



ofgem E-Serve

Promoting choice and value

for all gas and electricity customers

Adaptation to Climate Change: Report to Defra

Report

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Overview:

This report outlines how Ofgem addresses adaptation to climate change in carrying out its duties. It describes our duties, aims and objectives and how they relate to adaptation to climate change.

Ofgem's role in adaptation is to ensure that the energy sector accurately assesses the risk that climate change poses and takes specific adaptation measures in line with the regulatory frameworks, policies and initiatives.

To this aim, we have reviewed the climate change risks highlighted by regulated companies in their adaptation reports, mapped them against Ofgem's regulatory tools and policies and assessed whether these facilitate adaptation by companies. Our tools and policies embed clear legal obligations on security of supply and reliability, a large degree of flexibility and robust monitoring and review mechanisms. These provide sufficient flexibility to the companies to implement adaptation measures.

We have also reviewed potential barriers, uncertainties and interdependencies in relation to adaptation, and outlined measures to address them now and in the future.

Context

This report has been submitted to the Department for Environment, Food and Rural Affairs Secretary of State, as required under the 2008 Climate Change Act (CCA)¹.

The CCA requires a total of 91 organisations in the strategic infrastructure sectors to report. The Government will use the reports to complete the first UK Climate Change Risk Assessment and the first national adaptation programme, due to be laid before Parliament in 2012.

This initiative is a timely one: the electricity and gas sectors are vital for the functioning of our society, and their infrastructure is vulnerable to the impacts of climate change. Making the sectors' infrastructure more resilient to a warming climate is a complex endeavour, which will require time, resources and cooperation among the sectors' operators, relevant Government departments and other strategic infrastructure sectors.

Defra's direction to report, sent to us in March 2011, specifically asked us to produce:

- a) an assessment of the current and predicted impact of climate change in relation to our functions.
- b) a statement of our proposals and policies for adapting to climate change in the exercise of our functions and the time-scales for introducing those proposals and policies.

¹ In producing the report, we have taken account of Defra's statutory guidance to reporting authorities and of guidance issued by Welsh Ministers. These are available at <http://www.defra.gov.uk/environment/climate/sectors/reporting-authorities/>; <http://wales.gov.uk/topics/environmentcountryside/climatechange/tacklingchange/strategy/walesstrategy/> and: <http://wales.gov.uk/consultations/environmentandcountryside/climatechangeresilience/>

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Executive Summary

Ofgem regulates the gas and electricity sector in Great Britain. Our principal objective is to protect the interests of existing and future consumers in relation to gas and electricity conveyed by distribution or transmission systems. The interests of such consumers are their interests taken as a whole including their interests in the reduction of greenhouse gases and in the security of their gas and electricity supply. In pursuing our principal objective we have a duty to secure diverse and viable energy supply for the long term and contribute to the achievement of sustainable development.

All our regulatory tools and policies focus on consumers and must take sustainable development into account, including adaptation to and mitigation of climate change. This means that we do not directly assess the risks that climate change poses to companies, or require them to take specific adaptation measures. It is the energy companies who are best placed to assess such risks and implement adaptation measures in order to meet their legal obligations towards us, the Government and other stakeholders.

As an economic regulator, we must ensure that energy companies meet regulatory requirements economically and efficiently through our regulatory frameworks, policies and other initiatives. Our tools and policies embed adaptation needs and requirements indirectly, through obligations set on regulated companies to provide secure, reliable and sustainable energy supplies.

The main regulatory tools relating to adaptation are the price controls for network companies, the licensing regime, the network codes and the offshore regime.

Our main contribution to adaptation is through our price controls. These allow regulated network monopolies to make the necessary investments to meet their adaptation needs, and recover their costs from their customer base. They also set clear deliverables to hold the network companies to account.

We also play a role by setting licence conditions and accepting (or rejecting) network codes modifications, several of which relate to security and reliability of supply and hence help to ensure that the energy sector is resilient to climate change.

We indirectly promote adaptation by striving to establish open, competitive and transparent energy markets, where energy generators and suppliers must compete to offer secure and reliable supplies to customers at the best value for money under all conditions. In the same vein, we also monitor security of supply and engage with our European counterparts and institutions to create a single, reliable and secure European energy market.

In this report, we have reviewed the risks highlighted by regulated companies in their adaptation reports and their impacts, mapped them against our regulatory tools

and policies and assessed whether they enable companies to adapt to climate change.

We concluded that our tools and policies achieve this objective as they embed clear legal obligations on security of supply and reliability (with a large degree of flexibility in how to meet obligations) and robust monitoring and review mechanisms.

We have also reviewed potential barriers, uncertainties and interdependencies related to adaptation and outlined measures to address them now and in the future.

We will use our existing monitoring and review mechanisms to assess the effectiveness of our regulatory tools and policies in ensuring that energy companies meet their adaptation needs. If we find that our tools and policies are not working in consumers' best interests we will consider whether reforms are necessary.

1. Ofgem: who we are and what we do

Introduction

- 1.1 In this chapter we provide an overview of our duties, aims, objectives, structure and function, and the role of our key stakeholders. We also explain where we fit in the electricity and gas markets.

Our duties, aims and objectives

- 1.2 Ofgem is the Office of the Gas and Electricity Markets regulating the gas and electricity industries in Great Britain. We regulate the transmission companies, the distribution companies and the supply companies.
- 1.3 Ofgem operates under the direction and governance of GEMA – the Gas and Electricity Markets Authority ('the Authority') – which makes all major decisions and sets policies. The Authority was established by section 1 of the Utilities Act 2000 and consists of non-executive and executive members and a non-executive chair. The Authority's powers and duties are largely provided for in statute (such as the Gas Act 1986, the Electricity Act 1989, the Utilities Act 2000, the Competition Act 1998, the Enterprise Act 2002 and the Energy Acts of 2004, 2008 and 2010) as well as arising from European Community legislation.²
- 1.4 The Authority's principal objective is to protect the interests of existing and future consumers in relation to gas conveyed through pipes and electricity conveyed by distribution or transmission systems. The interests of such consumers are their interests taken as a whole including their interests in the reduction of greenhouse gases and in the security of supply of gas and electricity to them.
- 1.5 The Authority is generally required to carry out its functions in the manner it considers is best calculated to further the principal objective, wherever appropriate by promoting effective competition between persons engaged in, or commercial activities connected with:
- shipping, transportation or supply of gas conveyed through pipes
 - generation, transmission, distribution or supply of electricity
 - provision or use of electricity interconnectors.

² Further details on the Authority's powers and duties can be found on our website at: www.ofgem.gov.uk.

- 1.6 Before carrying out its functions in a particular manner with a view to promoting competition, the Authority must consider whether consumer's interests are best protected through promotion of competition or by using other approaches (whether or not such would promote competition).
- 1.7 In carrying out its duties the Authority must have regard to:
- the need to secure that, so far as it is economical to meet them, all reasonable demands for gas conveyed through pipes, and all reasonable demands for electricity, are met
 - the need to secure that licence holders³ are able to finance the activities which are the subject of obligations imposed on them under statute
 - the need to contribute to the achievement of sustainable development.
- 1.8 The Authority must also have regard to the interests of individuals who are disabled or chronically sick, of pensionable age, with low incomes, or residing in rural areas and may have regard to any interests of consumers in relation to communications services and electronic communications and to water or sewerage services⁴, which are affected by the carrying out of its duties.
- 1.9 Consistent with the above the Authority is required to carry out its functions in the manner it considers is best calculated to:
- promote efficiency and economy by licensed companies and the efficient use of gas
 - protect the public from dangers arising from the conveyance and the use of gas through pipes and from the generation, transmission, distribution or supply of electricity
 - secure a diverse and viable long-term energy supply
 - have regard to the effect on the environment of activities connected with the conveyance of gas through pipes and the generation, transmission, distribution or supply of electricity.
- 1.10 When exercising its powers and duties, the Authority must have regard to:
- the principles under which regulatory activities should be transparent, accountable, proportionate, consistent and targeted only at cases where action is needed as well any other principles of best regulatory practice

³ Throughout this report, we refer to these organisations as "companies".

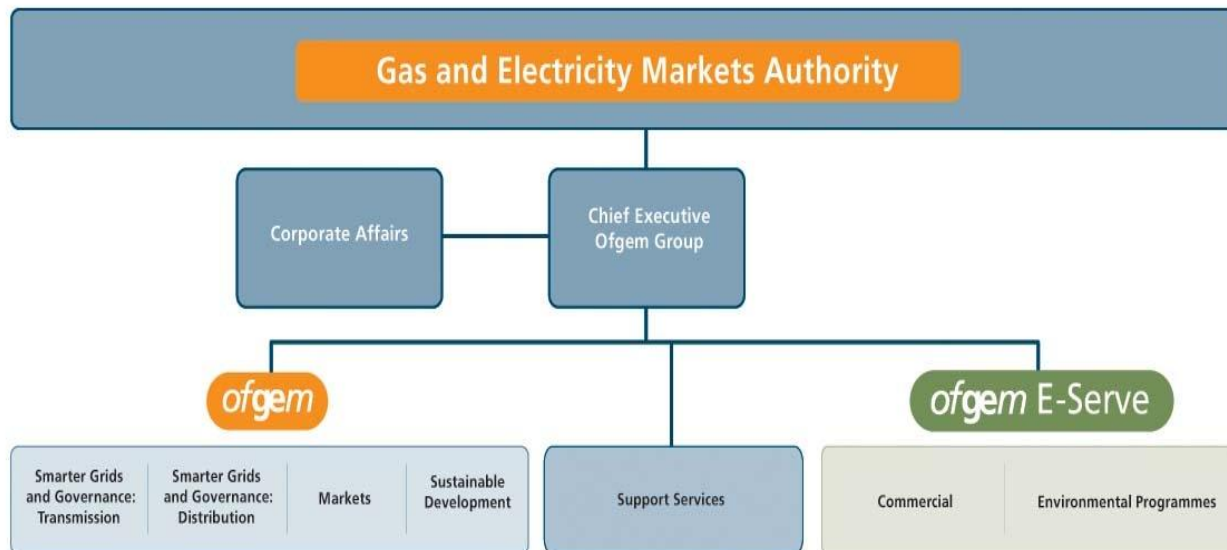
⁴ Within the meaning of the Water Industry Act 1991.

- statutory guidance on social and environmental matters issued by the Secretary of State.
- 1.11 Under the Competition Act 1998, we have powers to investigate suspected anti-competitive activity and take action for breaches of the prohibitions in the legislation in respect of the gas and electricity sectors in Great Britain.
- 1.12 We are funded by charging a license fee to the network licensed companies we regulate.

Our structure and functions

- 1.13 In 2009, in order to meet the new challenges facing the energy sector in GB, Ofgem was re-structured around a regulatory arm (Ofgem) and a service provider (Ofgem E-Serve). Both are in turn organised in divisions which fulfil specific functions. Ofgem's structure is shown the organogram below.

