National Audit Office

BRIEFING FOR THE HOUSE OF COMMONS ENERGY AND CLIMATE CHANGE SELECT COMMITTEE

JULY 2010

The Electricity Generating Landscape in Great Britain

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Contents

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This report can be found on the National Audit Office website at www.nao.org.uk

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Summary

1 The National Audit Office has compiled this briefing for the Energy and Climate Change Select Committee. It provides a brief outline description of key features of the policy and regulatory framework for electricity generation and the nature of the transition required over the next 10 years to meet carbon reduction and renewable energy targets. To meet the statutory carbon budget, to reduce carbon emissions by 34 per cent by 2020 compared to 1990 levels, the last government expected the power and heavy industry sector to cut its emissions by 20 per cent by 2020. In order to meet the legally binding obligation established under the EU Renewable Energy Directive 2009 for renewable energy to account for 15 per cent of energy in 2020, there will have to be a sevenfold increase in renewable energy generation compared to 2008 levels.

- Part 1 describes the current market system for the generation and supply of electricity including the regulatory and policy framework. It also sets out the nature of the transition required over the next 10 years in order to meet the 2020 targets for carbon reductions and renewable energy.
- Part 2 highlights the various risks involved in the current system, the transition to a low carbon generating system, and the operation of a low carbon system.
- References to key documentation on which this briefing is based are set out in the annex.

Key Points

2 The arrangements currently in place for ensuring security of supply in relation to electricity generation in Great Britain have been robust and resilient; and Britain has not experienced system-wide problems of the sort which have occurred in some other developed countries.

3 There are three key challenges in maintaining secure and affordable electricity supplies while moving to a low carbon electricity generating system over the next decade and beyond:

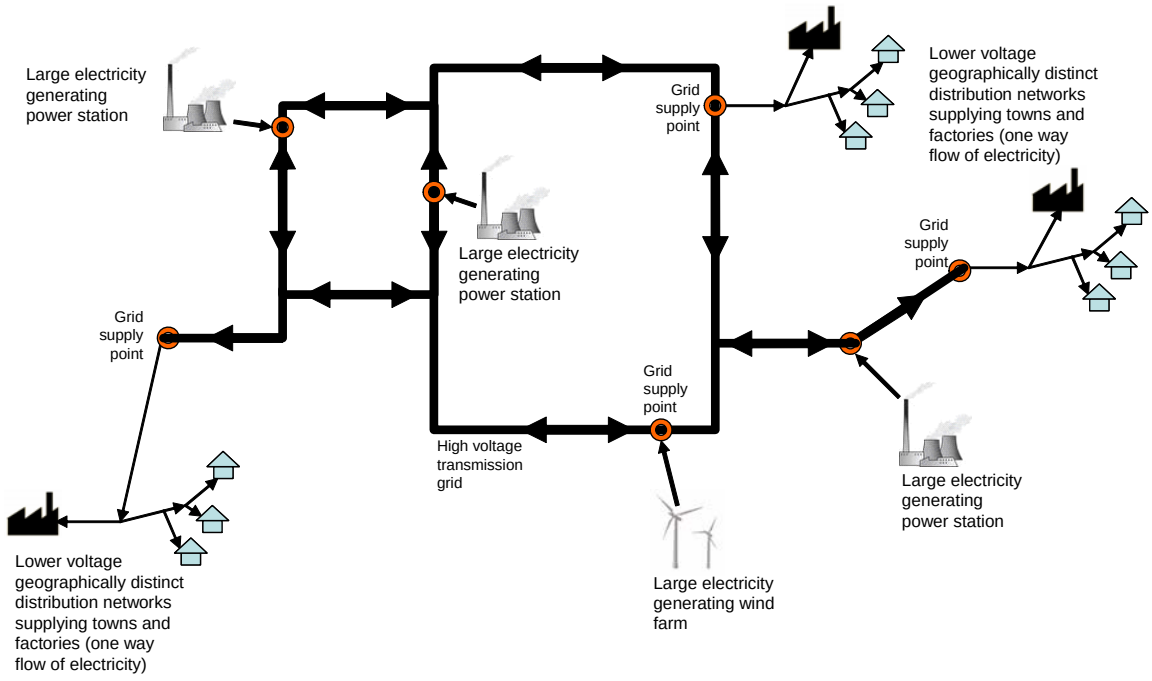
- A quarter of Great Britain's electricity generating capacity will close in the next decade, and there will need to be substantial investment in up to 50GW of new capacity by 2020.
- Much of this new capacity is expected to come from the development of onshore and offshore wind farms, but the scale of deployment required involves significant planning, financial, engineering, and supply-chain risks. Other low-carbon technologies such as nuclear, carbon capture and storage, and marine energy are only expected to contribute substantially to low-carbon electricity generation after 2020.
- The transition to a low carbon electricity generating system will substantially change supply and demand pressures on the system, which bring significant new risks and uncertainties to its operation. These uncertainties may also delay current investment decisions.

4 The policies required to incentivise the move to a low carbon generating system will result in an increase in the price of electricity over the next decade, as all forms of low-carbon generation are more expensive than fossil-fuel alternatives. This could increase the challenges the Government faces in meeting the target set in accordance with the statutory obligation to avoid people living in fuel poverty.

5 This briefing reflects the previous government's plans and strategies. The new government has indicated that it will implement various initiatives to promote investment in low carbon generation. These include, in particular, support for a higher EU carbon reduction target, the reform of the Climate Change Levy, the introduction of a carbon price floor, an emissions performance standard, capacity mechanisms and changes to the Renewables Obligation to make it resemble more closely a feed-in tariff.

PART 1: The electricity generating system in Great Britain

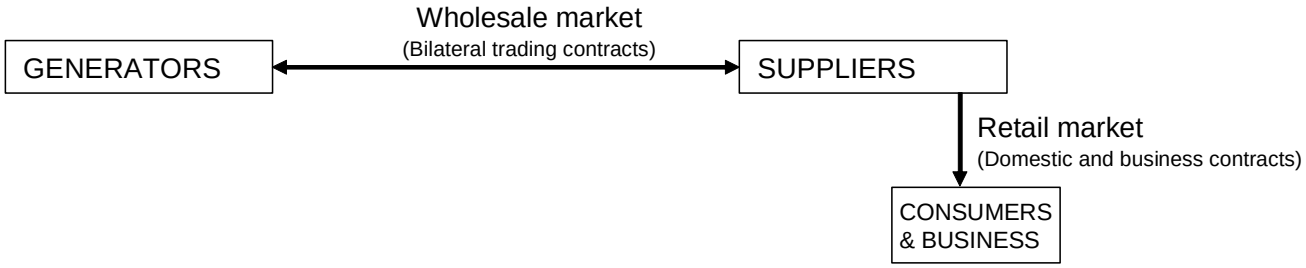
1.1 The physical system



i. The structure of Great Britain's electricity generation and distribution system is based around a high voltage transmission system (the national grid). The grid allows large power stations built far away from major population centres to connect to it, so that electricity can be transferred with minimal losses around the country. A series of distribution networks cover geographically distinct areas of the country, and carry electricity from the grid at lower voltages to population centres and industrial sites.

ii. In the future, there could be a substantial increase in *embedded (or distributed) generation*, which refers to electricity generation at a local level within distribution networks from, for example, solar Photo-Voltaic cells on house roofs, micro-Combined Heat and Power boilers in homes, or community biomass Combined Heat and Power generation plants. This would substantially change the nature of distribution networks because it would require two way electricity flows and the need to balance generation and demand at a local, as well as national, level. However, forecasts suggest that the level of embedded generation will only become significant after 2020.

