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UK GAS SECURITY: THREATS AND MITIGATION STRATEGIES

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THE SUSSEX ENERGY GROUP

The Sussex Energy Group is based at SPRU – Science and Technology Policy Research, University of Sussex. The Group undertakes academically rigorous, inter-disciplinary research that engages with policy makers and practitioners. The aim of this research is to identify ways of achieving the transition to sustainable, low carbon energy systems whilst addressing other important policy objectives such as energy security. SEG includes 25 social scientists and associated doctoral students. Core support is provided by the Economic and Social Research Council, with co-funding from a diverse array of other sources. Through the Group, the University of Sussex is a core partner of the Tyndall Centre for Climate Change Research and the UK Energy Research Centre.

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Dr Watson frequently works with UK government departments, and was a lead expert with the UK Foresight project on Sustainable Energy Management and the Built Environment (2007–08). He was a Specialist Adviser with the House of Commons Environment, Food and Rural Affairs Committee (2006–09). In 2008, he spent three months as a Visiting Scholar at the Kennedy School of Government, Harvard University. He is a Council Member of the British Institute for Energy Economics, a Trustee of the Koru Foundation, and a member of the Nuffield Council on Bioethics' working party on biofuels.

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EXECUTIVE SUMMARY

Reducing emissions and maintaining energy security represent the two greatest challenges for UK energy policy. Energy security and price stability is a growing political concern worldwide with huge economic, geopolitical and national security implications. Gas security has been central to the debate on energy security in Britain, focusing on increasing reliance on gas imports, price volatility and Britain's own dwindling resources and limited storage capacity. As a flexible, lower carbon fossil fuel, gas will play an important role in the UK's transition to a low carbon economy. An accurate, evidence based analysis of threats to gas security is necessary to ensure a balanced debate and policy response as the UK rapidly changes its energy system.

This paper reviews the UK's reliance on gas, assesses the full range of threats to supply and price security – both external to the UK and from within the UK – and identifies strategies to minimise security risks.

Gas plays a central role in the UK energy mix supplying 40% of the UK's primary energy. It is used extensively by households for heating, hot water and cooking and by industry, and provides 45% of the UK's electricity. Gas is likely to remain a major component of the UK energy system for many years. However, demand is likely to fall over the coming decade. Whilst business as usual forecasts from the Department for Energy and Climate Change (DECC) just a year ago showed some gas demand growth to 2020, the most recent projections show tha t climate policy could yield a substantial reduction in demand of almost a third by this date.

Contrary to much of the energy security debate, the most significant recent threats to the UK's gas supplies have not been from geopolitical crises abroad but from domestic infrastructure weaknesses in the UK.

This paper concludes that the most effective means by which the UK can minimise threats to gas security are demand reduction, increasing investment in gas storage capacity and improving diversity of UK gas supplies.

Reducing gas demand
Reducing overall demand for gas through energy efficiency measures in homes and businesses minimises the exposure of the energy system to gas security threats. It reduces the need for infrastructure and the impact of price spikes on customers.

Diversifying away from gas also reduces the proportion of the UK energy system exposed to gas insecurities. According to the Department for Energy and Climate Change, meeting the UK's 15% renewable energy target by 2020 could reduce gas imports by 20–30%. Meeting this target alongside other measures in the Low Carbon Transition Plan – particularly energy efficiency – could reduce overall gas demand by 29%.

Increasing gas storage
UK gas storage can meet 5% of annual gas demand. This is very low in comparison with many other EU countries, and a major concern. Increased investment in more strategic storage capacity is required urgently so that the UK can avoid undue exposure to supply disruptions, particularly in winter. The cost of strategic investment in storage is likely to be modest when compared to the cost to the economy of disruptions to gas or electricity supplies.

Improving diversity of gas supply
Ensuring that the UK is not over dependent on a particular source, supply route or producer reduces risks to gas supply and short term price spikes, although this may have less impact on overall price stability of gas because it is internationally traded. Norway is by far the major source of the UK's gas imports. Less than 2% of the UK's gas comes from Russia. As the UK's North Sea gas resources decline, the diversity of UK gas supplies is set to increase significantly. Imports from Russia, however, are expected to remain small. Much of the shortfall is expected to be met through piped and liquified natural gas imports from a diverse range of countries.

Reducing international risks
As the UK increasingly becomes an importer of fuels and as global competition increases, geopolitical threats to supply are often outside of the UK's control. The common assumption, though, that imported gas is inherently less secure than UK gas is not supported by the evidence.

Action to minimise gas demand, improve diversity of supply and to strengthen UK infrastructure and storage can significantly mitigate the risks – whether these originate inside or outside the UK.

In making decisions about what balance of strategies to employ, policy makers need to keep in mind this multi-dimensional nature of energy security. With appropriate investment and other strategies, the UK can maintain sufficient overall resilience to withstand disruptions at home and abroad as the UK moves to a low carbon energy system.

CONTENTS

INTRODUCTION

Energy security has risen up the global political agenda during the past few years. There are many reasons for this: rapid increases in oil and gas prices, particularly in 2008 before the recession hit; heightened concerns over terrorism in the wake of 9/11; the war in Iraq; and the blackouts that have hit several electricity networks – particularly in summer 2003.

The return of energy security

The global prominence of energy security as a critical policy driver is clearly reflected in the UK policy debate – it is increasingly prominent in recent energy White Papers, and has been the subject of several policy reviews including a recent report commissioned from former energy Minister, Malcolm Wicks MP (Wicks 2009). According to government statistics, the UK became a net importer of energy in 2004 when supplies of primary energy sources, such as coal, oil and gas, fell below the level of consumption. The UK had previously been a net exporter of energy (mainly as a result of North Sea oil and gas) for most of the previous 20 years. To compound matters, international prices of oil and other fossil fuels began to rise in the early 2000s after 15 years at relatively low levels. In addition, there was increasing anxiety about the UK electricity sector – due to the prospect that many existing coal and nuclear power plants were due to close in the near future.

Energy security vs climate change?

The prospect of new coal-fired power stations in the UK for the first time in over two decades has brought energy security into potential conflict with the other over-riding goal of UK energy policy: mitigating climate change. Advocates of new coal plants argue that it is necessary to replace older plants that are due to close to preserve the diversity of the UK's electricity mix. In an article in *The Times* earlier this year, Ed Miliband, Secretary of State for Energy and Climate Change, stated that:

> '[i]n the UK, a future without coal would most likely not mean more renewables, nor more nuclear, it would mean more power stations burning imported gas. Energy security comes from diversity, and coal provides an important part of that diversity'. (Miliband 2009).

Ed Miliband has taken a stronger line than his predecessor on the conditions under which new coal plants would be permitted, and has insisted that some of the capacity of each plant is fitted with equipment to capture carbon emissions (carbon capture and storage, or CCS) from day one. This technology could provide a way to square the policy circle, but as yet, it is unproven. He shares the views of many about the risks associated with a move away from coal – particularly the consequences of a continuing expansion of gas use in the UK.

This emphasis on CCS as a key technology for UK energy security is also shared by the Conservative Party. In their recent report, The Low Carbon Economy, it is argued that:

> '[CCS] can give us diversity of supply, importing coal from countries other than those which supply oil and gas; and it can increase our long-term security – through the potential for exploiting the UK's large indigenous coal supplies …' (Conservative Party 2008: 16).

Reviewing UK energy security: gas security and system resilience

These concerns about the particular role of gas – and the security of the UK's gas supplies – are understandable. Gas currently supplies 40% of the UK's primary energy. Gas-fired power plants generate 45% of the UK's electricity. Gas is also used extensively by households for heating, hot water and cooking, and by industry. It therefore has a central role in the UK energy mix – a situation that is likely to persist for some time. However, there is an expectation that demand will fall over the coming decade. Whilst business as usual forecasts from the Department for Energy and Climate Change (DECC) just a year ago showed some gas demand growth to 2020, the most recent projections of the impacts of climate policies show a substantial reduction in demand of almost a third by this date (DECC 2009d).

Against this background, Greenpeace commissioned this paper to review UK energy security with a particular focus on gas security and system resilience. The paper analyses UK gas security in an EU context, and considers the options for strengthening security in the context of increasing reliance on imported gas. It comprises three sections. Section 1 considers what energy security means, and argues that a systemic analysis of security needs to take into account a range of threats to security that are both external and internal to the UK. Section 2 analyses EU and UK gas supplies in some detail and discusses the debates about gas security at both policy levels. Section 3 then discusses some strategies for improving UK gas security, with a focus on demand reduction, improvements in supply diversity and investments in gas storage.

1. DEFINING ENERGY SECURITY: KEY THREATS

Threats to energy security come in many forms. Some threats can disrupt the provision of energy to consumers and businesses (e.g. through power blackouts) whilst others affect the price of energy (e.g. price spikes as a result of geopolitical tensions). Threats can be immediate or longer term, and can originate from inside or outside the country affected. Furthermore, the impacts of insecurity can be uneven. For example, energy intensive businesses and fuel poor households are particularly vulnerable to the effects of high energy prices.

