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Supply-Chain Resilience

UK Country Report for CRISMART/MSB

John Tesh and Jennifer Cole



About this Occasional Paper

This paper was commissioned by the Crisis Management Research and Training (CRISMART) centre at the Swedish Defence University on behalf of Myndigheten för samhällsskydd och beredskap (MSB), the Swedish Civil Contingencies Agency. It constitutes the UK country-report chapter of a larger study on how countries are planning to deal with disruptions in the security of supply chains, in particular: food and drinking water; energy resources (oil, natural gas, nuclear, solar, wind); and pharmaceuticals.

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Royal United Services Institute
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Introduction

OVER THE PAST twenty years, the UK has progressively adopted a risk-management approach to security, in which the priority for investment in resilience to all kinds of threat and hazard, and decisions on the best means of countering them, are informed by an assessment of the likelihood of harm or disruption to key British interests, and the seriousness of the likely impacts. Supply chain resilience is for the most part regarded as a matter for the (now largely private-sector) owners and operators of essential service providers in the national infrastructure sectors; but the UK government has tempered this market-based approach with moves towards a partnership model to manage what it sees as an increasingly risk-prone security environment for energy, food and some other strategic goods and services, in the medium- to long-term future.

Since the risks in these areas are global, the UK is increasingly in the market for international solutions with its traditional – and some non-traditional – partners. It is also increasingly the case that the longer-term issues for health and social policy, and for agriculture and other businesses, are being taken up in the UK's National Adaptation Programme for dealing with the impacts of climate change.¹ Such challenges have been recognised in *Global Strategic Trends*,² a Ministry of Defence document used primarily for military strategic planning, which highlights emerging security risks and potential challenges in the global environment.

Food

According to the most recent report by the UK Department for Environment, Food and Rural Affairs (DEFRA), the UK currently enjoys a high level of food security.³ However, global pressure on food supplies is increasing with rising population numbers and the fact that the production of some foodstuffs is being jeopardised by the impacts of climate change, which include more frequent and intense droughts and floods, and changing patterns of crop disease. Ensuring that all UK citizens have access to sufficient healthy and safe food at an affordable price is therefore a challenge which is likely to become more acute in the future.

Water

The UK enjoys reasonable security of drinking-water supplies⁴ and regulation surrounding the water industry has meant that it has been regarded as fairly resilient. In 2007, serious flooding revealed weaknesses when five water-treatment works and 322 sewage-treatment plants were flooded. Flooding of one of the water-treatment plants in Gloucestershire resulted

1. HM Treasury, *The National Adaptation Programme: Making the Country Resilient to a Changing Climate* (London: The Stationery Office, July 2013).
2. Ministry of Defence, 'Global Strategic Trends – Out to 2040', 5th edition, June 2014.
3. House of Commons Environment, Food and Rural Affairs Committee, 'Food Security: Demand, Consumption and Waste', Sixth Report of Session 2014–15, HC 703, January 2015.
4. This is the opinion of the authors, based on their interpretation of the published summary of the 2014 Sector Resilience Plan. See Cabinet Office, 'A Summary of the 2014 Sector Resilience Plans', August 2014.

in piped supplies of drinking water being lost to 350,000 people for up to seventeen days, and the industry struggled to arrange substitute deliveries of supplies in bowsers or bottles to customers. The 2012 Climate Change Risk Assessment suggested that UK water resources will come under increased pressure in the future, with between 27–59 million people in the UK already living in areas affected by water supply–demand deficits.⁵ This indicates the need for adaptation to increase water efficiency across all sectors (including the agriculture sector, where there will be less water available for crop irrigation) and to decrease levels of water abstraction in the summer months.

Pharmaceuticals

The NHS is one of the largest organisations in Europe and the competing demands for sustainability, efficiency and a reduction in the costs of administering its supply chain have posed challenges for resilience, which have been largely overcome so far. The resilience of contingency arrangements for the NHS supply chain for medical devices, consumables and pharmaceuticals was subject to independent review in 2013. The sheer size of the pharmaceutical pipeline means that the NHS does not normally need to stockpile medicines. However, successive National Risk Assessments have pointed to the exceptional need to expand the stockpile that has existed since the 1970s in the case of two contingencies: an influenza pandemic or a bioterrorist attack. For the future, the main risks to pharmaceutical resilience seem to be posed by antimicrobial resistance and the main opportunities for risk mitigation are through scientific advances.

Energy

The 2016 Energy Sector Resilience Plan says that each sub-sector had invested proportionately to build resilience to major risks, but that the size of infrastructure and networks meant that improvements could take years to complete. In the longer term, falling UK production of oil and gas coupled with sustained demand will result in the need to import increasing amounts of both – despite the introduction of policies to promote low-carbon energy and energy efficiency – and therefore a need to engage with energy producers in order to access secure, diverse and affordable supplies essential to economic stability and growth. The 2010–15 security tasks for energy security included: giving energy security greater prominence in the National Security Council and a higher priority in UK foreign policy; working with the EU, the International Energy Agency (IEA) and other international institutions to ensure secure access to energy supplies; developing and using early-warning capabilities to help anticipate disruption to the transit of energy supplies; and improving the functioning of domestic energy markets.

5. Department for Environment, Food and Rural Affairs, 'Climate Change Risk Assessment: Water', 2012, <<http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=15747>>, accessed 11 December 2015.

Scope

In this paper the UK approach to supply-chain resilience is examined mainly through a survey of government documents that deal with various aspects of the security of the supply of strategic goods, understood as those goods or services that are essential to the wellbeing of the British people and/or the economy. Some key definitions are:

- *Supply chain* is a ‘network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer’.⁶ Most work on risk management done in recent years has taken a holistic approach to improving the security and resilience of the network as a whole, and to understanding the links between many of these essential services so that the impact of a vulnerability in one service on others can be mitigated. Questions of affordability or safety, which form part of some widely used definitions,⁷ are not addressed.
- *Resilience* is defined here as the quality of systems that enables them to withstand sudden shocks, maintain key functions during the ensuing crises, and recover to the previous or an acceptable new equilibrium. This quality also enables them to adapt to longer-term changes in the risk environment.
- *Risk* is ‘an uncertain consequence of an event or activity with regard to something that humans value’,⁸ measured in its simplest form as a product of the likelihood of such an event and the possible impact.
- *Risk management* is a process of addressing all aspects of risk – hazard origin, exposure, vulnerability, impact – so as to reduce the risk overall through one or more of the available measures of anticipation, prevention, protection, response and consequence management.

