



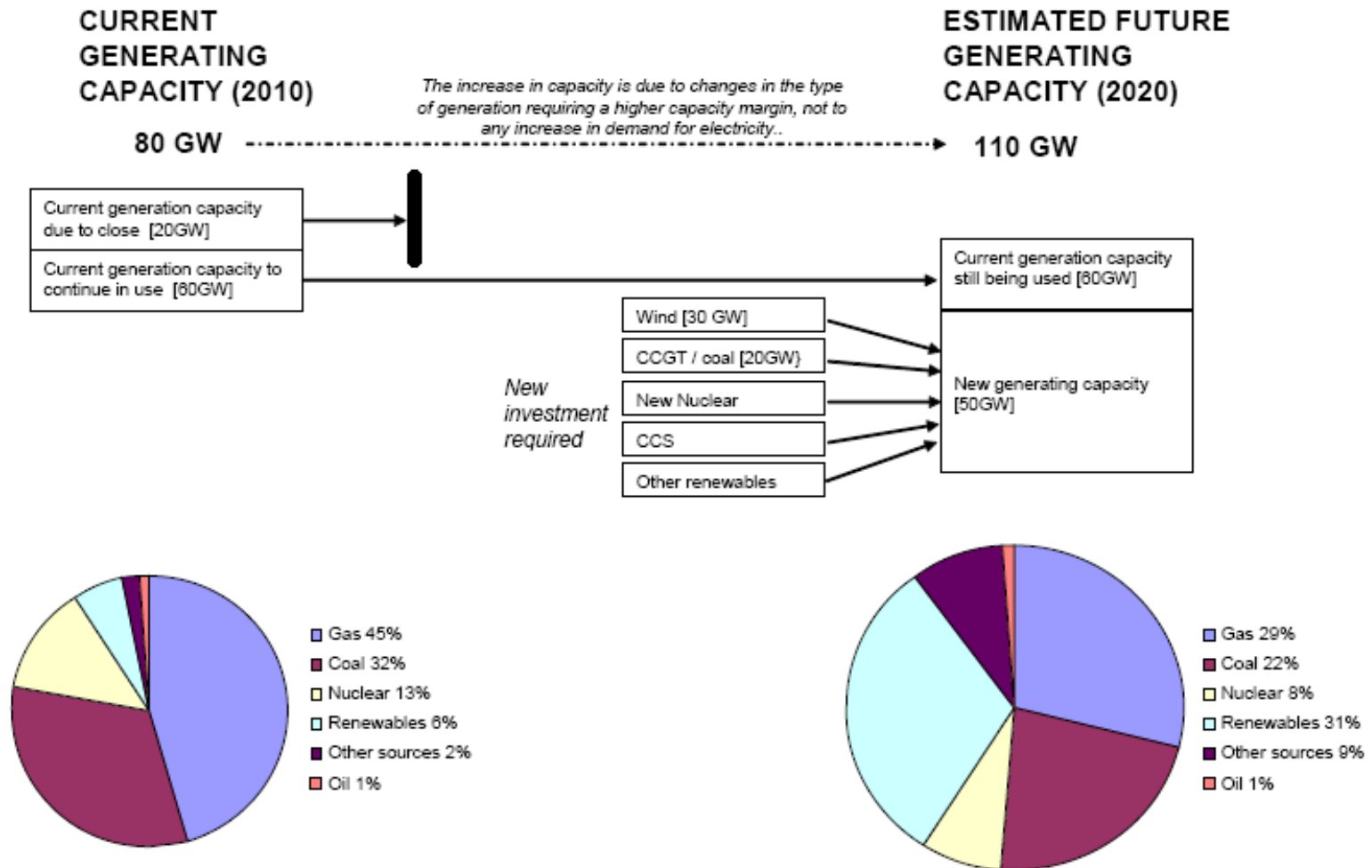
National Audit Office

Sustainable energy audit topics and challenges: Developing a sustainable electricity system