Many threats to energy security are familiar and regularly make headline news but other less prominent threats have had a greater impact on UK energy security. For example, Russia's well-reported disputes with neighbouring countries over gas supplies consequently impacted on some European consumers. On the other hand, the UK's domestic gas infrastructure has suffered several failures in recent years which have impacted on our gas prices and availability far more than Russia's disputes with its neighbours.

Given this complexity, there is a need to be clear about what the key threats to energy security really are. This is a pre-requisite for any sensible debate about the extent to which measures to reduce greenhouse gas emissions can also strengthen energy security. Broadly speaking, threats to energy security can be divided into four main categories (Performance and Innovation Unit 2002; Watson and Scott 2008):

- Fossil fuel depletion and external disruptions
- Underinvestment in infrastructure
- Technology and infrastructure failure
- Deliberate disruption.

1.1 FOSSIL FUEL DEPLETION AND EXTERNAL DISRUPTIONS

There are potential threats due to fossil fuel scarcity or disruptions to fossil fuel supplies from international markets. Many discussions of energy security confine themselves to these threats. This tendency is understandable in the light of the pervasive economic impacts of fossil fuel price shocks. Most industrialised economies are dependent on fossil fuels for the vast majority of their energy needs. Furthermore, the reserves and production of these fuels (particularly oil and gas) is highly concentrated in the Middle East and Russia.

The prospect of absolute scarcity of oil has returned to the energy debate in recent years. Despite the inaccuracy of many past predictions of a global peak in oil production, there is increasing debate about the prospect of a peak in the next 10-20 years (e.g. UKERC 2009a). However, sceptics of the peak oil argument point out that it stems from a static view of fossil fuel reserves, and downplays the impact of fossil fuel prices and extraction technology on future availability. Even if the sceptics are correct, bodies such as the International Energy Agency acknowledge that the era of cheap oil may be over as developers shift to non-conventional reserves, such as tar sands.

1.2 UNDERINVESTMENT IN INFRASTRUCTURE

The UK's energy security could be threatened by events closer to home, such as a lack of investment in national energy infrastructures. Access to energy by consumers does not only depend on accessing supplies of primary fuels, but also on timely investment in power stations, transmission lines, gas grids and storage facilities.

Within the UK debate, there has been a particularly prominent debate about the prospect of an 'electricity gap' as old power plants reach the end of their lives or are closed due to environmental regulations. The strong impression has been given by some that a crisis is imminent. However, this argument ignores the track record of significant investment in new generation capacity since the electricity industry was privatised. For example, in the decade after the electricity industry was restructured in 1990, over 20GW of gas-fired capacity was constructed. It also ignores the queue of gas and renewable energy projects that are currently under development and have the potential to fill any 'gap' before it arrives.

Perhaps what lies behind the electricity gap debate is the fact that many of the new plants being built will burn gas. The UK's position as a net importer of gas leads to concerns that are linked more to the first category of threat. However, there is also a related threat to security from underinvestment in the UK gas infrastructure. Analysts such as Jonathan Stern argue that the UK debate has neglected home-grown threats to our gas supplies (Stern 2007). The Rough gas storage facility fire in early 2006 and the disruption to a major North Sea gas pipeline in 2007 both led to abrupt price increases. There is a case for arguing that this was due to a lack of alternative pipeline routes and storage capacity in the UK gas infrastructure.

1.3 TECHNOLOGY AND INFRASTRUCTURE FAILURE

Technical failures due to faults or external stresses, such as extreme weather, are a feature of all large infrastructure systems. They are usually absorbed due to spare capacity, but if they become widespread class failures, the consequences can be more serious. For example, the series of faults that affected gas-fired power plants in the UK in the 1990s. These faults emerged as a result of rapid technical change, and put a number of gas-fired power plants out of action, often for months at a time. Ample capacity margins meant that the effects could be managed even when these failures coincided with the winter demand peak – but only just.

Weather impacts on energy infrastructures can also be serious. One of the predicted impacts of climate change is that extreme weather conditions, such as droughts and flooding, are likely to occur more frequently. The underperformance of France's nuclear power plants in summer 2003 occurred due to intense heat. The reduced output from these plants was a contributing factor in the blackout that affected a large part of continental Europe at that time.

Other examples within this category include the effect of hurricanes such as Katrina on offshore oil and gas facilities in the Gulf of Mexico. Reliability and back up capacity are therefore important features of a secure energy system.

1.4 DELIBERATE DISRUPTION

Threats of this kind – particularly non-terrorist ones – are often underplayed. Yet in the last quarter of a century, some of the most important threats to UK energy security have taken this form. The miners' strike of 1984/85 caused the electricity industry serious difficulties in maintaining supplies. Similarly the fuel protests of 2001 exposed the vulnerability of distribution systems to targeted blockades of just a few key depots. Historically speaking, non-fossil energy sources such as renewable energy and nuclear power have been less vulnerable to such disputes. However, nuclear power plants are obvious potential terrorist targets – as are other parts of the energy infrastructure, such as gas pipelines, LNG terminals and oil tankers.

SUMMARY

A key message from this analysis of different energy security threats is that there is no automatic relationship between a reliance on domestic energy resources and a secure energy system. As the Cabinet Office Energy Review of 2002 pointed out:

> 'Experience with coal in the 1970s and 1980s, and the fuel protests of 2000 suggest that the equation of "domestic" and "secure" does not always apply. Imports of energy are not necessarily less secure than domestic sources'. (Performance and Innovation Unit 2002: 57).

This runs counter to some political rhetoric which emphasises the need for more independence from international sources of energy. Instead, it emphasises energy security as being a challenge of interdependency. There are both foreign and domestic threats to UK energy security. Equally, improvements to security can be achieved through investments in the UK to improve energy system resilience, but also through international cooperation.

2. UK GAS SUPPLIES IN AN EU CONTEXT

This section provides an overview of the situation of UK gas supply and demand balances taking into account recent history and projections. Since the UK's imports are set to increase in the coming years and will primarily come from Europe, EU Commission directives will become increasingly relevant to the UK. Therefore the European gas situation and EU level discussions are briefly reviewed in this section.

2.1 THE EUROPEAN CONTEXT

The European Commission expects that the implementation of the 20-20-20 targets by 2020[1] will reduce energy consumption in the EU by as much as 15% and will result in a reduction of expected energy imports by up to 26% as compared to business as usual (CEC 2008c: 2).

Current imports

As shown in figure 1, the EU imports 61% of its gross gas inland consumption out of which 42% comes from Russia, 24% from Norway, 18% from Algeria, and 16% from other countries (most of which is imported as LNG). As a result of declining EU domestic gas production the share of gas imports is likely to increase (CEC 2008c: 4).

For the EU as a whole, the Commission refers to a 'well-diversified supply picture'. Yet, the energy supply situation is quite different among EU member states. While Denmark is energy self-sufficient, Ireland, Italy, Portugal and Spain import more than 80% of their energy needs. More specifically on gas imports, a group of member states (Estonia, Latvia, Lithuania, Bulgaria, Slovakia, Ireland, Sweden and Finland) is fully dependent on one supplier[2], whereas Greece, Hungary, Romania and Austria import more than 80% of their gas from Russia (CEC 2008a).

Future consumption trends

After rapid growth in EU gas consumption in the 1990s consumption is expected to remain more stable in the future – at around one quarter of EU primary energy consumption – if policies implemented by the end of 2006 are taken into account (see figure 2).

If additional policies for bolstering renewable energy, as agreed since the beginning of 2007, are implemented, EU gas consumption would decline to 23% of primary energy consumption as