The facilities, systems, sites and networks that deliver the essential services upon which human welfare and the economy depend are collectively known as the ‘national infrastructure’. Within this are elements categorised by the government as ‘critical national infrastructure’ – those elements where loss or serious disruption could result in major detrimental impact on the availability, integrity or delivery of essential services (including those services whose integrity, if compromised, could result in significant loss of life or casualties, taking into account significant economic or social impacts), and/or where loss or disruption could result in significant impact on national security, national defence, or the functioning of the state. The growing interdependence of these networks on each other and on other sections of the economy means that there is pressure to add to an already-long list of critical and not-so-critical assets.

6. Business Standards Institution, *Business Continuity Management: Guidance on Supply Chain Continuity*, PD 25222:2011 (London: BSI Standards Ltd, December 2011).

7. For example, the UN Food and Agriculture Organization defines food security as ‘when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life’. See the UN Food and Agriculture Organization website, <<http://www.fao.org/economic/ess/ess-fs/en/>>, accessed 11 December 2015.

8. Robert W Kates, Christoph Hohenemser and Jeanne X Kaspersen, *Perilous Progress: Managing the Hazards of Technology* (Boulder, CO: Westview Press, 1985), p. 21.

The UK government distinguishes thirteen critical sectors: chemicals; civil nuclear; communications; defence; emergency services; energy; finance; food; government; health; space; transport; and water.⁹ Chemicals, Civil Nuclear, Defence and Space are newly designated 'Critical Sectors'. Chemicals (formerly Hazardous Sites) and Civil Nuclear have previously produced Sector Resilience Plans. Defence and Space are developing their first Sector Resilience Plans.

It is important to note that, unlike the US and the Dutch, for example, the UK government largely does not hold budgets for implementing the security or resilience of critical national infrastructure; this is instead paid for by the owners/operators on the basis that reasonable costs can be included in the price charged on to the customer.

9. See Cabinet Office, 'Summary of the 2015–16 Sector Resilience Plans', April 2016.

I. General Description of UK Approach

IN THE YEARS following the end of the Cold War, governments discovered that UK national infrastructure enjoyed a relatively high level of security against traditional threats, which provided a good basis for security against the new threat posed by international terrorism and, to a lesser extent, organised crime. However, privatisation in the 1980s of many of the previously publicly owned assets in the national-infrastructure sectors had the effect of reducing some of the resilience these sectors had previously had to disruptions caused by natural hazards and man-made incidents. In addition, the increased adoption of more efficient practices – like the removal of redundancy or the adoption of ‘just-in-time’ supply chains – rendered some key services vulnerable to disruptions in the supply chain both downstream and upstream.¹ In some sectors (in particular the food sector), the effects were masked because of the abundance of alternative sources of supply in the market. In others (like the energy and water sectors), short-term disruptions were at first tolerated but increasingly became a source of criticism both of the industry and of the government.

The Government Strategic Response

The government’s initial response to these near-term risks of disruption was to reinforce central government machinery (the so-called Cabinet Office Briefing Room system²) for managing emergencies at the national level and to introduce legislation (the 2004 Civil Contingencies Act, which came into effect in 2005) to encourage effective teamwork at the local level between front-line emergency responders (‘category 1 responders’) and representatives of utility companies (so-called ‘category 2 responders’). These measures – in particular the machinery for local co-operation between front-line and category 2 responders – had not yet properly bedded in by 2007, when extensive and prolonged flooding in England exposed the lack of resilience of many elements of the national infrastructure. The government then decided to recognise the need for improved resilience of national infrastructure sectors as part of a new National Security Strategy (NSS).³ This addressed not only the concerns for the security of the state but also the safety of its citizens against all kinds of hazards and threats, which include war and terrorism as well as the harmful and disruptive effects of natural hazards and major accidents.

The 2010 NSS took this a stage further by looking at changes and trends that were evident in the UK and global landscape,⁴ as well as looking at what demands they might make on public

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1. This is the opinion of the authors and is not the official UK government position.
 2. This was named for the location where the meetings take place. The mechanism brings together senior politicians and policy-makers from the responsible departments to discuss the strategic approach to emerging issues.
 3. Cabinet Office, *The National Security Strategy of the United Kingdom: Security in an Interdependent World*, Cm 7291 (London: The Stationery Office, 2008).
 4. These included: the shift in economic power from the developed economies of the OECD towards the rising economies in Asia, Latin America and the Gulf; the increasingly multipolar distribution of power; the increasing interconnectedness of the world, both through technology, travel and migration, and through

policy in the mid- to long-term future. Most of these developments have the potential to pose risks to (as well as offering opportunities for) the security and resilience of supplies of goods and services essential to the wellbeing of UK citizens and the country's economy.

This high degree of exposure of the UK to events in the wider world persuaded the government, in 2010, to reject a policy of 'strategic withdrawal' from international engagement and to opt instead to pursue two complementary strategic objectives:

- Ensuring a secure and resilient UK (protecting people, the economy, infrastructure, territory and way of life from all major risks that affect them directly)
- Shaping a stable world (reducing the likelihood of risks affecting the UK or its interests abroad by tackling them at source).

The risk of strategic overstretch that this dual approach entails is partly mitigated by prioritising the risks according to their likely impact and the timescale in which they are likely to be realised.

National Risk Assessment

In order to be able to assess the potential for risk to UK security interests posed by these global trends, and to aid prioritisation of effort within and between the two strategic security objectives, the UK government carries out national risk assessments in two timeframes:

1. A National Risk Assessment (NRA), looking forward up to five years, analyses the risk of harm and disruption to the UK through the recurrence in the near future of domestic civil contingencies or emergencies. These are defined in the 2004 Civil Contingencies Act as events or situations – accidents, natural hazards, terrorism or war – that threaten serious damage to human welfare or the environment in the UK. Serious damage is defined as: loss of human life; human illness or injury; homelessness; damage to property; disruption of a supply of money, food, water, energy or fuel; disruption of a system of communication; disruption of facilities for transport; or disruption of services related to health. The NRA therefore assesses the risks of destruction or disruption to the national-infrastructure facilities that produce these essential services, including facilities for the reception, production or distribution of food, water and energy supplies. The analysis of risk is used to secure a consensus within government on the priority to be given to risk reduction, to target the risks (or their impacts) most in need of mitigation in each area, to guide thinking on the relative emphasis to be given to the different components of risk-

the global trade in goods, services and travel; the pace of scientific and technological innovation, including in the biological sciences; the changes in the nature of the risk of conflict; social and demographic trends; environmental factors, in particular through climate change; and greater demand for scarce natural resources. See Cabinet Office, *The National Security Strategy of the United Kingdom: Security in an Interdependent World*, Cm 7291 (London: The Stationery Office: 2008).

management strategies (for example, prevention versus response), and to enable cross-departmental programmes to build capability⁵ and capacity⁶ for response and recovery.