1.2: The wholesale and retail markets



Source: National Audit Office

i. The current arrangements in Great Britain for electricity generation and supply (known as the British Electricity Transmission and Trading Arrangements), together with other statutory legislation, aim to create two distinct markets for electricity.

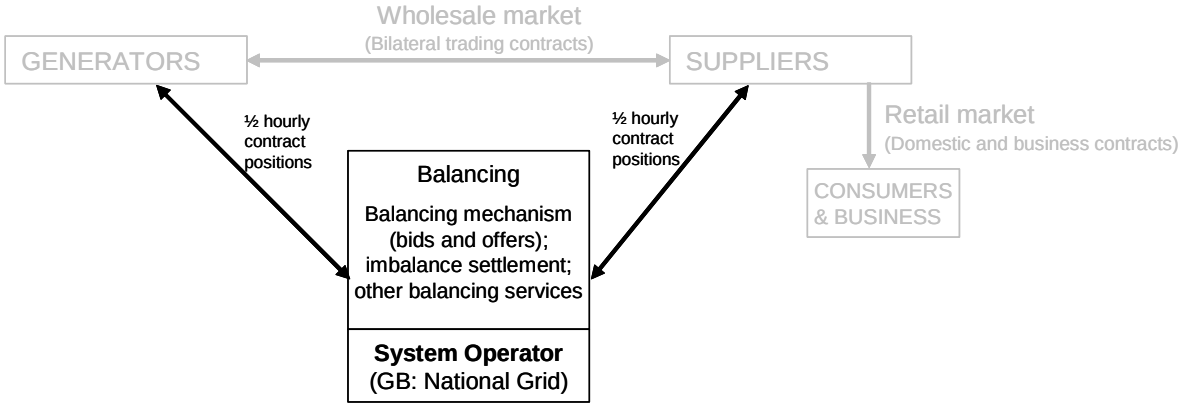
ii. The retail market operates between electricity suppliers and consumers. In order to promote competition and minimise prices, domestic consumers can choose to switch between electricity supply companies. The domestic retail market for electricity supply is dynamic, with nearly 400,000 switches taking place on average each month over the last eight years. Business and industrial customers may also switch suppliers, though some very large industrial plants may choose to participate in the wholesale market and contract directly with generators.

iii. The wholesale market operates primarily between electricity generators and suppliers. Requiring them to contract directly with each other is intended to promote competition and efficiency (for example, by reducing excess generating capacity), and therefore to reduce the price ultimately paid by the consumer. It should also provide financial incentives to invest in new generating capacity, because the price of electricity should rise as older plant is retired and the margin between available generation and peak demand falls.

iv. Over 95 per cent of electricity generated is traded directly in the wholesale market. The remainder is traded indirectly to match supply and demand (see 1.3). Supply companies build up their contractual positions to satisfy daily and seasonal variations in demand through a variety of contracts with generating companies, some of which may have been signed a year or more in advance. A considerable amount of trading, however, is carried out in the last 48 hours before the actual time of supply, as companies refine their forecasts of the likely profile for electricity demand in the light of the latest weather conditions and other factors.

v. It was originally envisaged that the complete separation of generation and supply companies would be central to the operation of the trading arrangements, as it was this which would create liquid and transparent markets in electricity. However, in practice prices are not transparent as there are no requirements on parties to disclose details about individual trades. In addition, takeovers have resulted in the emergence of a few large vertically integrated companies which span both generation and supply (see 1.5). Such companies can internally balance their requirements, and this has reduced the liquidity of wholesale markets. Longer term forward markets in electricity have also failed to develop in the way originally anticipated, and there is little future price visibility beyond a period of two years.

1.3: The balancing mechanism



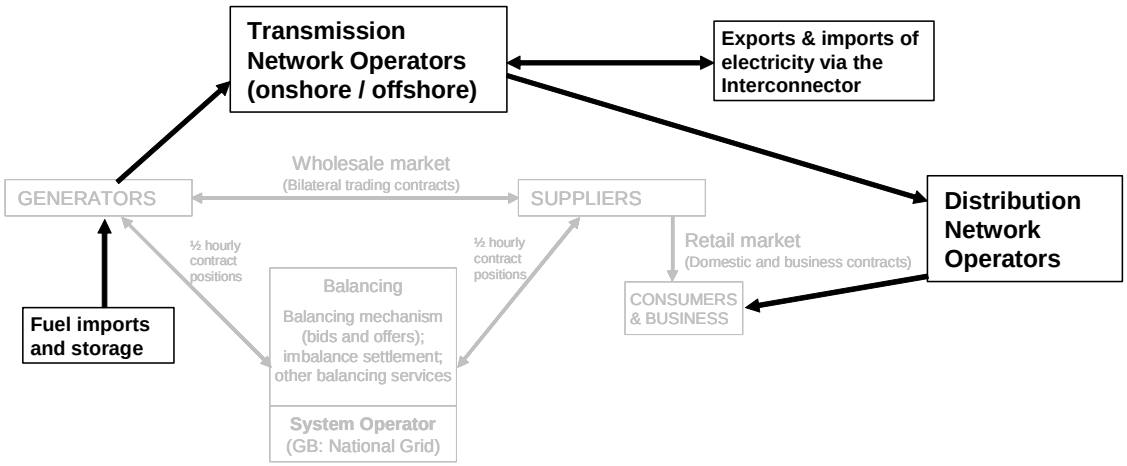
Source: National Audit Office

i. Electricity cannot be easily stored. In order to ensure security of supply, it is therefore necessary to match generation and demand on a minute-by-minute basis. The system operator (National Grid in Great Britain, licensed by Ofgem) is responsible for balancing the system in this way, and much of the complex administrative procedures involved are contracted out to another private sector company, Elexon. The administrative costs are recovered from generators and suppliers through Balancing Services Use of System charges.