FIGURE 1: EU GAS IMPORTS

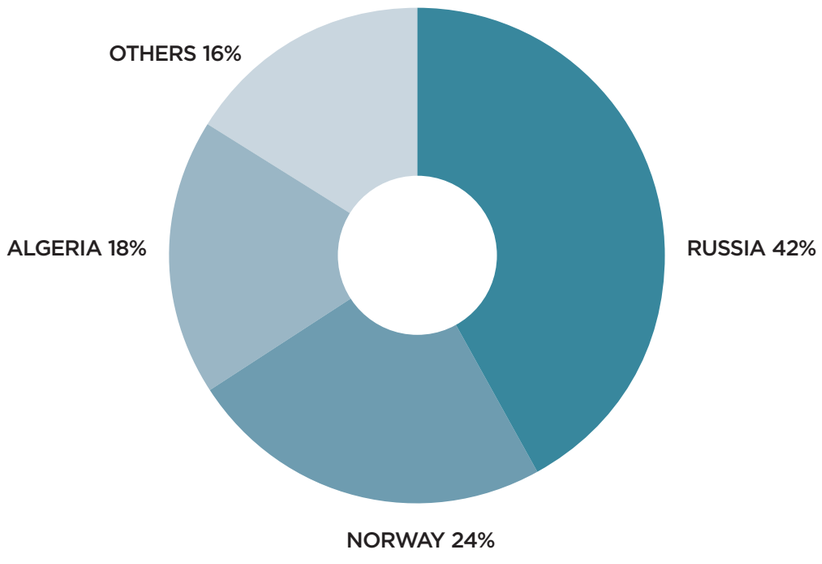
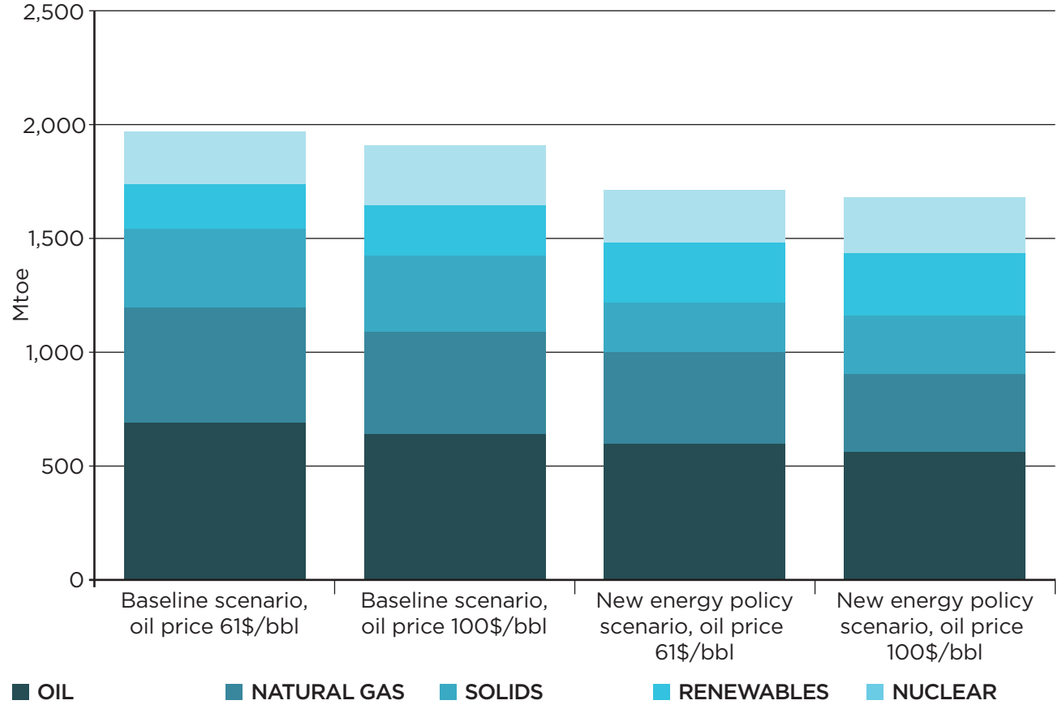


FIGURE 2: EU PRIMARY ENERGY FUEL MIX (MTOE) IN DIFFERENT SCENARIOS (CEC 2008A: 16)



these additional investments in renewable energy sources would replace gas. If oil prices rise again to $100 per barrel the share of natural gas could even decrease to 21% (CEC 2008a: 15-16).

Under current trends EU gas import dependency would raise to 77% in 2020 (see figure 3). However, rising oil and gas prices as well as the promotion of renewables will reduce gas consumption in power generation and will therefore reduce EU gas import dependency to between 71% and 73% in 2020 (CEC 2008a: 18).

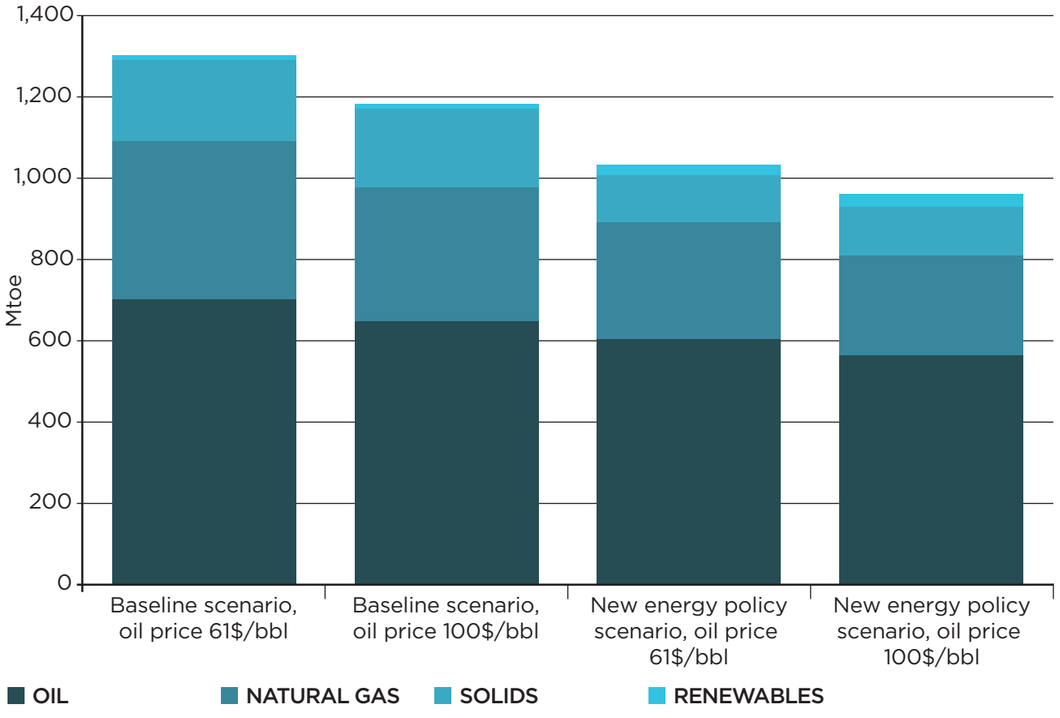
Energy security policies

Against this background the Commission recognises that the EU-27 is a net energy importer but argues that 'this import dependency is not a problem as such but requires appropriate policies' (CEC 2008a: 8).

To deal with dependency it argues for 'an active energy security policy' that builds on internal strengths including 'a well-functioning internal energy market with good interconnections, diversity in the types of energy used, clear regulation for security of supply and mechanisms for cooperation to deal with crises'. At the external level the Commission calls for diversification of suppliers and supply routes as well as closer cooperation with producers and consumers.

Security of gas supply was specifically addressed in 2004 in a Council directive[3] which requires member states to clarify roles and responsibility for security of gas supply and imposes mandatory protection for household gas customers.

FIGURE 3: EU NET ENERGY IMPORTS (MTOE) IN DIFFERENT SCENARIOS (CEC 2008A: 18)



Coordinating responses to disruptions

At European Community level the Gas Coordination Group was established to regularly review the gas situation in the EU and to act as a potential mechanism for coordinating responses in the case of supply disruptions. In its first report on the implementation of this directive, the Commission notes in November 2008 that security of supply 'is more and more seen as a public good deserving a closer attention from the European Union' (CEC 2008b: 3).

Strategic stocks

While the Commission supports greater harmonisation of security of supply standards and predefined emergency measures on regional and EU levels, it argues that due to insufficient evidence it is too early to go for obligatory strategic gas stocks since they are at least five times more expensive than oil stocks. Instead, the promotion and 'effective transparent operation of commercial storages, diverse supply connections enabling flexible sourcing from LNG or neighbouring providers within the EU internal market, and rapid demand reduction through interruptible contracts and fuel switching especially in electricity generation' (CEC 2008c: 11) are considered as more effective.

Planning security action

Other measures proposed as part of a five-point EU Energy Security and Solidarity Action Plan included (CEC 2008c):

- Infrastructure needs and the diversification of energy supplies
- External energy relations ('speaking with one voice')
- Oil and gas stocks and crisis response mechanisms
- Energy efficiency
- Making the best use of the EU's indigenous energy resources.

Emphasising infrastructure

In response to the gas crisis between Russia and the Ukraine in January 2009 the EU put more emphasis on energy infrastructure as a key element to ensure the EU's security of supply. The strong emphasis on gas and electricity infrastructure investments is also reflected in the EU's recovery plan (CEC 2009a). As adopted by the European Parliament in May 2009 it allocates almost half of the total sum of €5 billion in 2009 and 2010 (€2,365 million) to gas and electricity infrastructure investments (EP 2009).

SUMMARY

More recently the EU seems to follow a broader energy and gas security strategy that addresses the various dimensions of energy security outlined in section 2 of this paper with a strong focus on investment and infrastructure. This might be explained by the Commission's limited ability to act at the geopolitical level as member states still prefer bilateral strategies with supplier countries and thus undermine the regularly proclaimed objective to 'speak with one voice'.

Case study: responding to the Russia-Ukraine dispute supply crisis

The EU's ability to deal with a serious gas supply crisis was tested in January 2009 when, as a result of a dispute between Russia and the Ukraine, some member states and their neighbouring countries were partially or completely cut off from Russian gas supplies. Despite its ambitions to contribute to a quick solution of the crisis, the Commission played a rather weak role due to little technical capability and political credibility (Pirani, Stern et al. 2009). Whilst some Member States and private companies did act in solidarity within the EU and towards neighbouring countries that were cut off from Russian supplies (CEC 2009b), the effectiveness of the Commission in such situations remains in doubt (Pirani, Stern et al. 2009).