Figure 1: Ofgem organogram



Ofgem's key stakeholders

- 1.14 The wide ranging nature of our work means that we have key relationships with a broad spectrum of stakeholders. Figure 2 below highlights Ofgem's key relationships across the energy sector.
- 1.15 The European Union and the UK Government set the legal obligations and policy under which we regulate. Ofgem's other stakeholders include domestic, commercial and industrial energy consumers, gas and electricity

producers, transporters and distributors, as well as a number of other interested parties.

- 1.16 Adaptation to climate change is important to all our key stakeholders. As Ofgem must protect the interests of consumers, adaptation is particularly relevant to security of supply and network reliability. It is important therefore for the energy producers and network operators to assess climate change risk, as climate change could be detrimental to infrastructure, which would harm production and supply capabilities. Climate change could also alter demand and capacity and system requirements.
- 1.17 In carrying out our duties we use different approaches to consultation with stakeholders for different decisions and proposals. Policy decisions are typically made after a consultation period in line with our consultation policy⁵. We also use impact assessments to assess the impact on consumers.

Figure 2: Ofgem's key stakeholders

European Union					
European legislation such as the third energy package and the renewable obligation					
UK (e.g. DECC, DEFRA), Scottish and Welsh Government					
Sets the overall energy sector policy Energy is a reserved matter					
Other regulators	Local Government	Environmental Agency and Scottish Environmental Protection Agency	Technology suppliers	Heath and Safety Executive	Consumer Focus
Essential services such as water and communications	Local planning	Monitors and regulates environment such as air quality	E.g. Smart Meter technology	Protect people against risks to health or safety arising from work activities	Statutory consumer champion for England, Wales, Scotland
Non governmental organisations and interest groups					
Represent special interests such as vulnerable consumers, environmental concerns or the interest of specific groups					
Network operators					
The electricity and gas companies who own and manage the pipes and wires					
Energy shippers		Energy Suppliers	Energy Traders		
Consumers					
Domestic and industrial gas and electricity users					

⁵For further details please see:

<http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=14&refer=About%20us/CorpPIan>

How we fit into the gas and electricity markets

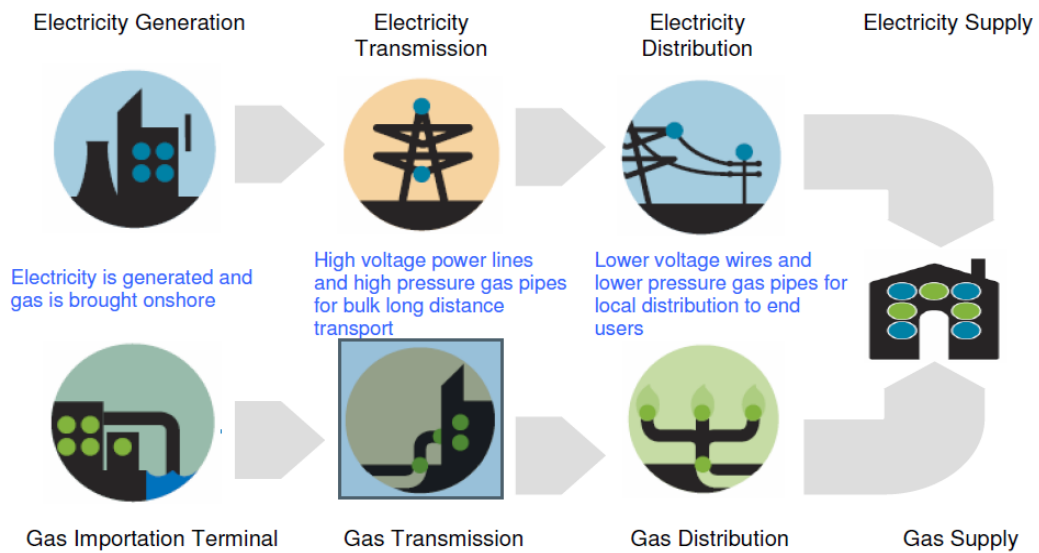
The gas market

- 1.18 Ofgem licences gas shipping, transmission, distribution and supply activities.
- 1.19 Suppliers, who sell to and bill customers, buy gas from shippers. Shippers are companies who contract with gas producers to bring gas onshore in order to meet the needs of homes and businesses. As well as taking gas from offshore gas fields, interconnector pipelines and Liquefied Natural Gas (LNG), shippers can draw on gas held in large gas storage facilities.
- 1.20 To ensure they can provide suppliers with the gas they need, shippers must buy capacity on the high pressure pipeline called the national transmission system (NTS). Gas is transported from the NTS to local distribution zones operated by the gas distribution companies.

The electricity market

- 1.21 Ofgem licences the electricity generation, transmission, distribution and supply activities.
- 1.22 Electricity produced by generators is sold on the wholesale electricity market. Electricity suppliers and traders buy their power on the wholesale market either directly from generators or through trading on power exchanges. Suppliers then sell the energy on to consumers.
- 1.23 As electricity cannot be stored economically, either than through hydro and pumped hydro storage , constant balancing is done by National Grid, which ensures that supply meets demand at any given moment.
- 1.24 Figure 3 below summarises how the gas and electricity markets operate:

Figure 3: The energy market



Source: National Grid

2. Our approach to climate change risks

Introduction

- 2.1 Defra's direction to report asked us to assess "the current and predicted impact of climate change in relation to (our) functions"⁶. We have assessed how climate change is affecting our objectives, functions and organisation, as well as the climate change risks affecting the companies we regulate.

How we are affected by climate change

- 2.2 We have assessed how climate change affects our objectives, regulatory functions and policies and concluded that climate change poses two kinds of risks to us:
- **direct risks**, which would impair our ability to carry out our day-to-day work
 - **indirect risks**, which affect the ability of the sectors we regulate to ensure a sustainable and secure supply of electricity and gas to consumers.

Direct risks to Ofgem

- 2.3 We deem that the risks from climate change to our daily work are low, mainly because of the nature of our work, which is desk and communication based. The most immediate risk we face is fluvial flooding, which could affect our London and Cardiff offices, and to a lesser extent our Glasgow office. The main threats relate to the ability of our staff to get to work and communication failures.
- 2.4 In case of significant disruption to our offices, we have access to a recovery centre from where we can operate until they become available again, and we have standard emergency procedures to enable us to carry out our functions during emergencies. We have procedures for home working, which help mitigate extreme weather risks, and enable us to carry out our duties during extreme weather events.
- 2.5 We have also established an Environmental Management System which is ISO 14001 compliant⁷. The EMS sets medium term (5 years) and annual objectives, which include improving energy efficiency, reducing waste and water consumption and raising awareness among staff of our environmental impact and reduction priorities. It already takes account of adaptation needs,

⁶ Defra, Direction to report on Climate Change Adaptation Report, page 2. Available on <http://archive.defra.gov.uk/environment/climate/documents/interim2/report-direction.pdf>

⁷ Recertification is due next year.

for example by reducing water usage and improving the energy efficiency of our premises, which in turn will result in reduced demand for cooling during the summer months. We also achieved the Carbon Trust Standard in 2011⁸.

Indirect risks to Ofgem

- 2.6 Indirect risks, i.e. those affecting the electricity and gas sectors, are the most serious ones, as they affect Ofgem's ability to fulfil its duties. Their assessment and management is the focus of the remaining sections.
- 2.7 Assessing the risks and responding to the challenges of adaptation are primarily the responsibility of the energy companies themselves. They are best-placed to understand their operations, and to identify where they need further advice and assistance. For this reason, we have not assessed the climate thresholds above which climate change and weather events will pose a threat to the energy system, and we expect the regulated companies to do this.

Ofgem activities and functions related to climate change

- 2.8 In 2009 we created a Sustainable Development division to embed sustainable development in all of Ofgem's work. The division focuses specifically on environmental and consumer protection issues.
- 2.9 Within the Markets division, we monitor security of supply and the functioning of electricity and gas markets. Security of supply is affected by climate change, and particularly by extreme weather events such as cold spells, droughts and storms. It is our duty to endeavour that consumers receive energy supplies and markets function efficiently under these circumstances. By monitoring market functioning, we aim to ensure that markets remain open, competitive, fair and transparent, and hence deliver energy to consumers at the best value for money under all conditions. The Markets division also provides regulatory expertise and advice to support the Government's central programme to deliver the rollout of smart meters.
- 2.10 The Smarter Grids and Governance division has carried out a comprehensive review of our energy network regulation⁹, with a view to enabling energy network companies to meet the challenges and opportunities of delivering networks fit for a sustainable, low carbon energy sector. The review resulted in the adoption of a new regulatory regime, RIIO (Revenue= Innovation+ Incentives + Outputs)¹⁰ which has replaced the previous RPI-X regime. RIIO

⁸ For further information please see: <http://www.carbontruststandard.com/pages/The-Standard>

⁹ The RPI-X@20 Review: <http://www.ofgem.gov.uk/NETWORKS/RPIX20/Pages/RPIX20.aspx>

¹⁰ For further information please see: <http://www.ofgem.gov.uk/Networks/Pages/Ntwrks.aspx>

is one of the main tools at our disposal to ensure that network companies adapt to climate change¹¹.

- 2.11 In addition, Ofgem jointly chairs with the Department of Energy and Climate Change (DECC) a Smart Grid Forum to consider the opportunities and issues associated with the development of smart grids in Britain. This work is led by the Smarter Grids and Governance Division, with input from other teams across Ofgem. The roles of smart grids in adapting to climate change are set out further in section 2.133.
- 2.12 The same division provides network support by:
- monitoring gas quality measurement, industry emergency arrangements, industry technical code changes and providing licence derogations
 - supporting other Ofgem directorates - in particular network price reviews
 - interfacing with third parties for Ofgem including the Government's Energy Networks Strategy Group (ENSG) and the Institute of Engineering Technology.
- 2.13 We created Ofgem E-Serve, a commercial and service-delivery arm, to administer the Government's environmental programmes to support renewable energy and energy efficiency, and to ensure that new offshore renewable generation projects are connected to the GB electricity grid economically and efficiently. Most of the activities carried out by E-serve relate to mitigation rather than to adaptation, with the exception of those related to energy efficiency and offshore wind, which include also adaptation aspects. These will be discussed more in detail in sections 2.133 to 2.138.

Climate change risks affecting the organisations we regulate

- 2.14 We have included here the risks that the regulated network companies have raised with us or highlighted in their own reporting¹², and compared them to those highlighted in high emission scenario of the UK Climate Projections science report (UKCP09)¹³. We have also compared the findings to a range of academic studies¹⁴. The assessments of the regulated companies appear to be consistent with the findings of UKCP09 and the literature we reviewed.

¹¹ As set out in more detail in paragraphs 2.85 to 2.116.

¹² Available on DEFRA's website at:

<http://www.defra.gov.uk/environment/climate/sectors/reporting-authorities/reporting-authorities-reports/>

¹³ http://ukclimateprojections.defra.gov.uk/images/stories/projections_pdfs/UKCP09_Projections_C4aV2.pdf

¹⁴ Please see bibliography.

