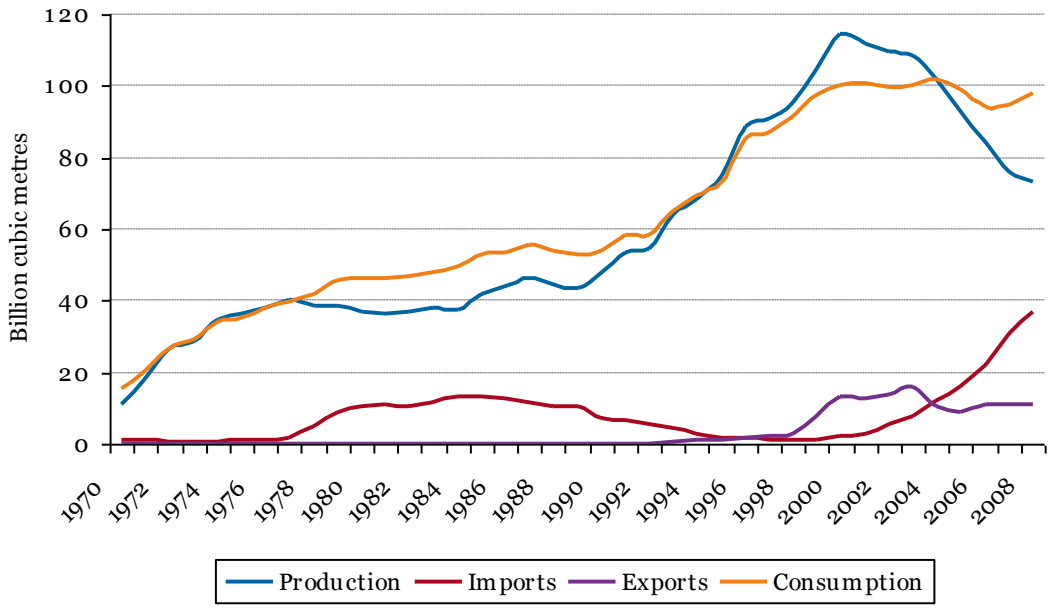
Currently there are different bases for these commitments with the EU obligation based on national final consumption and IEA obligation on net imports. The EU is moving to align with the IEA via a draft revised EU Directive on oil stocking that is currently under discussion in Brussels.

The UK has consistently complied with its EU / IEA obligations and successfully made product available for the Hurricane Katrina action in 2005, the last international coordinated response. Typically the UK holds 13½ million tonnes of crude oil and oil products (equivalent to 80 days) against its current EU obligation of 11½ million tonnes (67½ days of final consumption) or IEA obligation of ½ million tonnes (99 days of net imports). We estimate that the net imports obligation will mean a net increase in the UK obligation from about 2016 and 2018 rising, eventually, when UK production ends, to the equivalent of 99 days' consumption.

Natural gas

3.13 In 2008 natural gas accounted for 43 per cent of the UK's inland energy consumption. Industry, electricity generation and domestic heating and cooking each account for around a third of gas consumption. Despite rising UK production, we remained a net importer of gas until 1996, after which seven years of net exporter status followed. However, declining indigenous production after 2000 meant that the UK returned to being a net importer in 2004 and in 2008 net imports accounted for over 20 per cent of consumption (see Figure 34).

Figure 34: UK natural gas consumption, production, exports and imports: 1970-2008



Source: DECC Energy Statistics

3.14 Over the next decade, UK gas consumption is likely to fall as the share of renewable energy used in the electricity and heat sectors increases and as a result of improvements in energy efficiency. However, demand could begin to increase again from 2022. Moreover, UK gas production is expected to decline. DECC forecasts that the volume of gas which we will need to import will be about the same in 2020 as in 2010. This will however be more volatile than at present, with peaks of demand during cold, still periods when gas-fired generators will be supplying a high proportion of the electricity required. Figure 35 shows the latest DECC projection, published in the UK Low Carbon Transition Plan, that by 2020 net imports of gas could account for 45 per cent of the UK's gas consumption, rising to 61 per cent by 2025. In the absence of the renewable energy target these figures would respectively be 54 per cent and 67 per cent. Other projections have forecast significantly higher levels of import dependence – see for example Figure 36.

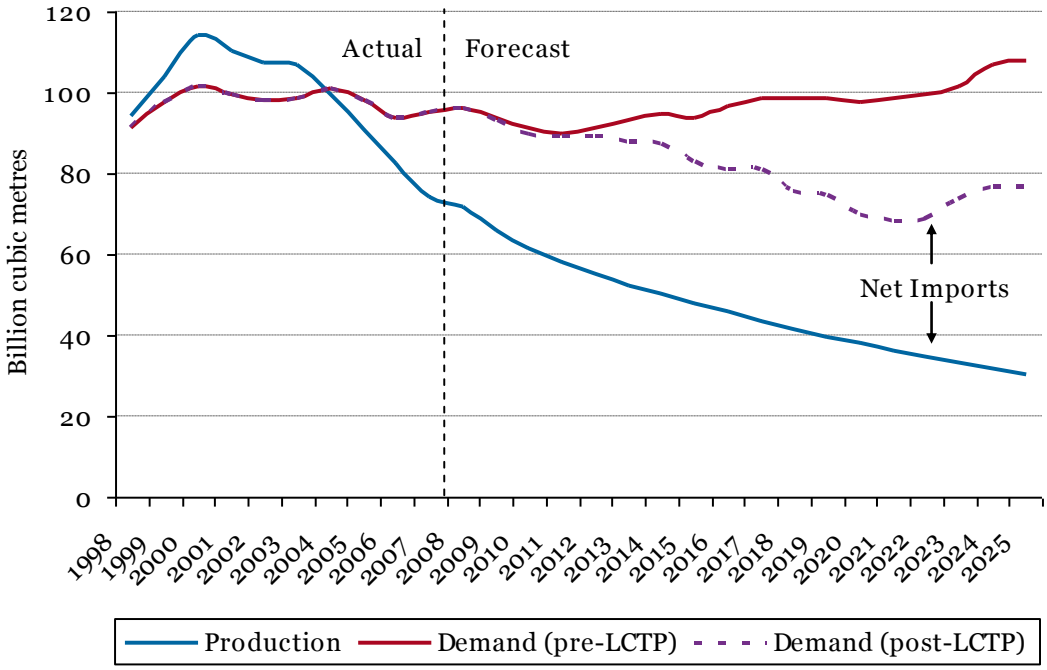
Box 10: Japan

Japan is nearly 100 per cent import dependent for fossil fuels. It sees energy security as a key policy priority. It has consistently pursued policies for many years to improve energy efficiency and is one of the lowest energy-intensity economies in the world, using only one ninth as much energy per unit of GDP as India and China. Long-term contracts underpin most LNG importation, with recent investment in Sakhalin in Russia enabling diversification of the supplier base. Japanese Ministers are on record as saying that, because of the security provided by these contracts, there is no need for Japan to consider strategic gas storage.

Japan has sought to diversify its power generation mix, with Prime Minister Fukuda committing to a twenty-fold increase in solar by 2020, and plans to expand nuclear power generation by 30 per cent by 2010. Energy prices are among the highest in IEA countries. Japan has sought to reform markets to the benefit of consumers, liberalising natural gas markets (since 1995, with around 40 per cent of the market now open), electricity markets (in 2000, with some 30 per cent of the market open to competition), and oil markets, which are now fully liberalised.

3.15 In the longer-term, natural gas looks set to remain an important, but declining, part of the UK's energy mix. While in most scenarios its use in electricity generation declines, gas remains important in the domestic and industrial sectors and accounts for between around 15 and 40 per cent of total UK energy consumption in 2050, depending on the extent of emissions reductions, with nearly all of this gas likely to be imported.

Figure 35: UK consumption and production of gas: 1998-2025



Source: DECC Energy Statistics and Projections

3.16 In 2008, 72 per cent of the UK's gross gas imports were by pipeline from Norway, up from 70 per cent in 2007. The remainder was imported from the Netherlands (23 per cent) via the Bacton–Balgzand (BBL) pipeline, via Belgium (3 per cent) through the Bacton–Zeebrugge Interconnector and as LNG (2 per cent) from Algeria and Trinidad & Tobago; to date in 2009, the UK has also received LNG from Egypt, Qatar and Norway.

Box 11: The Netherlands

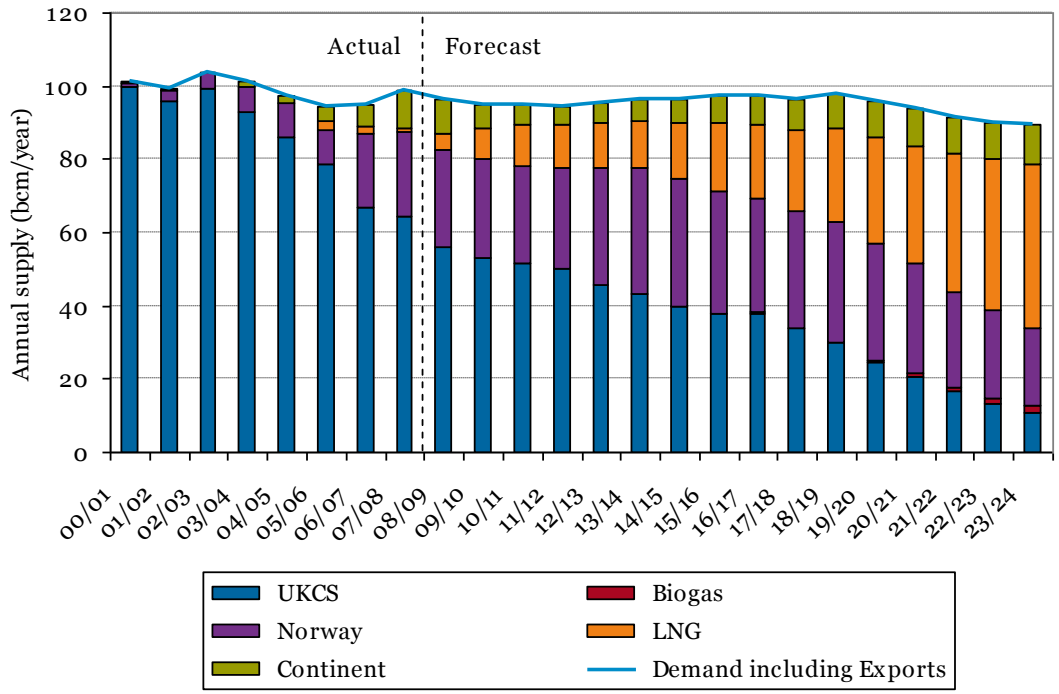
Energy efficiency and renewables are being pursued to reduce Dutch dependence on fossil fuel imports. Biomass and wind have increased their shares in recent years but still account, respectively, for only 7 per cent and 3 per cent of energy demand.

The Netherlands is a key supplier of gas to the European market. It has adopted a policy of controlled depletion of its giant Groningen field's resources so that it can continue to fulfil a role as a balance supplier when other gas supplies do not completely meet the needs of the European market.

The Dutch are strongly liberal in their energy policies, believing security should be delivered through market mechanisms with market players reacting to demand for gas storage by planning investments. However, the Netherlands see a role for the EU in encouraging investment in strategic infrastructure, promoting greater transparency on flows and stockpiles and long term requirements and resource availability.

3.17 Over the next two decades, Norway is likely to continue to be the source of a large share of gas imports to the UK with LNG also of increasing significance and Russia an increasingly important source of EU imports (although only a very small amount is likely to reach the UK).

Figure 36: Annual gas supply forecast (base case)



Source: National Grid (2009)

3.18 The implications of this increased reliance on imported gas for the UK's energy security are increased anxieties about securing supplies, increased exposure to the LNG market which is currently thin, absence of "storage" provided by having reserves on our doorstep which serve the UK market, and greater economic exposure to regional and international gas prices.

Box 12: UK gas storage

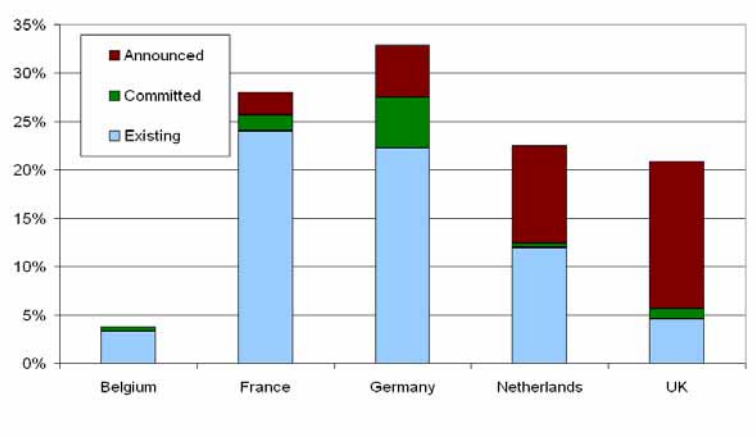
The UK currently has 4.4 billion cubic metres of gas storage capacity, equal to around 4 and a half per cent of the UK's annual gas demand. The maximum amount of gas that can be delivered daily from storage stands at 130 million cubic metres (MCM), little changed over the last few years. This volume of storage enables the UK to cover around 30 per cent of its maximum peak day gas demand. However there are a number of projects at different stages of the planning and development process which will potentially add significant amounts to the UK's gas storage capacity and deliverability.

National Grid's *Gas Transportation Ten Year Statement 2008* identified 17 gas storage projects at various stages of development when it was published December 2008. Since then, Centrica announced it had acquired a controlling

interest in a project to convert the Baird gas field in the southern North Sea into the UK's second largest gas storage facility. The proposed facility would have capacity of around 1.7 billion cubic metres, just over half the capacity of Rough, the UK's largest gas storage facility. In total, these 18 projects at various stages of development equate to a further 18.5 billion cubic metres of gas storage capacity.

Of course, not all of these projects will be developed. National Grid projects that roughly a third of these potential projects will come to fruition contributing an extra 5 bcm of storage space. According to their estimates, the UK would be able to store 10 per cent of its expected annual gas demand in 2020, up from 4.5 per cent today. This would enable 350 mcm to be delivered daily from storage, increasing the amount of UK maximum peak day demand that can be covered to 80 per cent. If all developers' plans were met then storage delivery from planned and existing facilities could reach over 500mcm per day, more than the UK's current peak day demand. Figure 37 shows how the UK's level of storage compares to other European countries, as a proportion of annual demand. Britain has historically been able to rely on its own production to supply a high proportion of demand, accounting for low levels of storage at the moment. But the ability to supply from domestic production will decline in the years to come, as set out in the text above.