In the UK the Russia-Ukraine crisis resulted in higher gas spot prices. During the crisis the UK was exporting gas to the continent via its interconnector due to higher gas prices in continental Europe. Despite this external threat to Western gas supplies caused by a dispute between Russia and the Ukraine, UK gas security was, officially, not considered as being under threat. Ed Miliband did not see any major threats to the UK's security of gas supply – and referred to the UK suppliers' legal obligation to supply UK customers (Macalister and Sparrow 2009).

This reaction was a balanced one. Unlike other UK policy statements that often emphasise the geopolitical threats to UK energy security in general – and gas security in particular – this assessment emphasised the benefits of the UK's diversified imports policy.

2.2 UK GAS SUPPLY AND DEMAND[4]

Falling demand

Projections for UK gas demand have been revised repeatedly in the last few years. Due to the economic recession, gas demand has recently fallen sharply. Demand in the second quarter of 2009 was 14% lower than in the same period in 2008. Even before the recession took hold, forecasts of future demand growth had been adjusted downwards. The National Grid's 2008 Ten Year Statement projected an annual gas demand growth of just under 1% per annum as opposed to the 2007 Ten Year Statement that predicted annual gas demand growth of 2.3% per annum. This change was mainly due to high fuel price forecasts and slower economic growth forecasts.

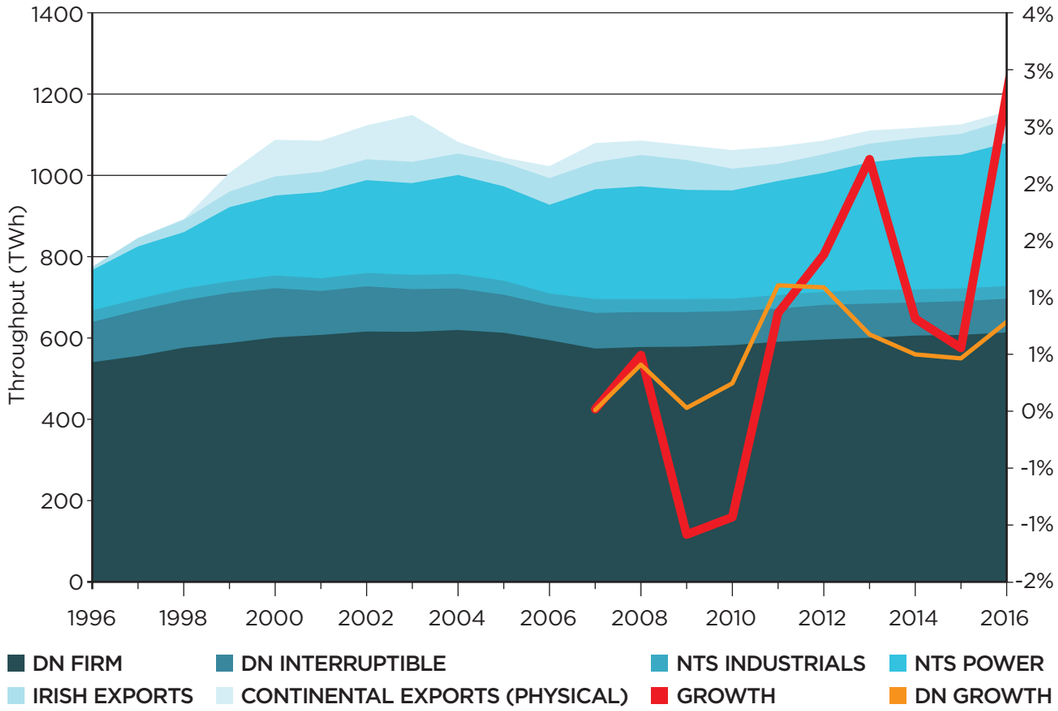
Key factors affecting demand

The National Grid's 2008 Ten Year Statement predicted levels of import dependency significantly lower than previously expected because of the lower increase in gas demand. In the 2007 Statement, import dependency was forecast to be 51% in 2010-11 and 79% in 2016-17 whereas the 2008 statement expects that in 2017-18 72% of the UK gas consumption will be based on imports – in the 2005 statement an import dependency of even 80% in 2014-15 was predicted (National Grid 2005; National Grid 2007; National Grid 2008a). This rather high variation in import forecasts illustrates the sensitivity of gas demand to a variety of factors including:

- prices
- economic growth
- weather
- policy intervention.

This underlines an important point: that gas security is a multi-faceted challenge that must be dealt with by measures that focus on all of these factors.

FIGURE 4: HISTORICAL AND FORECAST ANNUAL GAS DEMAND (NATIONAL GRID 2008B)



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

Falling demand in households

The 2008 Ten Year Statement also shows that between 2005 and 2008, household gas consumption has decreased by over 7% despite an increase of the number of supply points (National Grid 2008a: 20). It is assumed that this demand reduction is a result of consumers' response to high gas prices mainly through behavioural changes and to a lesser extent a result of thermal efficiency improvements (e.g. loft insulation). This trend in domestic demand reductions is expected to continue. According to the 2008 National Grid Ten Year Statement, growth in gas demand is mainly expected for the electricity generation sector at a level of 3% per annum over the forecast period.

Gradually increasing import dependency

As for the UK gas supply situation, recent history and the forecast shows a gradual increase in the UK's import dependency starting in 2000/01 reaching roughly a third of total gas supplies in 2007/08 (see figure 5). These include:

- **Imports from Norway:** Norway is the major gas supplier for UK gas imports and is expected to remain in this position until 2018/19 when liquified natural gas (LNG) supplies will take the lead position among gas import sources (Figure 6). This is a rapid change from the current position of very small LNG imports.
- **Liquid Natural Gas imports:** In 2008, LNG imports came from Algeria and Trinidad and Tobago, whilst in 2009 these imports also came from Egypt, Qatar and Norway (Wicks 2009).
- **Imports from Europe through interconnectors:** The third source of imports will continue to come from interconnectors with Continental Europe. Only a small proportion of this third source of imports originate in Russia - less than 2% of UK gas comes from Russia at present[5]. According to the recent review of UK energy security by Malcolm Wicks MP, this is likely to remain the case for the next two decades (Wicks 2009).

Supply security and price security

This trend of slowly increasing imports will result in a higher exposure of the UK to an increasingly internationalised gas market underlining the need to distinguish between supply security and price security. Whereas the physical gas supply is strongly dependent on national investments and infrastructures and thus on national policy and regulatory frameworks, gas prices will be determined by international market dynamics.

FIGURE 5: UK ANNUAL SUPPLY AND DEMAND (NATIONAL GRID 2008A)

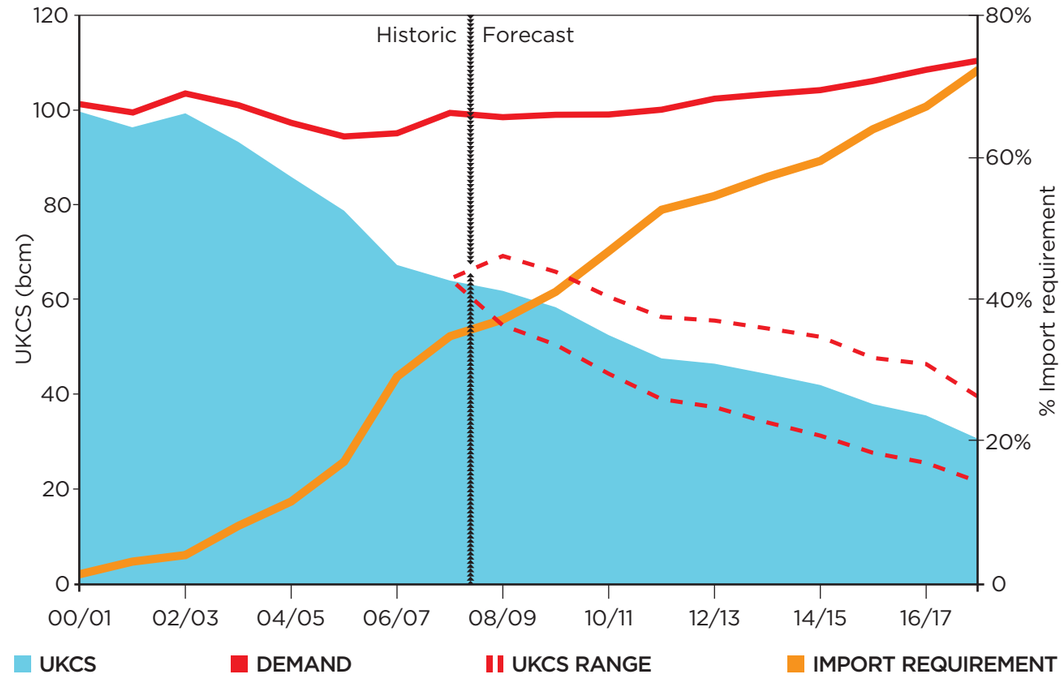


FIGURE 6: ANNUAL GAS SUPPLY FORECAST (BASE CASE) (DECC 2008)