- 2.15 The main risks affecting generation and network companies can be classified into extreme events and gradual changes. The companies in turn ranked those risks as high, medium and low priority.
- 2.16 All sectors face the same broad categories of risk, namely flooding, storm impacts- including storm surges, lightning and high winds- prolonged periods of extreme high temperatures and droughts. Each sector and subsector faces different levels of exposure to each risk. For example, while flooding poses a high level of risk to electricity networks substations and to power generation plants, it only poses a low risk to electricity overhead lines.

Key risks and opportunities for the Electricity Network companies

- 2.17 The main climate change impacts for the electricity network companies relate to:
- temperature increase
 - precipitation – increase in winter rainfall and summer droughts
 - sea level rise
 - storm surge.
- 2.18 As highlighted in figure 4 below produced by Energy Networks Association (ENA), flooding is a major adaptation risk for the electricity network, mainly to electricity substations. Network companies have established a ten year programme of work to improve substation resilience to flooding, which is being financed through the price controls. The programme was established following a review by a working group, which included Ofgem. This group produced the Electricity Networks Association (ENA) Engineering Technical Report 138¹⁵ in 2009. This report was produced in part in response to loss of supply incidents experienced in 2007 in Yorkshire and Carlisle in 2005.
- 2.19 With higher temperatures, the electricity current that can be carried on overhead electricity cables reduces as the ambient temperature increases.
- 2.20 Droughts can lead to the risk of ground movement, damaging underground cables and structures. It can also lead to a reduction in the ability of the ground to conduct heat from underground cables. Network companies have also highlighted other potential, lesser risks from wind storms, ice storms, lightning, heat waves and vegetation growth.
- 2.21 These risks have been assessed based on climate change projections using forecasting commissioned from the Met Office. Figure 4 summarises the main

¹⁵ <http://2010.energynetworks.org/link-to-engineering-documents/>

impacts on electricity networks from possible current and future climate change, while figure 5 summarises their likelihood.

Figure 4: Summary of main risks from possible current and future climate change which affect electricity networks¹⁶

	Climate Change Risks								
Network Component/Function at Risk	Extreme Events						Gradual Warming		
	Flooding (Fluvial)	Flooding (Pluvial)/ Heavy Rain	Flooding (Sea Breach including erosion risks)	Dam Inundation	Extreme prolonged temperature periods	Lightning	Temperature Increase	Drought (Soil Drying and Movement)	Demand increase due to Mitigation and HVAC*
Substations	H	M	H	H		M		M	
Transformers	M	M	M	H	M	M			H
Circuit Breakers	M	M	M	H					
Overhead Lines				H	M	H		M	H
Cables					M				H
Protection	H	M	H	H					
Earthing								M	
Logistics	M		M	M					
Vegetation Management							M	M	
Spares	M		M						
Resources	H	M	H		H		M		
Communications	M		M		H		M		
Operations Centres	M				M				
Customer Service	H	M	H		H				

* (HVAC: heating, ventilation, and air conditioning)

High Impact: Network component/function temporarily disables. Function disrupted.

Medium Impact: Network component/function substantially reduced in capacity or damaged. Function disrupted.

Source: Energy networks association – Electricity Networks Climate Change Adaptation Report, Engineering report 1, Issue 1 2011

¹⁶ The risks are based on UKCP09 projections for the end of the century assuming a High Emissions Scenario and 90% probability level and no adaptation measures taken.

Figure 5: Summary of the likelihood of the main climate change risks to the Electricity networks¹⁷

Relative Likelihood	Function at Risk	Impact
Almost certain	Overhead lines affected by interference from vegetation due to prolonged growing season	Medium
Probable	Substations affected by river flooding due to increased winter rainfall	Very High
Possible	Substations affected by sea flooding due to increased sea levels and/or tidal surges	Very High
	Substations affected by flash flooding due to increased winter rainfall	Very High
	Overhead lines conductors affected by temperature rise, reducing rating and ground clearance	High
	Underground cable systems affected by increase in ground temperature, reducing ratings	High
	Transformers affected by urban heat islands and coincident air conditioning demand leading to overloading in summer months	High
	Substation and network earthing systems adversely affected by summer drought conditions, reducing the effectiveness of the earthing systems	Medium
	Transformers affected by temperature rise, reducing rating	Medium
	Switch gear affected by temperature rise, reducing rating	Medium
	Overhead lines and transformers affected by increasing lightning activity	Medium

High Impact: Network component/function temporarily disabled. Function disrupted.

Medium Impact: Network component/function substantially reduced in capacity or damaged. Function disrupted.

Source: Energy networks association – Electricity Networks Climate Change Adaptation Report, Engineering report 1, Issue 1 2011

2.22 The electricity companies have also identified some opportunities from climate change, which include:

- milder winters should mean fewer and less severe icing events which should allow for a reduction in the design strength required for overhead electricity lines. This should lead to cost savings
- should peak loads move towards summer months, it may be possible to move maintenance programmes into spring and autumn, taking advantage of milder weather during these months.

Key risks and opportunities for Gas Network companies

2.23 The main climate change risks for gas network companies relate to:

¹⁷ The risks are based on UKCP09 projections for the end of the century assuming a High Emissions Scenario and 90% probability level and no adaptation measures taken.

- increased coastal and river erosion
 - increased temperature
 - increased flooding.
- 2.24 Increased coastal and river erosion have the potential to release gas and cause local security of supply issues due to damaged pipe work. However, National Grid Gas believes it is unlikely that the increased effect of river erosion will cause it any significant issue above that already being experienced.
- 2.25 There are potential security of supply issues as compressor stations are not designed to run at elevated temperatures. With increasing use of this equipment in the summer (for demand side response for example), further temperature rises can cause problems for stations designed to run in winter only.
- 2.26 If compressor stations are affected by flooding they can be bypassed without significant effect to supply. In the short to medium term flooding is unlikely to adversely impact on the supply of gas. However, there is a risk that equipment or communications failure might result in the loss of gas to consumers.
- 2.27 The gas network companies did not raise any specific opportunities from climate change other than stating that the adaptation process has identified the requirement for further research and collaborative work between government, agencies and industries to better understand potential climate change related scenarios and their impacts.

Key risks and opportunities for electricity generators

- 2.28 The generators considered the risks to generating plants under construction or operational in their reporting. They have assumed planning and permitting process for any future generating plants should already take full account of adaptation. Therefore they considered the time frame 2010 to 2039 (reflecting the expected lifetime of existing power stations). Wind farms, both on and off-shore, were excluded on the grounds that wind turbines are already designed to shut down under extreme weather conditions. The generators also highlighted that wind farms currently in operation make up a very small proportion of the generating capacity of the UK.
- 2.29 Electricity generators identified 17 hazards from climate change. Climate change is not considered to introduce any new types of risk but is likely to increase the likelihood or severity of these risks. The hazards most relevant to the sector are associated with flooding, extreme high temperature and drought.

2.30 Figure 6 below summarises the main climate change risks on a typical electricity generation plants. Generally the hazards from climate change were considered low risk by the electricity generation companies.

Figure 6: Summary of main impacts on Electricity generators from current and future climate change

No	Climate Change Hazard	Plant type	Potential consequences for plant
1	Flooding of Site	All	Possible generation unit shutdown; water damage to infrastructure on a variety of scales; pipeline fracture due to erosion
2	Flooding of Access Routes to Site	All	Commodity supply disruption; increased staff shifts; insufficient staff to maintain safe plant operation; partial or complete shutdown
3	Flood Events & Extreme High River Flow	All	Higher maintenance
4	Storm Surges	All	Commodity supply disruption; increased staff shifts; insufficient staff to maintain safe plant operation; partial or complete shutdown
5	Extreme High Temperature on Steam Turbine	All	Performance drop / capacity loss
6	Extreme High Temperature on Gas Turbine	CCGT, GT	Performance drop / capacity loss
7	Extreme High Temperature on Water Discharge	All	Load reduction to respect discharge limits
8	Drought on Water Availability	All	load reduction, increased water treatment plant usage
9	Drought on Water Discharge (Permitting)	CCGT, Coal	Load reduction to respect discharge limits
10	Drought & Change in Water Abstraction Legislation	CCGT, Coal	New permit conditions, additional operational constraints, load restrictions
11	Extreme Snowfall	All	Commodity supply disruption; increased staff shifts; insufficient staff to maintain safe plant operation; partial or complete shutdown
12	Extreme Low Temperature on Cooling Tower Fans	CCGT	Constraints in performance
13	Extreme Low Temperature on External Systems	All	Additional maintenance / repair; emergency water supply
14	Extreme Low Temperature on Cooling Tower	CCGT, Coal	Ice build-up on unloaded cooling tower and risk of packing collapse
15	Extreme Winds	All	Damage to installations; Health & Safety
16	Weather Conditions Causing Plume Grounding	CCGT, Coal	Hazards and complaints; additional restrictions
17	Subsidence / Landslide	All	Damage to infrastructure and pipelines on a variety of scales

Source: Association of Electricity Producers (AEP)

- 2.31 The generation companies have identified some opportunities from climate change, which include:
- a decline in the frequency of snow and ice could reduce the impact of some of the most serious weather risks facing generators today. This could lead to reduced winterisation costs, reduced down time, and increased productivity
 - milder winters are expected to reduce heating demand in winter. Demand for cooling during summer months is expected to rise. This should result in a more even annual demand profile, leading to a more even utilisation of generating plants
 - changes to demand profiles (e.g. summer peak loads) may result in higher demand at a time when primary fuels have been at their seasonal low price
 - should sustainably sourced renewable biofuel crops (such as wood pellets) begin giving larger or faster yields under climate change, there is a possibility to enhance biomass-fuelled energy generation
 - smart grids should increase resilience by encouraging demand to shift to match supply from increasingly weather driven renewable energy generation.

How we address climate change risks

- 2.32 All our regulatory tools and policies focus on consumers and must take sustainable development into account, including adaptation to and mitigation of climate change. This means that we do not directly assess the risks that climate change poses to companies, or require them to take specific adaptation measures. It is the energy companies who are best placed to assess such risks and implement adaptation measures in order to meet their legal obligations towards us, the Government and other stakeholders.
- 2.33 As an economic regulator, we must ensure that the companies meet their objectives economically and efficiently through our regulatory frameworks, policies and other initiatives. Our tools and policies embed adaptation needs and requirements indirectly, through obligations set on regulated companies to provide secure, reliable and sustainable energy supplies.
- 2.34 We outline our efforts to embed sustainability in our annual report Sustainable Development Focus¹⁸. Our strategy revolves around five priorities:
- managing the transition to a low carbon economy

¹⁸ For further information please see:
<http://www.ofgem.gov.uk/Sustainability/SDR/Pages/SDR.aspx>

- promoting energy saving
- ensuring a secure and reliable gas and electricity supply
- eradicating fuel poverty and protecting vulnerable customers
- supporting improvement in all aspects of the environment.