ii. The trading arrangements operate on the basis of rolling half hourly slots, 24 hours a day and every day of the year. Generators and suppliers have to report their forward contractual positions on a half hourly basis, and these are finalised one hour ahead of the actual time of supply ('gate closure'). Companies are subject to 'settlement charges' if they do not meet their contractual positions – if, for example, a generator generates more or less electricity than they have contracted to provide; or if a supplier requires more or less electricity than they have contracted to buy. These charges recompense the System Operator for any additional costs it incurs in balancing generation and supply. In practice, most generators and suppliers incur settlement charges because few balance their contractual positions exactly.

iii. The principal balancing mechanism used by the System Operator is the system of bids and offers submitted by generating and supply companies at gate closure. These bids and offers set out at what price they would be prepared to increase generation or reduce demand (bid), or reduce generation and increase demand (offer), in the relevant half hour period. After gate closure, the system operator can choose to call on bids and offers to balance supply in that period. If these are insufficient, the system operator has a range of other balancing options which it can call upon (see 1.8).

1.4: Transmission, distribution, exports & imports



Source: National Audit Office

i. The high voltage transmission network is designed to transfer electricity around the country from power stations to population centres and industrial sites. It operates at between 132 kilovolts and 400 kilovolts in order to minimise losses. In the event of an unplanned 'outage' (shut-down) of a major generating plant, it provides security of supply due to the fact that other generating plants connected to the grid can make up for any loss of output. The costs of developing and maintaining the network are recovered from generators and suppliers through Transmission Network Use of System charges, which include a locational element such that generators pay progressively more the further they are from centres of demand.

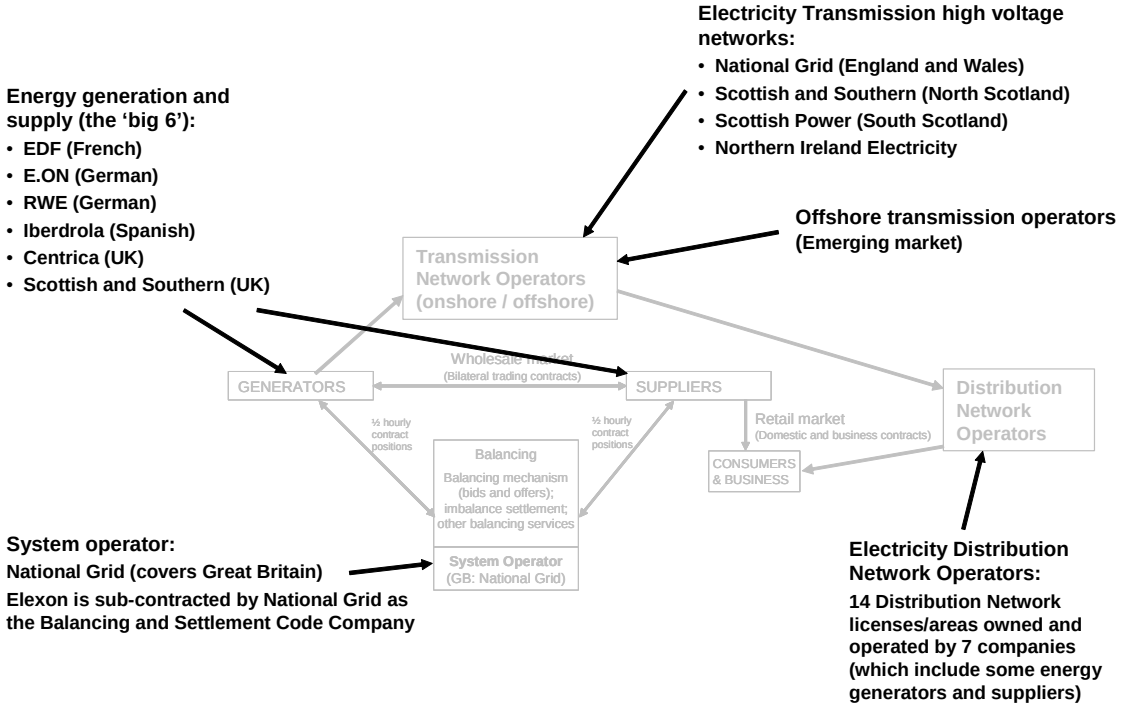
ii. The development of extensive offshore windfarms over the next decade will also necessitate the creation of an offshore transmission network. DECC and Ofgem have developed a regulatory framework for this, under which Offshore Transmission Owners are licensed through competitive tender to deliver the necessary transmission assets. Generating companies are prohibited from owning transmission assets, and transitional arrangements are in place to allow assets currently being developed or already in place to transfer to Offshore Transmission Owners.

iii. Distribution networks allow electricity to be transferred from the grid to domestic consumers and businesses. Transformers are used to reduce the voltage in steps, until it is delivered to domestic consumers at 230V. Large industrial sites may connect to the distribution system at higher voltages. The 14 distribution networks cover distinct geographical areas of the country, and the companies responsible for them (Distribution Network Operators) recover the costs of maintaining the networks from electricity suppliers through Distribution Use of System charges.

iv. Electricity generated in Great Britain can also be exported, or imported, via a cross-Channel interconnector between the English and French transmission networks. Capacity is sold to eligible users (mainly generators and suppliers) through auctions. A second interconnector to the Netherlands is due to be completed in late 2011.

v. British fossil fuel generating plants are increasingly dependent on imported gas and coal, and security of supply could be compromised if such supplies were halted. Gas storage capacity is particularly important as gas is used for domestic heating as well as electricity generation.