2. A classified National Security Risk Assessment (NSRA), first produced in 2010, looks at the full range of risks to national security that might materialise over a five- and a twenty-year horizon. This includes all major areas of national-security risk – domestic and overseas – that are of a sufficient scale or impact to require action from the government. As with the NRA, the NSRA involves an assessment of the relative likelihood of the risks and their relative impact based on the potential direct harm a risk could cause to the UK's people, territories, economy, key institutions and infrastructure. The intention is to provide an insight into potential future risks rather than immediate security issues, thereby giving the UK strategic notice about future threats, or changes to existing threats, and thus enabling the government to plan its response and capabilities well in advance. The priority risks identified in the first NSRA were the threat of international terrorism, hostile attacks on UK cyberspace, a major accident or natural hazard, and an international military crisis between states. These priorities informed UK strategy in the period 2010–15. However, the NSRA also pointed to the longer-term risks of disruption to oil or gas supplies as a result of war, accident, major political upheaval or deliberate manipulation of supply by producers. These risks, together with the risk of short- to medium-term disruption to international supplies of other resources (including food) essential to the UK, were identified as 'tier 3' risks. This implied that, while these risks would not be neglected, they would, for the time being, enjoy a lower priority for government than the higher-tier risks.

Accordingly, the focus of work on the national-infrastructure sectors, within the overall five-year plan for 2010–15,⁷ was as follows:

I. To build resilience in all national-infrastructure sectors against the existing range of common hazards and threats, in the round, with priority being given to correcting deficiencies in resilience to the highest-priority risks identified in the NRA.

This followed the recommendations of the 'Pitt Report',⁸ which was about learning the lessons from the 2007 floods and focused on the need to organise a national programme focusing on the utilities and involving a tripartite collaboration between the owners and operators of critical assets and networks, the government (all sponsoring departments, with co-ordination from the Cabinet Office) and the regulators. The national programme had three main components:

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5. For the purpose of this paper, a 'capability' is understood to mean human and technical means to accomplish a mission, function or objective that is necessary to achieve national preparedness and resilience goals. Capabilities may include people, their training and skills, plans and planning processes, equipment, supplies, logistics, exercises and legislation.
 6. 'Capacity' here is understood to refer to the quantitative dimension of capability – whether there is enough of a capability or capabilities to achieve the state of readiness required.
 7. Set out as 'national security tasks' in the 2010 Strategic Defence and Security Review. See HM Government, *Securing Britain in an Age of Uncertainty: The Strategic Defence and Security Review (SDSR)*, Cm 7948 (London: The Stationery Office, February 2010), p. 52.
 8. Michael Pitt, 'Learning Lessons from the 2007 Floods', Pitt Review, Cabinet Office, June 2008.

1. Agreement on a 'guide' to improving the resilience of critical infrastructure and essential services.⁹ The guide adopted government policy by stating that the main responsibility for the resilience of critical infrastructure lay with the owners and operators, and rejected the option of more regulation or standardisation in favour of a voluntary risk-based approach. The principles underlying the guide were that investment in security and resilience should be proportionate to the risks, enabled by a sharing of information between the different stakeholders, and delivered at the lowest practicable level. The latter was a reference to the perceived reluctance of some utility companies to participate and share information fully in 'local resilience fora' established for emergency-planning purposes under the 2004 Civil Contingencies Act. The infrastructure owners and operators gained agreement from the regulators that the costs of resilience measures would not come out of their bottom line (this had been a disincentive to investment in resilience to the more common natural hazards). Cross-fertilisation of ideas on resilience was encouraged through the creation of a government–industry forum where the problems posed by the interdependence of the infrastructure sectors could be discussed. The guide itself summarises an approach to infrastructure which combines:
 - Resistance (direct physical protection)
 - Reliability (the ability of infrastructure to maintain operations under a range of conditions)
 - Redundancy (back-up facilities or the ability to bypass blockages in a network and reduce 'single points of failure')
 - Response and recovery
 - Supply-chain resilience.

The clear aim was to bring together security and resilience to all kinds of threat and hazard under one umbrella.

2. Co-sponsorship of a number of British Standards or published documents designed to promote business resilience across the economy, including: Business Continuity (BS 25999), Organisational Resilience (BS 65000) and Supply Chain Continuity (PD 25222:2011). The initiative to improve general standards of business continuity was partly taken in order to reduce the vulnerability of small- and medium-sized businesses, many of which are key elements of the supply chain for those larger corporations that own and operate national infrastructure.
3. Development by sponsoring government departments, working with representatives of the infrastructure sector, of sector-resilience plans for critical infrastructure sectors. The first set of plans, in 2010/11, summarised the then-assessed level of resilience in each sector, going on to outline the approach each sector would take in improving on current levels of resilience. These plans are constantly under review and though some of the information is sensitive, summaries of the most recent versions are published on the Cabinet Office website.¹⁰

9. Cabinet Office, 'Keeping the Country Running: Natural Hazards and Infrastructure', October 2011.

10. See, for example, Cabinet Office, 'A Summary of the 2015–16 Sector Resilience Plans'.

Since then, refinements to the policy set out in the NSS and 2015 Strategic Defence and Security Review (SDSR), have included an increased emphasis on the regulatory framework that will ensure that critical national infrastructure is resilient to future threats.¹¹ In addition, the government is currently reviewing options to further integrate infrastructure policing, which are currently shared across a number of organisations with different levels of capacity and capability.

The highest-priority risks identified in the NRA are those that have the highest likelihood of happening and the greatest impact if they do. At the time of the 2010 SDSR, these were terrorist attacks using ‘unconventional’ materials (mass-effect weapons), ‘major tidal or coastal flooding, and an influenza pandemic’.¹² Since then, the risk of a widespread and prolonged electricity-supply outage has come more to the fore. In view of the potential speed of onset of these kinds of emergencies, the government has invested in strategic stockpiles of equipment or supplies that would be needed more quickly and in greater volume than the market could reliably provide, although there is generally a limited appetite for stockpiles because of their expense.

II. To continue to manage the risks inherent in the UK’s growing dependence on imports of oil and gas, and to analyse and assess the critical risks of disruption to other strategic goods in order to understand how to manage them before they materialise in the UK.

The 2010 SDSR prioritised energy security, the challenges of which had been well understood since the UK first became a net energy importer in 2009. For the other critical national-infrastructure sectors, the SDSR undertook to ‘improve the Government’s ability to consider and tackle the range of risks associated with other resources, such as key mineral components important for particular industries (e.g. rare earth metals which are crucial for some low-carbon technologies), water and food’.¹³

The government recognised that these risks might arise as a result of competition for resources among or within other countries and would certainly involve improving the government’s ability to understand and respond to the national-security impacts of climate change. Accordingly, the following couple of years saw a number of pieces of strategic analysis.