Tackling climate change risks through our regulatory tools

2.35 We enable regulated companies to adapt to climate change through our regulatory tools, policies and other instruments. A description of the relevant instruments and how they address climate change risks is set out below.

2.36 Ofgem addresses the risks of climate change through the following regulatory tools:

- licences
- transmission and distribution price controls for network operators
- the Offshore regime
- network codes.

Ofgem's licensing regime¹⁹

2.37 Through our licensing regime²⁰, Ofgem sets specific obligations on the network companies, shippers, generators and suppliers to ensure supply is protected.

2.38 We monitor licensed companies and take enforcement actions when they do not meet licence conditions. If licensees are found in breach of these conditions, or their obligations under standards of performance, the options available to Ofgem include:

- issuing an order for the purpose of securing compliance with relevant conditions or requirements²¹ and, or

¹⁹ For details on our licensing regime and company licences please see:

<http://www.ofgem.gov.uk/Licensing/Work/Pages/Work.aspx>

²⁰ Section 5(1) of the Gas Act 1986 (as amended) and section 4(1) of the Electricity Act 1989 (as amended) set out that companies involved in the generation, distribution, transmission, supply, transportation, shipping or provision through interconnectors of electricity or gas require licences, unless specifically excluded from doing so by the Secretary of State.

- imposing financial penalties up to 10 per cent of the turnover of the licensee's business²².
- 2.39 All the licences require the licensees to comply with industry codes which set the rules for how the market operates. Adaptation to climate change is relevant to some of these code rules (explained in the section on industry codes below).
- 2.40 There are also conditions within the licences which relate indirectly to adaptation to climate change. For example:
- in the gas transporter licence, condition 16 sets an obligation on the licensee to ensure pipe line system security standards. This standard is designed to ensure that supply meets the peak aggregate daily demand. Gas transporters will need to assess climate change risks to ensure they can carry out this function
 - both the electricity and gas licences include a requirement for distribution network owners to publish annual long-term development statements²³. The statements must provide an indication of the usage of their systems and likely developments. Companies that are contemplating connecting to the system or entering into transportation arrangements can use the statement to help identify and evaluate opportunities. The statement contains information on actual volumes, the process for planning the development of the system, including demand and supply forecasts
 - under condition 24 of the electricity distribution licence, the licensee must submit to Ofgem a statement that sets out criteria by which the licensee's quality of performance in maintaining the security, availability, and quality of service of its Distribution System may be measured. The licensee must provide Ofgem a yearly report detailing their performance during the previous year. If the company did not meet its performance standards due to climate disruptions, Ofgem would be alerted when monitoring these reports
 - standard condition 7 of the electricity generators' licence requires electricity generators to comply with the fuel security code²⁴. The code

²¹ For further information please see Ofgem's enforcement guidelines on complaints and investigations available at: <http://www.ofgem.gov.uk/About%20us/enforcement/Documents1/Enforcement%20Guidelines%20post%20consultation.pdf>

²² Further information about how decisions about financial penalties are reached can be found at: <http://www.ofgem.gov.uk/About%20us/Documents1/Utilities%20Act%20-%20Statement%20of%20policy%20with%20respect%20to%20financial%20penalties.pdf>

²³ Respectively under standard condition 25 of the distributors licence, and under standard special condition D3 of the transporters licence

²⁴ The fuel security code aims to assist with the effective management of a security period. A security period begins when the Secretary of State gives a direction under section 34(4)(b) of the Electricity Act 1989 that a generating station is to be operated in a certain way or with a

requires generators to follow the instructions from the energy emergency executive (E3) Committee²⁵, and to maintain certain emergency stocks of fuel. The E3 Committee sets emergency planning and operational response rules in the event of a gas and/or electricity supply emergency, which include emergencies caused by meteorological events.

Price controls on network operators

- 2.41 Ofgem set revenue caps and wider incentives for the monopoly transmission and distribution network companies. The price control's aim is to ensure that network companies deliver services as cost effectively as possible. The caps determine the base revenue that the network companies can recover for the use of networks by generators and suppliers. We have included mechanisms which allow revenues to vary with volume changes. Incentives are included to drive quality and cost efficiency.
- 2.42 Our price controls do not directly regulate profit. Instead the incentive-based regulation provides the network companies with sufficient opportunities for profit to attract and retain the finance that they need in order to conduct their operations and meet their regulatory obligations.
- 2.43 In determining the allowed revenue we review network companies' business plans and investment needs. The network companies can highlight anything that they believe should be done to mitigate climate change risks. If network companies do not take adaptation measures, they risk not meeting network reliability and customer satisfaction targets (see below) and therefore face penalties. Penalties are on top of the revenue lost from any disruption caused, e.g. from flooding, and the damage to their reputations. The network companies therefore have a number of incentives to ensure appropriate adaptation action is taken. As part of our assessment of investment needs we would typically seek the opinion of independent technical experts as to whether the proposed investment actions are efficient.
- 2.44 Our price control frameworks allow network companies to finance the costs of complying with statutory requirements on safety, reliability and continuity of supply²⁶, which are overseen by DECC and the Health and Safety Executive, by demonstrating their needs case to us.
- 2.45 Our price controls are our main contribution to adaptation of the energy sector, as they allow regulated network monopolies to make the necessary

view to achieving specified objectives. The Code enables Government to direct the electricity industry to provide information on power supplies and to take specific actions to manage the security period.

The fuel security code is available here:

<http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file41951.pdf>

²⁵ These are set out in the National Emergency plan for Gas and Electricity, available on http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/resilience/gas_electric/1_20100430123757_e_@@_nationalemergencyplangaselec.pdf

²⁶ Such as the Electricity Safety, Quality and Continuity Regulations

investments to meet their adaptation needs, and recover their costs from their customer base.

2.46 Ofgem sets price controls for each type of network, which are:

- electricity transmission
- gas transmission
- electricity distribution
- gas distribution.

Previous price control framework – RPI-X²⁷

2.47 The price controls currently in force were set under the RPI-X regime, an incentive-based regulation approach that has been used since privatisation of the gas and electricity industries. In its simplest form it operates by adjusting allowed revenues by inflation (RPI) and an X factor that represents anticipated efficiency gains (or cost increases). For example, if the RPI was 2 percent, and the regulator judged that the company could make efficiency savings of $X=3\%$ each year, then the revenue allowance would fall by 1 percent per year each year of the price control period. Price controls in the energy sector have generally been set for five year periods; an extra “roll-over” year has been added to the current transmission price control.

2.48 Whatever the allowed revenue, the company is allowed to keep a share of any cost savings that it makes beyond the target set by the RPI-X calculation, thereby providing an incentive for the company to reduce its costs even further than assumed by the regulator. This approach works in the interest of consumers in two ways: firstly, consumers receive a share of any savings that the company makes beyond the RPI-X target during the current price control period. Secondly, the revenue allowance for the next price control period will be based upon the company’s actual expenditure in the current period, so any savings are built into the next settlement.

2.49 If, however, a company fails to make the savings expected by the RPI-X target, then those additional costs would be shared between the company and consumers. This provides an incentive for the company to avoid cost over-runs, while also ensuring that the full costs are not borne by either the company or by consumers alone.

2.50 The simple approach set out above is modified by various mechanisms. There are uncertainty mechanisms whereby the funding allowances can increase (or decrease) in response to changing needs. For instance, to allow companies to recover necessary expenditure that was incurred for reasons beyond their

²⁷ Retail Price Index minus X (an efficiency value).

control. These are included where it is a cheaper option for consumers than pricing in the risk in the network company's revenue allowance. We have also put in place an increasing number of specific incentives designed to encourage particular behaviours, rather than simply a general reduction in costs. These incentives can have a cap, i.e. a maximum reward, regardless of how good performance is, in order to protect consumers from excessive costs. They can also have a collar, i.e. a maximum penalty, in order to protect the company from excessive costs if it does not meet the targets. We outline below some incentives designed to make the network companies' operations more resilient to the effects of extreme weather events and climate change.

- 2.51 The current price controls for electricity and gas transmission operators (TOs) are those set by the Transmission Price Control Review 4 (TPCR4), which runs from 1 April 2007 to 31 March 2012, with a one-year rollover to 31 March 2013. A rollover takes this to 1 April 2013 when the next full transmission price control is due to take effect.
- 2.52 The price control for electricity distribution network operators (DNOs) is set by the Distribution Price Control Review 5 (DPCR5) which applies from 1 April 2010 until 31 March 2015.
- 2.53 The price control for the gas distribution network operators is set by the 2007 Gas Distribution Price Control Review (GDPCR), running from 1 April 2008 to 31 March 2013.

Current price control elements related to adaptation

Electricity Transmission

- 2.54 The current price elements most closely related to adaptation are the reliability incentives. These are set targets for 'energy not supplied' that require reliability of very nearly 100 percent. Qualifying faults on the network are measured over the course of each year, and the total is compared to the transmission operator's (TO's) target. For every unit of energy that was supplied beyond the target, the company receives an extra amount of allowed revenue; for every unit below the target, the company's allowed revenue is reduced by a set amount. The arrangement's aim to minimise supply interruptions from the grid, and restore supplies as quickly as is practicable.
- 2.55 The reliability incentives allow the TO to claim an adjustment for events which it believes are exceptional and have had a significant impact on its performance.
- 2.56 Exceptional events include extreme weather events and are defined in the operator's licence as events "resulting in more than 50 faults being recorded by the licensee on the licensee's transmission system in any 24 hour

- period”²⁸. Ofgem would determine whether the event was exceptional and take into account whether the TO had taken reasonable steps to prevent the event having the effect of interrupting supply and to mitigate its effect.
- 2.57 It should be noted that performance against these incentives reflects a number of risks that face the networks, not just the need for (or the results of) adaptation to the impacts of climate change. The companies should consider the overall set of risks that face their networks; they are best-placed to judge the relative importance of each risk, and to decide how to address them.
- 2.58 The revenue allowances that are set at the start of each price control period represent our best view of the efficient costs of funding the networks over that period. However, during the price control period, the companies can incur additional efficient expenditure. This is either because it could not be foreseen at the start of the period, or it was anticipated but the details (particularly the impact on revenue) were unclear at that time. For some areas of expenditure, the TOs have specific uncertainty mechanisms, e.g. a “volume driver” that increases the revenue allowances if more connections are required than was forecast. If efficient expenditure increases materially in an area for which there is not a specific uncertainty mechanism, then there are options. The TOs can request a “re-opener” of the price control in order to agree a new allowance based upon the up-to-date information. Or we can allow them to “log up” their costs for review at agreed points, e.g. the end of the financial year.