Figure 37: Storage capacity as % of annual demand

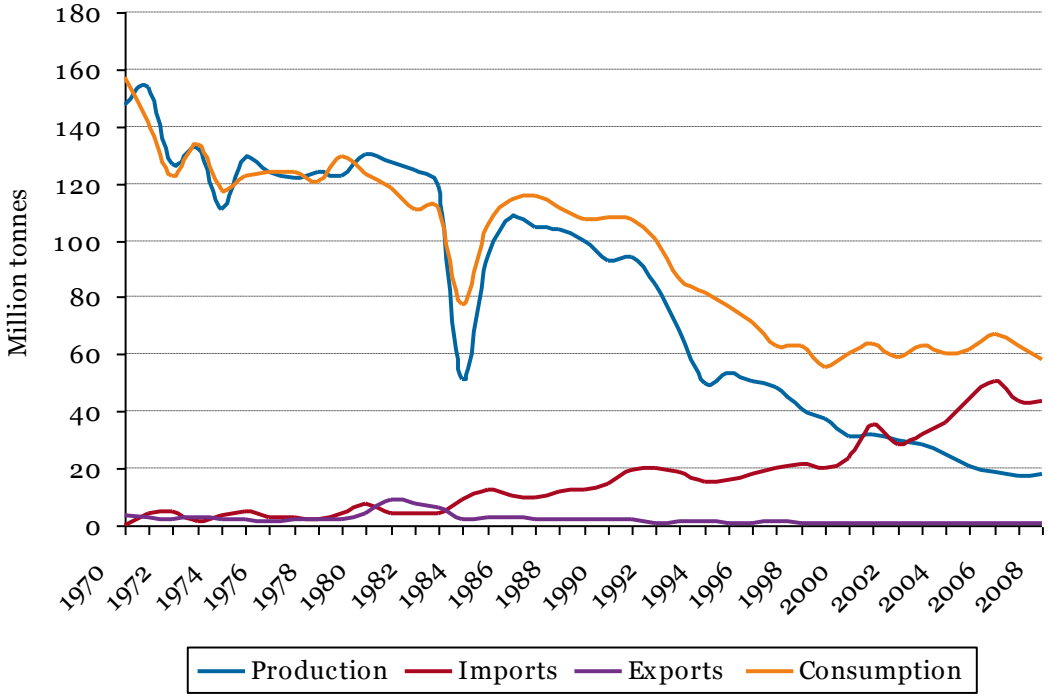


Source: Centrica

Coal

3.19 In 2008 coal accounted for 18 per cent of the UK's inland energy consumption. Most of the demand (86 per cent in 2008) comes from the electricity sector with the majority of the remainder from the iron and steel sector. The UK became a net importer of coal in 2001 and in 2008 net imports accounted for 74 per cent of UK coal consumption.

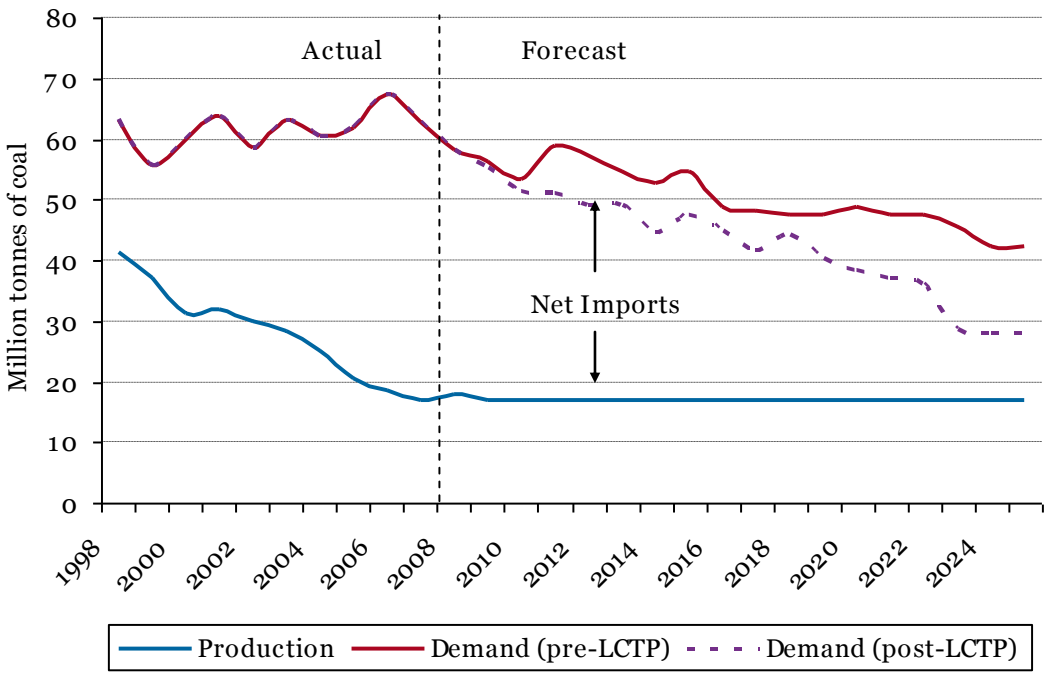
Figure 38: UK consumption, production, imports and exports of coal: 1970-2008



Source: DECC Energy Statistics

3.20 Future levels of UK consumption and production of coal are uncertain. However, in a reversal of recent trends, it is probable that consumption will decline more quickly than production over the next few years, and possibly beyond. As a result, the UK's dependence on imported coal is likely to decline but still remain significant over the next two decades. Under certain assumptions about domestic production and consumption, net imports of coal could account for around 56 per cent of UK coal consumption in 2020, and 39 per cent by 2025. In the absence of the measures set out in the Low Carbon Transition Plan these figures would be 65 per cent and 60 per cent respectively.

Figure 39: UK production and consumption of coal: 1998-2025

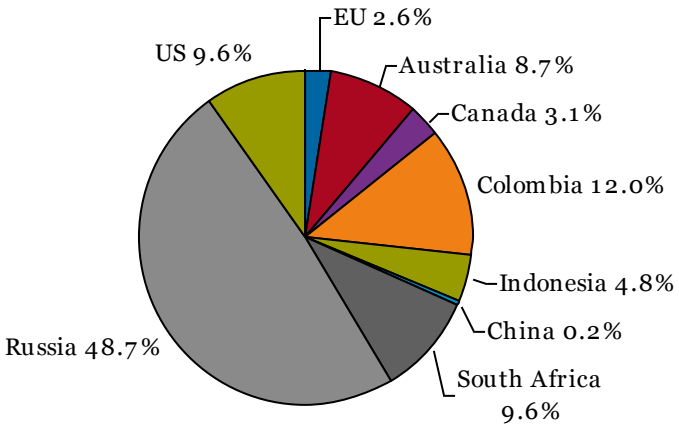


Source: DECC Energy Statistics and Projections

3.21 The longer-term trend depends on the extent to which coal with CCS is used in the electricity generation mix. In some scenarios coal consumption, and net import dependence, could actually increase in the longer term, but in sharper emissions reduction scenarios coal consumption is reduced and the UK has the potential to meet a significant amount of this coal demand through domestic production, provided that UK coal is capable of being used in such a way that emissions targets can be met.

3.22 In 2007, four countries accounted for 83 per cent of the coal imported by the UK: Russia (46 per cent), South Africa (18 per cent), Australia (11 per cent) and Colombia (9 per cent). Significant volumes were also imported from the US, Canada, China and Indonesia (see Figure 40).

Figure 40: UK imports of coal in 2008



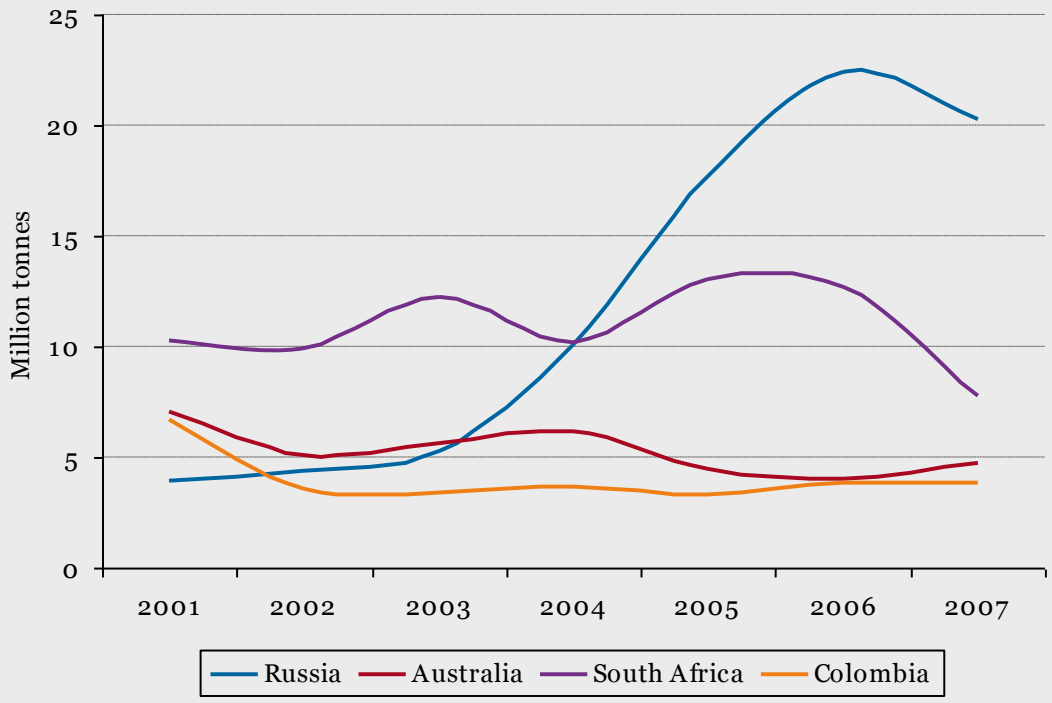
Source: Digest of UK Energy Statistics 2009, table 2B, DECC

3.23 Coal is a globally traded commodity and future availability will therefore depend on the global supply and demand trends set out in Chapter 2. In the period to 2030, global exports from Australia, Russia and South Africa are expected to increase, meaning that the UK is likely to continue to import the majority of its coal needs from these countries. 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 power generation within Russia. While this would not be expected to result in concerns about the physical availability of coal supplies, since alternatives sources are available, these alternative sources are currently more expensive (see Box 13).

Box 13: The role of Russian coal

Russian coal is generally well-suited for use in the UK, in terms of its low sulphur content and its volatile content (which allows it to be burnt with acceptable NOx emissions). In addition, high overall demand for coal imports into the UK has led to greater pressure on larger port facilities, whereas Russian supplies are usually shipped in smaller vessels, which can use other ports, as well as having relatively short shipping times to the UK. As a result there has been a significant increase in UK imports of Russian coal in recent years.

Figure 41: UK imports of coal from selected countries: 2001-07



Source: DECC Energy Statistics

Alternative sources of coal are available, principally from Colombia, Indonesia and Venezuela. However, these sources are currently more expensive than Russia and while South African supplies are available, they are currently less attractive in terms of NOx emissions. Future developments in Russian coal production and consumption are therefore particularly important for the UK. There is the prospect that Russia could 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.

In addition, the main Russian coalfields are a long way from port and supply interruptions have been caused over recent years as a result of congestion and shortages of rail cars. Such risks have potential implications for the availability and price of future supplies to the UK from this source.

Renewable energy

3.24 Renewable sources accounted for 2.5 per cent of the UK's total primary energy requirements in 2008, up from 2.0 per cent in 2007, 1.9 per cent in 2006 and 1.8 per cent in 2005. To achieve the 15 per cent renewable target in 2020 will require a large increase in the UK's renewable energy over the next 11 years. A higher level of renewable energy in the UK's (and EU's) energy mix should have a positive impact on our exposure to international security of supply risk by reducing the amount of fossil fuel consumed and reducing the extent of the increase in fossil fuel imports.

3.25 The exact extent of the impact will depend on what other forms of energy are 'displaced', but estimates suggest that the policies to achieve the 15 per cent renewable energy target could reduce UK consumption of fossil fuels by around 12 per cent in 2020 and 11 per cent in 2025 compared to what they would otherwise have been. However, it is likely that some of the renewable fuels themselves will need to be imported.

Biomass

3.26 Biomass accounts for around 1 per cent of total UK primary energy consumption, with most of it (around 80 per cent) used for electricity generation and the remainder used for heat. The majority of this demand is met through domestic production.

3.27 Biomass consumption in the UK is expected to increase significantly over the next decade, in order to help meet the UK's 15 per cent renewable energy target, and also in the longer term as part of the move to a low-carbon economy.

3.28 Analysis for the Renewable Energy Strategy (RES) indicates that nearly a quarter of the changes to reach the UK renewable energy target could come from bioenergy in the heat and electricity sectors. Delivering the RES is therefore expected to increase the demand for biomass feedstocks in these sectors.

3.29 The UK biomass sector has potential to expand to meet this increased demand for biomass. RES analysis suggests that in a world with no barriers to biomass deployment, we could develop sufficient biomass supply in the UK to meet our expected biomass needs to 2020 and beyond to 2030. However, this assessment assumes that we could rapidly increase the production of energy crops in the UK, make better use of agricultural residues and exploit fully waste biomass currently going to landfill.

3.30 The analysis also concludes that a global biomass market will develop and biomass, specifically woody biomass, will increasingly become a globally traded commodity. As a result, demand and supply of some biomass sources (particularly homogeneous products such as woody

resources) should be considered globally. Others, particularly those difficult to transport, will still operate largely within local markets. There is considerable uncertainty over the price of biomass feedstocks – both of imports and biomass grown in the UK – as this depends on how both supply and demand develop. However, increased UK consumption of biomass-based energy is likely to have positive security of supply implications by increasing fuel diversity and reducing reliance on imported oil and gas. While imported biomass will be subject to some supply risks, these will typically be less than those associated with imported oil or gas.

Biofuels

3.31 In 2008, biofuels account for around 1 per cent of the UK's consumption of petrol and diesel. Biodiesel accounted for 81 per cent of biofuel consumption with bioethanol meeting the other 19 per cent. One of the main reasons for biodiesel meeting the majority of biofuel consumption is that it is cheaper and easier to handle and distribute in a blend with fossil fuel compared with bioethanol. This trend is expected to continue in the future. The UK is a net exporter of biodiesel but imports the majority of its bioethanol needs.

3.32 The level of biofuels consumption in the UK will increase significantly over the next decade. The Renewable Energy Strategy considers scenarios where the share (by energy content) of biofuels in petrol and diesel supply is between 8 and 12 per cent by 2020.

3.33 The UK biofuels industry is still relatively small and with current technologies and using UK feedstocks, we can make enough biofuel to replace only around 5 per cent of our road fuel supply. It is feasible that given the development of more advanced technologies such as biomass to liquid for diesel production and lignocellulosic bioethanol production, we could use a greater range of biomass feedstocks (crops and waste), increasing this percentage significantly.

3.34 However, over the next decade, the UK is likely to increase its volume of imported biofuels, with Brazil and continental Europe likely to be the main sources of supply. While there are also risks associated with the import of biofuels (such as crop failures or disruption in countries that produce both biofuels and fossil fuels), overall biofuels could impact positively the UK's security of supply, provided that sustainability concerns can be addressed. This would be through:

- Reducing the imported oil needed from regions associated with supply risks, as biofuel imports will tend (but not always) to come from countries with less risk.

- Diversifying and increasing the number of supply sources and routes for transport energy.

- Reducing the impact of crude oil supply disruptions, with biofuels most likely reducing the proportion of total transport fuel supply disrupted by any given global supply disruption.