These included the Climate Change Risk Assessment (CCRA), required under UK climate-change legislation (the 2008 Climate Change Act),¹⁴ which examined the potential impact of climate change in the UK in five main areas:

- The agriculture and forestry sector
- The building and infrastructure sector

11. HM Government, *National Security Strategy and Strategic Defence and Security Review 2015: A Secure and Prosperous United Kingdom* (SDSR), Cm 9161 (London: The Stationery Office, November 2015).

12. HM Government, *Securing Britain in an Age of Uncertainty*, p. 49.

13. *Ibid.*, p. 52.

14. Department for Environment, Food and Rural Affairs, ‘Climate Change Risk Assessment: Government Report’, 2012.

- Health and wellbeing
- Business
- The natural environment.

The CCRA presents a range of potential climate impacts within three timeframes (the 2020s, the 2050s and the 2080s) and consistent with the UK Climate Projections, published by DEFRA in 2009. A variety of scenarios is assessed from a low-emissions scenario to a high-emissions scenario.

Since the CCRA is an assessment of domestic risks to the UK, the government also commissioned a report from its chief scientific adviser on the international dimensions of climate change, which emphasised the potential disruptive impact on infrastructure, energy supplies, global food production and the extraction of vital raw materials:¹⁵

Adverse economic impacts could affect overseas resources and infrastructure on which the UK depends. A wide range of potential threats are identified including disruption to vital infrastructure serving global markets, disruption to energy supplies, global food production, the extraction of vital raw minerals, the impact of extreme weather events on communications networks and data centres, and a growing threat of protectionist responses from countries adversely affected by climate change. For example, the UK is a new energy importer and had an energy deficit of £8.2 billion in 2009. Climate change may disrupt critical infrastructure (for example pipelines, ports and overseas refineries) affecting the price and security of UK energy imports.

This approach was consolidated in the SDSR 2015, which stated that the UK will meet future energy needs from both domestic production and imports from overseas, managing the risks posed by regional instability, climate change, natural events and rising global demand.

Other pieces of strategic analysis include a series of government reports and studies on the policy implications of pressures and risks arising from the main developments identified in the NSS, including:

- The UK cyber-security strategy¹⁶
- CONTEST, a renewed counter-terrorism strategy¹⁷
- A number of studies and policy papers on energy and food security (see below).

The most recent NSS and SDSR was published in November 2015 – combining the two documents for the first time – and covered most of these issues following a three-year programme to update and review the NSRA.

15. UK Government Office for Science, 'International Dimensions of Climate Change', Final Project Report, July 2011, p. 9.

16. HM Government, 'The UK Cyber Security Strategy: Protecting and Promoting the UK in a Digital World', November 2011.

17. HM Government, 'CONTEST: The United Kingdom's Strategy for Countering Terrorism', July 2011.

II. Food and Drinking Water Supplies

Food

Current Situation

THE FOOD-AND-DRINK INDUSTRY comprises elements of food manufacturing and wholesale and retail supply chains.¹ The lead department within government is DEFRA; the Food Standards Agency (FSA) deals with food safety or contamination issues. DEFRA works with the food industry through a Food Chain Emergency Liaison Group (FCELG) which meets three or four times a year to consider any disruptive challenges to the industry. DEFRA has lead responsibility for responding to a disruption to food manufacturing or distribution in England but has no statutory powers to intervene in the industry in an emergency and sees no current need to do so other than, possibly, under a declared state of emergency under Part II of the 2004 Civil Contingencies Act. Responsibility for responding to disruptions in food supply is a devolved matter in the rest of the UK (it is the responsibility of devolved administrations or governments in Scotland, Wales and Northern Ireland). In the case of an emergency, the responsibility for feeding displaced persons or local populations would initially fall to local authorities. Supply-chain resilience is, ultimately, the responsibility of the food-retail industry, and the major supermarket chains operating in the UK have extensive emergency plans detailing how food distribution would be maintained in the face of serious disruptive challenges to, for example, the energy or transport networks.

The 2014 summary of resilience plans reports that the UK food sector has a highly effective and resilient food supply chain owing to the geographic spread, number of firms and competitive nature of the industry.² Although there is a widespread dependence on other essential services (power, fuel, water, telecommunications – including supervisory control and data acquisition, SCADA – systems and transport), the sector's resilience to disruption of these has been demonstrated in recent years and, in particular, during the 2007 floods.

The commercial pressures of the food sector have created a just-in-time culture that requires an immediate response to a disruption of production or supply. Yet the number of supply chains and the manufacturing and retail options available, coupled with the high degree of substitutability of foodstuffs in the industry, make the sector resilient to disruption.

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1. These include: fishing and fish-farming primary producers; the agricultural supply industry (animal-feed manufacturing, agricultural machinery, fertilisers and pesticides); distribution networks for primary produce; agricultural wholesalers; the food and drink processing; manufacturing and supply industries; grocery retailers; caterers; and imports (some £23 billion in 2012).
 2. Cabinet Office, 'A Summary of the 2014 Sector Resilience Plans', August 2014.

The sector is currently following up on the findings of recent government research on the resilience of the food supply chain to port disruption and 'pinch points' created by the disruption of fuel supplies. Further work is expected to look at the food industry's ability to respond to and recover from a major coastal flooding event. Threats to the food-and-drink industry from food fraud were highlighted in an independent review published in September 2014.³ Other work on current issues includes:

- Further development of Publicly Available Specification guides (PAS 96 – a form of guidance falling short of a British Standard) on 'defending food and drink' to include the threat of criminality or fraud⁴
- Publication of a report on plant health by an expert task force in May 2013, followed by the publication of a plant-health risk register in January 2014, the appointment of a new chief plant health officer in April 2014 and the publication of a Plant Biosecurity Strategy in the same month.⁵

Longer-Term Risks to the Food Supply Chain

The UK is not self-sufficient in food: the British import food valued at nearly £40 billion and the National Farmers' Union estimates that the food now produced in the UK amounts to 60 per cent of what is needed to be self-sufficient.⁶ As such, the high degree of food security in the UK at present stems in part from the abundance of food produced by other countries. Much of the government's attention is focused on the growing pressure on the global food system and its implications for policy-makers in the UK in the future.