Gas Transmission

- 2.59 The gas transmission network faces different challenges to those in the electricity sector. It is more reliable than the electricity transmission network, partly due to the fact that the gas networks are not vulnerable to all of the weather and climate risks that face the electricity networks. However, any failures on the gas transmission network can result in more serious consequences, and the Health and Safety Executive (HSE) places strong incentives upon the TO, National Grid Gas (NGG), to maintain a safe system²⁹, which necessarily implies a reliable system.
- 2.60 The current price control TPCR4 applies similar principles to gas transmission as to electricity transmission. Funding allowances were calculated taking account of the requirements of safety and reliability, and uncertainty mechanisms are available should events require an increase in the efficient expenditure.

²⁸ For more information on reliability incentives for electricity transmission in TPCR4 see: http://www.ofgem.gov.uk/Networks/Trans/Archive/TPCR4/ConsultationDecisionsResponses/Documents1/9001-tx_incentives.pdf

²⁹ Pipelines health and safety, HSE: <http://www.hse.gov.uk/pipelines/index.htm>

Electricity Distribution

- 2.61 The current price control for electricity distribution, DPCR5, enables DNOs to adapt to the impact of climate change by:
- **encouraging them to facilitate new uses of the networks that are likely to arise as we move to a low carbon economy.** These include technologies that can make the electricity distribution system more resilient to the impacts of climate change, for example by enabling quick identification of faults, supporting distributed generation and optimising demand and supply under all conditions.
 - **enabling DNOs to invest to maintain and/or replace the majority of assets that were installed during the 1950s and 1960s.** DPCR5 will provide £14bn in funding to maintain existing quality of service. The majority of this is likely to be used by DNOs to replace ageing, unreliable or failing assets. Some of this expenditure is also required to improve the resilience of the networks to flooding.
 - **encouraging all DNOs to pay more attention to all aspects of customer service.** These include incentives to reduce the number and length of any interruptions to customers' supply.
- 2.62 DPCR5 provides companies with incentives to deliver on all of these requirements. We consider that the proposals set out in this document provide each DNO with the revenues and potential to earn returns that they need to maintain and improve network reliability, to get ready for the low carbon economy and to improve the level of service and reliability they provide to their customers. We are allowing revenues of around £22bn over the five years, and £14bn expenditure on the networks.
- 2.63 We have given shareholders an opportunity to enhance returns by improving network efficiency, reliability or customer service. Shareholders in a company that significantly improves performance in all of these areas could earn shareholder returns of up to 13 percent. Shareholders in a mismanaged, inefficient company performing poorly could earn as low as 3 percent and customers will pay lower prices.
- 2.64 We aim to ensure that companies do not outperform the settlement by allowing the general health of the network to deteriorate requiring greater investment and higher prices for customers in the future by setting out clearly the agreed outputs we expect the DNOs to deliver in return for the revenues we allow them to collect from customers.
- 2.65 DNOs will have to meet all their licence and statutory obligations. If a company breaches any of its licence conditions we will look to set penalties to have a proportionate impact on shareholder returns.

- 2.66 The electricity distribution incentives on network reliability and customer service enable the Distribution Network Operators (DNOs) to address the risks of climate change.
- 2.67 Under the current electricity distribution price control, the DNOs face the Interruptions Incentive Scheme (IIS)³⁰ for reliability. This has two components: firstly, the customer interruptions (CI) incentive compares the number of interruptions that occur, relative to targets. Secondly, the customer minutes lost (CML) incentive compares the total time for which those interruptions last, relative to targets.
- 2.68 Another route by which they have an incentive to adapt to climate change is the guaranteed standards (GS) of performance incentive³¹. For example, customers are entitled to payments depending upon the time taken to restore their power after interruption due to a severe weather event.
- 2.69 As noted above, the impact of climate change is one risk that can affect performance against the targets for CI, CML and GS. It is not possible to say how much of the total annual revenue exposure is directly linked to climate change. However, by considering all of the risks, including the impact of climate change, the DNOs can devise approaches for delivering the level of service for which customers are willing to pay.
- 2.70 The incentives discussed above encourage the DNOs to deal with instances of supply interruption as quickly as possible and, as in the electricity transmission incentives, DNOs can claim an adjustment for exceptional events. However, the DNOs recognised that the likely impacts of climate change would make such events more common, and would hence reduce the reliability of the networks and increase the payments that they have to make under the incentive schemes. It would be unacceptable to address this issue by simply reducing the expected levels of performance in line with the challenges posed by climate change. Instead, the DNOs considered how to adapt their networks to cope with the impacts of climate change.
- 2.71 For example, DNOs identified flooding of key assets on the ground, such as sub-stations, as the most immediate and significant risk. The companies convened a working group to consider the risk posed by flooding, for which expert advice was provided by the Environment Agency (EA) and the Met Office. The working group produced a methodology for assessing the flood risks, and the DNOs then used this methodology to identify the vulnerable sites on their networks. As part of their DPCR5 proposals, the DNOs presented funding requests to Ofgem to cover the costs of defending key sites from set levels of flooding. Ofgem assessed these requests to determine an

³⁰ Electricity Distribution Price Control Review, Final Proposals - Incentives and Obligations, Chapter 16, http://www.ofgem.gov.uk/Networks/ElecDist/PriceCtrls/DPCR5/Documents1/FP_2_Incentives%20and%20Obligations%20FINAL.pdf

³¹ Electricity Distribution Price Control Review, Final Proposals - Incentives and Obligations, Chapter 17, http://www.ofgem.gov.uk/Networks/ElecDist/PriceCtrls/DPCR5/Documents1/FP_2_Incentives%20and%20Obligations%20FINAL.pdf

efficient level of funding, and granted allowances based upon the “cost per risk removed”³².

- 2.72 This example illustrates Ofgem’s role in the process of adaptation to climate change. As an economic regulator, we seek to ensure that the costs incurred by the regulated network companies are efficient. But it is the companies that have the best understanding of their networks and their businesses, and that are therefore best placed to develop methodologies and assess risks.
- 2.73 However, we appreciate the value of understanding the work that the companies undertake. For example, members of Ofgem’s staff were observers on the flood defence working group which was established in the wake of the Carlisle floods in 2005³³, and saw the development of the methodology for assessing flood risk.

Thinking ahead in the current price control: the Low Carbon Network Fund and the incentives to innovation and distributed generation

- 2.74 Several technologies, such as distributed generation, electric vehicles and heat pumps are expected to play a major role in decarbonising the power sector over the coming decades. Although these are more directly related to mitigation, they also have the potential to make the system more resilient to the impacts of climate change by increasing its efficiency and reliability and the diversity of the generation sources.
- 2.75 Ofgem and the DNOs agree that the current networks should be able to cope with the likely uptake of these technologies over the 2010 to 2015 period. However, we need to ensure that the DNOs use this time to prepare for the more significant changes that will happen in the coming years. This will mean using the DPCR5 period to try out new technologies and the commercial and operating arrangements.
- 2.76 To this end, we have retained the Innovation Funding Incentive (IFI) and the Distributed Generation Incentive (DGI) that we introduced in the previous price control (DPCR4). In addition, we have established a Low Carbon Networks (LCN) Fund.
- 2.77 We introduced the **IFI** to stem the consistent decline in investment in research and development (R&D) by DNOs since 1990. The incentive funds up to eighty percent of technical R&D projects for the DNOs. Eligible IFI projects may propose innovative measures to improve the design, construction, commissioning, operation, maintenance and decommissioning of distribution

³² The allowances for flooding totalled £112million across the 14 DNOs for the DPCR5 period. For more information see: Electricity Distribution Price Control Review, Final Proposals - Allowed revenue - Cost assessment, p22, http://www.ofgem.gov.uk/Networks/ElecDist/PriceCtrls/DPCR5/Documents1/FP_3_Cost%20Assessment%20with%20SS%20comments.pdf

³³ For more information, see <http://2010.energynetworks.org/link-to-engineering-documents/>

network assets. As such, the IFI could also fund projects that aim to make distribution network assets more resilient to the impacts of climate change.

- 2.78 The registered power zone (**RPZ**) only operated in the DPCR4 period. It has effectively been replaced by the LCN Fund. It encouraged DNOs to develop and demonstrate new, more cost effective ways of connecting and operating new distributed generation sources. By using a widespread number of smaller generation sources, distributed generation has the potential to make the system more resilient to climate change impacts.
- 2.79 In the same vein, the **DGI** aims to encourage DNOs to invest efficiently and economically in the provision of DG connections and to be proactive in responding to connection requests.
- 2.80 The **LCN Fund** allows up to £500m support, between 2010 and 2015, to projects sponsored by the DNOs to try out new technology and new operating and commercial arrangements. The objective of the projects is to help all DNOs understand what they need to do to provide security of supply at value for money as Great Britain moves to a low carbon economy. They should also provide valuable learning for the wider energy industry and other parties.
- 2.81 These projects involve the DNOs partnering with suppliers, generators, technology providers and other parties to explore how networks can facilitate the take up of low carbon and energy saving initiatives such as electric vehicles, heat pumps, micro and local generation and demand side management, as well as investigating the opportunities that the smart meter roll out can provide to network companies.

Flexibility in DPCR5: dealing with uncertainty and correction mechanisms

- 2.82 We introduced a range of mechanisms to address uncertainty and to provide appropriate protection to both customers and DNOs for two main reasons. Firstly, for some categories of expenditure there are volume uncertainties which are partially outside of the control of the DNOs. Secondly, there are other expenditure items where we do not have sufficient information to set any allowances ex ante. We will rely on specific mechanisms to provide the appropriate revenues after the expenditure was incurred. With regards to financing adaptation needs, the latter could be used to finance uncertain costs associated with Critical National Infrastructure (CNI), black start capability and emergency batteries.

Gas Distribution

- 2.83 The current price control for gas distribution, GDPCR1, provides the GDNs with opportunities and incentives to adapt to the impact of climate change. The interruptions reporting and customer satisfaction surveys provide a financial and reputational incentive for the GDNs to ensure that customers' gas supply is not adversely affected by factors including the changing climate. The GDNs' allowed revenues cover their expected efficient costs for

maintaining a safe and reliable system. This should include any works that they deemed to be necessary to adapt their networks to the changing climate. As with the other networks, there are options for re-openers or logging-up in the event that additional expenditure is required.

New price controls – RIIO

2.85 The RPI-X regime has brought significant benefits for consumers:

- reductions in network charges
- improvements in operating efficiency
- more efficient financing
- improved quality of service
- increased investment.

2.86 However, the energy sector is facing new challenges, including decarbonisation, the replacement of ageing assets, and the need to do so without exposing consumers to unnecessary costs. In discussion with stakeholders, we identified that existing frameworks led to certain results that were not compatible with the network companies playing their full part in meeting these challenges. Some of these results could affect the companies' contribution to adaptation to climate change:

- encourage short term decision making and planning
- limited consideration of innovation and how best to deliver
- failure to understand stakeholder views in this area
- limited focus on 'cross-sectoral' interactions.

2.87 Our RPI-X@20 review considered how the price control regime could be changed in order to encourage the network companies to play their full part in meeting the new challenges faced by the sector.