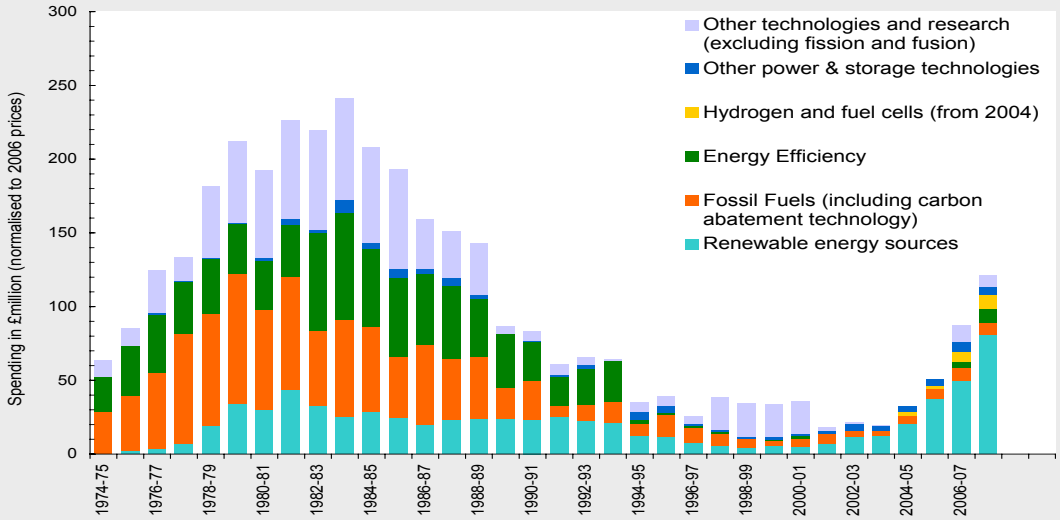
- Alleviating the petrol and diesel retail price impact of spikes in crude or petroleum product prices.

Box 14: Energy research and development (R&D)

The Government's strategy to develop low carbon and renewable technologies is devised and delivered in conjunction with a wide range of organisations including private sector and academic bodies. The Government sets the overall strategic direction by: ensuring that each part of the innovation system works effectively with the whole system; bringing together participants to set common goals; setting the level of public funding to leverage the investment from the private sector; and working to expand research and industrial capacity. The objective of Government support for renewable and other low carbon energy technologies is to promote development of new technologies from initial concept to the point where they can be deployed commercially.

UK spending is recovering after some very lean years in the late 1990s, a result of privatisation of the sector and research labs, a market design whose primary aim was to cut costs, the end of the OPEC crisis, the development of North Sea oil and gas, and ending UK wind and marine technology support. For years the UK was criticised for minimal commitment to energy technology, but we are now backing up our commitment to the climate change agenda with an increase in spending. Despite this, our spending remains low by international standards. The rapid increase of the last few years looks set to level off this year and potentially reduce in future.

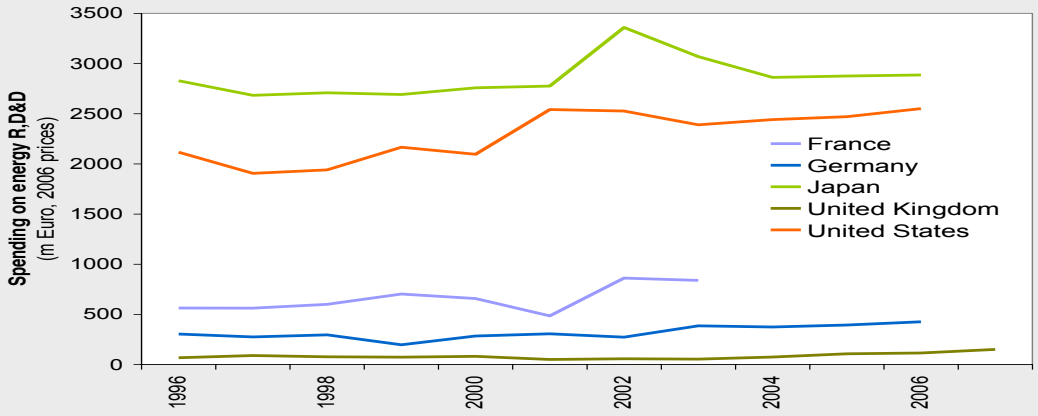
Figure 42: UK energy R&D spending 1974-2007



Source: IEA. (NB spending on nuclear fission & fusion, which was a very large amount in the 1980s, is not included on this graph)

The UK does not compare well with other countries. This is partly a result of the UK not having a major industrial base in the energy sector and the UK having ended its involvement in the development of technologies such as wind power (now dominated by central Europe), nuclear energy (France) and solar photovoltaics (Japan).

Figure 43: International spending on RD&D 1996-2007



Source: IEA

The Stern Review made it clear that we will not be able to achieve our ambitious targets to reduce CO_2 by 2050 using existing technologies alone. It flags technology development as a key action necessary to achieve stabilisation and that direct Government support is needed to deliver new technologies in the short to medium term.

UK public sector spending for energy innovation has increased in recent years. Support for early stage has been stepped up with efforts on energy R&D through a range of commitments by Research Councils, the Technology Strategy Board and the Energy Technologies Institute which have recognised this increasing priority. DECC provides funding for demonstration through the Environmental Transformation Fund, Low Carbon Innovation Fund and market pull mechanisms such as the Renewables Obligation which has been reformed to support more emerging technologies. In 2007-8 the UK spent a total of £151 million on research, development and demonstration of energy technologies, of which £57 million supported demonstration.

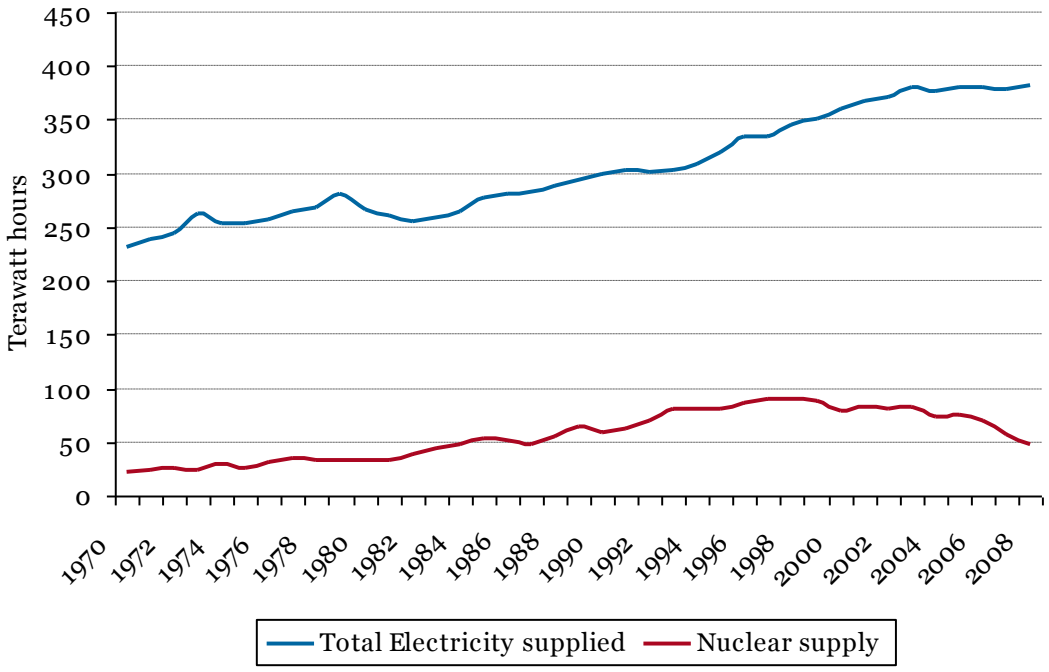
The nature of private sector financing of R&D makes it difficult to determine the total amount of private sector spend.

Nuclear

3.35 In 2008, nuclear power accounted for 5 per cent of the UK's primary energy demand and around 12.5 per cent of the electricity supplied. This compares to over 25 per cent of the UK's electricity supply for

most of the 1990s. The declining share reflects both a fall in the amount of nuclear generation and an increase in total electricity generation.

Figure 44: UK electricity supplied (gross basis)



Source: DECC Energy Statistics

3.36 The majority of the UK's nuclear power stations are due to close over the next two decades. The 2008 Nuclear White Paper set out the Government's view that nuclear should be part of the UK's low-carbon energy mix, that companies should have the option of building new nuclear power stations and that the Government should take facilitative actions to enable this to happen.

3.37 In response, industry has expressed an appetite to build new plant with operation potentially starting as early as 2017/18. It is difficult to predict exactly how much new nuclear capacity might be built over the coming decades but most scenarios show nuclear power remaining an important part of the UK's energy mix out to 2050, even in a world of much expanded renewable electricity generation. For example, modelling for the Renewable Energy Strategy shows, in most scenarios, a similar level of nuclear power in the electricity generation mix by 2030 as currently. Longer-term modelling for the Committee on Climate Change shows that in scenarios where UK emissions fall by 80 per cent, 90 per cent and 95 per cent, the contribution of nuclear power to total UK electricity supply in 2050 is respectively around 12 per cent, 30 per cent and over 60 per cent. Part of this increase reflects the need to supply increasing amounts of low-carbon electricity to the heat and transport sectors.

Box 15: France

Nuclear power accounts for 80 per cent of France's electricity supply and it is self-sufficient for electricity generation. France is set to become a world leader in new nuclear generation technology and is positioning itself as a key supplier nation within Europe for electricity. President Sarkozy is in favour of new reactors but in the meantime EdF are looking to extend the lifetime of its ageing reactors. France is however import dependent for oil, coal and gas, so energy security for these fuels remains a key policy priority. France has been promoting better transparency of information on gas stocks and transportation capacity and the sharing of best practice on national emergency plans as key elements to help coordinate European response in the event of loss of a major supplier. France does not have strategic gas storage as such but maintains 80 days' consumption in commercial stocks. They view LNG as an alternative to storage which could also form part of their emergency response plan.

3.38 Nuclear power can benefit security of supply by increasing the diversity of the fuel mix. Where it replaces gas-fired generation that would otherwise have been built it reduces reliance on gas imports and also the need for back-up distillate power. However, at the same time, it increases reliance on imported uranium.

3.39 The majority of nuclear fuel is made from enriched uranium. The UK is not a uranium producer but uranium ore may be stockpiled. 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 and there are considerable resources available in OECD countries. The UK sources most of its uranium from Australia.

3.40 There is a great interest throughout the world in new nuclear capacity as a means of improving the security of electricity supplies and tackling carbon emissions and the OECD Nuclear Energy Agency and the International Atomic Energy Agency has concluded that world uranium resources are more than adequate to supply the expected global expansion of nuclear power[16]. Even if global demand significantly affected the price of uranium, since this fuel represents a much smaller part of the cost of electricity in nuclear power plants than for other technologies it will have only a limited effect on overall generating cost. To give an example of this comparison, uranium costs represent around 10 per cent of overall plant running costs, whereas fuel costs in gas-fired power plants represent around 70 per cent of running costs.

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

Is "energy independence" achievable?

3.41 Although there is no formal definition, "energy independence" is generally understood to mean the ability of a country to achieve energy self-sufficiency through domestic production of all the energy it consumes.

3.42 The discussion in this section begins by considering whether, how and over what timescale it would be feasible for the UK to move to a situation where it produces as much fossil fuel as it consumes.

The medium-term (2020)

3.43 As set out earlier in this Chapter, even given current ambitious policies to improve energy efficiency, reduce carbon emissions and expand the use of alternative energy technologies, the UK's imports of oil and gas as a proportion of demand will increase over the next 10–15 years. There is limited scope significantly to increase future UK oil and gas production beyond what is currently projected. So assuming no increase in UK production beyond that currently projected, in order to be producing as much oil and gas as it is expected to consume in 2020 the UK would need to reduce its consumption of both gas and oil by around 45 per cent on top of the significant reductions already expected, in particular for gas.

3.44 For oil, this challenge is equivalent in scale to eliminating the total volume of oil currently used in road transport or only consuming the same amount of oil as the UK consumed in 1959/60. The Renewable Energy Strategy (RES) "lead scenario" considers a renewable energy share in the UK's transport sector of 10 per cent by 2020. An even more stretching scenario of 12 per cent is also considered but this reduces oil consumption by only a further 1 per cent in 2020. Accelerated deployment of electric and hybrid vehicles would also be possible. However, even the most optimistic and potentially costly ("Extreme Range") deployment scenario looked at as part of the analysis commissioned by BERR and DfT[17] envisages having 3 million electric vehicles on the road in 2020, which would reduce oil consumption by only around 2.5 per cent. Combined these measures could therefore reduce total UK oil consumption in 2020 by only up to 3-4 per cent, leaving a significant amount to be imported.

3.45 For gas, the scale of the challenge is equivalent to reducing consumption in 2020 by the amount currently used for electricity generation. Moreover, because of the strongly seasonal nature of UK gas demand, we would also need a large increase in gas storage capacity to avoid the need to import gas in winter. The lead scenario in the RES considers renewable energy shares in 2020 of 29 per cent for large

[17] "Investigation into the Scope for the Transport Sector to Switch to Electric Vehicles and Plug-in Hybrid Vehicles", Arup and Cenex, October 2008

electricity and 2 per cent for small-scale electricity. More stretching scenarios are considered of 32 per cent for large scale electricity and 3.5 per cent for small scale but this would save only a further 3 per cent of gas consumption in 2020. In addition, the largest Severn Tidal Power scheme currently being considered (the Cardiff-Weston barrage) could potentially reduce gas consumption by 4.5 per cent in 2020 – although there are significant challenges to delivering it in this timescale. In combination therefore these measures would save around 7.5 per cent of gas consumption in 2020. Assuming it replaced gas generation, each additional new 1.6 GW nuclear plant could reduce UK gas consumption by a further 1.5 per cent so it would take an unfeasibly large expansion of nuclear power by 2020 to reduce gas imports significantly. Higher shares of renewable energy in the heat sector are also considered unrealistic.

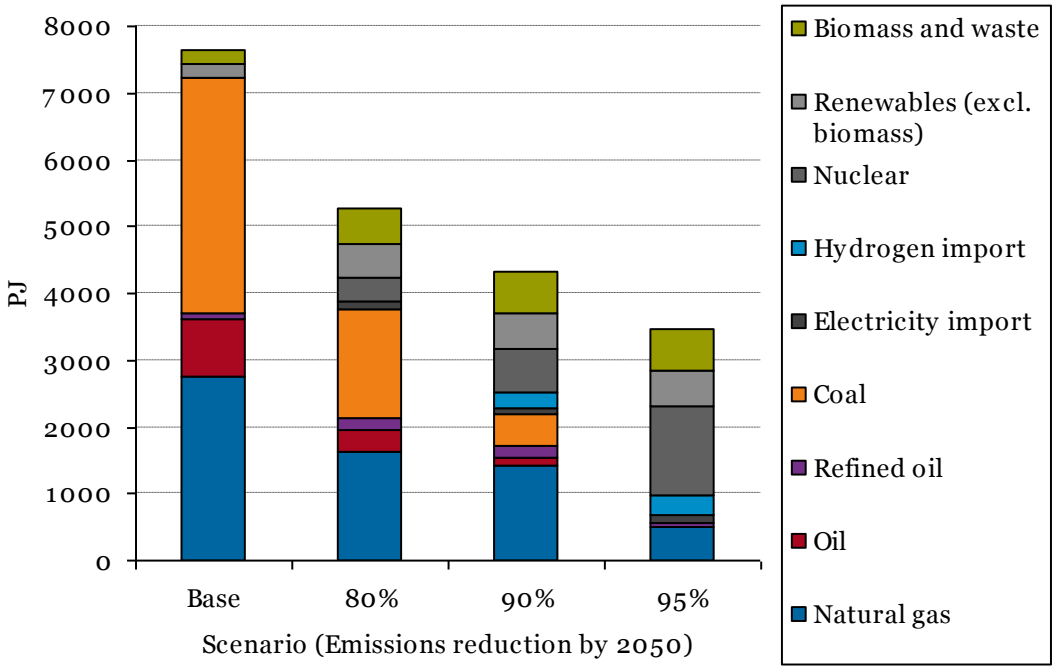
3.46 Could expanded use of UK coal replace gas in power generation? With much greater investment and a different approach to opencast mining, the UK could potentially produce as much coal as it is forecast to consume in 2020 but it is difficult to envisage how consumption could be expanded further without relying on imports and there would also be environmental implications from both increased production and consumption of coal.