1.5: The companies involved

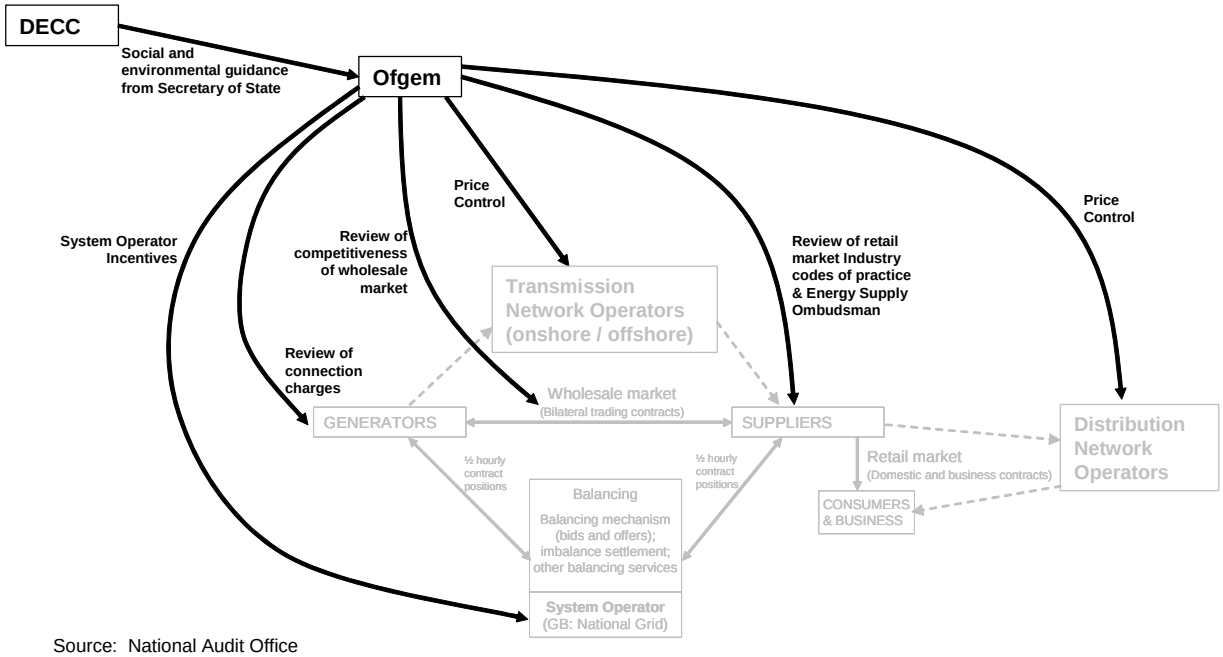


Source: National Audit Office

i. National Grid plc, an international energy company, is licensed by Ofgem as the System Operator in Great Britain. It is therefore responsible for balancing generation and supply. It also owns and operates the high voltage electricity transmission network in England and Wales, which enables power from remote generating stations to be efficiently carried around the country to the main centres of demand.

ii. Mergers and acquisitions have resulted in a small number of vertically integrated energy companies spanning both generation and supply (see 1.2). The 'big six' are multinational utilities and are among the largest energy companies in Europe. Four of them also own 9 of the 14 distribution networks in Great Britain.

1.6: The regulatory framework



Source: National Audit Office

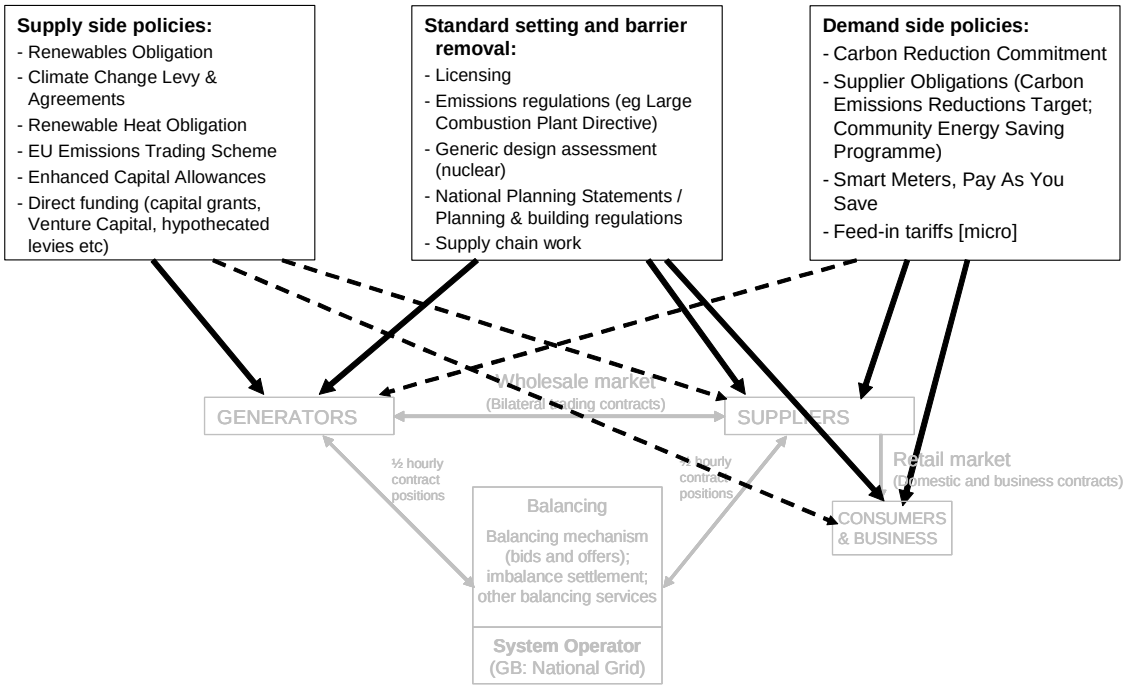
i. Ofgem is responsible for regulating the electricity sector to protect the interests of existing and future consumers. Its specific responsibilities include:

- periodic reviews of the prices charged by transmission network operators, and the prices charged by distribution network operators;
- reviews of the financial incentives for the system operator; and
- monitoring, reviewing and reporting on other aspects of the operation of the system (such as consumer welfare, the operation of wholesale and retail markets, connection charges, and the operation of interconnectors).

ii. Prices charged to consumers by suppliers are not directly regulated, as they are in principle subject to competitive trading, but Ofgem has powers to investigate supplier pricing arrangements where it considers there may be potential market abuses, as it did in 2009. It may also conduct more strategic reviews of the operation of the entire market system, as it did in *Project Discovery* (February, 2010). Ofgem also has to take account of ongoing EU reforms which aim to promote liberalised and competitive energy markets across Europe and ensure greater independence in the operation of transmission networks from generation and supply interests. More generally, these reforms may result in some changes to national markets and to the way energy is traded between Member States.

iii. DECC is responsible for energy policy, including consideration of the need for changes to the strategic electricity market framework. It does not have any direct involvement in the regulation and operation of the electricity market system, other than to issue Ofgem with general guidance designed to set out the priority to be accorded to social and environmental objectives when conducting price reviews.