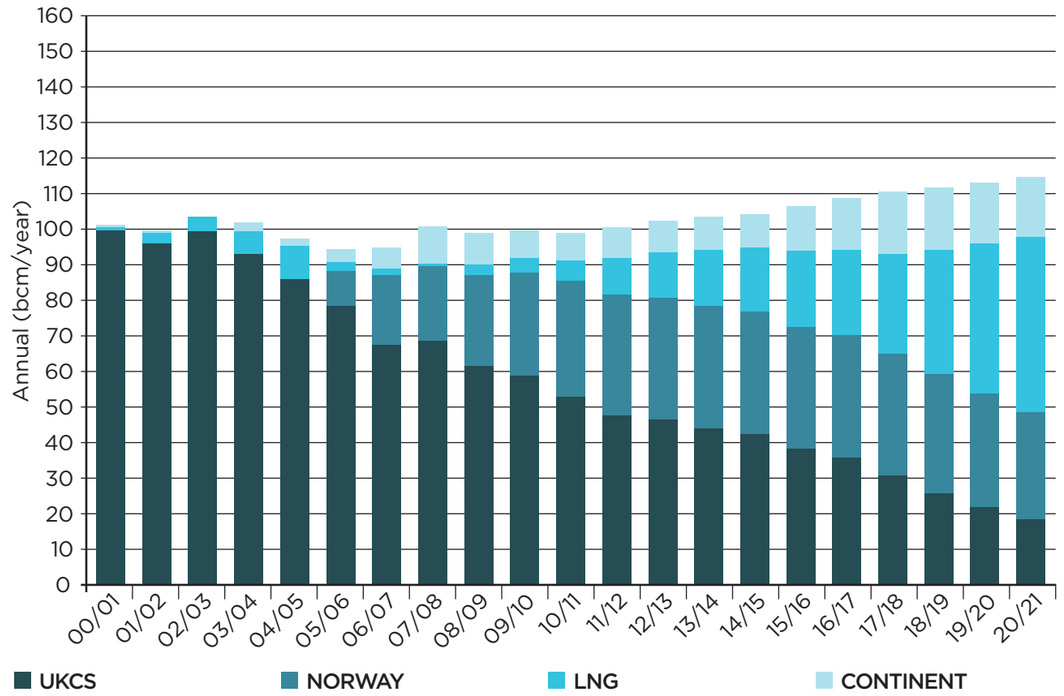
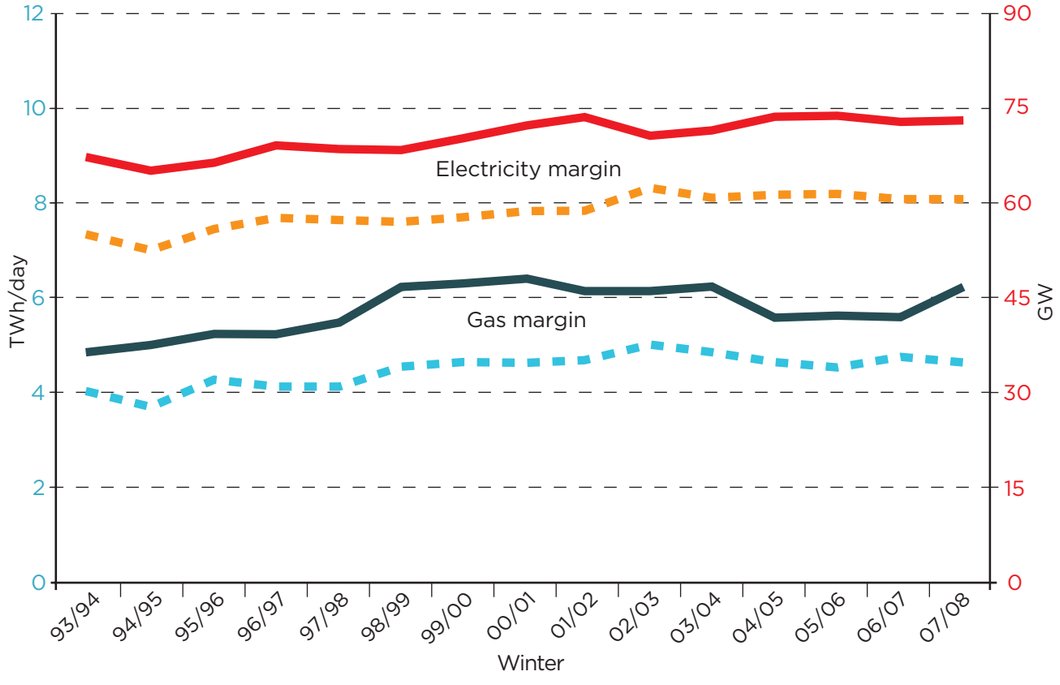


FIGURE 7: GAS AND ELECTRICITY CAPACITY MARGINS – MAXIMUM SUPPLY AND MAXIMUM DEMAND 1993/94 TO 2007/08 (BERR 2008A: 9)



LEFT AXIS

- FORECAST MAXIMUM GAS SUPPLY
- ACTUAL MAXIMUM GAS DEMAND

RIGHT AXIS

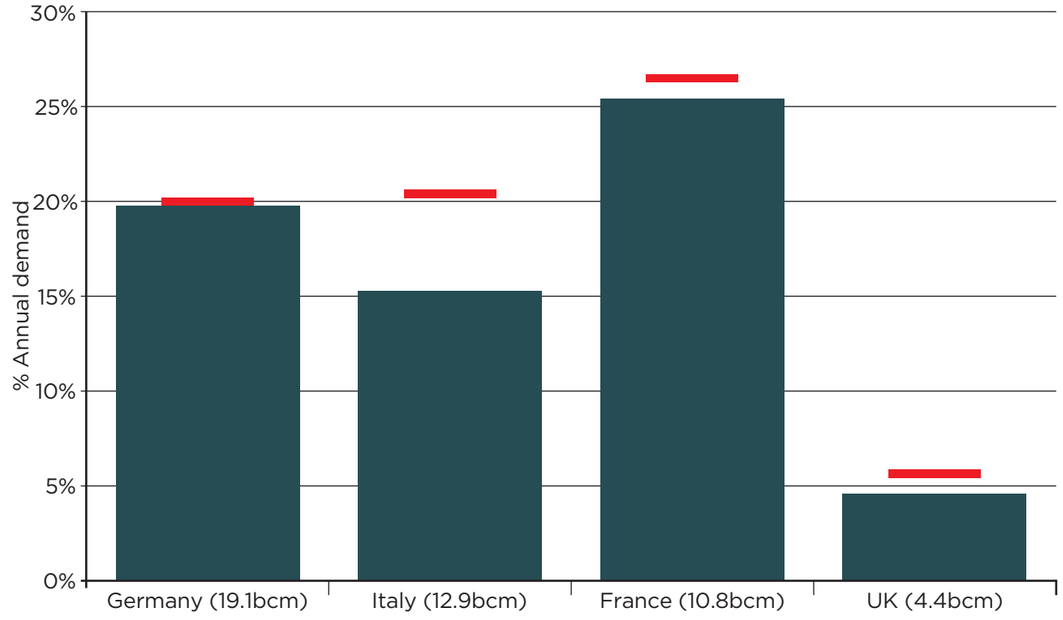
- TOTAL ELECTRICITY DECLARED NET CAPACITY
- SIMULTANEOUS MAXIMUM ELECTRICTY LOAD MET

Future balance of gas supply and demand

The UK's future gas supply situation in terms of available supply capacity and expected demand shows excess supply capacity (National Grid 2008a: 59). For all years up to 2017/18 capacity by far exceeds average demand in February – the month with highest gas demand. The significant decrease in UK Continental Shelf (UKCS) supplies will be offset by strong increases in medium range storage and LNG import capacity. National Grid assessed the UK's gas security of supply for three winter periods (2008/09, 2012/13 and 2017/18) and concluded that there is sufficient infrastructure capacity available to cover even extreme demand fluctuation, which is, however, subject to supply availability. In addition the UK's 15% renewable energy target by 2020 could reduce fossil fuel consumption by 10% and gas imports by 20-30% (Department of Energy and Climate Change 2009c).

These results broadly confirm a previous analysis by Oxera for the Department of Trade and Industry, assessing potential measures to improve gas security of supply, in 2007. On the basis of existing gas delivery infrastructure, UKCS production estimates and additional infrastructure projects up to 2009/10 (as reported by the government's advisory body, JESS[6]), Oxera identified a great improvement of the UK's gas supply and demand balance over time. Yet, Oxera also concluded that the UK gas market is likely to become tighter from 2013/14 onwards under the investment scenarios it considered at the time (Oxera 2007). One reason for this more pessimistic view is that the forecast annual rate of gas demand growth in 2007 was 2.3%, whilst in 2008 this had been revised downwards to 1% (see earlier discussion above).