3.47 Even when combining the various measures above (including assuming a further five nuclear power plants could be built by 2020), imported oil and gas would still account for around one-quarter of the UK's total energy consumption in 2020. While further improvements in energy efficiency would be possible, the above analysis demonstrates that, even if it were desirable, it would not be feasible to eliminate (or even very significantly reduce) the UK's dependence on fossil fuel imports by 2020. Moreover, many of the measures that would help to reduce fossil fuel consumption are likely to be more costly and therefore result in higher energy prices to end-consumers.

The longer-term (2050)

3.48 In the longer-term, it would be feasible – but very challenging and potentially costly – to reduce most of the fossil fuel consumed in the UK.

Figure 45: Scenarios for UK energy demand in 2050



Source: AEA (2008) MARKAL-MED model runs of long term carbon reduction targets in the UK for the Committee on Climate Change report "Building a low-carbon economy – the UK's contribution to tackling climate change", December 2008

3.49 Given the very negligible amount of domestic UK oil and gas production envisaged by 2050, only the 95 per cent reduction in GHG emissions scenario looked at by the CCC is capable of significantly reducing imports of fossil fuels – for example, imported fossil fuels are still likely to account for around 40–50 per cent of total UK energy consumption in the 90 per cent emission reduction scenarios. Even in the 95 per cent scenario, fossil fuels (mostly gas in the residential and industrial sectors) account for 15 per cent of energy consumption and would need to be imported. Moreover, the UK would be dependent on imported hydrogen and electricity to meet a further 11 per cent of its energy needs, while nuclear power (reliant on imported uranium) would account for 39 per cent. Even in the longer-term it is therefore unrealistic to expect the UK to achieve "energy independence".

Chapter 4: Implications for the UK's energy security

4.1 Chapters 2 and 3 show clear trends in predicted future energy use. Some of these trends are unavoidable. UK production of oil and gas will decline over the coming years, with imports making up a greater proportion of demand over the next decade and more. This will not be prevented even if we move rapidly towards much greater use of non-fossil fuels and reduce our energy use through effective energy efficiency measures, which I believe is essential to maintaining energy security. Such moves are also necessary to achieve our climate change targets.

4.2 Most other OECD countries, such as Japan, Korea and Germany, have long been import dependent for most of their energy supplies and have nevertheless succeeded in maintaining energy security. Import dependence does not of itself create energy insecurity; diversification of source, routes and type of energy can support a robust energy system. For example, Spain has in recent years successfully diversified its sources of supply of gas through the development of increased LNG capacity and has worked to deploy new technologies, including solar. Interdependence between suppliers and consumers, built over time, can also promote energy security. We do not need to fear the future, and there is a lot the Government can do to create the conditions for our future security. Recommendations are set out in Chapters 5 and 6 for further action to promote energy efficiency and a more diverse fuel mix, as well as improving Europe's import capacity and the ease with which energy can move around the Continent.

4.3 Action to improve energy efficiency should be the greatest priority both domestically and in the Government's relations with other states and multilateral institutions. Greater energy efficiency is the least costly way to maintain economic prosperity while achieving the reductions in carbon emissions we need. I was struck in discussions with the IEA by their analysis that at least half of the reduction in carbon emissions required to stabilise CO_2 levels in the atmosphere at 450 parts per million (ppm), which is consistent with keeping the increase in global temperature down to 2 degrees Celsius, will need to come from more efficient energy use. The cleanest, most secure energy is that which is not used. It is also the cheapest.

4.4 Adoption of alternative technologies needs to be a priority too, to decarbonise our economy and to reduce our requirement for imported fossil fuels and, internationally, to support global efforts to tackle man-made climate change. We need to press ahead with the research, development and deployment of technologies which will enable us to

reduce use of oil and gas and to use coal in a way that minimises climate impact. International collaboration is crucial to ensuring the rapid development of some key technologies while, for others, the UK can work both multilaterally and bilaterally to promote their adoption.

4.5 But though more progress on energy efficiency and on developing new low emission technologies will help enhance both our own and the world's energy security, and is crucial to slowing and then arresting man-made climate change, an increasing dependence on imported gas carries risks that are new to the UK. This is due to the rigidities inherent in gas importation compared to importing oil or coal. These risks are amplified given likely increasing global demand and uncertain prospects for supply.

4.6 Recent improvements to our gas infrastructure, including the Interconnector and Bacton-Balgzand (BBL) pipelines which enable connection to Continental European gas markets, the Langeled pipeline enabling increased imports from Norway, and the Isle of Grain, South Hook and Dragon regasification facilities mean that we now have a well-balanced portfolio of import capacity. This is welcome and makes our system resilient to disruption affecting any particular supplier. But while capacity makes import possible, it does not mean that the molecules will necessarily arrive in the UK, and gas can flow out of the country as well as in. UK gas buyers have over the past two decades moved away from concluding long-term contracts in favour of buying short-term in the market. This can make sense for individual companies in the UK energy market, but in aggregate, could present risks to our security of supply. A number of recommendations in Chapter 6 are aimed at reducing our risks associated with gas importation and securing higher levels of gas storage to improve our resilience to supply difficulties, and ensuring the Government understands our security of supply position and is in a position to frame appropriate policy responses.

4.7 As regards oil, there is a significant risk of volatile and higher prices, which would have a depressing effect on economic growth, especially given the dampening effect of the world economic slowdown and financial crisis on investment on production and infrastructure. This review comes at a time when there is considerable uncertainty about the long-term effects of the economic downturn on both supply and demand of the economic downturn. A number of my recommendations aim to improve transparency in the oil market, support short-term efforts to facilitate production in states capable of increasing production levels, and reduce our reliance upon oil in the longer-term.

4.8 I recognise the apparent inconsistency between seeking to reduce use of carbon-emitting fuels while simultaneously seeking to secure imports and enable states with hydrocarbon resources to produce and export these. As the analysis in Chapter 2 clearly shows, there is little scope for substitution away from oil in most industrial and transportation uses in the short term, during the transition to a lower-carbon future, and gas

will be an important element of our fuel mix into the future. It is crucial of course that the short term is not prolonged indefinitely. That is why one key theme in this review, informing recommendations relating to UK engagement with other states and action within our own borders, is support for activity aimed at reducing oil reliance in the transportation sector and for other measures aimed at diversifying fuel use away from fossil fuels globally as well as support for producer states to diversify their economies away from being dependent on hydrocarbon derived income.

4.9 Chapter 5 considers what the UK might do in co-operation with multilateral institutions including the European Union and what the UK might prioritise through bilateral relationships with other states, and which countries should be prioritised. Chapter 6 then considers what we can do within our own borders to mitigate risks created by our engagement in global and regional energy markets.

Chapter 5: Our international strategy

5.1 As Chapter 2 showed, oil and gas production is becoming increasingly concentrated in a smaller number of countries, many with loose commitment to market and trade imperatives, or to democracy and the rule of law as it is understood in the UK. And many Governments are more ready to intervene in support of their national interests than has been the case for the UK. Close connection between the state and leading companies in a number of EU countries has been in contrast to our rules-based, market-liberal approach.

5.2 This chapter considers the approach the UK should take in this international context.

Multilateral priorities

5.3 Multilateral institutions are organizations formed between a number of nations to work on issues that relate to all of the countries in the organization. They can play a key role in addressing global energy security barriers and integrating these with climate security objectives because global action on these issues is essential to effecting change. Even with ambitious climate change targets, the world will still rely on coal, oil and gas to meet over two- thirds of its energy needs by 2030 (Figure 9). Whilst we must ensure that these resources are effectively extracted and transported we must also make every effort to protect the environment and take a leading role to ensure that use of these fuels can be decarbonised as far as possible. We can reduce demand for the world's finite supply of fossil fuels by promoting efficiency throughout the energy value chain and encouraging the large-scale deployment of renewables and alternative fuels in both developed and developing nations.

5.4 A number of multilateral organisations have been established over the years to tackle these issues. For example, the International Energy Forum (IEF) was established to enhance the oil producer-consumer dialogue to improve the functioning of the oil market and transparency. Out of that, the Joint Oil Data Initiative (JODI) was established to promote stable and transparent frameworks through data sharing. The International Energy Agency (IEA) was originally established to co-ordinate international energy emergency responses to oil supply disruptions but also undertakes long term analysis and plays an important role in encouraging energy technology co-operation through its technology agreements, works to avoid short term supply disruptions, undertakes long term analysis and coordinates international energy emergency responses amongst its members.

Organisations such as the World Energy Council also tackle a number of skills and investment issues related to international energy markets.

5.5 In recent years the G8 and G20 summits have taken an active interest in engaging in energy and climate change issues; for example this year the G8 pledged to support developed countries in cutting their emissions by 80 per cent by 2050 and committed itself to limiting the increase in global temperature to 2 degrees Celsius ,whilst the G20 countries committed to make the best possible use of investment funded by fiscal stimulus programmes towards the goal of building a resilient, sustainable, and green recovery.

5.6 As we can see, the multilateral agenda is broad and there is no one organisation that addresses all of the global energy security and climate security objectives. The effectiveness of multilateral institutions depends a lot on the membership list and their willingness to co-operate with one another and translate multilateral agreement into multilateral action – a challenge when you get a number of countries around a table all with different needs, aims and objectives. The UK participates in a wide range of these multilateral institutions with a view to influencing the priorities of the various organisations. However, the UK needs constantly to evaluate which of the multilateral organisations has the best chance of making a direct and practical impact on delivering one or more of the desired outcomes.

5.7 Ideally, energy institutions would be capable of promoting substantive discussion among all the key energy players of the world and effectively promote the uptake of energy efficiency and new low emission technologies. We are not in that happy position now. The number of organisations and the time required to input usefully into all of these, not to mention the need to join up the agendas of the various organisations, means there is a risk that important opportunities to effect change can be lost or not picked up. Each of the general energy institutions has key weaknesses. The IEA represents members of the OECD, yet the OECD's share of world oil consumption is continually falling (to 57 per cent in 2007) as growth in China and other non-OECD nations dominates. The IEA will soon represent less than 50 per cent of world oil consumption. China, India and other large oil consuming and importing countries are not members, although they sometimes attend meetings as observers and are increasingly cooperating. It has just 28 member countries: not even all of the EU member states are members of the IEA. The major non-OECD oil exporting countries are not represented. The IEF, which promotes dialogue between energy producers and consumers, is useful as a discussion forum but is not well-resourced and lacks mechanisms for influencing their behaviour.

5.8 The Energy Charter Treaty (ECT) differs from other international energy institutions in that it is a legally binding instrument, signed by 51 producer, consumer and transit countries (plus the European Communities) which aims to strengthen the rule of law on energy issues and has uninterrupted transit as a core principle. Covering

energy from hydrocarbons it provides a framework of rules covering the entire energy chain and a binding dispute settlement system (state-state arbitration and investor-state arbitration) for investment disputes. Historically the ECT had a Eurasian focus and its membership reflects this, but this could change as a number of global players (e.g. USA, China, Canada, Iran and Saudi Arabia) have observer status and the Charter Secretariat are actively working to encourage ratification, which would significantly improve its global reach. If Russia were to ratify the Treaty this would also improve its effectiveness.

Energy efficiency

5.9 Change can be more profound when there is multilateral agreement on the way forward rather than when individual countries each seek to do things their own way. All the multilateral institutions with which the UK is involved can play a role in promoting energy efficiency, and energy efficiency needs to be at the heart of energy dialogues with our global partners. The endorsement in 2008 by the Group of 8 (G8) of the IEA's package of 25 recommendations for improving global energy efficiency across seven priority areas (cross-sectoral activity, buildings, appliances, lighting, transport, industry and power utilities, which together could reduce global CO_2 emissions by 20 per cent per year by 2030 if adopted as global standards) is a significant step forward[18]. Working both bi-laterally and through the multi-national institutions we must encourage the development and deployment of ambitious and effective national strategies for energy efficiency to take forward implementation of these recommendations. In particular, there is significant scope to act internationally to drive up energy performance standards for vehicles, appliances and buildings.

5.10 The lack of institutional capacity for the development of effective policy frameworks represents a significant barrier to energy efficiency in many parts of the world. In this context, I welcome the recent launch of the International Partnership for Energy Efficiency Co-operation (IPEEC) which provides, for the first time, a high-level inter-governmental body that brings together key developing and developed countries on an equal footing to advance global energy efficiency. We should encourage the rapid expansion of the Partnership to provide a mechanism for effective exchange of information and experience, improved collaboration and better co-ordination of disparate existing initiatives in this field.

Low carbon technologies

5.11 Significant barriers to deployment of low carbon technologies exist. These vary between countries (e.g. within Europe, but in particular between developed and developing countries) and between technologies (i.e. how close the technology is to being fully

[18] http://www.iea.org/G8/2008/G8_EE_recommendations.pdf

commercial). In general the principal barrier is that low carbon technologies are more expensive than conventional alternatives (e.g. fossil fuels for electricity generation) and this affects the level of private sector investment.

5.12 Multilateral institutions such as the IEA have a strong role to play in providing credible and robust energy data and analysis, including technology roadmaps, at an international level and supporting actions within the G8 and increasingly in the developing world (in particular the plus five[19]). The International Renewable Energy Agency (IRENA) has the potential to play an important role in promoting renewables internationally, provided it can avoid duplication with existing bodies. The UK's decision to join the organisation is very welcome. The UK continues to support the Renewable Energy and Energy Efficiency Partnership (REEEP) and the role it can play in addressing the barriers to the take-up of renewables and energy efficiency and this provides a forum for working closely with a range of priority countries (such as Norway). The Department for International Development supports wider work on renewables deployment in developing countries through the World Bank.

5.13 International collaboration to develop CCS is also very important as the world develops this important technology through learning from early CCS demonstration projects. To facilitate international progress on CCS, the UK is co-hosting with Norway the Carbon Sequestration Leadership Forum Ministerial meeting on 12-13 October 2009 in London, where Ministers and CEOs from around the world will convene to agree steps to bring forward the commercialisation of CCS.

5.14 The Major Economies Forum established by the USA in 2009 is intended to help generate the political leadership necessary to achieve a successful outcome at the December 2009 UN climate change conference in Copenhagen and advance the supply of clean energy while cutting greenhouse gas emissions. Working groups on key technologies (cleaner fossil fuels, low carbon vehicles, energy efficiency in buildings, smart grids and renewable energy) have been established to identify barriers to development and use key actions and collaboration to unlock this.