1.7: The policy framework



Source: National Audit Office

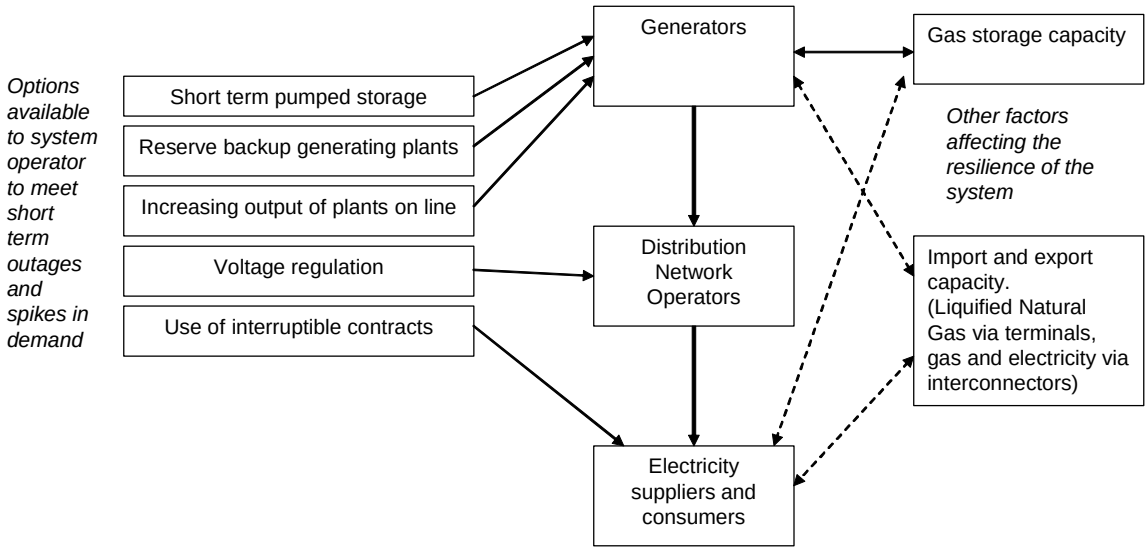
i. In order to attain EU and national strategic objectives such as targets for renewable energy generation and carbon reductions, the government seeks to influence the electricity market through various policy instruments which operate on generators, suppliers, and consumers.

ii. Policy instruments which focus mainly on generation, such as the Renewables Obligation, aim to increase financial incentives for investment in renewable and low-carbon generating capacity; while those focussing on suppliers and consumers aim to promote greater energy efficiency and reduce demand. Some policy instruments may affect more than one sector, and those which increase or decrease generating costs will also impact on demand. For example, the EU Emissions Trading Scheme affects electricity generators, but also large industry's demand for energy.

iii. Regulations and standards may impact on both generators and suppliers either directly (such as the Large Combustion Plant Directive, which will force the closure of many older polluting coal-fired power plants), or indirectly (such as building standards encouraging the construction of more energy-efficient homes).

iv. The new government has indicated that it may introduce a number of new initiatives in the energy policy landscape, including a minimum price for carbon and further reform of the Renewables Obligation so as to resemble more closely a feed-in tariff.

1.8: The resilience of the current system



Source: National Audit Office

i. As electricity cannot easily be stored, the system operator (National Grid in Great Britain) must balance generation and supply on a continuous basis. It has a variety of options available to do so which can be categorised in three main ways:

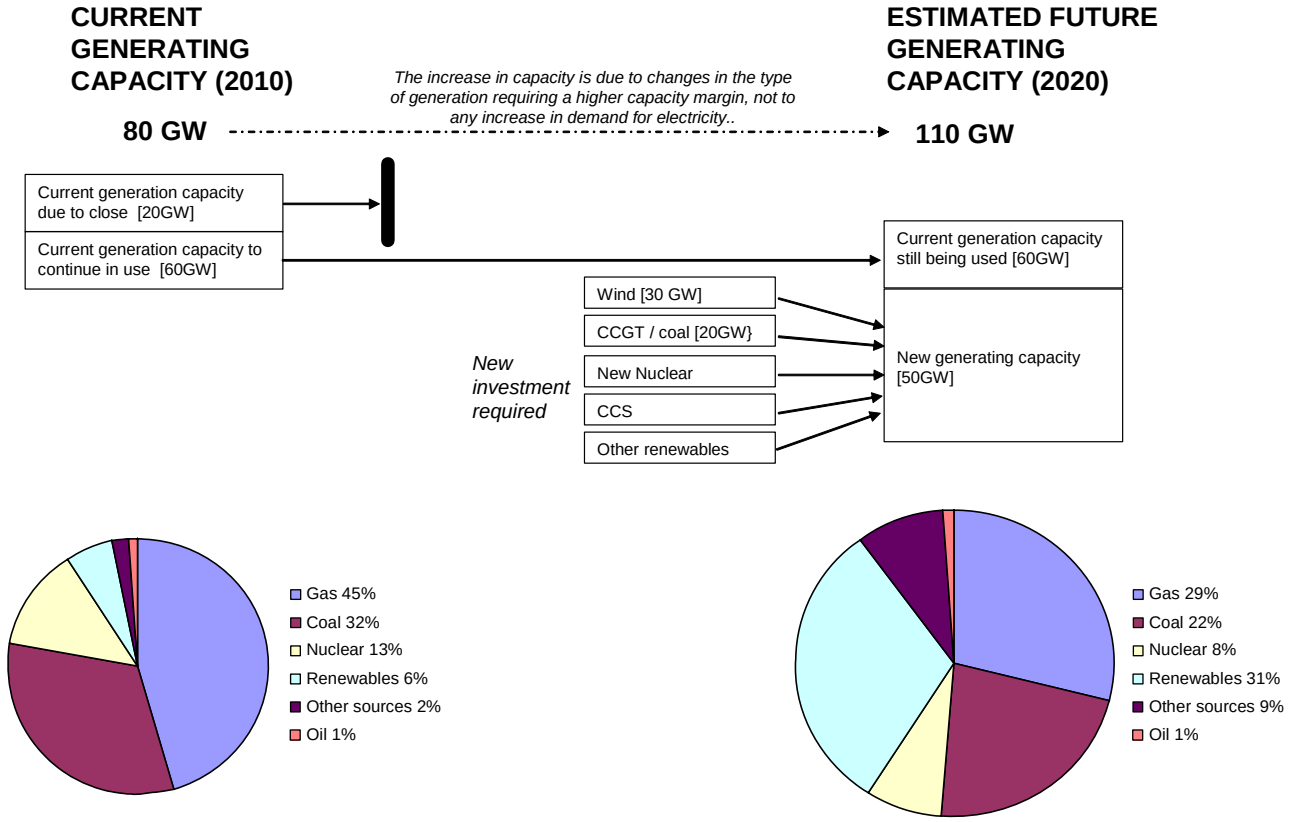
- Increasing generating capacity: the system operator can call on power plants which are already generating to increase their output for limited periods of time through the balancing mechanism system of bids and offers. It also has contracts with generators for reserve generation which can be accessed very quickly. The latter include pumped storage – reserve hydro-electric power stations, the sole purpose of which is to provide emergency generating power within minutes.