A report by the Foresight team of the Government Office for Science summarised the global problem as follows:⁷

The global food system will experience an unprecedented confluence of pressures over the next 40 years. On the demand side, global population size will increase from nearly seven billion today to eight billion by 2030, and probably to over nine billion by 2050; many people are likely to be wealthier; creating demand for a more varied, high-quality diet requiring additional resources to produce. On the production side, competition for land, water and energy will intensify, while the effects of climate change will become increasingly apparent. The need to reduce greenhouse gas emissions and adapt to a changing climate will become imperative. Over this period globalisation will continue, exposing the food system to novel economic and political pressures.

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3. HM Government, 'Elliott Review into the Integrity and Assurance of Food Supply Networks – Final Report: A National Food Crime Prevention Framework', July 2014.
 4. Business Standards Institution, *Guide to Protecting and Defending Food and Drink from Deliberate Attack*, PAS 96:2014 (London: BSI Standards Ltd, October 2014).
 5. Department for Environment, Food and Rural Affairs, 'Protecting Plant Health: A Plant Biosecurity Strategy for Great Britain', April 2014.
 6. National Farmers' Union, 'The National Farmers' Union 2015 General Election Manifesto', 2015, <<https://www.nfuonline.com/the-nfu-2015-election-manifesto/>>, accessed 14 December 2015.
 7. UK Government Office for Science, 'The Future of Food and Farming: Challenges and Choices for Global Sustainability', Foresight, Final Project Report, 2011.

The report argues for an international, cross-boundary approach, one that not only co-ordinates policy with other international actors in the food system, but also co-ordinates food-security policy with policy in other sectors including energy, water supply, land use, the sea, ecosystem services and biodiversity. The aim is to meet five challenges:

- ‘Balancing future demand and supply sustainably’ – to ensure that food supplies are affordable⁸
- Ensuring there is adequate stability in food supplies – and protecting the most vulnerable from the volatility that does occur
- Achieving global access to food and ending hunger (recognising that producing enough food in the world so that everyone can potentially be fed is not the same thing as ensuring food security for all)
- Managing the contribution of the food system to the mitigation of climate change
- ‘Maintaining biodiversity and ecosystems while feeding the world’.⁹

Since the publication of the Foresight report, various other official reports have tracked the development of subsequent UK policy in this area.¹⁰

Water

Current Situation

The water-management system was set up in 1963 and has since seen a number of reforms, most significantly the privatisation in 1989 of the ten Regional Water Authorities, based on catchment areas rather than municipal or other administrative boundaries. The current industry comprises twenty-nine water companies still based on catchment areas, providing either water-only or water and wastewater services.

8. *Ibid.*, p. 77.

9. *Ibid.*, p. 143.

10. The 2011 government White Paper on the natural environment promised further consultation between government, industry and environmental partners on how to reconcile the goals of improving the environment while increasing food production. See HM Government, *The Natural Choice: Securing the Value of Nature*, Cm 8082 (London: The Stationery Office, 2011). See also Department for Environment, Food and Rural Affairs, ‘Green Food Project Conclusions’, July 2012; Department for Environment, Food and Rural Affairs, ‘Sustainable Consumption Report: Follow-Up to the Green Food Project’, July 2013; House of Commons Environment, Food and Rural Affairs Committee, ‘Food Security’, Second Report of Session 2014–15, HC 243, June 2014; and House of Commons Environment, Food and Rural Affairs Committee, ‘Food Security: Demand, Consumption and Waste’, Sixth Report of Session 2014–15, HC 703, January 2015. Other activities contributing to the debate include: the May 2012 announcement of a £250-million strategic investment in UK bioscience by the Biotechnology and Biological Sciences Research Council (BBSRC) – see BBSRC, ‘Minister Announces £250M Strategic Investment in UK Bioscience’, 24 May 2012, <<http://www.bbsrc.ac.uk/news/policy/2012/120524-pr-minister-announces-250m-investment/>>, accessed 11 December 2015; and the work of the Sustainable Agriculture and Food Innovation Platform and the Global Food Security programme.

DEFRA provides the strategic policy direction and statutory framework. Water UK is the trade body for the UK water industry, providing representation for all UK water- and wastewater-service providers at national and European level, and engaging with government, regulators (Ofwat), stakeholder organisations and the public. Ofwat is responsible for the economic regulation of the industry, consulting the Drinking Water Inspectorate, the Environment Agency and the Consumer Council for Water. In 2012, the water-industry infrastructure comprised 1,162 water-treatment works, 373 wastewater-treatment works, 4,262 service reservoirs and about 345,000 km of main pipelines.

Legislation

Water is a devolved issue with separate legislation for England, Scotland, Wales and Northern Ireland. For England, the obligation on water companies to integrate resilience is implied in the Water Industry Act 1991 and the Security and Emergency Measures Direction 1998, which is the water-industry equivalent of the British Standard on business continuity and is the only example of a national-infrastructure service provider being required to make plans to provide a specific fallback service in the event of disruption to the primary means of supply. As category 2 responders under the 2004 Civil Contingencies Act, water companies are also obliged to make plans to prevent or mitigate emergencies, and co-operate and share information with front-line responders. In 2004, the Water Council UK established a 'mutual aid' protocol for all members to ensure delivery of water by companies in an emergency.¹¹ This facilitates inter-company borrowing of emergency equipment from the considerable stockpiles held by the various companies during severe incidents. The protocol was revised in 2009.

Capabilities

As part of the Cabinet Office's National Resilience Capabilities Programme, DEFRA works with the water industry to develop capabilities to manage the risks affecting the industry, using the NRA to explore vulnerabilities that need to be addressed. Over the past few years, the key vulnerabilities have been the industry's dependence on a supply of electricity (to pumping stations), telecommunications (impacting water companies' SCADA systems) and chemicals (essential to water- and wastewater-treatment operations, which were substantially disrupted during the flooding in 2007 and the snow in January 2010).

Following direction from DEFRA that the creation of a pricing formula for water supply should allow for the proportionate costs of resilience, Ofwat's determination on water-company prices in November 2009 provided some £400 million over five years to make plants more resilient. Moreover, the Water Act of 2014 contains a variety of measures to boost resilience further, including a primary resilience duty for Ofwat, as well as giving the power to the environment secretary to direct water companies to plan for a certain level of resilience. Other measures designed to improve innovation and efficiency are also expected.

11. This built on the experience and lessons identified from the 2007 floods in the Severn Trent/Gloucester area about the difficulty in delivering and resupplying water bowsers in narrow country lanes and the logistics of bottled-water distribution.