[19] The G8+5 group of leaders consist of the heads of government from the G8 nations (Canada, France, Germany, Italy, Japan, Russia, the United Kingdom and the United States), plus the heads of government of the five leading emerging economies (Brazil, China, India, Mexico and South Africa).

Box 16: Non-proliferation

Nuclear power is a low carbon, reliable and proven form of power generation with an increasing role to play in meeting the world's growing energy needs. The Nuclear Non-Proliferation Treaty (1970) gives signatories the right to develop research, production and use of nuclear energy for peaceful purposes without discrimination. Commensurate with that, the Non-Nuclear Weapon States agree not to manufacture or acquire nuclear weapons by whatever means. The Treaty is reviewed formally every 5 years with the next Review Conference due to be held in May 2010. In preparation, the UK's Government has set out a 'Road to 2010' plan to feed into these important discussions covering detailed proposals on civil nuclear power, on disarmament and non-proliferation, on fissile material security and the future role of the International Atomic Energy Authority (IAEA). The UK will be seeking the widest possible international engagement and consultation around this plan and will host a Recognised Nuclear Weapon State Conference in advance of the Review Conference.

The role of multilateral institutions in signalling future risks

5.15 As discussed in Chapter 2, it is likely that the current reductions in energy demand are temporary and that in the next five years resumed economic growth will again lead to increased pressure on global energy resources, infrastructure, the supply chain and skills. Multilateral organisations, particular those with a financial focus, can play a key role in signalling that the economy is returning to normal patterns of economic growth. There is scope for the International Monetary Fund (IMF) to take a more comprehensive view of energy markets surveillance, building this into its assessments of the world macro economy, and working closely with the IEA to provide joint risk analysis of oil price scenarios for the world economy. The IMF's work with the Financial Stability Board on an Early Warning System for financial markets could provide a useful model.

Multilateral institutions fit for the 21st century

5.16 There is a vast range of multilateral organisations and I believe the Government needs to consider how far the existing framework enables a sufficiently coherent and adequate response to global energy security and linked climate change issues. Where there are successful international partnerships and programmes the UK should push for these to be consolidated and joined together to maximise their impact.

5.17 The Jeddah and London Energy Meetings held last year were an important step in strengthening the consumer-producer dialogue. In particular, the Expert Group set up under the auspices of the IEF at the London Energy Meeting has been tasked with considering ways to strengthen the global energy institutional architecture, as well as

considering ways in which countries can work together to reduce oil price volatility.

Recommendations

- Ensure that energy efficiency is at the heart of energy dialogues with our global partners.
- Multilateral institutions with a financial remit should be used to gain a better understanding of the links between energy markets and the risks to the global economy; the IMF, working with the IEA, and World Bank should take a more comprehensive view of energy markets surveillance and the potential global economic impacts.
- The UK should continue to support the important work of the Expert Group examining ways of strengthening the global economic architecture and tackling oil price volatility.

The European Union

5.18 The UK's membership of the EU is different to its membership of other multilateral institutions because the EU is a legislative body. Its actions and laws can directly affect our energy security, positively or negatively. When dealing with other multilateral organisations or third countries, the UK can often use the added value that EU level action or coordinated diplomatic work can bring. Moreover, some policies, such as the liberalisation of EU energy markets, can be pursued only through EU level action. Our energy security requires that we consider how to use this effectively e.g. to press for greater market opening in producer countries, and encourage and assist energy efficiency and the take up of low carbon technologies internationally. However, the UK must also consider carefully where competence on energy policy is ceded to the EU and whether this is in the UK's national interest.

5.19 Since the Hampton Court summit in 2005, convened under the auspices of the UK's Presidency of the European Council whilst I was Energy Minister, the European Union has sought to develop an integrated energy policy focussed on sustainability, competitiveness and security of supply. The challenges to achieving this are considerable: how to ensure that the EU's energy policy is flexible enough to respond to the global environment, whilst ensuring there is a stable regulatory framework that gives sufficient certainty to the market; how to achieve our climate change and carbon reduction goals; how to ensure security of supply against a backdrop of potential instability and political manipulation in some key supplier countries; and how to deliver fair, affordable energy prices. The EU's primary focus has traditionally been on internal measures to improve the functioning of energy markets and the EU's resilience. It has already

acted to implement this integrated policy through packages of legislation to tackle climate change and open up EU energy markets, as well as the recent "Strategic Energy Review", focusing on energy security.

Box 17: Market liberalisation and the Third Energy Package

Liberalisation involves the opening to competition of the production and supply sectors. In competitive markets companies have less power to influence market prices through their own individual actions, and therefore they are less able to pass through cost increases. They therefore have a constant incentive to reduce costs in order to increase the margin on their sales and/or extend their market share. This should lead to improvements in efficiency and performance.

Transmission and distribution are natural monopolies because it is not efficient to replicate networks. Left unconstrained, monopolists select a price that maximises their profit. Therefore in liberalised markets, as it is not possible to introduce competition, the regulator of such national monopoly networks seeks to mimic competitive forces by controlling rents through price controls.

Theory suggests that liberalisation is likely to result in lower prices and improved service levels.

The third internal energy market package aims to protect security of supply and ensure consumer choice and investment in essential infrastructure. The legislation will: increase the separation of production and supply businesses from transmission networks to promote competition; facilitate cross-border trade in energy; make national regulators more effective; and introduce measure to increase solidarity among Member States.

The package is expected to come into force in early 2011.

5.20 The EU Commission, with strong encouragement from the UK, has sought to promote open and competitive markets. The adoption of the Third Energy Package offers the chance to make a major step towards achieving a liberalised market, provided it is properly enforced. There might be risks for the UK, particularly with respect to gas security, if the package is not implemented on time and in a consistent way across member states. The principal danger stems from the increasing integration of our particularly liberal energy market with European gas markets and our increasing import dependence. If we do not have access to the networks and gas supplies in other states on the same basis that they can access ours and gas supplies do not follow price, gas might tend to flow out of the UK to states with less open markets than ours in the event of a crisis or supply shortage. If the Third Energy Package does not bring about liberalised markets across the Union, we will need to think clearly about how we should mitigate this risk.

Enhancing interconnection and promoting resilience

5.21 Achieving our energy security and sustainability objectives will be supported by well-integrated European electricity and gas networks. These are needed to give households and industry secure energy supplies and to transport the energy produced by new low-carbon technologies. Europe's energy networks are ageing and lack key interconnections. Moreover, enormous investment will be needed in new networks to transport electricity from renewable energy and other low carbon production sites, which are often in remote locations, to centres of consumption. The lead will be taken by the commercial sector, but governments and the EU have an important role in facilitating this investment.

5.22 Perhaps the best known barrier to investment in energy networks is long, complex planning procedures. The EU could have a role in ensuring exchange of best practice. But a key barrier to investment in cross-border connections is the lack of consistency between the regulatory regimes in the EU. This makes it very difficult to build pipelines and electricity lines between countries and the difficulties are compounded when the infrastructure crosses more than one border. The Third Package of legislation on the internal energy market provides a framework for resolving these problems. It gives regulators greater powers and introduces a duty to promote the interests of the EU's internal market. It also creates an Agency to facilitate cooperation between regulators cross-border and organisations for the cooperation of system operators at EU level which are charged with, *inter alia*, the development of ten year European investment plans. These measures should lead to more consistent regulatory regimes which in turn should facilitate cross-border investment. The EU should seek to implement these measures as quickly as possible, in particular those which do not require legislation.

5.23 LNG imports are not fixed to pipelines and routes and can enter Europe at a number of different points, enhancing the diversity of routes and sources of EU energy supply. Further interconnection is necessary to enable the flow into the heart of Europe of gas landed at LNG terminals on the periphery. The European Commission and EU regulators through the new agency can play an important role in supporting investment in such infrastructure.

5.24 Significant progress has also been made to improve EU resilience to interruptions in gas supply and the UK has been closely involved in discussions between the Commission, Member States and industry organisations on the possible content of a revised security of gas supply instrument. As a result of the serious gas dispute between Russia and the Ukraine in January this year, the timetable for that revision has been brought forward and a draft text emerged from the Commission in July. The intention is to improve security of gas supply standards across the EU, increase EU resilience to supply shocks through more

co-ordinated planning and improve Member State emergency planning procedures and processes.

Energy efficiency and the low-carbon economy

5.25 The EU's Energy Policy seeks to reduce the level of import dependency whilst also committing to reduce greenhouse gas (GHG) emissions by 20 per cent on 1990 levels by 2020 and to meet 20 per cent of energy production from renewable sources. In addition, the EU has also adopted a 20 per cent energy efficiency target. Unlike the renewables and GHG targets, the efficiency target is neither mandatory nor apportioned between Member States. This was primarily because member states had only just adopted a separate target to make energy savings of 9 per cent by 2016 under the Energy Services Directive (albeit utilising a different methodology).

5.26 In recent years, member states have had to negotiate and implement a wide range of EU energy efficiency legislation including the Energy Performance of Buildings Directive, the Co-generation Directive and the Energy End-Use Efficiency and Energy Services Directive as well as undertake ongoing negotiations on individual product standards under the Eco-Design of Energy Using Products Directive. However, the UK has a mature policy framework for energy efficiency and the direct impact of other legislation has, as a result, perhaps been more limited.

5.27 Successful action on EU-standards – for energy-using and related products and vehicles – is absolutely vital if we are to deliver our challenging domestic ambitions. Significant progress has been made in this area. After a slow start, the framework provided for by the Eco-Design of Energy Using Products Directive is proving an effective tool for agreeing new energy performance standards. In March a package of 8 Minimum Standards and Energy labelling regulations on motors, TVs, circulators, fridges and washing machines was agreed that will deliver savings of £350 million per annum and around 4 million tonnes of CO_2 a year by 2020 in the UK alone. A steady stream of standards for further priority product groups will come forward and the Eco-design framework has now also been extended to cover energy-related products. Backed by the strong evidence base we have in the Market Transformation Programme, the UK has been a very influential player in this process. Similarly, substantial progress has been made in setting new standards for vehicles to supersede existing voluntary agreements with manufacturers.

5.28 The Swedish Presidency of the European Council (July-December 2009) is keen to progress the low carbon – or "eco efficient" – agenda. The UK should work closely to support the Presidency in this aim, in particular working towards an ambitious revision of the EU's Energy Saving Action Plan and embedding the importance of the move to a low carbon economy in the EU's policy agenda e.g. during discussions on

the revision of the EU's Budget and/or Europe's competitiveness agenda ("The Lisbon Strategy").

The EU's External Energy Role in diversification of routes and sources

5.29 The EU has an important external energy policy role. When dealing with other multilateral organisations or third countries, the UK can often use the added value that EU level action or co-ordinated diplomatic work can bring. Our energy security requires that we consider how to use this effectively e.g. to press for greater market opening in producer countries, and encourage and assist energy efficiency and the take up of low carbon technologies internationally.

EU importation of gas from the East

5.30 In 2006, European Heads of State and Government declared the need to develop "a common voice in support of energy policy objectives when addressing third countries". Since then, however, the rhetoric has not been translated into reality. There are many reasons for this, but it is crucial for the EU now to find practical ways of operating in a more coordinated way, while respecting subsidiarity.

Box 18: Russian gas supply to the EU

Russia is the largest supplier of gas to the EU. Over a quarter of the gas consumed in the EU comes from Russia. Russian gas accounts for 40 per cent of EU gas imports, compared with about 20 per cent from Norway.

Russia has vast gas reserves so could become an even more important partner as the EU becomes increasingly dependent on imported gas. The Russian Government forecasts that gas production will rise by 44 per cent in the period to 2030. This rise means Russia could have as much as 310 bcm of its domestic gas production available for export in 2015, rising to 350 bcm in 2030. Russia can also import gas from Central Asian countries to sell on to customers in the EU.

However, Russia's main source of gas, the Nadym-Pur-Taz gas fields, which have been its resource base for many years, is set to decline from 2012. To achieve its production goals, Russia will need to replace this declining production by developing new fields in other regions. Most important among these will be the Yamal region, in the Arctic. The harsh climate and lack of existing infrastructure will make it a challenging region to develop. If all goes to plan, Yamal will begin producing gas from 2012. Russia's Ministry of Energy believes it could produce up to 315 bcm by 2030.

Despite planned increases in gas output, there may be other reasons why Russia exports too little gas to meet European demand. In the medium-term, dwindling production from mature fields combined with under-investment in

new fields could cause a supply crunch; particularly if Russia funds large downstream projects, such as the Nordstream and South Stream pipelines, at the expense of developing new production capacity. There is also a risk that Russia will choose to diversify its customer base, exporting its gas to Asia or, via LNG, to elsewhere, instead of exporting to the EU.

Whatever strategy Russia chooses to pursue, the EU will remain its key export market. 55 per cent of Russia's gas exports go to Europe at present: the equivalent of one fifth of Russia's total gas production. This is too significant a portion to diversify away from in the foreseeable future.

5.31 It is clear that relations with Russia will remain very important to Europe's external energy policy. We are interdependent: the EU is reliant on Russia as a major gas supplier and Russia is also reliant on the EU as a customer. Currently, very little Russian gas reaches the UK, but our increasing interconnection with the continent and the geopolitical impacts of energy supply disruptions means that this is a UK concern too. We need to develop with EU partners a shared analysis of Russia's role in EU energy security and whether this poses any particular risks to the EU. We need to be sensitive to the fact that different EU member states have different types of relationship with Russia based on the level of their dependency on Russian gas, their commercial interests and historical ties. These differences limit the EU's ability to 'speak with one voice' when negotiating with Russia.

5.32 At present most gas imported from Russia into the EU transits either Ukraine (75 per cent) or Belarus (18 per cent). The need to diversify our sources and routes of supply further has already been recognised. In the medium term the development of the Nordstream pipeline may bring some Russian gas direct to Germany, but the bulk will still have to transit third countries. The proposed Southstream pipeline could also provide an alternative route for Russian gas. But we should be aware that alternative supply routes do not address the risk associated with over-dependence on a single gas supplier.

5.33 At the root of this is the question of what Russia's strategy is and how its actions should be interpreted. Some would emphasise that Russia's primary objective is to act in its overall national interest so that its resource endowment contributes to its geopolitical position. Others would point to Russia's failure to invest, its lack of financial and technical capacity to do so and increasingly reliance on imports from Central Asia to satisfy existing demand. Both factors are significant for Europe and the UK.

5.34 In this context, developing the "Southern Corridor" (a gas route from the Caspian region to Europe, not through Russia) is very important as it would diversify both route and source of European gas supplies. Pipelines in the Corridor could potentially take Iraqi or Iranian gas in the future. This is a complex project, whose risks need to be handled carefully, and this has not been helped by a lack of co-ordinated messages coming out of the EU. During my visit to Turkmenistan as UK

Energy Minister in 2007, it appeared that the Turkmen government had received a number of visits from different EU member states and was unsure who they should be dealing with to make progress. Unless the key players work together effectively it will be difficult to progress the Southern Corridor and capitalise upon the present political momentum to enable Central Asian and Caspian gas to come to Europe without transiting Russia. It is important that we build on recent signs of greater consensus and engagement from the EU on this issue, in particular the visits by Commissioner Piebalgs to the region last year, the Czech Presidency's summit in May and the agreement by EU Heads of State in March on the need for an action plan by the end of the year, and the signing of an Inter-Governmental Agreement setting the broad legal and regulatory framework for construction of the Nabucco pipeline. Longer-term, it may be necessary for the UK and the EU to invest greater resource into developing relationships in this area, if reasonable progress towards realising the project is made. If substantial progress cannot be made in a reasonable timescale, the Government should reconsider whether this is actually a realisable project.