FIGURE 8: GAS STORAGE CAPACITIES IN SELECTED EUROPEAN COUNTRIES (NATIONAL GRID 2008A)



- END 2007
- UNDER CONSTRUCTION

Trends in the gas capacity margin over the past few years add further weight to this relatively positive picture. This is in contrast to the case of electricity, in which the percentage margin between total electricity capacity and maximum load fell from 23% for the winter period in 2006/07 to 19% in 2007/08. The percentage margin between forecast maximum gas supply and actual maximum gas demand has increased from 16% in 2006/07 to 34% in 2007/08 (BERR 2008b). Figure 7 illustrates this.

UK gas storage capacity shortages

Against the background of the scenarios shown in figures 4 to 7, there is a need to consider whether the UK gas infrastructure will continue to be resilient enough. This paper has already highlighted the issue of gas storage – and the way in which the lack of storage has contributed to gas security problems in recent years. The UK has a significant shortage in gas storage capacity (4.4 billion cubic metres) when compared to other major European countries such as Germany (19.1bcm), Italy (12.9bcm) or France (10.8bcm). While the existing UK gas storage capacity equals less than 5% of annual gas demand, German gas storage capacity equals 20% of annual gas demand. Even if the storage capacities currently under construction in the UK are taken into account, this picture does not change significantly (see figure 8). However, if the proposed UK storage investments are realised, the National Grid assumes that storage space could increase to 10% of expected annual UK gas demand by 2020/2021. However, this would be a lower proportion of demand than the case for many other countries in Western Europe.

2.3 THE POLITICAL CONTEXT IN THE UK

Despite the projections of increasing supply margins and storage capacity, the UK's gas security debate has continually tended to focus on external threats to security whilst neglecting the more relevant internal factors like infrastructure related risks (e.g. JESS 2006). This led the 2007 White Paper to misleadingly frame energy security predominantly as a 'global challenge' (DTI 2007: 28). This focus on external dimensions of energy security has increased

considerably since the 2003 UK Energy White Paper. Until a few years ago, government policy documents tended to consider international energy trade as an integral part of the (economic trading) relationship with other countries. Since the 2006 Energy Review, such trade has been increasingly framed as a threat to the UK (Scrase and Ockwell 2009). As noted in the introduction to this paper, there are understandable reasons for this external focus. The UK is no longer self-sufficient in gas and prices have been relatively high for the past few years. However, empirical assessments of UK gas security reveal a different picture. In particular, they show that the key threats to UK gas security in recent years have come from failures in UK gas infrastructure (Stern 2009). This evidence suggests that the policy discussion needs to put more emphasis on internal threats to gas security, such as underinvestment or failure of critical infrastructures.

Interestingly, a more recent technical report by the government published at the end of 2008 takes this broader view on energy security and acknowledges its multi-dimensional character. Department of Energy and Climate Change Energy Markets Outlook Report concedes:

> 'While discussion about security of supply often focuses on the risks arising from import dependency, or the margin of electricity generating capacity above peak electricity demand, shortcomings in these areas have not historically been the main causes of interruptions to energy supply'. (DECC 2008: 8).

The Energy Markets Outlook Report highlights various risks to energy security including many of those highlighted earlier in this paper:

- unplanned outages of transmission and distribution networks
- accidents, such as the fires at the Rough gas storage facilities and at the Coryton and Pembroke oil refineries
- extreme weather, such as the floods that affected much of the West of England in 2007 or the hurricanes that threaten oil supply in the Gulf of Mexico
- industrial action, such as the dispute at Grangemouth which affected petroleum deliveries and the operation of the Forties pipeline
- 'lower probability risks' such as terrorism or pandemics.

In addition, the Energy Markets Outlook Report distinguishes between different time scales in relation to security of energy supply:

- **Short term** – particular emphasis on the reliability of the infrastructure in place, including technological and commercial mechanisms.
- **Medium term** – focusing on the availability of infrastructure, the planning process and supply chain issues which includes raw materials, technical components and skills.
- **Longer term** – major concerns over the availability of primary sources of energy.

Despite this broad, systemic analysis of energy security within the Energy Markets Outlook, such a holistic view has not yet been reflected in major policy documents.

3. STRATEGIES FOR UK GAS SECURITY

The DECC Energy Markets Outlook provides a useful point of departure for a discussion of strategies to maintain or improve UK gas security. It mentions a number of options for doing this, including:

- investments in import and storage infrastructure
- improving UK and EU gas markets
- working to develop international energy markets, encouraging demand-side action
- maximising the implementation of energy efficiency measures (DECC 2008).

All of these measures are likely to be important in reducing the risks from the threats outlined in section 2 of this paper. In this concluding section of the paper, three strategies for improving UK gas security are discussed in more detail: demand reduction, gas storage and the diversity of gas supplies.

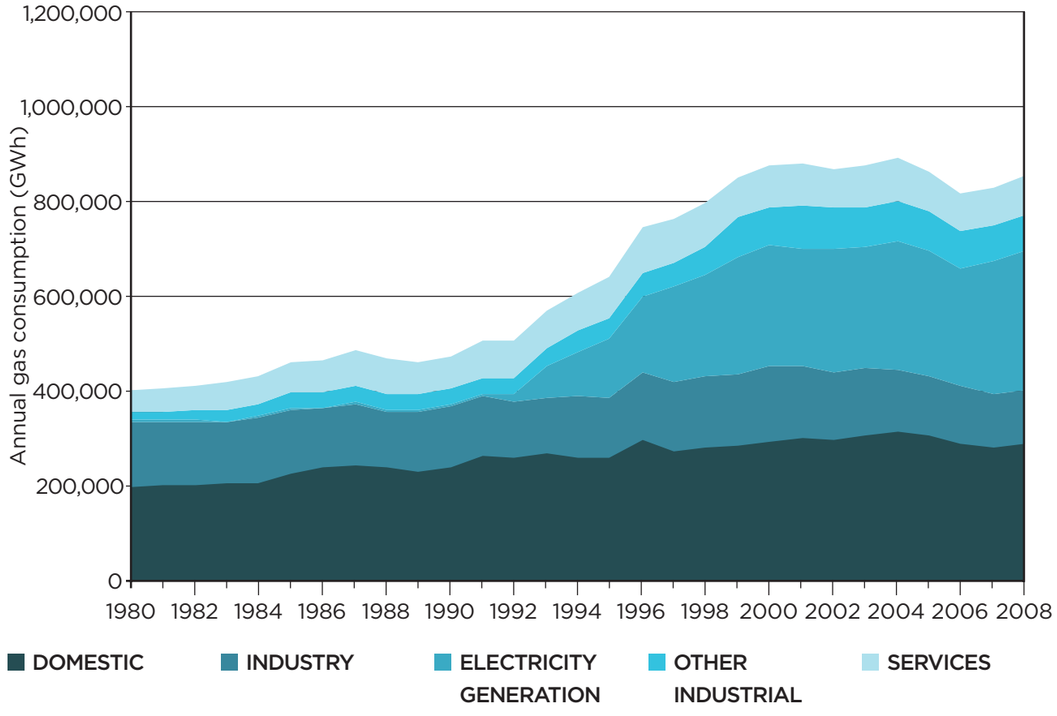
3.1 DEMAND REDUCTION

Reducing energy demand is potentially one of the most important ways to improve the resilience of the UK energy system. As a recent study by the UK Energy Research Centre (UKERC) has pointed out, reducing energy demand reduces the need for energy supply infrastructure. Demand reduction may not necessarily deal with external threats (e.g. to improve security by reducing import dependence) as is sometimes claimed. For example, reduced demand may still be met by imports if these imports are cheaper than indigenous sources of energy. However, it does mean that any threats to energy system security – whether internal or external – are likely to have a lower impact. As the UKERC study concludes: 'the gas/electricity system could ride out all but the worst infrastructure outages if demand levels fall' (UKERC 2009b). Furthermore, the impacts of high prices will not be as economically damaging if energy accounts for a lower proportion of the costs of households and businesses.

When it comes to managing UK gas demand, there is clearly a role for energy efficiency investments as well as for alternative ways of meeting demand for heat and electricity. Within this, it is important to note which sectors are the largest consumers. As figure 9 shows, households and the power sector are the largest gas consumers in the UK. The figure also shows why rising gas use in the power sector has emerged as an issue of concern for UK energy security. However, measures implemented with the intention of reducing this rise in future (such as building new coal plants) will not necessarily help reduce the vulnerability of other gas users to security threats. For example, the construction of 5GW of new coal-fired power stations fitted with CCS instead of gas-fired power stations could displace around 5bcm of annual gas demand. This would only be approximately 5% of current UK annual gas demand. Therefore, from a security point of view, the demand for gas in other sectors – particularly households – also matters.