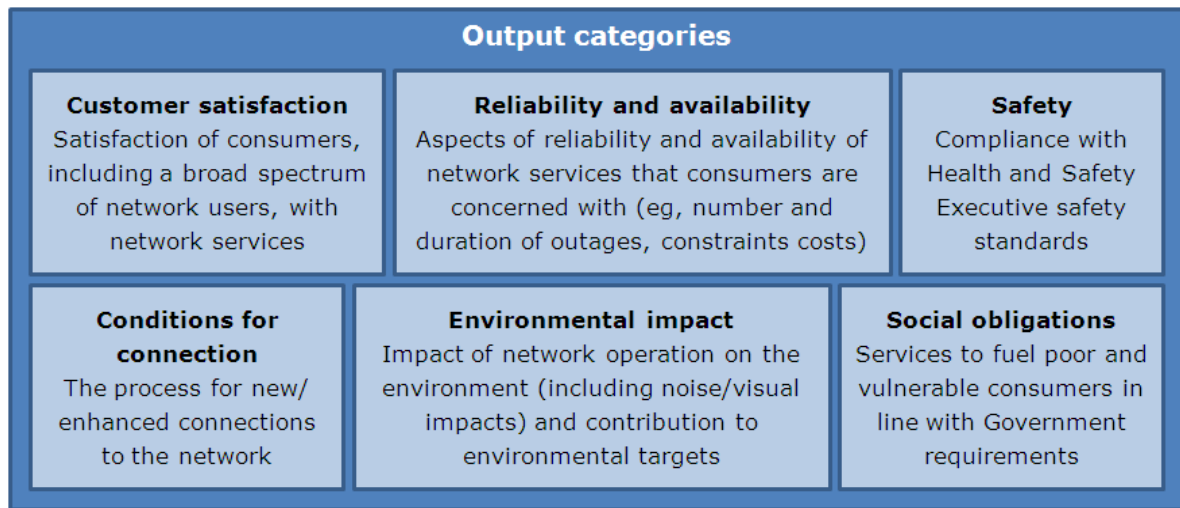
2.88 The result of the review was the new RIIO framework: Revenue = Incentives + Innovation + Outputs. We are implementing this framework for the next price controls in transmission (RIIO-T1) and in gas distribution (RIIO-GD1), which will run from 1 April 2013 to 31 March 2021. We will then apply the framework to electricity distribution (RIIO-ED1) on 1 April 2015.

- 2.89 The RIIO model ensures that companies focus on longer term planning than at present. To this aim, price controls have been set for eight year periods, compared to five years currently.
- 2.90 Under RIIO each network company must set out what it intends to deliver for consumers of network services over time and what revenue it needs to earn from existing and future consumers to ensure delivery is financed. The onus is on network companies to justify their view of required expenditure in well justified business plans.
- 2.91 In their plans, companies will need to produce evidence-based forecasts of: output requirements; demand for network services over time; cost of delivery (including input prices) and financing costs.
- 2.92 These will inform, to a large degree, our assessment of the outputs that network companies are required to deliver and the associated revenue to be earned from consumers.
- 2.93 Companies' adaptation needs will be addressed principally through output requirements, and through the innovation stimulus package, i.e. additional funding for innovative measures and projects by the network companies.
- 2.94 We outline in more detail in the following sections how the output requirements, the innovation stimulus package, our assessment of the well-justified business plans and the uncertainty mechanisms aim to ensure that network companies meet their adaptation needs.

Output requirements

- 2.95 The outputs that we expect network companies to deliver will sit in one of the six output categories shown below in Figure 7. These categories reflect the broad role that energy network companies will play in delivering the objectives of the RIIO model.

Figure 7: Price control output categories



2.96 We will review the appropriateness of the categories periodically, to reflect network company activities, changing stakeholder priorities including Government priorities, and any lessons learnt from implementing the RIIO model. We would consult stakeholders on any changes to the categories in the relevant price control reviews.

2.97 Figure 8 below outlines example primary outputs.

Figure 8: Example primary outputs by category and sector

Output category	Electricity Distribution	Gas Distribution	Electricity transmission	Gas Transmission
Customer satisfaction	1. Broad measures of customer satisfaction reflecting experience of consumers and network users 2. Qualitative survey evidence			
Safety	1. Comply with minimum legal requirements as specified by the Health and Safety Executive 2. Additional safety initiatives considered to be in public interest			
Reliability and availability	1. Customer interruptions (CI) 2. Customer minutes lost (CML) or energy not supplied (ENS)	1. Supply restoration after an interruption 2. Customer minutes lost (CML) or energy not supplied (ENS)	1. Energy not supplied (ENS) 2. Constraint measure	1. Baseline entry capacity 2. Buy back at entry 3. Baseline flat/flex offtake capacity 4. Buy back at exit
Conditions for connections	1. Time to connect a generation node 2. Time to connect a demand node	1. Time to connect an entry/exit or demand node	1. Time to connect a generation node 2. Time to connect a demand node	1. Time to connect an entry/exit or demand node
Environmental impact	1. Carbon footprint of network including losses 2. Proportion of new low carbon generation 3. Other emissions 4. Visual impacts 5. Role in consumer energy efficiency	1. Carbon footprint of network including shrinkage 2. Proportion of new low carbon energy 3. Other emissions 4. Role in consumer energy efficiency	1. Carbon footprint of network including losses 2. Proportion of new low carbon generation 3. Other emissions 4. Visual impacts	1. Carbon footprint of network including shrinkage 2. Proportion of new low carbon energy 3. Other emissions
Social obligations	1. Targets for vulnerable customers, e.g. PSOs			

2.98 Reliability is the key output category in terms of adaptation to climate change. In our March 2011 “Decision on strategy for the next transmission price control - RIIO-T1”³⁴, we set out our primary outputs for reliability. For electricity transmission, the TOs’ Energy Not Supplied (ENS) will be measured against target levels, and that any over- or under-performance will be rewarded or penalised at a set incentive rate (£/MWh). This rate will be based upon our estimate of the Value of Lost Load (VOLL), which is how much consumers value ENS. We decided to apply a common incentive rate across all three electricity TOs, in the range of £4,300/MWh to £22,000/MWh, and considered £16,000/MWh to be a reasonable value for the TOs to use in their business plans. The TOs’ exposure to the incentive rate will depend upon the efficiency sharing factor that is used. For example, if a TO had a 50 percent factor, then it would pay £8,000/MWh under our suggested value of VOLL. The efficiency sharing factor can be lower if the company’s cost estimates are close to our view of the efficient level of funding, thereby encouraging the companies to offer good value for consumers. As discussed above in reference to the DNOs, the impact of climate change is but one of many factors that can affect network reliability. The TOs’ performance against the ENS incentive will be determined in part by the impact of climate change and by the TOs’

³⁴ <http://www.ofgem.gov.uk/Networks/Trans/PriceControls/RIIO-T1/ConRes/Documents1/T1decision.pdf>

adaptation activity. However it is not easy to determine exactly what proportion of the overall incentive ENS payments (whether penalty or reward) could be linked to climate change or to the TOs' adaptation measures.

- 2.99 For gas transmission, we set out that NGG's reliability primary output will require NGG to comply with its obligation to ensure gas flows in accordance with the needs of system users. Specifically, NGG is required to develop the pipeline system such that it can cope with a '1 in 20' peak aggregate daily demand. This primary output should be ensured through secondary deliverables of asset health, criticality and replacement priorities. In order to satisfy the reliability primary output, NGG will have to consider all of the risks that face its network, including the effects of a changing climate, otherwise it faces reputational and financial penalties. We are currently considering NGG's proposals as submitted in its business plan.
- 2.100 In gas distribution, we set out the output categories against which the GDNs' performance will be measured, including one relating to the reliability and performance of the gas distribution network. DNOs will be required to assess the current and future health and criticality of their distribution networks, which must include the consideration of impacts arising from the effects of climate change. Operating and investment plans may then be targeted to address the risks identified by the outputs process. Under proposed continuity of supply licence conditions, DNOs will be subject to financial and reputational penalties in the event of loss of supply as a further incentive to ensure the distribution network remains reliable. The timetable for the RIIO-GD1 price control review was altered following the HSE's review of the iron gas mains replacement programme. We will receive DNOs' business plans at the end of November 2011.
- 2.101 For electricity distribution, the current price control will run to 2015. Thereafter, the implementation of the RIIO framework to electricity distribution can be expected to have similar arrangements to those set out above for the other networks.
- 2.102 There is a risk that if price controls were focused only on the delivery of primary outputs, network companies may be encouraged to deliver these at the lowest cost during the eight-year price control period, potentially at the expense of measures that could help reduce the costs of delivering primary outputs over the longer term. To protect against this, we have set secondary deliverables in the RIIO price control framework. These can be classified as:
- **projects to manage network risk** ensuring that delivery of primary outputs in future periods is not put at risk by decisions made in the price control period
 - **projects for delivering primary outputs in future periods** with action taken during the current price control period

- **technical and commercial innovation projects** or other projects which require upfront costs but have the potential to deliver benefits in terms of long-term value for money in future periods.

How we assess network companies' well justified business plans

2.103 We will assess the business plans based around fifteen criteria, of which the following have a bearing upon adaptation to climate change:

- efficiency of costs over the longer term
- long-term context
- reflect uncertainty
- effective engagement and understanding of stakeholder views
- risk
- reflecting best practice.

2.104 Any proposals from the companies regarding adaptation to climate change will have to take these criteria into account, and will have to provide sufficient justification for each.

2.105 As noted before, TOs must consider climate change alongside all of the risks that face their networks. The TOs have included in their business plans proposals for flood defences for sub-stations that have been identified as being vulnerable to flooding in the future. We will assess their evidence that supports their proposed work (e.g. consider whether they have properly used established methodologies) in order to determine what work is reasonable, and we will assess their cost estimates in order to provide efficient funding.

2.106 As part of the development of their business plans, the regulated network companies conduct stakeholder engagement to factor in potential impacts of risks upon consumers. This should form an important part of the evidence in their well-justified business plans.

2.107 We also seek to understand the views of stakeholders. For example, during the development of the RIIO-T1 and RIIO-GD1 price controls, we have arranged specific meetings (such as the Price Control Review Forum - PCRF) between stakeholders and the companies. This gives us insight into the concerns and needs of consumers and of specific customers, allowing us to assess the companies' plans against these measures. We take stakeholders' views into consideration when, for example, determining an appropriate level for VOLL in the ENS incentive, which in turn provides an incentive for the companies to adapt their networks to the impact of climate change.

- 2.108 The transmission owners submitted their RIIO-T1 business plans in July 2011, and we will be publishing our initial view on these in October 2011.