Recommendations

- The Government should press for thorough and timely implementation of the Third Package to ensure there is equivalent opening of energy markets across the EU to the UK. It should develop robust contingency plans if the equivalent opening does not materialise.
- The Government should be a leading voice in support of strong, effective regulation of product and energy efficiency standards for buildings at European level. It should give strong support to the low carbon agenda of the Swedish EU Presidency.
- The Government should work with the EU Commission and other EU member states to ensure that barriers to investment in infrastructure are removed. It is particularly important to promote interconnection between states capable of taking LNG delivery and those that are not.
- The Government should do what it can to support EU work to promote diversification of routes and sources of gas supply into Europe including through the use of EU diplomacy to influence third countries where they are better placed to do this than the UK bilaterally. This should in the short term include the development of the Southern Corridor project, with a review in a reasonable timescale of whether the project has a realistic chance of being realised.

Bilateral relations

5.35 Relations with other states will be of increasing importance as our integration with world energy markets, and our import dependence,

grow over the next decade and beyond, for the reasons set out in Chapters 2 and 3.

5.36 The UK is strongly reliant upon gas imports from a small number of countries, imported both via pipeline and as LNG; and for oil supply on the functioning of the global oil market. Our import reliance will increase over the next decade and more, even if we can maximise UK production and the contribution of alternative technologies for power generation and space heating. Other countries of course face the same trends, against an uncertain environment for fossil fuel production. Boxes 5, 7, 10, 11 and 15 outline briefly how some other import-dependent countries are tackling their anxieties about security of supply.

5.37 In this context I believe that the Government's highest priority in its dealings with other countries should be ensuring that key bilateral relationships are developed and maintained to support decisions by suppliers to commit to supplying the UK market and to support the development of better-functioning energy markets..

5.38 Next in terms of priority should be relations with states which are participants or potential participants in the global LNG market or potential suppliers to the UK. Due to the acknowledged need for EU energy security to improve the UK's own security of supply, bilateral relations with producer states in the Caspian Region and with transit states such as Turkey, will be an important component. Support for countries capable of increasing oil production will also help reduce the risk of an oil price spike several years hence, if global economic growth picks up. Promoting and supporting energy efficiency and carbon-reducing technologies should be the main focus of bilateral energy relations with energy-producing or transit states.

Norway

5.39 Norway is by far our largest external supplier of crude oil and of natural gas, accounting for over 80 per cent of our crude oil imports and over 70 per cent of gas imports. There are energy security benefits in having a diverse range of gas import sources, encompassing both pipelines and LNG. Within this envelope, though, it makes sense to risk-weight our exposure to different sources of imports. I believe that our energy security would be enhanced if we imported higher levels of Norwegian gas, recognising Norway as a stable, democratic state with a long history of reliable supply and a strong commitment to maintaining its status as a supplier of impeccable reliability.

5.40 If we wish to maintain and increase supply levels from Norway, we need first of all to be an attractive customer for Norwegian suppliers. We have the great advantage of the infrastructure in the North Sea which links our countries and facilitates importation. During my visit to Norway during this review, I was told repeatedly that the UK's open and transparent market, including the ease with which gas could be

exported from the UK to continental Europe, was a fundamental reason why Norwegian suppliers are keen to send their gas our way. The Government needs to ensure that both of these advantages are built upon, by maintaining our attractive market structure and by working to ensure that existing and new infrastructure does enable trade on competitive terms with those available elsewhere. Our regulatory structures need to be stable to enable partners to make strategic commitments to the UK market.

5.41 But building our broader relationship with Norway will help too. Other states are actively engaging in building relations and looking to support their importers to increase supplies from Norway. Though Norwegian companies and the Norwegian Government are well-disposed towards increasing supplies to the UK, and see some clear commercial reasons for doing so, there are pressures in the other direction – other European countries also see Norway as an attractive supplier and Norway will see advantages in having a diverse customer base. We need to ensure that the case for the UK is made at the highest political levels as well as commercially. Building a broad-based, positive relationship of partnership in CCS, renewables, development, diplomacy and cultural interaction would be a firm base for discussion of further partnership in oil and gas.

Qatar

5.42 LNG is a vital part of our gas supply and will become still more significant. The Government needs to do what it can to make the UK an attractive import destination and to ensure that our infrastructure is capable of receiving sufficient LNG to meet our future needs.

5.43 I believe that one key element of the Government's strategy to attract LNG to the UK market should be to consolidate the excellent relationship established with Qatar at every level. The Qataris are rapidly expanding their gas liquefaction capacity and are already the largest global supplier of LNG. Between 2008 and 2011, QatarGas will construct 6 mega-LNG trains, which will more than double Qatar's gas export levels as compared to 2007. Yet, with their geographical position enabling Qatar to supply both Asia and Europe with gas, the UK will face increasing competition for Qatari supplies.

5.44 Under the leadership of the Emir of Qatar, QatarGas has made a strategic investment in regasification capacity in Milford Haven in Wales, underpinned by long-term supply agreements. The UK Government deserves credit for its active high-level engagement with the Qatari government which has given impetus to their decisions on this project. Maintaining and enhancing our engagement will be important in supporting further strategic (political and commercial) decisions by the Qataris to commit to supply to the UK. This could include broader joint working on energy, including renewable energy

and energy efficiency, to enable Qatar to maximise its yield from its resource endowment and improve energy intensity.

LNG supply

5.45 We will further reduce gas supply anxieties if we build relations with other states from which we already or could in future import. In some circumstances good bilateral relations could be a foundation for supply agreements between UK gas importers and producers in other states; in others, they could lead to a more liquid LNG market through increased levels of supply facilitated by UK Government assistance with the development of production. Perhaps of most potential help could be focused support for LNG development in states which have prospects to produce and export.

5.46 For geographic reasons, the UK draws most of its gas from the Atlantic Basin and from the Middle East, via the Suez Canal. In the Atlantic Basin, Africa has arguably the greatest potential in terms of gas production and export. The UK already imports LNG from both Algeria and Egypt in North Africa, where Libya also has great potential. In the context of broadening gas imports, as well as easing the oil market, I led a delegation to Nigeria last summer, as the then UK Energy Minister, and this led to the formation of the UK-Nigeria Energy Working Group, helping to support Nigeria in its ongoing energy reforms. However, although Nigeria has the largest gas reserves in West Africa, other states including Angola and Gabon also have significant potential. The UK Government should strengthen its bilateral relations with those African states where there is potential for UK importation of LNG.

5.47 If and when broader considerations permit, building effective working relations with Iran, which has the second largest gas reserves in the world and which has low levels of production for export at the moment, could make a significant contribution to our energy security.

Oil supply

5.48 Lack of investment in oil production risks leading to high oil prices in the medium term, when oil demand growth resumes as the global economy recovers. This risks having a dampening effect on the recovery, impacting both on living standards and also on investment in carbon-reducing technologies, many of which require considerable capital in their deployment. The UK will face an additional challenge with the decline in Norwegian oil production over the next decade. It is important that we continue to promote producer-consumer dialogue to seek to achieve a reasonable balance between demand and supply, enabling prices at levels which do not destabilise the global economy. In this context, the Government should continue to build on its excellent relations with the Kingdom of Saudi Arabia, which contributed to the success of the Jeddah meeting and follow-on London

Energy Meeting last year, fostering consumer-producer dialogue. This momentum needs to be maintained and it is important that the expert group established under the auspices of the IEF, following the London Energy Meeting, to consider how best to co-ordinate the work of energy institutions, is properly supported.

5.49 The Government's work with its counterparts in Nigeria and Iraq, which I heard about during this work, to support the development of effective administration of their hydrocarbon resources is important in this regard. This will help both states to produce more oil and gas, providing vital resources in the economic development of each, and provide a model for other potential collaborations. The prioritisation mechanism which I suggest in Chapter 6 will also help in the future to identify the key countries with which we might work. These include those identified as important in the gas market; many of which are also key producers for international oil markets. Much gas production is associated with oil production. Enabling countries to use such gas productively, rather than simply flaring it, can contribute to their own development as well as minimising the contribution of gas production to global warming.

Supporting other countries in reducing their energy usage and decreasing their climate-changing emissions

5.50 Many supplier and transit countries could use energy much more efficiently, reducing the need for investment in production, reducing emissions of greenhouse gases and enabling those states to capture more of the value from "their" hydrocarbons. The Government should use its bilateral influence and development resources to assist states in this. For example, Ukraine is by some measures the world's most energy-inefficient nation. Focused assistance with tackling this would enhance Europe's energy security as Ukraine's requirements to off-take Russian gas in transit could then sharply decrease. It is also important to support Russia's efforts to achieve its own target of a 40 per cent improvement in energy efficiency by 2020. This would do a great deal to support EU energy security.

5.51 Equally important is working with states to adopt alternative technologies for power-generation and other energy uses. Many oil-producing states are rich in potential solar resource, which might in future enable them to reduce their own use of fossil fuels. Such technologies could also offer potential for increasing energy supply in less-developed countries, facilitating economic development without contributing significantly to global warming.

5.52 In some cases multinational institutions will be better placed than the UK to further these aims. The Government should regularly review where it can add value through bilateral work and concentrate on these countries.

Joint co-operation on nuclear power

5.53 The UK is actively involved in co-operating with other countries that have civil nuclear programmes, to share, *inter alia*, a commitment to the highest standards of safety, security and safeguards, working with the relevant nuclear international bodies. This work sends a strong political message both as an endorsement of the merits of respective civil nuclear programmes around the world and a signal of commercial opportunity to industry. Of note, the UK recently signed Memorandums of Understanding with Jordan and the UAE on nuclear co-operation. In both these countries, their respective approaches to developing indigenous civil nuclear power programmes, with proactive and transparent adherence to international norms and obligations, provide strong positive examples for others to follow.

Recommendations

- Prioritise Norway, Qatar and Saudi Arabia as the most significant bilateral relationships to our energy security. Relationships built on a broad base including diplomatic, development and cultural collaboration will provide a firm basis on which to pursue our energy security goals.

- Include within a second tier of priority countries those who are actual or potential suppliers of gas primarily to the UK, but also to the European or global markets, including "Southern Corridor" states. This list of countries could change over time and should be regularly reviewed by the mechanism suggested in Chapter 6.

- In a third tier of priority should be countries capable of increasing oil production in the short-run to reduce the risk of a price spike when global oil demand picks up. The Government is well-placed to draw upon the UK's expertise in oil and gas production to help such countries to benefit from their resource endowments.

- In relations with oil and gas producing or transit countries, prioritise assistance with energy efficiency and non-fossil technology adoption.

Chapter 6: Actions we could take within our own borders

6.1 "Energy independence" is attractive as a slogan but it is not a practical or desirable option in the short or medium term. In the coming decades, as set out in Chapter 3, we will need to import a great deal of our energy. Indeed, DECC forecast that by 2020, on an annual basis we will be importing around half of the oil and gas we need. Chapter 5 set out a strategic approach to our relations with other countries which recognises this reality and seeks to reduce the risks contained in our growing integration with international energy markets. But this is only part of what needs to be done. Britain can do much more to reduce risk by managing its energy demands rigorously and by seeking to maximise "home-grown" production.

6.2 Energy efficiency must be the starting point. This must not be regarded as some kind of soft option or "nice-to-have", but rather as a rigorous and vigorous action programme to reduce substantially the country's demand for energy. This will enable Britain to become a lead nation, pioneering the way to a new green economy that combines growth with reduced energy use.

Reducing our fossil fuel requirements

Energy efficiency and carbon reduction

6.3 The UK Government has done a good deal to further energy efficiency. The rollout of smart gas meters, the introduction of the Carbon Reduction Commitment to the non-energy intensive sector, to help save participants an estimated £1 billion by 2020, at 2008 energy prices, and the decision that all new homes in England will be zero-carbon from 2016, and all new buildings by 2019, are all welcome initiatives. One million homes were insulated last year.

6.4 Budget 2009 recognised the need to do more. It included a further £375 million to support energy and resource efficiency in businesses, public buildings and households over the next two years, and £70 million for decentralised small-scale and community low-carbon energy.

6.5 The UK Low Carbon Transition Plan, published in July 2009, sets out how further energy efficiency will contribute to enabling us to meet our climate change objectives. I welcome the ambitious proposals it contains, in particular the support for households to reduce their

energy use. Energy efficiency targets are difficult to achieve and the Government will need to keep progress towards achieving the targets under close review. Quick progress on the measures proposed in its recent consultation on the Heat and Energy Saving Strategy together with the proposed new Community Energy Savings Programme (CESP), being launched this year, and the increase in the Carbon Emissions Reduction Targets (CERT) obligation is necessary. Taken together these could reduce emissions by up to 50 mega tonnes of CO_2 per year by 2020.

6.6 The Government's 'Big Energy Shift' initiative has valuable insights into what would persuade the public to take up renewable energy generation and energy conversation, so that we can meet our renewable energy targets and GHG emission reductions. The initial research points to the need for national and local Government to take a strong lead to encourage behavioural change. Decisive leadership by Government can lead to broad acceptance of the desirability of change, as we saw with the ban on smoking in enclosed public spaces. It is important that the Government lead the way by taking symbolic action to demonstrate that every householder and business needs to tackle the problem, for example by installing insulation and microgeneration in schools and hospitals.

6.7 The EU has been successful in establishing the Emissions Trading System (ETS), in which a number of heavy industries and all electricity generators in the EU are required to monitor report and surrender allowances to account for their installation's actual emissions and can trade allowances among each other at the prevailing carbon price. The ETS has established a carbon price for emissions and a stable regulatory framework that covers about 50% of the UK's emissions. Additionally, Climate Change Agreements in the industrial sector, have been very successful over the last eight years in improving energy efficiency in energy intensive sectors, so that their bills are estimated to be £2 billion a year lower than if they were still operating at the efficiencies of the 1990s. The Carbon Reduction Commitment will also help drive energy efficient behaviour among large businesses.

6.8 But the Government must continue to promote lower energy use in the commercial sector. During the review I heard that there is a great deal of scope for achieving energy efficiency improvements through replacement of capital stock such as pumps and valves with more efficient models. A reasonable carbon price and use of other mechanisms, combined with Government support for companies in improving their energy use, are needed if we are to achieve the kind of reductions which will contribute significantly to building our energy security.

Recommendations

- The Government must take a bold lead on energy efficiency and energy conservation by taking symbolic action itself at a substantial scale.
- The Government should employ all measures at its disposal to promote greater energy efficiency in the commercial sector.

Nuclear

6.9 Nuclear power is a low carbon technology. On reasonable assumptions, life-cycle emissions are about the same as those of wind generated electricity and are significantly lower than emissions from fossil-fuelled generation. Indeed our current carbon emissions from power generation would be 5-12 per cent higher without nuclear power (assuming that it would be replaced by fossil-fuelled generation). At a time when the UK is becoming increasingly reliant on imported fossil fuels we need to ask whether the UK should be more ambitious on nuclear power. When national security considerations are added to climate change exigencies I believe the answer is yes.