National Grid states that 'schemes such as [the Carbon Emissions Reduction Target], coupled with high energy prices and the subsequent publicity and guidance around household energy saving measures have the potential to significantly reduce [distribution network] demand over the forecast period' (National Grid 2008a: 27). The introduction of smart meters might reduce domestic demand by 5%, although there is no clear evidence on the impact of such a measure. It is however considered by some analysts to be potentially significant in lowering gas prices, and thereby making new investments less likely (Oxera 2007). Oxera provided a cost-benefit analysis of seven different measures to increase the UK's gas security considering the period between 2007/08 and 2020/21 (Oxera 2007). It concludes that 'measures that promote greater demand-side flexibility are largely beneficial to security of supply and should be encouraged where possible (although no clear mechanism has been identified through which such behavioural changes can be guaranteed)' (Oxera 2007: xi).

FIGURE 9: GAS CONSUMPTION BY SECTOR (DECC 2009A)



SUMMARY

Under every forecast it is very likely that gas will retain a significant role in the UK energy system for many years. Therefore, there is a need for policy to strengthen gas security (and therefore energy security) through other complementary strategies.

3.2 GAS STORAGE

As the previous section of this paper has noted, one of the UK's key vulnerabilities is the lack of strategic gas storage. This vulnerability was underlined in 2006 when the Rough gas storage facility fire meant that the majority of the UK's storage capacity was unavailable for an extended period of time. This is a classic example of the way in which a technical failure in domestic energy infrastructure can be a threat to UK energy security. The impact of the Rough fire would have been less serious if the UK had a greater level of strategic gas storage – and the distribution of this storage capacity were more balanced.

As section 3 also noted, the UK has a modest amount of storage capacity in comparison with other EU countries. UK storage can meet approximately 5% of annual gas demand. In Germany for example, the figure is closer to 20%. This lack of storage is partly a legacy of the UK's period of self-sufficiency in gas, and partly a product of the particular model of gas market regulation the UK implemented during the 1990s. This model encouraged companies to make maximum use of their existing assets and did not provide incentives for investment in spare capacity or strategic gas storage. Whilst a number of UK storage projects are in planning or under construction, their eventual impact is uncertain. There is still a debate about the extent to which current incentives are enough for gas companies to invest in sufficient strategic storage (Stern 2009). If levels of investment do not rise significantly to increase UK storage capacity to a much higher percentage of gas demand, the case for new policy incentives will become very strong. As the UK Energy Research Centre observed in its report on the security of low carbon energy systems:

'There is a policy choice to be made about investment in 'strategic' storage or other facilities which could probably only be justified if developers could earn a risk-free regulated rate of return on the assets. Nevertheless, the cost of strategic investment is relatively modest compared to aggressive energy efficiency measures or back-up capacity for renewables' (UKERC 2009b: 141).

3.3 DIVERSITY OF GAS SUPPLIES

A third approach to improving gas security is to enhance energy system (and gas system) diversity. In principle, diversity is a good way of making sure that an energy system is not over dependent on a particular energy source, supply route or producer. However, in energy policy discussions, advocates of diversity are sometimes imprecise about the kind of diversity a particular strategy will add to the energy system.

Diversity is a system property that is usually discussed in the context of the electricity system. As noted in the introduction to this paper, Ed Milband recently wrote that 'Energy security comes from diversity, and coal provides an important part of that diversity' (Miliband 2009). But the context of this quote was a discussion of electricity not energy. This illustrates an important point: diversity can be discussed with respect to the overall energy system – or a subset of that system, such as electricity generation or infrastructure for gas imports.

A further issue is that diversity is about more than just having a lot of different options in an electricity generating mix or a portfolio of supply routes for gas imports. There are three distinct sub-properties of diversity: variety, balance and disparity (Stirling 1998) and all must be taken into account at the same time.

- **Variety** is a simple measure of the number of different options that are supported or deployed within the portfolio.
- **Balance** refers to the profile of shares of these different options within the portfolio. For example, a portfolio of gas storage in which one site accounts for 60% of the capacity and four further options account for 10% each might be less diverse than a portfolio of five sites that can provide 20% each.
- **Disparity** captures the extent to which constituent options are different from each other. An electricity generation portfolio that supports ten different lower carbon coal technologies is less diverse than a portfolio that supports ten renewable energy technologies. This is because the renewable energy category includes many more disparate options.

Recent government energy indicators include a measure of diversity known as the Shannon-Wiener index for both electricity and energy as a whole. This index captures some attributes of diversity (such as variety and balance) but does not capture others (disparity).

As shown in figure 10, the Shannon-Wiener index illustrates a steady increase in overall UK energy diversity from the early 1970s until the mid 1990s. The decline in diversity in the late 1990s is mainly due to a general increase in gas demand (particularly from power generators) and the decline of other fuels. Increased use of coal and renewables resulted in an increase in diversity in 2005 and 2006 which was corrected for in 2007 by lower consumption of coal and nuclear electricity (see figure 10).

Figure 11 shows that the diversity of the UK's fuel mix for electricity generation also increased quite significantly from the mid 1960s to the mid 1990s and has remained rather stable since then. Electricity diversity strongly increased from the early 1990s as a result of the dash for gas. While the recent resurgence of coal increased diversity, the decline of nuclear energy has decreased diversity.

FIGURE 10: DIVERSITY OF SUPPLY OF PRIMARY FUELS (1970–2008) (DECC 2009B)

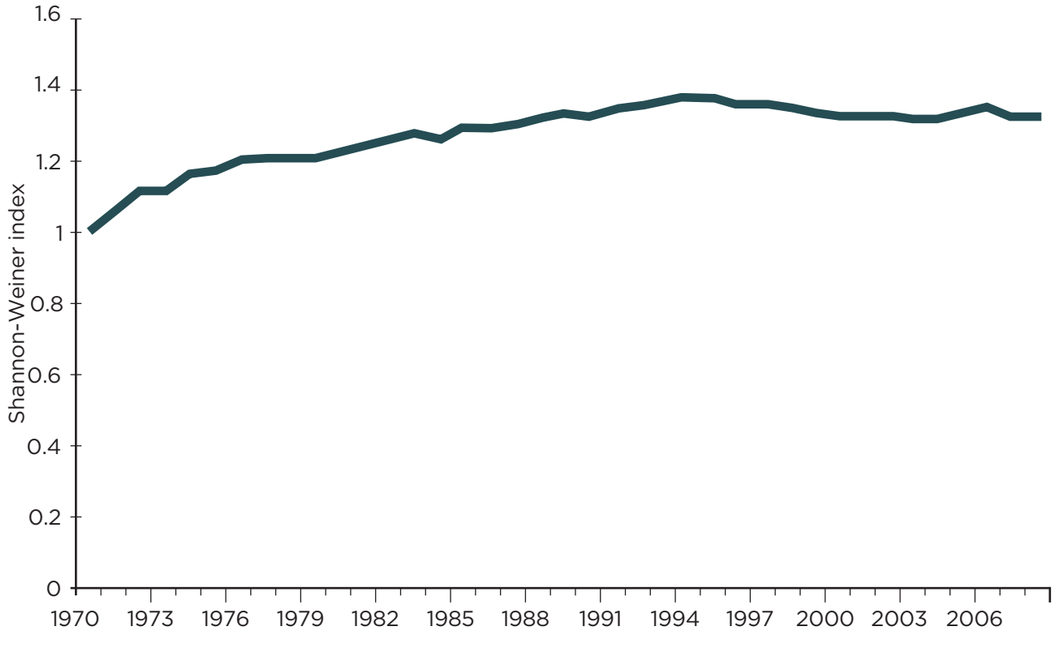
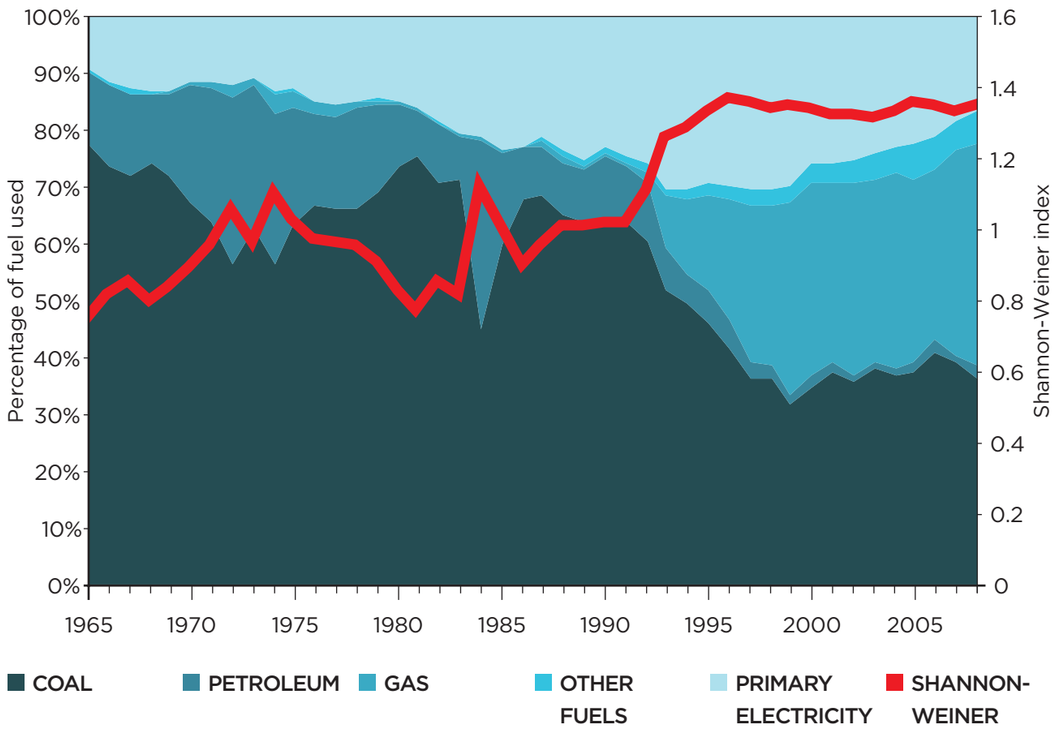