Options for managing uncertainty

- 2.109 The ex ante nature of the regime will mean there will always be uncertainty about the forecasts. As a result, several risks could arise. For example, revenues raised from consumers could be higher/lower than necessary to cover the costs of providing network services, with consumers paying more/less for network services than was required. The primary outputs (and potentially secondary deliverables) that we agree with network companies could also turn out to be insufficient or inappropriate.
- 2.110 Recognising these issues, we have set out provisions to allow revenue to adjust during the price control period in response to changes in operating conditions. We expect network companies to bear their own business risk and therefore uncertainty mechanisms should only be used where action is required due to changes outside of network company control which could significantly impact costs.
- 2.111 The main sources of uncertainty during a price control period relate to outputs, input prices and volumes of activity required. Under the RIIO model, there are a number of options to deal with uncertainties arising in these areas. Uncertainties related to adaptation include, but are not limited to:
- a) uncertainty mechanisms.
 - b) a mid-period review of output requirements.
- 2.112 Uncertainty mechanisms enable us to make changes to the revenue allowance during the price control period. They may be used to protect network companies from cost changes outside of their control. The form that uncertainty mechanisms take may depend on the outputs companies need to deliver. Uncertainty mechanisms might be triggered by, for example, changes in prices, volumes, primary outputs or secondary deliverables.
- 2.113 The uncertainty mechanisms can be classified as:
- **uncertainty mechanisms fully-calibrated at the price control review:** the magnitude of associated revenue adjustments will be set at the price control review and the precise numbers (e.g. in £m per unit) are written in the licence. The use of such mechanisms will be triggered automatically. As such, we will not carry out a review to adjust revenue but rather revenue will adjust automatically in line with an agreed formula specified at the price control review
 - **forward-looking revenue adjustment determined by Ofgem during the price control:** where the companies' updated assessment of expected expenditure requirements reveals that additional revenue is required, the revenue adjustment can be set during the price control period

- **revenue allowance determined after the company incurs the relevant expenditure:** once data on actual expenditure is available, the revenue adjustment is set.
- 2.114 RIIO includes provisions for a **mid-period review** of the primary outputs that network companies are required to deliver mid-way through the eight-year period. The review may be particularly important when the RIIO framework is first implemented and in periods of significant change (for example, the transition to a low carbon economy in electricity). This review will be conducted in the fourth year of the eight-year price control and will have effect from the start of the fifth year. We expect that the six output categories will remain valid but, within an eight year period, there may be a need to change the primary outputs, including, where needed, to meet new adaptation needs.
- 2.115 The RIIO framework also has many elements that will encourage innovation. The longer price control periods and focus on outputs will enable companies to better realise the benefits of their innovations. We have also included specific funding mechanisms to encourage the higher risk research and development aspects of innovation. There is a fixed, limited allowance available to each company, the Network Innovation Allowance, to enable them to carry out small and local research and trials. There is also the annual competition for innovation funding - the Network Innovation Competition (NIC), which was heavily modelled on the LCN Fund. There are two competitions, one for gas distribution and gas transmission; the other for electricity transmission. The NIC will fund innovation in technology and operating and commercial arrangements which will provide environmental benefits or facilitate the low carbon future. These could include innovation projects that benefit adaptation. Funding will be available to progress projects at any stage of innovation, from R&D to trials and pilot schemes. One of the selection criteria is that projects must produce learning that can be shared and will be useful to the other network companies. Also, the proposing company is required to set out their proposals for disseminating this learning.

The Offshore regime

- 2.116 Ofgem has worked in collaboration with the Department of Energy and Climate Change (DECC), to establish a new regulatory regime for offshore transmission networks to ensure that new offshore renewable generation projects are connected to the GB electricity grid economically and efficiently. A key part of the regime is the grant of Offshore Transmission Licences to transmit the electricity produced offshore to the demand centres in Great Britain. We grant offshore transmission owner (OFTO) licences are granted on the basis of a competitive Tender Process. The tender process assesses the bidders' organisational, financial and operational capabilities, and requires bidders to demonstrate that they will be able to deliver on their licence obligations in relation to the offshore project they are bidding for.

2.117 In relation to adaptation, bidders must demonstrate their ability to:

- operate and maintain transmission structures both offshore and onshore
- carry out operations in the marine environment including repairs of the transmission infrastructure
- take over and run assets developed by a third party
- effectively manage subcontractors.

2.118 The OFTO licence is largely based on our general licensing framework. It enshrines the same general obligations, as well as some specific ones designed for delivering electricity from offshore production sites. For example, the OFTO licence includes an 'Availability Incentive' to ensure renewable generators remain connected to the transmission system/network. Where the OFTO does not meet the targets set in its licence it forfeits part of its revenue as a penalty. Therefore OFTOs have an incentive to ensure climate change risks do not harm this incentive. The licence also includes regulatory reporting requirements, on reliability and availability of the offshore link. These reporting requirements are based on onshore reporting requirements (RIIO and RPI-X price controls), though they differ in that they are proportionate to the size of the OFTO network.

The industry codes

2.119 There are a number of industry codes in the gas and electricity markets, which establish detailed rules that govern market operation, the terms for connection and access to energy networks. The code rules that govern the interactions of market participants (network companies, generators, etc.) are proposed by expert industry bodies, and accepted, or rejected, by Ofgem. The licence regime requires licensees to abide to the codes.

2.120 Each code has a panel or committee that oversees the assessment of proposed changes to that code. A general rule is that a change should only be made if it better meets that particular code's relevant objectives (such as improving economic efficiency and reasonable economic incentives for suppliers to secure domestic customer supply standards) than the current arrangement. These codes include a requirement to assess environmental impacts of code changes where there is a material impact on greenhouse gas emissions. The requirement in the codes has been in place since December 2010. Most of the industry codes have a degree of self-governance, whereby the overseeing panel or committee may also make the final decision on whether or not to implement a modification proposal. However, modifications which are considered to have a material impact on competition or consumers may require the consent of, or a direction from, the Authority.

2.121 The codes are 'live' documents, meaning that they can be changed when justified. Modification proposals may be made by code signatories (generally network operators and those who use that network) and designated consumer

representatives. Some codes allow for other affected parties to raise change proposals, though the scope of these changes may be limited. Since January 2011 Ofgem has also had the power to direct licensees to raise modifications.

- 2.114 Through these codes, it is possible for participants in the gas and electricity markets to propose changes that take into account the effects of climate change on the operation of the system.

*The Grid Code*³⁵

- 2.122 The Grid Code covers all material technical aspects relating to connection, operation and use of Great Britain's electricity transmission system. The Code is approved by Ofgem.

- 2.123 The Code includes rules and procedures in situations of disruption such as when adverse weather events occur³⁶. With adverse weather events likely to increase it is important these rules are robust enough to ensure effective functioning of the network.

*National Electricity Transmission System Security and Quality of Supply Standard*³⁷

- 2.115 This standard addresses the overall levels of supply security. The standard specifies the conditions under which various levels of load should be maintained or re-connected in the event of an interruption. Although this standard allows for the loss of multiple circuits, it does not provide for the loss of certain single points of failure, such as substations. Therefore these sites must be given particular attention in terms of resilience planning for adaptation to climate change purposes. The standard is approved by Ofgem.

*Connection and Use of System Code (CUSC)*³⁸

- 2.116 The CUSC is a licence-based code setting out the principal rights and obligations in relation to connection to and/or use of the GB Transmission System and also relating to the provision of certain balancing services.

- 2.117 The code includes rules and procedures in situations of disruption. For example events of default, de-energisation, disconnection and decommissioning (all covered in section 5) including events of default with regard to balancing services use of system charges. With adverse weather events likely to increase it is important these rules are robust enough to ensure effective functioning of the network.

³⁵ For further information please see: <http://www.nationalgrid.com/uk/Electricity/Codes/>

³⁶ The Grid Code includes various provisions such as OC7- Operational Liaison, OC8- Safety Co-ordination, OC-9 Contingency Planning and OC-10 Event Information Supply. These are all potentially relevant to adaptation issues.

³⁷ For further information please see: <http://www.nationalgrid.com/uk/Electricity/Codes/>

³⁸ Ibid.

*The System Operator–Transmission Owner Code (STC)*³⁹

2.118 This defines the high-level relationship between the GB system operator and the three transmission owners. It includes a requirement for the SO to publish seven year statements, designed to help existing and prospective users of the transmission system in assessing opportunities available to them. The seven year statement highlights future demand and generation opportunities. It can also include a section on reinforcement investment. The code also includes investment planning rules, and a requirement to consider the impact of any investment on customers.

*The Distribution code*⁴⁰

2.119 The Distribution Code covers the technical aspects relating to the connection and use of the distribution licensee's distribution network. It specifies day-to-day procedures that govern the relationship between the distribution licensee and users of its distribution system for planning and operational purposes in normal and emergency circumstances.

2.120 Requirements relevant to adaptation to climate change may include:

- The Distribution Introduction (DIN) 2 requirement on distribution companies to maintain and operate an efficient, coordinated and economical system.
- The DIN 4 requires licensees to:
 - avoid the breakdown, separation or collapse (total or partial) of the DNO's distribution system or the national electricity transmission system
 - preserve safety under all circumstances, including the prevention of personal injury
 - prevent damage to plants and/or apparatus.

*The Balancing and Settlement Code*⁴¹

2.121 The Balancing and Settlement Code (BSC) sets out the rules and governance for the balancing mechanism and imbalance settlement processes of electricity in Great Britain.

2.122 The BSC contains rules on how losses on the low voltage electricity distribution networks are allocated through the use of Line Loss Factors

³⁹ For further information please see:

<http://www.nationalgrid.com/uk/Electricity/Codes/sotocode/Library/>

⁴⁰ For further information please see: <http://www.energynetworks.info/dcode-homepage/>

⁴¹ For further information please see: <http://www.elexon.co.uk/Pages/home.aspx>

(LLFs). It also includes rules on how losses on the high voltage transmission system are allocated across BSC Parties through the use of Transmission Loss Multipliers (TLMs). The code methodologies can be reviewed from time to time by a review panel. Any signatory to the code can propose modifications, which Ofgem approves – or rejects.

The Gas codes

2.123 The main gas code is the Uniform Network Code (UNC)⁴². It has a common set of rules for all industry players, which ensure that competition can be facilitated on level terms. It governs processes to which adaptation to climate change may be concerned such as planning, demand estimation, maintenance planning, safety and emergency procedures. For example:

- under section H of the transportation principal document (and section H of the offtake arrangements) there is a requirement on transporters to estimate current and future demand. As part of this estimate (used for system and supply capacity planning), transporters include weather variables in demand modelling. This modelling must ensure climate change is adequately considered to ensure accurate demand estimation. Since 2000, every five years transporters review and, where appropriate, revise the formula by which the composite weather variable is determined on the basis of new weather experience. Two modifications to the UNC, proposed by SSE and E-ON, are currently being considered to ensure more accurate demand forecasting. Instead of using historical data, the modifications propose that greater account is taken of climate change impacts, with the use the modelling done by the Met Office and the Hadley Centre.
- under section L of the transportation principal document, National Grid Gas is required to publish and consult on annual maintenance programmes. Under section O, it is required to publish ten year statements. This outlines maintenance programmes and the opportunity for National Grid to highlight how the transmission network can meet future demand. It also gives users the opportunity to comment on such programmes and highlight where they believe possible improvements are needed for adaptation.