**Richard Gauld, UK National Audit Office
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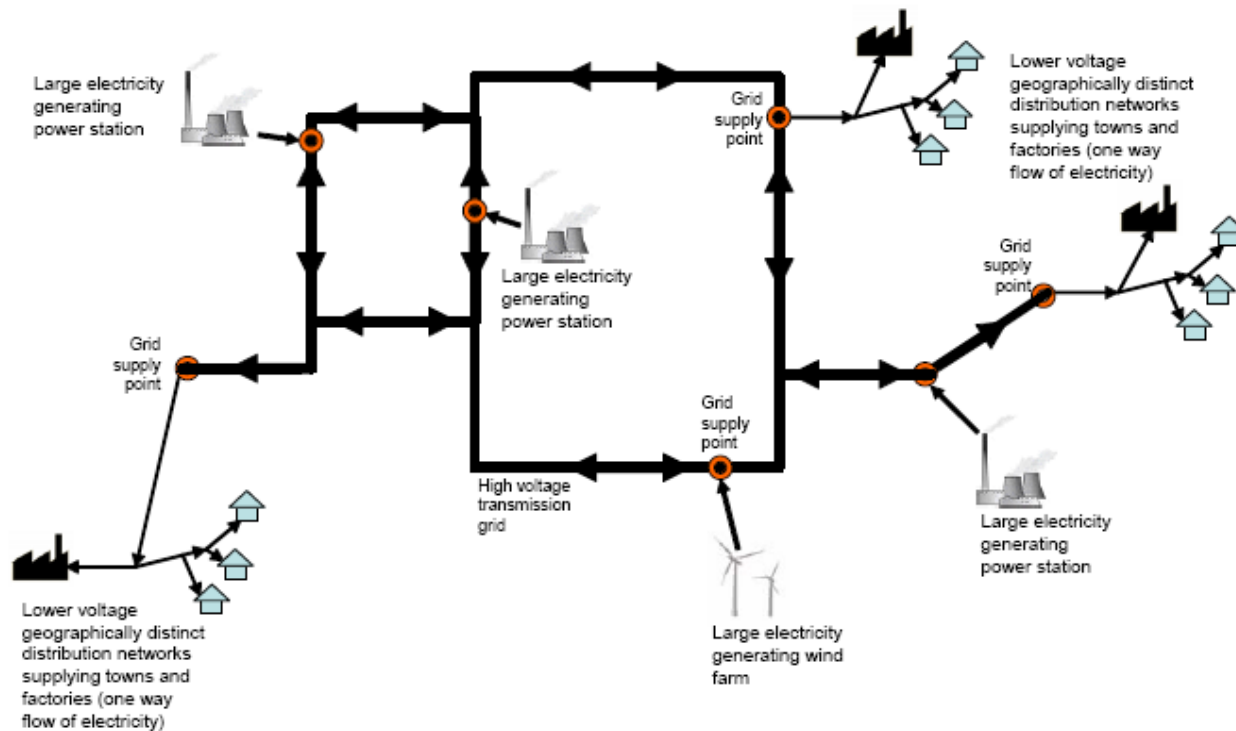
Part 1: the GB electricity system