- Reducing demand: large industrial plants often negotiate lower tariffs with energy suppliers in return for accepting that their electricity supply may be interrupted. The system operator can utilise such contracts to reduce demand.

- Voltage regulation: the system operator may reduce the voltage for short periods of time by up to 6 per cent. This has a slight effect on industry and consumers (including, for example, lights becoming slightly dimmer) but can simulate an additional generating capacity of up to 6GW, the equivalent of five nuclear generating stations of the size of Sizewell B. Voltage reductions can only be used as a short-term measure because consumers and business will respond over time by increasing demand (for example, by turning on more lights).

ii. Gas storage capacity and imports and exports of electricity through interconnectors can also provide resilience against increasing demand or temporary losses in supply.

1.9: The transition to a low-carbon system



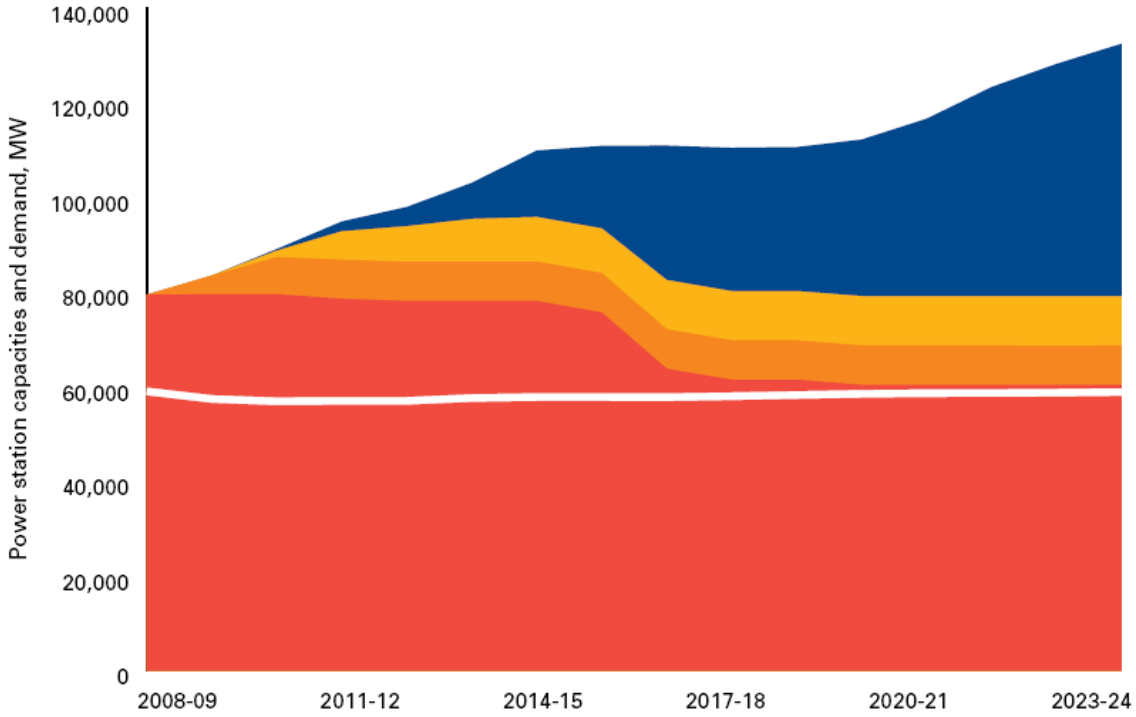
Source: National Audit Office / DECC

i. Britain's electricity generating capacity in 2009 was approximately 80GW. Up to 20GW of existing coal and nuclear power stations will be retired before 2020 (depending on the impact of the draft EU Industrial Emissions Directive, which is currently being considered by the European Parliament), and substantial investment will be required to replace this capacity. From 2020 to 2030, further investment on the same scale will also be required as more existing power plants are retired.

ii. Much of the new investment will need to be in wind power if 2020 targets for renewable generation and carbon reductions are to be met. This is because other renewables, new nuclear, and fossil fuel generating plant with Carbon Capture and Storage are unlikely to contribute substantially to power generation until after that date. As the load factor for wind farms (their actual output as a percentage of their rated capacity) is lower than for other power stations, correspondingly more capacity would need to be built in order to provide equivalent generating power. Britain's generating capacity is therefore forecast to increase substantially by 2020, with estimates ranging from 100GW to 130GW. The figures shown above for closures and new capacity (both in total and by sector) should therefore be treated as indicated only.[1] The government has not set targets for future generating capacity either in total or by sector.

[1] They are based on DECC's *Energy Markets Outlook Report* (December 2009) and the July 2009 *Renewable Energy Strategy* and the associated updated emissions projections.

1.10: Forecast supply and demand trends



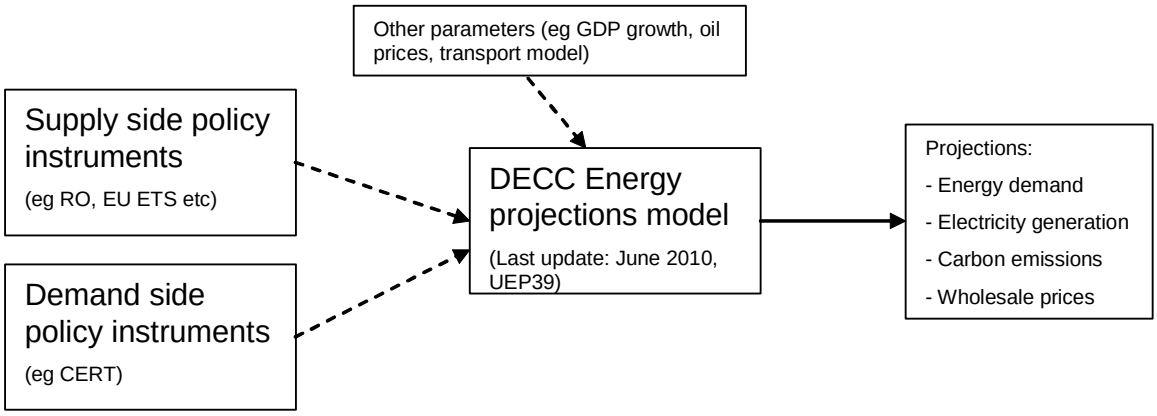
* Transmission contracted

Source: National Grid Seven Year Statement extrapolated to 2023; Department of Energy and Climate Change

i. The extent to which electricity generating capacity has exceeded likely demand is known as the 'capacity margin'. Historically, this figure has remained in excess of 20 per cent for most of the last two decades. The retirement of existing nuclear and older coal-fired plants will reduce the capacity margin from 2016 onwards. DECC consider that, if the generating plants currently under construction or consented but not yet under construction are all built, the capacity margin will remain sufficient to ensure security of supply. The margin would be further increased by delivery of additional planned investment, not yet consented.

ii. The overall generating capacity required in 2020 will also be affected by demand trends. Over the last 50 years, electricity demand has steadily increased at around 1.5 per cent per annum. However, DECC's current forecast, the white line in the above graph, is that demand over the next decade will remain flat, on the grounds that energy efficiency improvements will counterbalance growth which might otherwise have occurred. Demand may increase significantly after 2020 depending on trends in other sectors, such as a possible increase in the use of electric vehicles in transport.