Longer-Term Risks to the Water Supply Chain

The 2012 CCRA highlighted water distress as a future risk, particularly for areas like the southeast of England that are already prone to drought and where population levels have been rising. As part of action being undertaken to improve long-term resilience, water companies produce Water Resource Management Plans setting out how they intend to provide supplies of water to customers over the next twenty-five years and beyond.¹²

12. See, for example, Severn Trent Water's 2015 Water Resources Management Plan, which includes a twenty-five-year demand forecast describing how much water its customers will need in the future, taking into account factors such as climate change and population, and a twenty-five-year supply forecast showing how much water is available for use now and how this may change in the future. See Severn Trent Water, 'Water Resources Management Plan', <<http://www.severntrent.com/future/plans-and-strategy/water-resources-management-plan>>, accessed 11 December 2015.

III. Pharmaceutical Supplies

Current Situation

THE HEALTH SECTOR is a large, complex, interconnected set of healthcare services. The Department of Health (DH) provides strategic direction and a statutory framework. The 2004 Civil Contingencies Act and the NHS's Operating Framework require the NHS to respond safely and effectively to major risks. The Sector Resilience Plan assesses the resilience of the health sector as inherently good. This is a consequence of: the size of the service; the fact that most healthcare services and supplies are replicated throughout the UK and there are well-tested, mutual aid agreements in place; and the attention paid to emergency response in the past ten to fifteen years, which have seen, *inter alia*, a Publicly Available Specification guide tailored specifically to the circumstances of the sector. The NHS remains somewhat vulnerable to disruptions to other services – utilities (especially electricity), transport and fuel supply – a problem compounded by the fact that the service has to operate at almost full capacity all the time and many subsidiary organisations are too busy to devote time to business continuity.

In 2016, the resilience plan for health has the following elements:

- A review of the resilience across the health sector to fuel shortages
- A pilot project, which has already been initiated, to develop and test an online supply risk assessment process
- Continued work on the findings of the Mass Casualties National Resilience Capabilities Assessment.

Pharmaceutical Stockpiles

Medical-supply problems can occur for a number of reasons, and there is a team within the DH which deals specifically with such problems, both in the community and in hospitals. The team works with the Medicines and Healthcare Products Regulatory Agency (MHRA), the pharmaceutical industry, NHS England and others in the supply chain to prevent shortages. One facility is the UK Essential Medicines Buffer Stock (EMBS), which was set up in 2009 to make the supply chain more robust in the event of a pandemic or other emergency, but has also proved important in addressing short-term supply shortages. When there is no UK stock available, and it is considered appropriate, a release of medicines from the EMBS into the supply chain ensures that supply to patients is maintained. Contracted suppliers rotate the stock to provide a cost-effective system that provides a stockpile that is immediately available and with at least twelve months' expiry date.

In addition to the EMBS, there has for a number of years existed a specific chemical, biological, radiological and nuclear (CBRN) stockpile which does not include the essential stocks for more general use in the NHS. The CBRN stockpile is maintained and managed by the UK

government and is available to all of the UK health departments. (Health is devolved in the UK to England, Scotland, Wales and Northern Ireland, but they work together when it comes to managing stockpiles.)

The current main stockpile includes some twenty-plus products. It is based primarily on the assessed risk of an infectious-disease pandemic and of a bioterrorist attack (in the NRA), and on whether the supplies are generally available in the NHS. Only those which are not usually available are stockpiled. The total replacement value is over £100 million, so there is quite a considerable stockpile available for use in the UK.

There are protocols for release, and these depend on the need and speed of wanting them in place. There are items that can be distributed to particular areas within twenty-four hours and a number that can be distributed within a shorter timeframe. An advantage of the UK being relatively small is that it is possible to get items around the country rapidly if needed.

The CBRN stockpile started in the late 1970s. When smallpox was eradicated, the vaccine was retained against the event that the disease should re-emerge. After the 1995 Tokyo sarin-gas attacks, it was decided that the UK needed to have nerve-gas antidotes in order to respond quickly if an attack of that sort happened here. Further enhancements were made in 2002 and 2003, looking particularly at countermeasures for anthrax and botulinum toxin. Further enhancements made after 2003 enhanced the amount of nerve-agent countermeasures and personal-protection equipment. This is stockpiled out in the field to ensure it is ready for rapid use if needed.

There is also a more central stockpile containing antibiotics for bacterial biological agents. It includes products to deal with elements of radiation exposure, including potassium iodate, which was already in place for the UK's nuclear installations but a further stockpile has been generated nationally. More smallpox vaccines have been brought in to supplement the stores stockpiled previously and there are some specific antidotes to deal with particular types of chemical poisoning. Additional products including specialised needles and syringes, if required, have also been added.

During the London 2012 Olympic and Paralympic Games, a stockpile of pharmaceuticals for pandemic flu was available, if needed, to use for CBRN issues. This enabled a single stockpile to provide for pandemic flu, outbreaks of new infectious diseases, a catastrophic CBRN attack, a smaller-scale CBR attack or an industrial accident involving hazardous chemicals.

The countermeasures stockpile remains under review to see whether it is proportionate to the anticipated threats or hazards and consistent with clinical guidelines. The review has looked at whether it is realistic in terms of the timescales allowed for managing the logistics and distribution of stocks and whether it represents value for money within the risk appetites of each of the UK administrations.

Longer-Term Risks to Pharmaceutical Resilience

In future, the biggest challenge to health is not directly a supply-chain issue but the development and spread of antimicrobial resistance (AMR), which occurs when drugs are no longer effective in treating infections caused by micro-organisms. In the UK, the numbers of infections complicated by AMR are expected to increase markedly over the next twenty years. In the 2015 National Risk Register (a public version of the NRA), the government reported that if a widespread outbreak were to occur, the UK could expect around 200,000 people to be affected by a bacterial blood infection that could not be treated effectively with existing drugs, and around 80,000 of these people might die.¹ High numbers of deaths could also be expected from other forms of antimicrobial resistant infection. AMR is a global problem and the UK Government is working with international partners to secure support for concerted action at a global level. Co-ordinated international action is needed to tackle AMR as a priority issue through the World Health Organization and other UN bodies.