6.10 Currently the UK has 19 operating reactors at 10 nuclear power stations. These provided around 12.5 per cent of the UK's electricity supply in 2008. (In previous recent years, the figure has been closer to 15 per cent; it was depressed in 2008 by a number of unscheduled plant operating challenges.) Retirement of nuclear power stations over the next decade and more will lead to shifts in the energy mix with a short term decline in the role of nuclear power as new nuclear power stations take several years to build. However, nuclear is a reliable and well understood technology. The first nuclear power station in UK opened in 1956 and we have had nuclear electricity in this country ever since. At its peak in the 1990s nuclear contributed over 25 per cent to our electricity supply. I believe it should continue to be an important element of our power-generation mix, in conjunction with renewable and other technologies, beyond 2020, and that we should be ambitious about the potential amount nuclear could contribute.

6.11 In order for new nuclear build power stations to be built in the UK, we need to have the right policy and regulatory framework in place. The steps that the UK Government is taking are set out in the 2008 Nuclear White Paper. I welcome the active role that the Office for Nuclear Development (OND) is taking in ensuring that the right structures are in place in time for companies to begin operation of new nuclear power plant from 2018, or sooner if possible. Projections show that we are potentially on track to have around the same amount of nuclear in our mix in 2030 as we do currently, some 12-15 per cent.

6.12 The UK Low Carbon Transition Plan states that if we electrify much of our transport and heating, our demand for electricity in 2050 could be

50 per cent higher than it is today, making it possible that electricity could account for half of our overall energy use; it is therefore important that it relies on large scale, low carbon and proven technologies to meet a proportion of this increased demand. As nuclear meets these criteria it is well placed to play a key role in our future energy mix. I believe that the level of ambition should be much higher in the longer term than currently projected. To enhance energy security and reduce our reliance on imports, a range between, say, 35-40 per cent of electricity from nuclear could be a sensible aspiration, beyond 2030. Such an increase in nuclear deployment is certainly ambitious but it should be noted that over 80 per cent of France's electricity come from nuclear power plants. This means that aside from uranium France is much less dependent on overseas markets for its security of supply than the UK will be in the future, less exposed to movements in fossil fuel prices.

6.13 The auction of sites on which new nuclear power stations might be built, the purchase of British Energy by EdF, the founding of the new nuclear laboratory and new schemes to train workers, including the National Skills Academy for nuclear, are all steps in the right direction to facilitating nuclear new build. In addition, the UK has strict, independent, safety and environment protection regimes for nuclear power. Any new nuclear power station will be subject to safety licensing conditions and will have to comply with the safety and environmental conditions.

6.14 Concerted effort is needed not just from the Department of Energy & Climate Change (DECC) but other Government Departments to achieve all that is necessary to create the right framework for nuclear new build. An example of this collaborative working was in achieving a pay deal for nuclear inspectors at the Health & Safety Executive (HSE). This required concerted action to align DECC, the Department for Business, Innovation & Skills (BIS), HM Treasury (HMT), Cabinet Office (CO), the Department for Work & Pensions (DWP) and HSE. Whilst there was concerted action between Departments, there was scope for improve coordination of this. The lesson for the future is that we should be seeking to create simple governance structures wherever we can, removing unnecessary interfaces where it is appropriate to do so. The work required across Government to implement the measures in the new Planning Act is an ideal opportunity for Government to show that it can act in a decisive, joined up way. Successful delivery of this planning reform will allow applications to build new nuclear power stations to be considered and concluded more rapidly, with greater efficiency and in a more inclusive manner. As such, it is a pre-requisite of any successful programme of nuclear new build in this country and should be accorded high priority. As part o f this process, the draft National Policy Statement (NPS) for nuclear power, which the Government is publishing for public consultation and Parliamentary scrutiny later this year, will set out in more detail why the Government considers there is an early need for nuclear power as part of this mix. I

believe the Government should take this opportunity to make a strong and clear statement of need for nuclear power plants.

Recommendations

- An aspiration that nuclear should provide some 35-40 per cent of our electricity beyond 2030 should be considered by Government.
- The Government should take the opportunity to make a strong and clear statement on the need for new nuclear power plants in the forthcoming National Policy Statement for Nuclear.

Renewables

6.15 Increasing the share of renewables in our energy mix is critical to reducing our reliance on imported fossil fuels, as well as achieving our climate objectives. The UK's own Climate Change Act sets a legally binding target for reducing UK carbon dioxide emission by at least 26 per cent by 2020 and at least 80 per cent by 2050, compared to 1990 levels, and the EU's Renewable Energy Directive requires the share of renewable energy in the UK's energy mix to increase to 15 per cent by 2020. Both measures are welcome. They have given impetus to achieving higher levels of renewables deployment.

6.16 The target of 15 per cent renewable energy use in the UK by 2020 is a demanding one by any measure, given the low contribution of renewables to our energy mix at present. Achieving it will be a key challenge for Government and companies. Proposing anything more ambitious up to 2020 is not realistic. However, if the Severn Barrage project for generating electricity goes ahead, it may be possible to revisit this judgment.

6.17 The Government should focus on a range of renewable technologies to meet our renewables target and prioritise our resources to reduce our reliance on fossil fuels. In particular, I believe that marine energy – wave and tidal – has the potential to make a significant contribution to our longer-term energy needs, in the period 2020-2050. According to the Carbon Trust Marine Energy Challenge 2006, marine energy could provide up to 20 per cent of our energy needs. As a global centre for wave and tidal energy with many leading devices being developed by UK companies and many overseas device developers active in the UK, I believe the Government should do everything it can to bring this technology to commercial deployment, unlocking any issues preventing deployment and providing the necessary leadership through action.

Recommendation

- The Government needs to consider whether further policy instruments that direct investment in capacity towards non-fossil fuel power generation, including wind, tidal and wave are required.

Electric vehicles

6.18 As set out in Chapter 3, 70 per cent of the UK's oil use is in the transport sector. More efficient vehicles and a progressive move towards replacing conventional vehicles with less-emitting alternatives needs to be a key element both of our own moves to reduce carbon emissions, and those which need to take place globally.

6.19 The Government has already taken action in Budget 2009 to put Britain at the forefront of a green motoring revolution by encouraging a mass market in ultra low carbon electric and hybrid cars as part of wider plans to make the most of the low carbon economy, with estimates that around a million green jobs could be generated by 2030. In addition to continued improvements in the efficiency of conventional technology, plug-in hybrids, battery electric vehicles, hydrogen-powered and fuel cell vehicles are all likely to play a role. Collaboration between public agencies is important to catalyse the development and deployment on a commercial scale of these technologies. An important example is the second phase of the Innovation Platform project, with a budget of around £100 million and partners including the Technology Strategy Board, Engineering & Physical Sciences Research Council (EPSRC), Department for Transport (DfT), Advantage West Midlands and One North East, which is intended to cover a broad span of key technologies for lower carbon cars, include battery technology, plug-in hybrid and all-electric concepts.

6.20 Regulators are setting a challenging framework for the reduction of CO_2 tailpipe emissions for vehicles. The EU Regulation for CO_2 emissions from New Cars will cut average carbon dioxide emissions across the European Union to 130g/km from 2012 with full compliance by 2015, and to 95g/km by 2020, a 40 per cent reduction from 2007 levels. Proposals for the regulation of tailpipe emissions from vans are also expected. The Government needs to continue to promote non-car travel, including by facilitating improvements to public transport and cycling, and by reducing the need for and desirability of car transport for individual citizens.

Recommendations

- The Government should continue to support the development and deployment of alternative transport technologies, building on the very welcome programmes already announced.
- The UK has real potential as a major technology innovator both in design and engineering technologies which should enable us to play a leading role in new vehicle development. The Government has an important catalytic role, including in fostering international collaboration and working with major car makers who manufacture here to centre development of new technologies in the UK.

Research and development in the energy sector

6.21 As the analysis in Box 14 shows, spending on R&D in the energy sector in the UK is lower than some of our international competitors'. We have potential competitive advantage in some technologies, including marine and tidal, and investment to support these could yield very large benefits in the medium term. Funding for CCS development will serve to increase the levels of UK R&D, and I welcome this. I believe that over time, levels of public investment should be increased and further steps taken to stimulate private investment.

6.22 In his review of the Government's science and innovation policies "The Race to the Top", Lord Sainsbury says: "Research effort is required throughout the energy value chain, not just in relation to high-profile areas such as new generation technologies. For example, the UK is undergoing a period of significant network renewal and expansion in gas and electricity. Similarly, improvements in metering technologies offer substantial gains in energy efficiency and network design"[20].

Recommendation

- The Government should takes steps to increase the UK public and private sector spending on R&D in line with recommendations in the Stern report and current Commission/EU proposals to ensure it can meet the challenges of the climate change agenda.

Smart grids

6.23 Infrastructure investment will be key to unlocking the low carbon opportunities in our economy. Massive investment is needed in the UK's electricity grid to make it smarter to support a greater

[20] http://www.hm-treasury.gov.uk/d/sainsbury_review051007.pdf

contribution from intermittent renewable energy and to address changes in consumer demand, e.g. through uptake of microgeneration and electric vehicles. I welcome the Government's commitment to roll-out smart meters to every home by 2020.

Role for coal

6.24 Given the abundance of proven coal reserves and its relative low cost and flexibility to meet fluctuations in demand for power, I believe that there is a long term future for coal in the UK's energy mix. Indeed, given the importance of supply diversity to our security, it would be foolish to abandon coal. However that future is contingent on coal being able to be part of our low carbon future. It must be part of the solution, not as now part of the problem.

6.25 By 2016, we will have seen a third of the UK's coal fired power plants close due to the Large Combustion Plant Directive (LCPD), with further closures likely to follow under the proposed Industrial Emissions Directive, so it is the right time to be thinking and acting radically on the UK's coal policy. CCS could enable new coal plants to be part of the low carbon economy but the technology has never been tested on a commercial scale and as a complete process on a power station. The UK is taking a leading role in developing this and the Budget announced plans to make funding available for up to four demonstration plants. The Government is treating this with the urgency it needs, and is consulting on a proposed new financial and regulatory framework for coal power stations that will explore the pathway from CCS demonstration to deployment.

6.26 If CCS does enable resurgence in the use of coal, as part of a low carbon electricity mix, then the UK will need to consider where to obtain additional coal from. As set out in Chapters 2 and 3, importing coal does not give rise to the same energy security issues as gas (or oil), but it will support security if we can have a balance of sources of supply, including a strong domestic component. With major investment in both deep mines and planning permission to exploit further surface mines, UK coal production could be retained at current levels of around 20 million tonnes per year through to at least 2025.

6.27 It is also important to pursue new coal technologies which will enable us to make further use of British coal. Underground Coal Gasification (UCG) is a technology that enables the energy to be recovered from coal in situ without the need to resort first to conventional coal mining processes. UCG involves the gasification (partial oxidation) of the coal in the coal seam and the transport of the gasification product to the surface for its subsequent treatment and use. Further practical work at industrial scale will however be needed before this could be considered a commercially viable and sustainable technology in UK conditions.

6.28 The decision by the Coal Authority to grant an initial 3 year licence to an exploration company to develop a UCG project in the Firth of Forth holds great promise for the future use of British coal reserves. If the project goes ahead there could be at least 25 years of production from this resource.

Recommendations

- The UK should remain at the forefront in developing CCS technology and demonstration.
- The UK should develop its own economically viable coal resources where it is environmentally acceptable to do so, including through the use of innovative technologies.

The refinery sector

6.29 Patterns of demand for refined oil products are changing with more demand for diesel and aviation fuel and less for petroleum. UK refineries, most of which were first developed many years ago, are set up to produce large amounts of petroleum and smaller quantities of the fuels for which UK demand is growing. They face key challenges in the years ahead, as most are less value-adding than the average of European refineries. This matters as it is important that we should have indigenous refinery capacity to process imports of crude oil in situations of crisis and emergency, though import-dependence for products does not give rise to significant security of supply concerns in normal times.

Recommendation

- The Government in recognising the importance for our energy security of UK refining capacity, needs to remain mindful of refiners' needs and challenges in its decision-making on regulations, tax treatment and the like.

Connection with sources of renewably-generated power

6.30 More electricity interconnection with sources of renewably-generated power can be a part of our energy security framework which also contributes to tackling man-made climate change. On my visit to Norway in connection with this review, for example, I had interesting discussions on the potential for electricity interlinkage which would

enable balancing between Norwegian hydro generation and UK-waters offshore wind. There could be potential too for the UK to benefit from Iceland's rich geothermal resource, via interconnection. In the longer term, there could be rich potential for connection between European electricity grids and solar generation plans in North Africa or the Middle East.

Recommendation

- The Government should explore the potential for greater import capacity of clean energy from other states, for energy security as well as climate reasons.

Can market arrangements deliver an appropriate fuel mix?

6.31 The Government has made important, positive efforts to encourage a greater role for non-fossil fuels in our power generation mix, including relatively directive policy instruments such as the Renewables obligation. Many commentators argue that gas, the cheapest and quickest technology to install in significant mega-wattage, is likely to take an increasing share of the power generation market, to replace closing coal-fired stations, and also potentially some nuclear power stations in the middle of the next decade. These gas-fired power stations would then be a part of our power mix for decades afterwards. (This emphasises the importance of developing CCS technologies at a commercial scale, initially for use on coal-fired stations but with a view to their use on gas-fired stations as well.) We would potentially be locking-in import-dependence at an uncomfortable level and have an unbalanced fuel mix leaving UK businesses and consumers highly exposed to future moves in international gas prices.

6.32 I believe that the Government needs to consider carefully whether there are cost-effective ways of avoiding this outcome. Effective demand-reducing energy efficiency measures might be sufficient while extending the life of existing plant where feasible and legally permissible could also contribute, giving more time for the deployment of alternative generation technology including nuclear, with its long-lead times. The Government and industry will wish to consider whether it needs to take a more strategic role in determining the fuel mix for power generation, perhaps within bands, to try to avoid a "dash for gas". If it did so, it would need to ensure that the regulatory and market structures provided sufficient assurance to operators that they would be able to sell the power that they generated to justify investment in non-fossil power-generation. This would be a significant move away from the "market knows best" orthodoxy, but might be

justified on energy security grounds. It would echo the welcome moves to ensure that sufficient renewables capacity is installed.

Reducing risks associated with gas importation

Maximise UK Continental Shelf (UKCS) production

6.33 Production of both oil and gas from the UKCS is in decline. Figure 35 shows that this trend is expected to continue. In 2004 we became a net importer of gas. Our degree of import dependence is a function both of this and of levels of demand. Measures proposed in previous paragraphs would reduce our dependence on gas as a fuel. Maximising UK supply is a further crucial element in mitigating the risks involved in our continuing use of oil and gas.

6.34 The UK Government should look for ways to support companies in maximising economic production from existing and future oil and gas fields, through its regulatory and fiscal arrangements, consistent with other objectives including ensuring that the public revenues benefit from the exploitation of mineral wealth. The announcement in this year's Budget supporting and incentivising small and technically challenging developments may need to be supplemented by further changes to the tax regime supporting exploration and production to maximise investment and production levels. In the years to come we will require a far more sensitive and sophisticated fiscal strategy for the UKCS than we have seen until now.