Transition to a low-carbon system

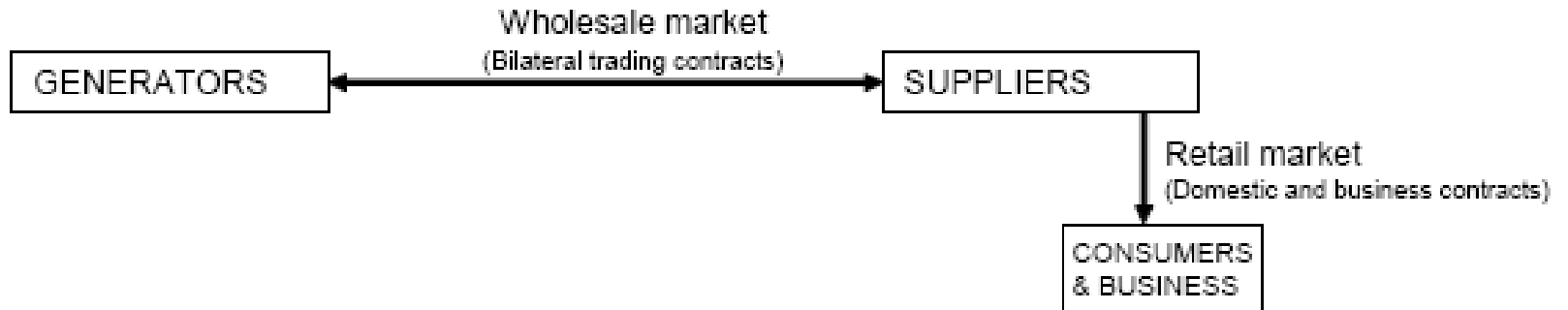


Source: National Audit Office / DECC

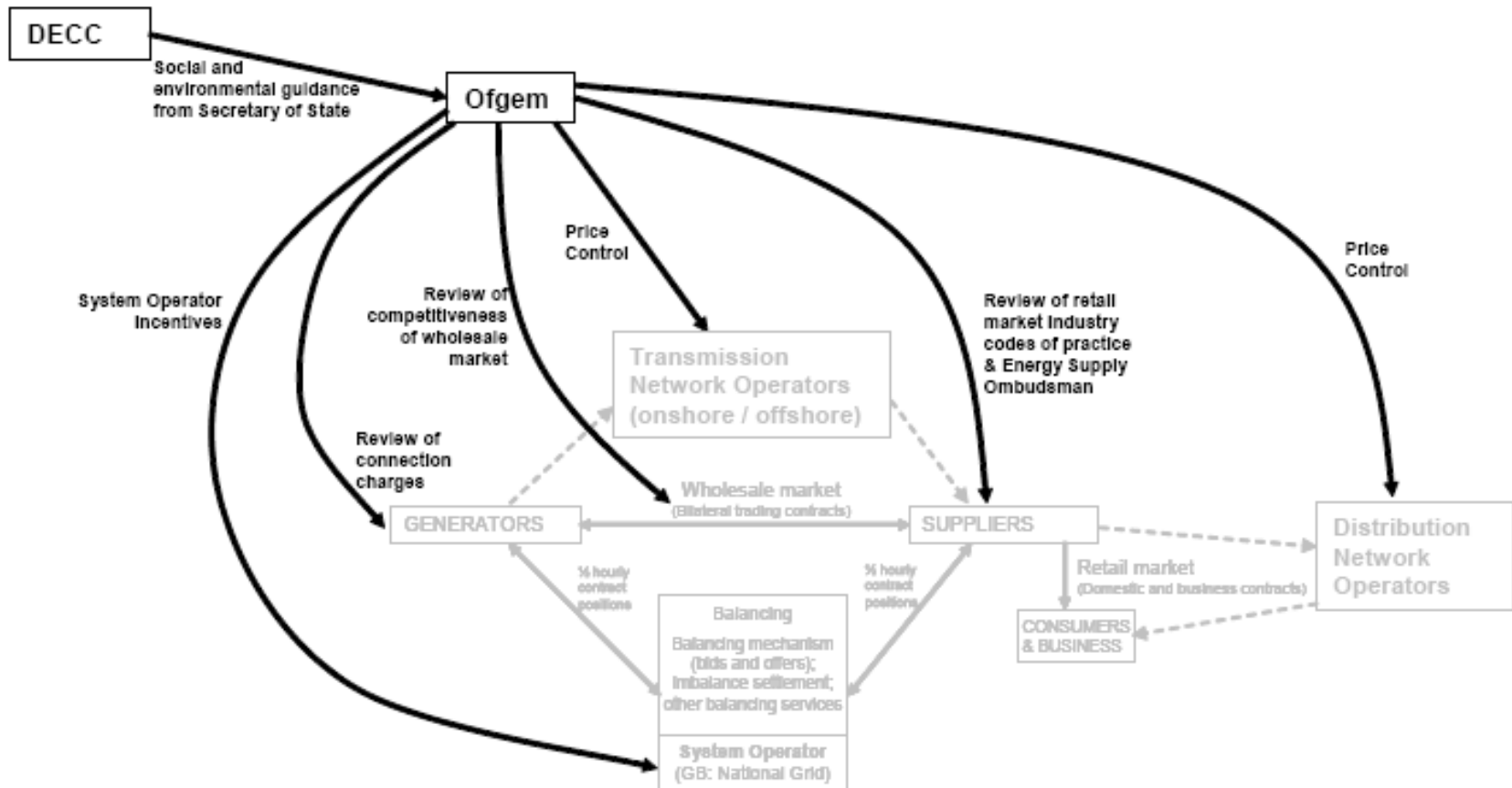
The physical system



Wholesale and retail markets

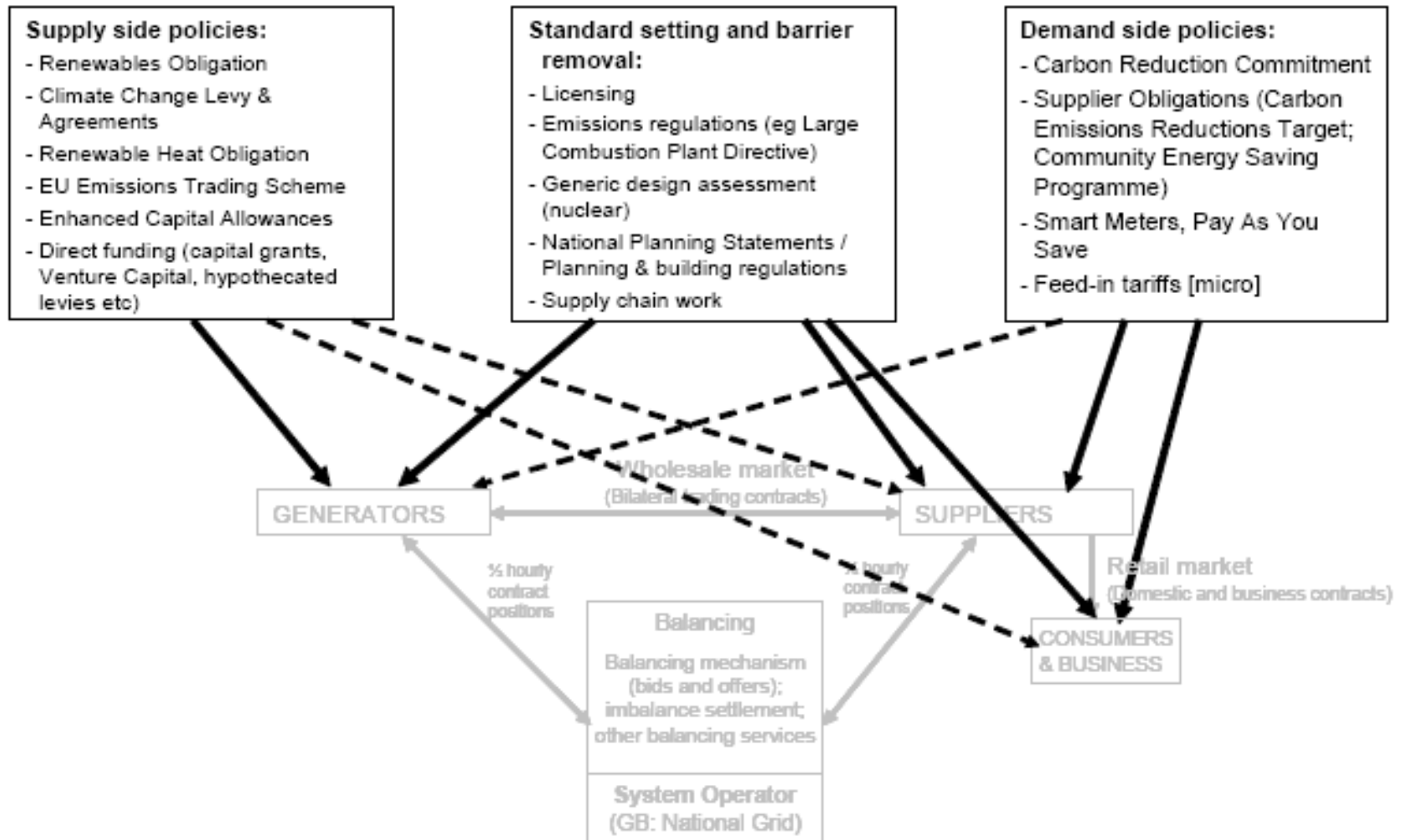


The regulatory framework



Source: National Audit Office

The policy framework



Part 2: Risks to system operation and transition

Short-term operational risks:

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.

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: <ul style="list-style-type: none"> - 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: <ul style="list-style-type: none"> - 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.

Long-term operational risks: resilience & 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.

Part 3: An evaluation framework

An audit evaluation framework

Theme	Risks to VFM
(A) Governance (roles and responsibilities)	Lack of clear responsibilities between stakeholders
(B) Strategy and objectives	Lack of clarity and coherence in policy
(C) Forecasting and modelling	Lack of consistency and reliability in assessments of future energy security.
(D) Appraisal of policy options	Policy not based on proper assessment of costs and benefits
(E) Delivery	Failure to manage the transition as a major project results in delays and inefficiencies.
(F) Monitoring, reporting, and evaluation	Weaknesses in reporting result in a lack of accountability.