1.11: System modelling and forecasting – the DECC energy model



Source: National Audit Office

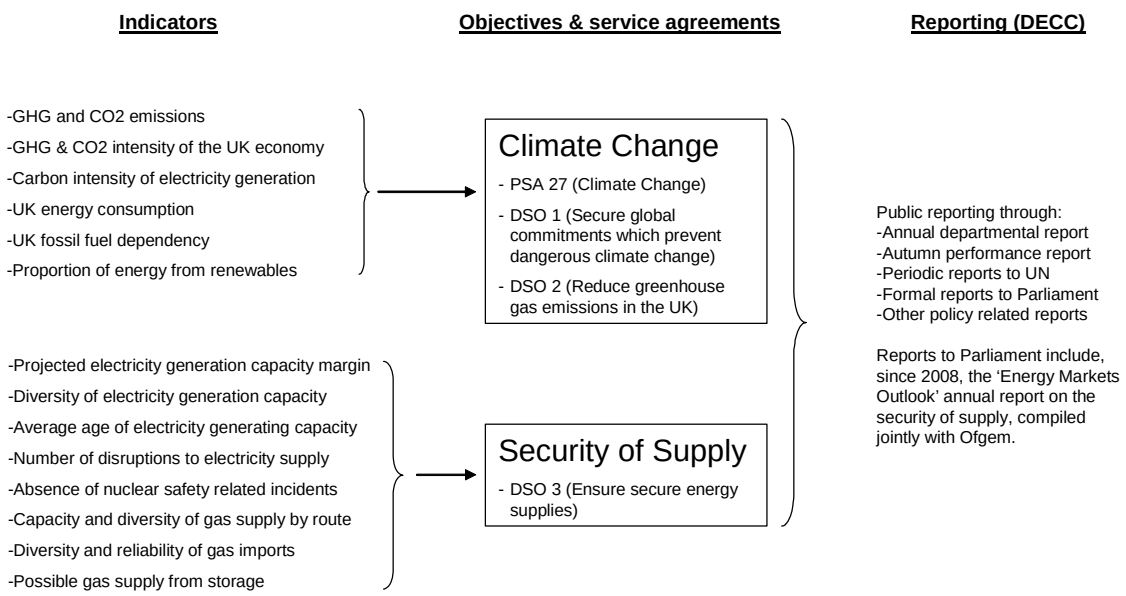
i. Modelling and forecasting are of fundamental importance in order to understand the way in which energy markets may develop and the likely impacts of existing and planned policy measures. DECC maintains a complex energy model and regularly publishes Updated Energy Projections (UEP) setting out long term forecasts. These forecasts include some sensitivity analysis for the impact of supply and demand side measures and for the impact of external factors such as GDP growth and the price of oil.

ii. In addition to the DECC energy model, there are a number of other processes for forecasting and assessing future security of supply. These include:

- The National Grid's annual Seven Year Statement (electricity) and Ten Year Statement (Gas), both of which are based largely on information provided by energy companies. The Seven Year Statement sets out what plants are likely to be retired or come onstream, and on this basis the National Grid assess the capacity margin over the period of the forecast (the extent to which generating capacity exceeds supply).
- Ofgem and DECC's joint annual report on future energy security, utilising information from the DECC model and from the National Grid.
- Cambridge Econometrics' six monthly independent energy forecasts. These have consistently indicated poorer performance against renewable and carbon targets than forecasts produced by DECC.
- Other organisations' specific modelling and forecasting exercises or reviews, including the Project Discovery initiative (Ofgem) and the Energy Market Assessment (HMT & DECC).

iii. The Climate Change Committee has an important role in assessing the adequacy of the government's policies for meeting carbon budgets. To do this, it conducts its own modelling and has also been assisted by Cambridge Econometrics.

1.12: Reporting



Source: National Audit Office

i. The last government's framework of Public Service Agreements (PSAs) and Departmental Strategic Objectives (DSOs) for assessing government departments' performance included climate change and security of supply measures for DECC. These drew on a wide range of statistics published by DECC and by the Office for National Statistics. The new government has discontinued the system of PSAs and departments will not report against PSA targets from this year.

ii. Ofgem has statutory duties and reports to Parliament on them, but in general these reports lack quantification of outcomes. It has no service agreement, or strategic objectives agreed with government. Ofgem separately publishes various reports on its activities such as, for example, its monitoring of regulated companies' costs and service quality.

Part 2: Risks to system operation and transition

2.1: Short-term operational risks - the current system

Risks	NAO comment
(A) Insufficient reserve power options to deal with sudden outages and/or spikes in demand	Current generating capacity margin is high. There are well-established options in place which provide considerable backup capacity
(B) Interruption in fuel supplies and insufficient fuel storage	Britain's gas storage capacity is low in comparison with other European nations. There have been a few occasions in the last decade when there have been severe shortages, and interconnectors have not operated to alleviate them. However, there has been some increase in storage capacity recently, and substantial further increases from private sector investment are planned (though not yet contracted). There have also been significant increases in Liquid Natural Gas (LNG) import capacity.
(C) Damage to generation capacity and to grid and distribution infrastructure	Weather damage (storm and flooding) represents the single largest risk to electricity supplies, and major blackouts have sometimes occurred. But there are well-established contingency arrangements in place. Natural risks and potential risks arising from terrorism are also considered in the Cabinet Office's National Risk Register.
(D) Poor network infrastructure maintenance	Britain has not experienced major network failures caused by poor maintenance of infrastructure, though there have sometimes been breakdowns at a local distribution level. Price control reviews take account of the costs of system maintenance but it is unclear whether such expenditure is adequately addressing any underlying and long-term infrastructure problems.
(E) Poor maintenance of generating plants	Unexpected shutdowns of nuclear power stations have occurred but have not led to any disruption in supplies because of the existing capacity margin. Other generating plants are less susceptible to systemic risks.
(F) Failure in market operation	There is no evidence to suggest any significant risks in the operation of bilateral contracting and the Balancing and Settlement Code.
(G) Supply through interconnector to Europe prioritised over Britain's supply	The operation of the interconnector lacks transparency and it is unclear whether the market sends the right price signals for it to help alleviate shortages in Britain. But the volume of imports is small, and overall risks are low due to the extent of the present capacity margin.

i. Current arrangements for ensuring security of supply in relation to the current system have been robust. Any disruptions in supply ('outages') which have occurred have been due to major storms and flooding or to hardware problems at a local level relating to distribution networks, rather than because of system-wide failures in matching generation and supply.