FIGURE 11: SHARES AND DIVERSITY OF FUELS USED FOR ELECTRICITY GENERATION (1965-2008) (DECC 2009B)



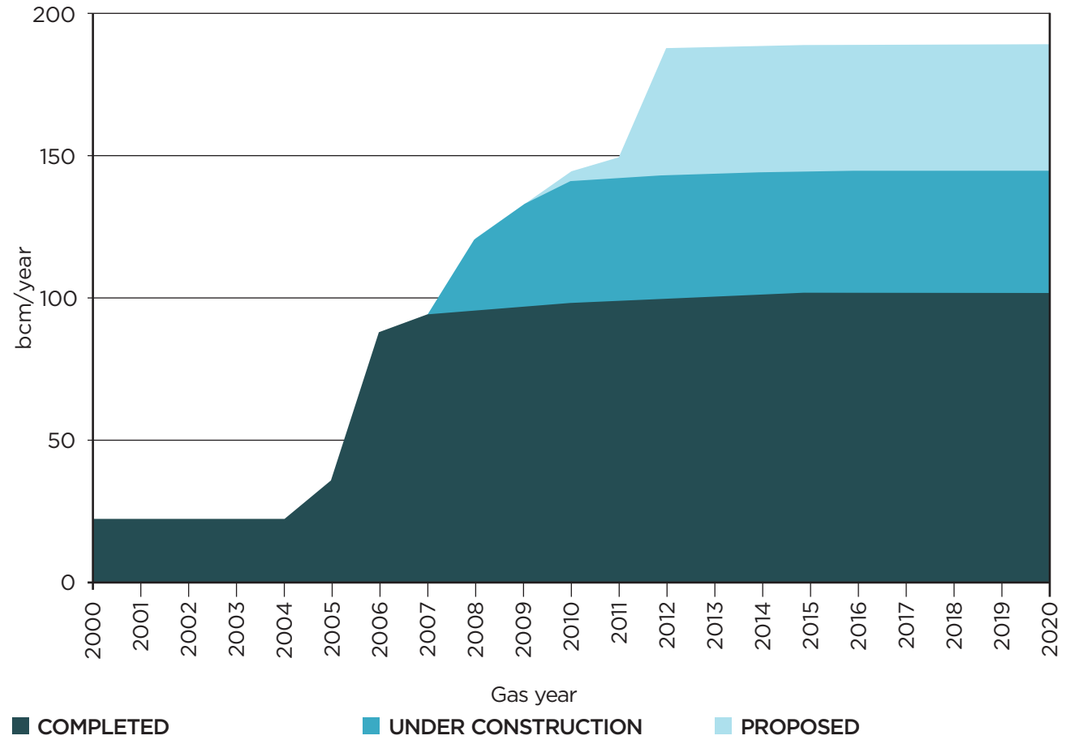
In addition to a lack of measurement of disparity between sources within the UK energy or electricity mix, one key weakness of both these indices is that they do not capture diversity within each energy source (or group of sources in the case of primary electricity). Therefore, all gas is lumped together in a single category – and it makes no difference to the index whether the UK uses gas from ten different countries or just one. Similarly, the index makes no distinction between a UK energy or electricity system that gets all its gas via a single pipeline and one that uses a variety of different supply pipelines and LNG terminals. In reality, sourcing UK gas from several countries via a number of routes makes a big difference to energy security. A technical failure of one piece of gas import infrastructure or a disruption to a particular international pipeline would have far less effect if the gas supply system includes a high level of diversity.

Within the policy debate about UK gas security, there has recently been some recognition of this important point. In a speech to Imperial College in December 2008, Ed Miliband emphasised that increasing diversity within the UK's gas supply system is now a key strategy for energy security:

> 'As we increasingly become an importer of fuels, and as global competition increases, government must take a view about whether our security is supported by sufficient diversity. So government must actively safeguard our security of supply by ensuring a range of sources of gas – hence our interest in the Southern Corridor linking Europe to the Caspian Sea and our interest in building gas supply from Gulf states, such as Qatar.' (Miliband 2008).

Figure 12 illustrates this growth in UK gas import infrastructure. It shows that the amount of capacity is expected to continue to increase over the coming decade.

FIGURE 12: ANNUAL UK GAS IMPORT CAPACITY BUILD-UP (DECC 2008)



As a result of this increase in import capacity, the diversity of UK gas supplies is set to increase significantly. As section 3 of this paper has already illustrated (see particularly figure 6), government projections expect a portfolio of gas supplies by 2020. This projection includes LNG (approximately 43%), North Sea gas from Norway (27%), gas from the UK Continental Shelf (17%) and gas via interconnectors from the main European gas grid (13%). Any imports of Russian gas would come under the latter category – though, as noted earlier, these are minimal at less than 2% of UK demand at present.

Whilst this improvement in diversity will clearly be positive for energy security, it does not necessarily help with the price dimension of security. Because gas is internationally traded, such diversity would not completely insulate UK gas consumers from high prices. In fact, due to obligations placed on suppliers in other EU countries, UK prices have often been higher than those in continental Europe at times of high demand. However, this diversity may reduce the impact of short term price spikes from disruptions to part of the gas infrastructure (such as the one that followed the damage to the North Sea CATS pipeline in 2007).

4. CONCLUSIONS

In conclusion, these strategies of demand reduction, gas storage investment and improving diversity within the gas supply system can all add to UK energy security. Energy efficiency has a particularly important role to play in minimising the exposure of the energy system to security threats – and the lack of strategic storage in the UK is an area of major concern. These strategies are not only important in mitigating threats from external disruptions to gas supplies, they can also help to make the gas system resilient to security threats within the UK.

Imported gas is not inherently insecure

As noted several times in this paper, these internal threats to gas security have had the most tangible impacts on the UK over the past few years – not supply disruptions abroad. The tendency to focus on external threats within the political discourse is understandable: geopolitical threats are often outside the UK's control. But when such threats get over emphasised at the expense of tangible domestic threats to energy security, UK political discourse has a problem. This perhaps reflects a process of psychological adjustment to import dependence – a normal state of affairs for many countries. But the common assumption that imported gas is inherently less secure than UK gas is clearly wrong.

A multi-dimensional approach to energy security

Given that the UK's gas use is likely to be significant for many years to come, all three of these strategies are important to pursue. As the government notes, it is also important to ensure international markets work effectively – though there are limits to this due to security measures taken by other countries (such as obligations to store a certain amount of gas which is then unavailable to trade). In making decisions about what balance of strategies to encourage, policy makers need to keep in mind the multi-dimensional nature of energy security – and the benefits of access to international markets as well as the costs.

As the Department of Energy and Climate Change's Energy Markets Outlook Report acknowledges, no single indicator for security of energy (capacity, margin, reliability, diversity and price) is sufficient on its own. Instead it argues that the relative importance needs to be taken into account, e.g. low diversity does not necessarily constitute a threat to security of supply but depends on the expected reliability of each source (DECC 2008). Therefore, security needs to be assessed from a system perspective.

Policy makers cannot be expected to predict and respond to each individual security threat that might arise. Instead, policy needs to ensure that the overall resilience of the UK energy system is high enough to withstand disruptions at home and abroad as the low carbon transition is implemented.

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ENDNOTES

1 20% reduction of greenhouse gas emissions by 2020 compared to 1990; 20% reduction of EU energy consumption compared to projections for 2020; 20% share of renewable energy by 2020.

2 Estonia, Latvia, Lithuania, Bulgaria, Slovakia, and Finland import 100% of the natural gas from Russia, Ireland from the UK, Sweden from Denmark (CEC 2008a).

3 Council Directive 2004/67/EC of 26 April 2004 concerning measures to safeguard security of natural gas supply.

4 Key data sources were recent Ten Year Statements by National Grid and various publications by BERR/DECC.

5 Parliamentary written answer from Mike O'Brien MP, 19th January 2009.

6 From 2001 to 2006 the Joint Energy Security of Supply (JESS) working group was the government's advisory group on energy security. It has been succeeded by an annual Energy Markets Outlook, published by DECC.