At a UK level, the Department of Health, the NHS, DEFRA and the Veterinary Medicines Directorate are working together with other partners to lead the implementation of the UK five-year Antimicrobial Resistance Strategy, published in September 2013.² A cross-government, high-level steering group comprising government departments and agencies and the devolved administrations published the measures which are being used to assess the impact of the actions being taken across the UK to reduce the spread of AMR and improve antibiotic prescribing. The steering group's 'Annual Progress Report and Implementation Plan' was published on 11 December 2014.³ In addition, in July 2014, the prime minister commissioned an independent review of AMR, chaired by Jim O'Neill, of how the development of new antibiotics can be stimulated and how best to encourage innovative thinking and research in order to change methods for treating infectious diseases. The review has already produced two reports. The first of these – 'Antimicrobial Resistance: Tackling a Crisis for the Health and Wealth of Nations' – appeared in December 2014.⁴ It quantifies the likely global economic burden of AMR between now and 2050. The second – 'Tackling a Global Health Crisis: Initial Steps' – was published on 5 February 2015.⁵ It describes steps that could and should be taken now in the international effort to tackle AMR. Further reports were published throughout 2015 and 2016, with the final report – 'Tackling Drug-Resistant Infections Globally: Final Report and Recommendations' – delivered in May 2016.⁶ The final report sets out actions to be agreed on at an international level in order to deal with the challenge of AMR, including the need for a massive global public awareness campaign; improved global surveillance of drug resistance; and the promotion of new rapid

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1. Cabinet Office, 'National Risk Register of Civil Emergencies: 2015 Edition', March 2015, p. 15.
 2. Department for Environment, Food and Rural Affairs and Department of Health, 'UK Five Year Antimicrobial Resistance Strategy 2013 to 2018', September 2013.
 3. HM Government, 'UK 5 Year Antimicrobial Resistance (AMR) Strategy 2013–2018: Annual Progress Report and Implementation Plan', 2014.
 4. Review on Antimicrobial Resistance, 'Antimicrobial Resistance: Tackling a Crisis for the Health and Wealth of Nations', December 2014.
 5. Review on Antimicrobial Resistance, 'Tackling a Global Health Crisis: Initial Steps', February 2015.
 6. HM Government and Wellcome Trust, 'Tackling Drug-Resistant Infections Globally: Final Report and Recommendations', Review on Antimicrobial Resistance, May 2016.

diagnostics. By the summer of 2016, the review will recommend a set of actions to be agreed on at an international level in order to deal with the challenge of AMR.

On the opportunities side, technological advances including, in particular, synthetic biology offer potentially significant gains to pharmaceutical security and resilience in both the medium and long term. In the medium term, it could offer modifications to existing pathways for pharmaceutical production. In the longer term, there is the potential for self-sufficient pharmaceutical generation, reliant only on basic raw supplies and even the prospect of developing pharmaceuticals tailored not only to specific infectious organisms but also to the host.

One additional point worth mentioning is a finding from research conducted during the production of the 2014 report on 'On Tap: Organised Crime and the Illicit Trade in Tobacco, Alcohol and Pharmaceuticals in the UK':⁷ governments need a strong understanding the black-market supply of illicit pharmaceuticals in order to be able to properly address the challenges raised by any disruption to this supply – as well as to the official and legitimate supply chains. Considering the legitimate supply only may underestimate the actual quantities required to maintain the health of the population during any event that disrupts distribution of and access to supplies.

7. Charlie Edwards and Calum Jeffray, 'On Tap: Organised Crime and the Illicit Trade in Tobacco, Alcohol and Pharmaceuticals in the UK', *RUSI Whitehall Report 3-14*, 2014.

IV. Energy Supplies

Current Situation

THE ENERGY SECTOR is made up of the upstream oil and gas, downstream oil and gas, electricity generation and electricity networks. Major risks to the sector are flooding (including coastal flooding), storms and gales, and loss of key staff. To build resilience to these and other risks, energy companies:

- Adopt an all-risks approach: under the Enterprise Act 2002, the regulator Ofgem introduced performance levels for the gas and electricity industry including supply-restoration timescales and a 'RIIO' performance standard for network companies' price-control periods to ensure efficient investment for continued safe and reliable services
- Address specific vulnerabilities: companies are implementing a large programme of flood-protection measures, which is due for completion by the early 2020s
- Put in place contingency arrangements: energy companies have worked extensively to establish contingency plans in the event of disruption due to severe weather-related events and to manage staffing in the event of pandemic influenza.

Owing to the size and complexity of energy networks, completion of programmes can take a number of years, meaning that while vulnerabilities are being addressed, there is an ongoing, but reducing, risk of disruption. Priorities include:

- Upstream oil and gas: assessment of the risk to oil and gas beach terminals from fluvial and coastal flooding
- Electricity generation: assessment of the risk to power stations from fluvial and coastal flooding
- Electricity networks: assessment of the risk posed by severe space weather and cyber-attack
- Downstream oil: working on maintaining capability to make fuel deliveries in the event of a serious disruption.

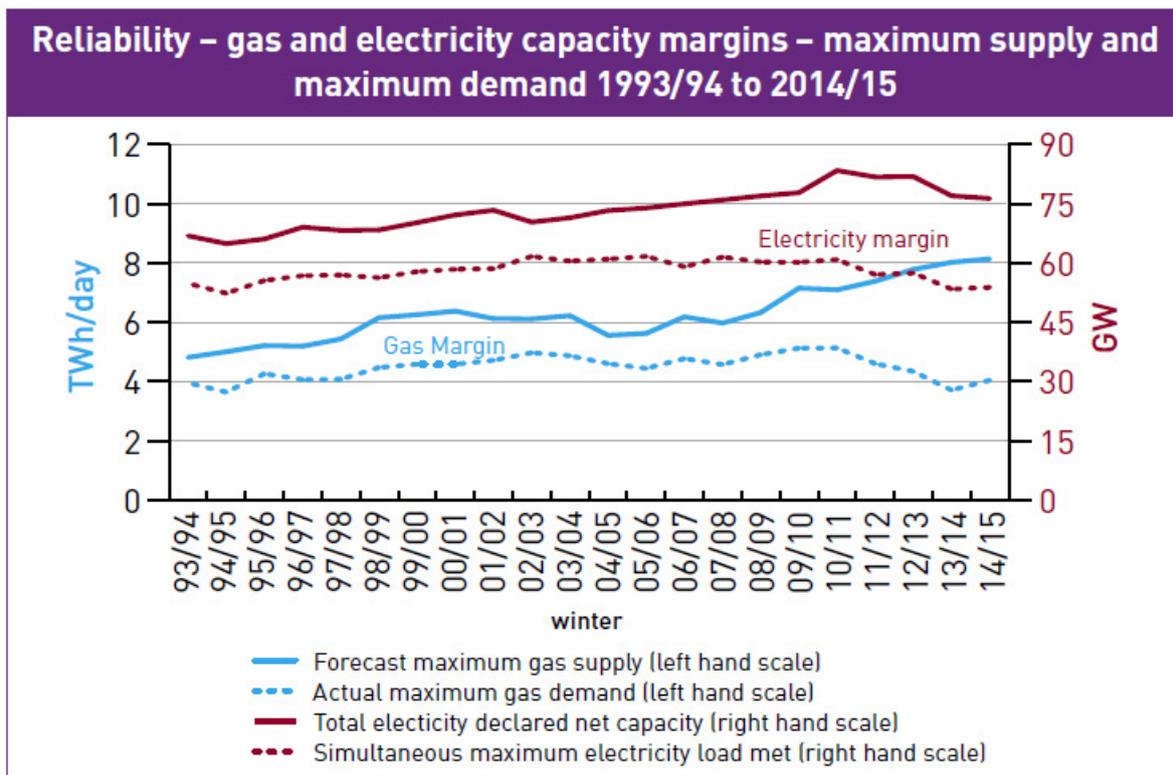
The separate infrastructure resilience plan for the nuclear-energy sector sets out government policies to minimise the risk of civil nuclear emergencies domestically or internationally, which takes into account lessons identified from real incidents – such as Fukushima in Japan – and includes an extensive exercise programme regulated by the Office for Nuclear Regulation.