2.2: Medium term operational risks - the transition to a low carbon system

Risks	NAO comment
(A) Unanticipated early closures of existing generating plants lead to reduced capacity margins.	Although unexpected reductions in nuclear capacity have not so far led to supply problems, there remains a risk that a serious systemic problem could result in relatively sudden, long-term closures – with consequent impacts on supply.
(B) Insufficient investment in new generating capacity.	The market structure may not operate effectively in incentivising investment in new generating capacity. Companies may delay such investment (particularly in low carbon generation) for various reasons: - uncertainties about future international and domestic energy and carbon prices - uncertainties about the future policy framework - scale of capital funding required for individual projects - high cost of capital, reflecting the financial risks involved.
(C) Sufficient commitment to investment in new low-carbon generating capacity, but technologies fail to deliver and/or projects are delayed.	Delays may occur for a variety of reasons: - new technology does not deliver commercial solutions - supply chain problems inhibit new development - planning problems delay infrastructure and new generating plants.
(D) Sufficient investment in new generating capacity, but in fossil fuel rather than low-carbon technologies, leading to failure to meet renewable energy and CO2 reduction targets.	If investment in fossil-fuel technologies continues to be more financially attractive, it might displace the investment in low-carbon generation which is required to meet renewable and carbon targets. In any event,, there will need to be significant investment in new fossil-fuel generation plants in order to maintain capacity margins and ensure security of supply.
(E) Inadequate development of infrastructure delays connection of new generating capacity	Significant strategic investment is required to allow the development of substantial offshore wind generation, and to address existing bottlenecks in the grid, such as between Scotland and England. Some companies have been offered connection dates as late as 2020 for new renewable capacity. National Grid has published a consultation on grid investment; and OFGEM is making allowance for investment in connections in price controls, and working to remove industry barriers to investment.
(F) Unexpected rises in electricity demand.	Current modelling and scenario analyses involve assumptions about future demand, investment in energy efficiency and behaviour change which may prove over-optimistic.

i. DECC does not envisage that there will be any significant threat to the security of supply in the next decade, as it considers that present approved commitments to build new generating plant will be sufficient to ensure an adequate capacity margin (an excess of supply over demand). Ofgem considers that the risks to security of supply will increase from 2016 (the year by which all coal fired power stations which do not comply with the Large Combustion Plant Directive will have to close).

ii. The 2020 renewable energy target requires a sevenfold increase compared to 2008 levels in renewable generating capacity. Much of this increase is expected to come from large scale development of onshore and offshore wind farms, but the scale of deployment required involves significant planning, financial, engineering, and supply-chain risks. The government has estimated that £100 billion investment will be required to achieve the renewables target, while the Green Investment Bank Commission has cited a figure of £550 billion to achieve the renewables and climate change targets more broadly. Uncertainty about the future policy framework and the extent of further changes to it are reflected in the absence of longer term markets for electricity; while the scale of investment required, together with the lack of forward price signals, may delay investment in low-carbon generation. Government policies to incentivise investment in low carbon technologies will increase the challenge of addressing fuel poverty.

2.3: Long-term operational risks - resilience and impacts of a low carbon system

Risks	NAO comment
(A) Scale of intermittent supply (wind) renders the market system less able to cope with supply imbalances.	Significant flexible reserve generating capacity may be required because of the expected increase in intermittent wind generation. Marginal prices may be subject to extreme variations and spikes. It is unclear whether the current market system offers sufficient incentives to maintain security of supply in this situation. There may be particular problems for nuclear power, given its relative inflexibility and fixed generation costs. Existing electricity storage options (for example, pumped storage) are limited, and the extent to which technological developments (for example, breakthroughs in battery technology) will address this is uncertain.
(B) Physical infrastructure (grid and distribution networks) is unable to cope with variable flows.	There have been instances in Europe where excess power (for example from wind generators) has resulted in major system failure and outages, due mainly to infrastructure problems in transmission networks. It may also be difficult to predict the risks associated with the development of a 'smart' grid (involving two-way flows of electricity and the need for balancing at a local level). Research suggests that the current infrastructure can cope with substantial increases in the level of renewable and distributed generation. Under provisions in the 2010 distribution price review, Ofgem is supporting Distribution Network Operators' efforts to support the take-up of low carbon and energy saving initiatives.
(C) Extensive dependence on imported fuels (gas, coal, and LNG).	Electricity generation in Britain is substantially dependent on gas and will continue to remain so for at least two decades. The decline in North Sea gas reserves is leading to increasing import dependence, and the recent Russia / Ukraine dispute highlights the issues this can pose. The UK government has emphasised for some years the need for diversity in energy supplies. If the 'Peak Oil' scenario were to occur within the next decade (ie the turning point at which demand for oil outstrips total supply), this would result in significant escalations in the price of fossil fuels.
(D) Increased costs of investment in low carbon generation lead to social and economic impacts	The additional costs of investment in low carbon generation are typically borne by consumers. Increases in energy prices reduce living standards and exacerbate fuel poverty, which remains a significant social issue. Higher energy prices could also leave British companies at a competitive disadvantage if developing countries continue to rely on cheaper fossil-fuel generation.
(E) Investment made in network and low carbon generation may be rendered nugatory due to technological advances in other areas.	Possible advances in, for example, photovoltaic or nuclear fusion technologies may alter the economics of energy investment and lead to stranded assets. This may particularly affect complex technologies such as Carbon Capture and Storage. Network investment, especially for new offshore transmission infrastructure, may become nugatory if anticipated investment in new offshore windfarms does not happen.

i. The anticipated large growth in intermittent wind power by 2020 will have significant consequences on the operation of the wholesale electricity market, and the uncertainties involved may in turn impact on current investment. In the light of such concerns, the government is now considering whether the current market arrangements offer sufficient incentives for low-carbon generating capacity, and whether they should be reformed in any way. It is likely that any measures to facilitate greater security of supply would result in an increase in the costs of electricity to the public.

ANNEX: References

This briefing has been based on a wide range of documentary sources. Key references include the following:

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