6.35 If the UKCS is to realise its full potential to supply the UK's energy needs, I believe it is necessary to develop the regulatory regime further to ensure it provides sufficient incentives to explore the full geological potential of the UKCS. This should include enabling the production of the West of Shetland reserves through an adequate gas transportation capacity.

Recommendations

- The Government should keep the tax treatment of profits from UKCS production under continuous review, to ensure investment is maintained at the level which is necessary properly to realise maximum potential in the North Sea, as a key contribution to energy security.
- The Government should continue to do everything it can to develop the West of Shetland province, and stand ready to play a catalytic role in bringing together the interests necessary for its further development, including an adequate gas transportation capacity.

UK gas market issues

6.36 The UK's market-based systems for gas distribution and for electricity generation have brought considerable benefits. Competition between market players has, particularly in the earlier years of the systems, brought lower costs for consumers than in comparable countries. It has provided efficient and sufficient investment in transmission and import infrastructure, providing secure energy for businesses and households. Our open, competitive market has attracted overseas investment and is seen by energy suppliers as an attractive export destination – I was told in Norway that Norwegian gas suppliers valued our open market structures and the ease with which gas could be traded within the country or to Continental customers. These are important characteristics of our market which we need to maintain.

6.37 As our import reliance grows, though, we will be exposed to different kinds of risk in gas supply. We need to build our resilience to reflect our changed circumstances. Below I discuss, in turn, gas contracts, the supplier obligation and gas storage. Each is considered discretely, but in fact they are interlinked, as in each of these areas actions might be taken to support confidence about security of supply, helping to mitigate the risks I have identified in our increasing gas dependence.

Contracts

6.38 Gas import and distribution companies treat their contractual arrangements with suppliers as commercial secrets. I understand and respect the reason for this. But the Government can make soundly-based decisions in energy policy only if it understands the supply position properly. Such commercial confidentiality risks leading to either mistakenly burdensome policies, or misplaced confidence about our energy security position. For reasons of energy security the Government should be informed about the contractual arrangements of our key suppliers. Other countries require this; in France, suppliers are required to supply to the Energy Secretary details of all the gas they have procured or intend to.

6.39 While the details of contracts are obscure, I heard during my review that there had been a trend away from longer-term, fixed volume contracts by UK importers, in a context where these are favoured by many European importers of gas. In the case of Norwegian supplies, for example, some are contracted on a long-term basis, but others are "swing supplies" provided to the UK market in circumstances where customers on the Continent do not take up all of the gas to which they are contractually entitled. I am concerned that this could leave the UK vulnerable, exposing it to increased price volatility and potentially preventing it physically receiving the gas needed to meet demand, especially during very harsh winters but also at times of geopolitical risk or crisis.

6.40 The Government should therefore assess whether there is action that should be taken to avoid exposure to supply disruption. It would be advantageous to the security of our gas supplies if long-term, fixed-volume contracts were in place for a greater proportion of our future import requirement. The Government should consider ways of supporting UK energy suppliers and users in securing such agreements.

Supplier obligation

6.41 A number of European states place public service obligations on gas suppliers. For example, in France, companies are required to supply domestic, public service and commercial customers who have not signed an interruptible contract even in a 1 in 50 winter, and to have plans in place to deal with a 6 month loss of supply from their principal supply source. The UK's market seeks to achieve security in a more flexible, less-costly way.

6.42 Suppliers are required to sign up to Network Codes which set out the rules for players to participate in the gas market. The governance arrangements for these Codes are largely managed by market participants.

6.43 National Grid has an obligation to have in place "reasonable incentives" on suppliers to meet the demands of their domestic customers in a 1 in 50 winter. These reasonable incentives include the cash-out charges, which shippers face if they deliver too little (or too much) gas i.e. if they deliver too little gas (or too much) they pay a cash out charge related to the volume by which they have under- (or over-) supplied against contract.

6.44 Although the licence obligation applies only to domestic (i.e. household) demand, cash-out charges apply to a supplier's entire portfolio. However, suppliers are likely to have in place interruptible contracts with some of their industrial and commercial (I&C) customers. If for any reason the shipper is unable to deliver the volume of gas required, or demand is higher than expected, the supplier can require these I&C customers to reduce their off-take, or a customer may choose to self-interrupt and sell its gas back to the market (under the terms of the interruptible contract), so that the gas that has been delivered onto the system by shippers can be taken off by domestic customers. If a customer's supply is reduced under the terms of its contract, the supplier can notify the reduction to National Grid, and will not be exposed to cash-out charges for that volume. This provides the incentive for suppliers to prioritise supply to domestic customers, if supplies are tighter or demand is higher than expected.

6.45 With competition between suppliers and shippers, and the design of the cash-out arrangements, there are, therefore, in principle commercial incentives on these companies to ensure that demand is fully met as above.

6.46 National Grid provides the final balancing such that even if shippers and/or suppliers fail in the above, it has an obligation always to balance the system so that demand (excluding any volume reductions achieved though interruptible contracts) is met.

6.47 The Government reviewed this system in 2005 and decided that no change was necessary. Since then we have seen the regulatory regime applied to the financial institutions, believed to be adequate, fail when tested by adverse circumstances.

6.48 There is no way in the present regulatory system for gas for National Grid or the regulator to establish whether in aggregate there is actually likely to be sufficient availability of physical gas. Other markets to whom we are physically linked have more prescriptive requirements and in a situation where there was shortage on either side of the Channel, there could be a danger that customers in the UK would be lower on the priority list for suppliers than those in continental Europe.

6.49 Higher cash-out charges for failure to deliver might be a solution, in sharpening the commercial incentive to avoid supply interruption. Alternatively, the regulator might be given powers to examine the circumstances of a failure to meet obligations to supply customers, with an ability to levy financial penalties if such investigation shows that reasonable efforts to supply were not made.

6.50 Regulatory systems are complex and the risk of unintended consequences from making changes is always present. A careful consideration of the costs and benefits of strengthening the system is required before deciding on options for further consideration. Ofgem, in its Project Discovery, is reviewing the operation of the existing structure, focusing on whether it provides sufficient assurance of security of supply in the changing market conditions. This is an important review and the Government needs to reflect carefully on its outcomes when it concludes, probably around end-2009. Our regulatory arrangements were designed for a market fully supplied and more by indigenous production, with limited scope for exports. We must avoid the complacent assumption that what worked yesterday will work tomorrow where the supply situation is changing so quickly and significantly.

6.51 Governance of the Network Codes also needs to be carefully examined. Market participants' involvement in the governance arrangements must be limited to technical and practical issues. Where there are important security of supply issues, these must be capable of being addressed even where market participants do not agree on the urgency of doing so.

Storage

6.52 As the UK's gas production declines we will need more gas storage, and the ability for alternative fuels to be used in situations of supply shortage (for example, stocks of distillate held at power stations which can be used instead of gas when necessary) to enhance resilience to potential supply shortage or disruption. UK levels of gas storage are much less than those in a number of other EU member states. In the past, indigenous production has meant that this was not problematic.

6.53 Discussions with a number of market players during the review showed agreement that we will need substantially higher amounts of storage in future. A lack of adequate storage compromises our ability to respond quickly to emergencies by rapidly introducing additional gas to the market. More than two-thirds of existing storage is in the Rough facility. It could leave us vulnerable if, as in 2006, access to Rough was disrupted (in that case, by an accidental fire). All of our gas in storage is owned and operated by commercial players, many based overseas, who can if they choose withdraw their gas from storage to sell onto continental markets (as occurred last winter) or to meet supply commitments there.

6.54 A number of players in the gas market have plans for more commercial storage (see Box 13). There has been only limited development of new gas storage projects in recent years, and the amount built has consistently failed to meet earlier projections, but the Government has recently made welcome moves to streamline the planning process and on the tax treatment of "cushion gas" in Budget 2009. It needs to ensure that the legal changes to planning law do have the desired effect in simplifying the system in practice, and to track the building of new commercial storage to ensure that it does materialise at the scale anticipated, especially given the more difficult financing environment for storage projects. Some new storage is in the advanced stage of development, and the Aldbrough facility is about to come on stream, enhancing our security. But other storage is further back in the planning or conceptual stage.

6.55 One option for delivering a higher level of storage which we could be confident would be available in the case of supply emergency would be for the Government to contract for Strategic Storage, which could be accessed in only very limited circumstances. We are already obliged, like all IEA member-countries, to hold substantial emergency oil stocks, which can be released upon agreement by the IEA Governing Board (see Box 9). There have only been two IEA collective actions to release emergency oil stocks – in 1991 during the first Gulf War and in 2005, after Hurricane Katrina put much of the production capacity in the Gulf of Mexico out of action. There is no such international system for gas storage.

6.56 Strategic gas storage would be very expensive – it costs roughly 5 to 7 times as much to store gas as to store a comparable energy content of

oil. Any decision to proceed with strategic storage would risk displacing investment in commercial storage, as commercial players would see the existence of strategic storage, which they would suspect might be accessed simply in response to high prices and not only in supply emergency, as undermining their investment case. The circumstances in which strategic storage might be accessed would have to be tightly defined so that it was genuinely accessible only at times of supply shortage, to minimise the extent to which investment in strategic storage displaced private investment in commercial storage. I recognise the fine balance of argument here.

6.57 Is a compromise between commercial and strategic storage possible? It could increase the UK's gas security if there was a requirement that a proportion of the stored commercial gas could be released only to meet supply requirements in the UK. The interaction of this with the ability of suppliers to move gas between the UK and continental Europe using the Interconnector and possibly in future the BBL pipeline would have to be carefully considered. The legality of any mechanism under EU law would also have to be carefully considered, as this could plainly impact on freedom of trade across national borders.

6.58 Revision of EU gas security arrangements can also provide us with increased security. EU member states and the Commission are presently considering revisions to the existing arrangements. Proposals published in July 2009 would require much greater access to stored gas in all member states in response to supply emergency anywhere in the Union. This would give our suppliers better access to stores in other countries, and if successfully implemented, could also significantly contribute in the event of serious supply difficulties in the UK.

6.59 If commercial storage is not installed at the predicted rate, or access to storage on the Continent does not become more open, the Government will need consider this matter again. My own view is that the case for strategic storage should be considered very carefully, as an insurance policy against unpredictable developments in an uncertain world, where future supply and the evolution of European energy markets are subject to significant risks. Commercial concerns are noted, but we must review these matters against a more vital bottom line, Britain's national interest.

A controlled depletion policy?

6.60 As part of my considerations of gas storage, I also looked at the case for considering whether a proportion of our gas reserve should be held for exploitation only in emergency, if we could not secure the supply we needed in any other way. The Netherlands, for example, has adopted a policy of controlled depletion of its Groningen field to ensure that it has a proportion of domestic supply over the coming decades. I considered whether a similar strategy would be sensible in the UK context. However, I was concerned that it would not be possible to develop fields in time to respond to an emergency situation; this could work

only as part of a solution to chronic crisis in gas supply rather than to help in dealing with a fast-developing crisis. Preventing production from one or more existing fields until required in such a situation would require the owners to be compensated, at cost to the Exchequer – and to the economy. Most UK gas production is from oil fields and it would be very expensive to defer oil production as well as gas production. Deferring production from one or more dry gas fields would be akin to having one or more new gas storage facilities which would be a cheaper, more flexible solution, allowing the facility to be re-used as required. Currently, UK policy is concentrating on enhancing development and depletion by removing perceived barriers. On this basis I do not believe it is possible to construct a case for reducing the depletion rate. It would involve significant risks and costs, and I believe that optimisation is more likely to be achieved by minimising the resource costs of extraction. Current licensing and regulatory arrangements generally recognise the need to enhance activity and to remove barriers facing entrants and I believe the UK Government should continue to pursue these policies with vigour.

Recommendations

- The Government should support companies looking to conclude long-term supply agreements with overseas suppliers.
- The Government should require firms supplying the UK gas market to provide sufficient information on their contracted supply levels so that it has the contextual information to make soundly-based policy decisions.
- The Government should carefully consider the outcomes of the examination of the supplier obligation in Ofgem's Project Discovery to assess whether it provides sufficient assurance of secure supplies.
- The Government should keep under review the possibility of further measures to enhance levels of gas storage, should commercial storage developments fail to materialise at the scale anticipated.

Enabling the government to track and act upon changes in international energy security

6.61 Achieving energy security is a key challenge for the Government. The National Security Strategy correctly positions it as a key element of national security. The Government needs to ensure that energy security is treated with the same focus as other national security issues. It needs to have mechanisms for tracking changes in the international energy scene, and to have coherent, agreed priorities for action and for the engagement of senior Ministers and others where this is necessary.

Priorities for international engagement on nuclear issues, renewable power and CCS, and other areas, need to be considered in the light of and capitalised upon in terms of their contributions to the UK's energy security.

6.62 Additionally, the Government needs to ensure it has adequate mechanisms for coming to a view about the significance of energy security as a risk issue, compared to other national security risks and concerns.

6.63 Both DECC and the Foreign Office have divisions responsible for International Energy issues. This is understandable, but there is inevitable overlap and, despite excellent working relationships, I do not believe that the sum total of this work, together with that of other Government Departments and Agencies, is maximised. The Government should therefore examine the case for a new Office for International Energy Security, bringing together more closely those working in FCO with those working within DECC on these issues reporting through the Secretary of State for Energy and Climate Change and the Foreign Secretary to the Prime Minister.

Recommendations

- The Government should identify meaningful indicators which will enable it to establish whether the international energy picture is improving or worsening, with respect to UK and EU energy security in particular. The indicators should, inter alia, address the Government's efforts to diversify the UK's energy imports.

- The Government should establish a process for annual review of this analytical material and other reporting, to establish clear cross-departmental agreement on priorities for action, and make recommendations for structured Ministerial engagement including, where appropriate, Prime Ministerial and Royal engagement, including identification of the priorities for Ministerial visits in support of energy security objectives. This review should be chaired by DECC and include FCO, Cabinet Office, HMT, DfID, ECGD and the intelligence agencies, and others as necessary.

- Within the context of the National Security Strategy, the significance of energy security as a source of risk in relation to the other key drivers of national security should be assessed regularly. The right forum to consider this issue appears to be the Ministerial Committee on National Security, International Relations and Development, taking advice from the Sub-Committee on Environment and Energy.

- The Government should examine the case for a new Office for International Energy Security, bringing together more closely those working in different Government Departments on these issues.

List of Figures

List of Boxes

Annex A: Membership of the expert group

The Review drew on the expertise of, and was supplemented by consultation with, international institutions, academics, industry, overseas governments and others. An Independent Expert Group was established to help inform thinking and review the conclusions as they emerged.

Below is a list of those individuals and organisations that were members of this Group:

James Smith, Shell UK Ltd

Mark Carne, BG Group plc

Dr Peter Davies, Independent Advisor

Ian Marchant, Scottish & Southern Energy

Tom Burke, Rio Tinto

Ingrid Holmes, Climate Change Captial

Dr Timothy Stone, KPMG

Professor Dieter Helm CBE, University of Oxford

Christopher Allsop CBE, Oxford Institute of Energy Studies

Simon Blakey & Michael Stoppard, Cambridge Energy Research Associates

Dr Leo Drollas, Centre for Global Energy Studies

Professor Paul Stevens, Chatham House

Louise Kingham, Energy Institute

John Topper, IEA Clean Coal Centre

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