For oil, as a member of the EU and the IEA the UK is required to hold emergency stocks; the length of consumption time the stocks are required to last is set out in the EU obligation. A release of strategic oil reserves co-ordinated by the IEA remains the UK's primary tool to combat a significant supply disruption to international oil markets.

Energy security is complex to measure, but the annual government report looks at the difference between maximum supply and demand for gas and electricity as key indicators.¹ The 2015 report – illustrated by Table 1 – concluded that the electricity capacity margin has mainly increased year-on-year over the past decade due to both a decrease in peak demand and an increase in capacity but that, in 2014/15, a slight increase in demand and fall in capacity due to plant closures and conversions resulted in the capacity margin falling to 42 per cent.

For gas, there has been a year-on-year increase in the capacity margin, with the large increase from 2011/12 and 2012/13 a result of reduced demand and increased supply. Reductions in the demand for gas in recent years have been due to a switch from gas to coal for power generation and a relatively muted domestic demand due to comparatively warm weather.

Table 1: Gas and Electricity Capacity Margins 1993/94–2014/15.



Source: National Grid and Department for Energy and Climate Change.

Longer-Term Risks to the Energy Sector

The 2010 SDSR reported that falling UK production of oil and gas, coupled with sustained demand, would make the UK increasingly reliant on fossil-fuel imports. Without low-carbon policies, net

1. Department of Energy and Climate Change, 'UK Energy in Brief 2015', 2015. See also Department of Energy and Climate Change, *Digest of United Kingdom Energy Statistics 2015* (London: The Stationery Office, 2015).

oil and gas imports would rise rapidly. Low-carbon policies could help to reduce this demand (and encourage others to do the same) but the UK would still need to import considerably more than it did before. The UK faces a number of risks to its ability to access secure, diverse and affordable supplies of energy essential to economic stability and growth, including: political instability in key energy countries; insufficient investment in states that supply energy; and other imperfections in the functioning of global and UK markets. These risks are set to intensify; though the 2015 SDSR showed confidence that the UK will tackle energy security challenges robustly and set out a determination to help the EU reduce its energy dependency on Russia. The latest government statistics show that 46 per cent of energy used in the UK in 2014 was imported and that UK imports are sourced from a wide variety of countries.²

Coal: Russia remained the leading source, accounting for 42 per cent in 2014, followed by the US (26 per cent) and Colombia (23 per cent). The vast majority of coal imported was steam coal (87 per cent), mainly for electricity generation.

Crude oil: the key source of imports is Norway, which in 2014 accounted for 45 per cent, with OPEC countries supplying a further 36 per cent.

Petroleum products: the UK imports a wide variety of petroleum products, though it remains a net exporter of certain fuels, including petrol. Traditionally, the Netherlands has been the largest source of imports, acting as a major trading hub. However, Russia is now the largest supplier of transport fuels, in particular diesel. Aviation turbine fuel is generally sourced from Asia.

Gas: Norway accounted for 57 per cent of UK gas imports in 2014, with pipelines from the Netherlands and Belgium supplying 15 per cent and 1 per cent respectively. The remaining 27 per cent arrived as liquefied natural gas, of which 92 per cent was from Qatar.

The latest comprehensive energy-security strategy to manage the risks that arise was published by the then (coalition) government in 2012.³ These included both demand and supply measures, including improving the reliability of networks and decarbonising supplies.⁴

Increasingly, however, the UK is working with international partners to tackle the energy-security issues in the medium- to long-term future, and the government has coined the phrase 'energy diplomacy' to cover: the promotion of low-carbon technologies and energy efficiency to restrain rising oil and gas demand; the encouragement of global investment in oil and gas production; greater liberalisation of energy markets; and strengthened trading links and infrastructure. This includes work at a European level – in particular to implement the requirements of the latest

2. Comparable data from Eurostat for 2013 show that the UK had the ninth-lowest level of import dependency in the EU, behind Estonia, Denmark, Romania, Poland, the Netherlands, the Czech Republic, Sweden and Bulgaria. All EU countries are now net importers of energy. See European Commission, 'European Economy: Member States' Energy Dependence: An Indicator-Based Assessment', *Occasional Papers 145*, April 2013.

3. Department of Energy and Climate Change, *Security Strategy*, Cm 8466 (London: The Stationery Office, 2012).

4. See also Department of Energy and Climate Change, 'The Energy Efficiency Strategy: The Energy Efficiency Opportunity in the UK', November 2012.

suite of European legislation aimed at establishing a single market in energy across the EU – to improve EU market integration and increased cross-border trade for both electricity and gas. To enhance energy-price stability, the government continues to support producer/consumer dialogue and greater market transparency and is an active member of the International Energy Forum, which brings together all the main oil-producing and consuming countries.

Europe more generally may, in future, face potential difficulty in securing supplies amidst tensions between Russia and Ukraine. Given the likelihood that the UK will need to increase imports of oil and gas in future, a secure supply from Europe is in the UK's interests. A European stress test, conducted in 2014 after Russia ceased gas supplies to Ukraine, emphasised the need for co-operation and solidarity between countries to ensure consistency in supply. It found that, even with flow adjustments geared towards greater energy-sharing between European countries, the EU and the Energy Community Contracting Parties would be missing 5–9 bcm of gas, with Eastern European countries being most heavily impacted.⁵ Increased co-operation with European countries would assist the UK in its supplies. Another consideration for this may also be the likelihood of a UK exit from the EU, which should be taken into consideration for the country's energy security.

5. European Commission, 'Q&A on Gas Stress Tests', memo, 16 October 2014, <https://ec.europa.eu/energy/sites/ener/files/documents/MEMO-14-593_EN.pdf>, accessed 11 December 2015.

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