⁴² For further information please see: <http://www.gasgovernance.co.uk/>

Figure 9: Summary of our regulatory tools

Tool	OFGEM's role (e.g. design and approval; endorsement, etc)	Does the tool allow/mandate regulated entity to adapt to climate change? (yes/no)	How?
Price Controls	Ofgem designs implements and enforces price controls	Yes	Desired outputs are set in the price control. This includes reliability, customer satisfaction and other categories which are relevant to adaptation to climate change The Network companies' business plans are reviewed and investment needs considered in setting allowed revenue during the price control period
Licenses	Ofgem enforces licensing regime	Yes	Licence holders have obligations such as ensuring supply to consumer. They must consider all risks to being unable to deliver energy which can lead to penalties being imposed by Ofgem
Offshore regime (tender and license)	Ofgem grants licenses to for OFTOs through competitive tender process	YES	Successful bidders must demonstrate operational capability to meet license conditions in offshore environment. OFTOs must comply with licence conditions.
Network codes	Ofgem accepts (or rejects) modifications to network codes such as the gas uniform network code In other codes, Ofgem sits on the modifications reviewing groups	Yes	Signatories to the code are able to propose modification which can take into account changes required to adapt to climate change

Other policies and activities

Asset Risk Management (ARM) within the monopoly network companies

- 2.124 We do not generally get involved in the day-to-day asset management of each company as we consider that such decisions are best taken by network companies. However, we have previously sought assurance about the practices and procedures that companies use to management their infrastructure assets. In 2002 we completed a survey to assess the processes of each company. The results of the survey were used to develop Ofgem's bespoke asset risk management survey (ARM survey). This was designed to probe and report across three key headline topics: business strategy, network strategy and asset life-cycle management. This survey provided valuable information in understanding how the companies carry out ARM and highlighted areas for future action.
- 2.125 Our experience informed a parallel initiative being led by the Institute of Asset Management – to develop the Publicly Available Specification (PAS) 55 published by the British Standards Institution (BSI). We asked each network company to undertake independent PAS 55 certification on a voluntary basis and for their certification status to be made publicly known. Each company reported on its progress towards certification and all were accredited to BSI-PAS 55 by April 2008.

Monitoring security of supply

- 2.126 We monitor the gas and electricity markets and assess security of supply risks on a regular basis. We also contribute to security of supply reporting published by DECC⁴³. As part of our security of supply monitoring we consider the risks in the various parts of the supply chain, and can highlight risks and potential disruption caused by climate change.

Fostering competition and transparency in energy markets

- 2.127 We strive to ensure that energy markets are open, liquid, transparent and competitive. We believe that such markets will indirectly foster adaptation as energy suppliers will compete against each other to supply energy to consumers in a secure and reliable manner and at fair prices.

⁴³ The statutory security report published by DECC is produced jointly with Ofgem and with input from National Grid. It sets down technical information on the security of supply, to meet reporting requirements set out in Section 172 of the Energy Act 2004. The reports can be downloaded at:

http://www.decc.gov.uk/en/content/cms/meeting_energy/en_security/sec_supply_rep/sec_supply_rep.aspx

Policy considerations relating to security of supply are set down in the Government's Annual Energy Statement which aims to provide market direction, set strategic energy policy and helps guide investment. The first statement was delivered to Parliament on 27 June 2010. It can be downloaded at:

http://www.decc.gov.uk/en/content/cms/meeting_energy/aes/aes.aspx

- 2.128 For example, in November 2010 we started our Retail Market Review, an investigation into the markets for electricity and gas for households and small businesses in Great Britain.
- 2.129 In March 2011, we published our findings and initial proposals⁴⁴. We found that further action is needed to make energy retail markets in Great Britain work more effectively in the interests of consumers. Consumers are at risk from a number of features in the market which reduce the effectiveness of competition.
- 2.130 Our initial proposals are designed to make it much easier for consumers to identify who is offering the cheapest tariff; make it easier for new suppliers to enter the market; enforce measures to enhance transparency and competition in both the domestic and non-domestic market; and increase the transparency of company accounting practices.

European and international policy engagement

- 2.131 Great Britain is going to be increasingly interconnected with, and dependent upon, the European electricity and gas markets, as well as on the global Liquefied Natural Gas (LNG) markets. Extreme weather events and gradual climate change impacting on the rest of Europe and on global gas markets already have an impact on us, and will have an even greater one in the future.
- 2.132 We are working to address these risks in cooperation within the Council of European Energy Regulators (CEER), as well as in the framework of the Agency for the Cooperation of European Regulators (ACER). By engaging at European level, we are working to implement the provisions of the Third Energy Package⁴⁵, which aims to create a single, open and competitive energy market in Europe. It is expected that an integrated and efficient European market will be better able to guarantee secure and sustainable supplies to Great Britain as the climate changes.

Energy efficiency, smart meters and smart grids

- 2.133 Energy efficiency may alleviate the challenge and costs of adapting to climate change by reducing the need to build new generation or network capacity,

⁴⁴ For further detail please see:

<http://www.ofgem.gov.uk/Markets/RetMkts/rmr/Pages/rmr.aspx>

⁴⁵ The Third package relates to a gas Directive, electricity Directive, and three Regulations (one on conditions for access to the natural gas transmission networks, one on conditions for access to the network for cross-border exchanges in electricity and one on the establishment of the Agency for the Cooperation of Energy Regulators, ACER). The deadline for transposition of the Directives was 03 March 2011. The Regulations are directly applicable from this date. For further information, please see:

http://ec.europa.eu/energy/gas_electricity/legislation/legislation_en.htm

and the need to implement the associated adaptation measures. It could also reduce the energy demands related to cooling in summer in domestic, commercial and industrial premises.

- 2.134 Smart meters can help facilitate energy efficiency. Smart metering will give consumers far better information about their energy usage. This information could be used to identify unnecessary wastage and therefore improve efficiency. It will also enable the commercial development of new products and services, from tailored energy efficiency advice through to smart appliances and home automation. These products and services can help consumers reduce consumption or shift demand away from peak times, reducing the need to build new generation or network capacity. Smart meters can also facilitate the development of smart grids.
- 2.135 Smart grid technologies potentially offer a number of advantages over many current network solutions. Electricity networks allow the integration of all users connected to them, both producers and consumers. Smart grid technologies offer the opportunity to make this integrating role to be performed with a greater level of intelligence. In particular, this can allow the design and operation of the complete supply chain to be better optimised. Smart grids could also enable the uptake of distributed energy sources. These could make the energy system less dependent on centralised generation sources and as such enhance its resilience if one of more generation plants were to be cut off due to extreme weather events. Ofgem is engaging with the Government on the implementation of its smart metering policy, by advocating and protecting the long term interests of consumers. To this effect, Ofgem is introducing a package of measures to help improve consumer protection.
- 2.136 Ofgem E-serve administers the Government's energy efficiency programmes, the Carbon Emissions Reduction Target (CERT) and the Community Energy Saving Programme (CESP)⁴⁶.
- 2.137 Alongside this, several projects funded through the Low Carbon Network Fund are trialling aspects of smart grids which will inform the electricity distribution companies' understanding in this area.
- 2.138 We co-chair the Smart Grids Forum with DECC. This forum aims to bring together key opinion formers, experts and stakeholders in the development of Great Britain's smart grids, to provide strategic input to help shape Ofgem and DECC's thinking in this area.

Ofgem's engagement with Government and other official bodies on security and resilience

- 2.139 We work with DECC, the Cabinet Office, and other official bodies on projects relating to the security and resilience of critical national infrastructure. This

⁴⁶ Please see our website for further details:

<http://www.ofgem.gov.uk/Sustainability/Environment/EnergyEff/Pages/EnergyEff.aspx>

work can involve technical considerations, funding, and responses to emergencies. For example, we participated in the recent Project Watermark that rehearsed responses to flooding. Ofgem contributed to the preparations and attended a session at DECC's 'incident control room'.

Other requirements on energy companies

2.140 Network companies are also subject to statutory requirements which are overseen by DECC and the Health and Safety Executive. For example, they participate in the DECC Energy Emergencies Executive Committee⁴⁷.

Adaptation to climate change actions being taken by the energy companies

2.141 The network companies have outlined in their reports to Defra that they are already undertaking a number of climate change adaptation initiatives. The following section summarises these actions.

Adaptation to climate change actions being taken by the electricity network companies

2.142 The following actions have been undertaken by network companies as a result of the price control mechanisms. For example:

- Scottish and Southern Energy Power Distribution is trialling real time monitoring of conductor temperature to facilitate dynamic line rating and mitigate against temperature related conductor clearance issues
- National Grid Electricity Transmission has commenced an investment programme to defend sites to 1 in 200 or 1 in 1000 year flooding events dependant on its cost benefit analysis. National Grid has already invested in a mobile flooding defence system (able to cover a distance of 1.2km)
- other mitigation actions are being considered through demand side management (smart grids) and energy storage as part of Low Carbon Network Fund projects.

2.143 The Electricity Networks Association (ENA) is planning to set up a workstream to consider revising design standards for wooden poles supporting overhead line designs. The ENA also intends to carry out a focussed review of industry engineering documents that are likely to be affected by climate change and will propose changes to standards accordingly. Compliance with any revised standards can be considered by the individual companies in their business planning.

⁴⁷

http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/resilience/gas_electric/1_20100430123757_e_@@_nationalemergencyplangaselec.pdf

Adaptation to climate change actions being taken by the gas network companies

2.144 National Grid has an action plan in place to resolve all outstanding river crossing erosion issues. At present it monitors and assesses all river crossings. New river crossings are assessed on the best available technique involving tunnelling and/or direct drilling as opposed to trenching, which has shown more susceptibility to river erosion.

Adaptation to climate change actions being taken by the electricity generators

2.145 Generators have highlighted a number of mitigation actions that they will consider, including:

- carrying out flood risk assessments
- consideration of additional flood defences
- increasing storage capacity of the most critical commodities
- assessment of increased water storage and insurance of priority towns' water supplies in emergency situations
- seeking ways to reduce water consumption
- monitoring systems
- assess cooling options
- introducing new safety procedures or reviewing existing ones, such as those requiring closing off areas in high wind conditions
- improving cladding of exposed facilities.

3. How we assess climate change risks

Introduction

- 3.1 The direction to report asked us to describe the process by which we assess all potential primary and secondary climate effects that may impact our organisational objectives in the short and/or long term and illustrate our approach in discussing climate change risks with stakeholders. The direction also requires us to outline: the uncertainties and assumptions in our assessment process, the barriers to the implementation of our adaptation plan and ways to overcome them, monitoring and evaluation plans and potential opportunities.

Our methodology to assess climate change risks

- 3.2 As advocated in the statutory guidance, in defining the methodology to assess the risks to our organisation we have taken due account of the methods illustrated in 'Climate adaptation: risk, uncertainty and decision-making process', developed by UKCIP (UK Climate Impact Programme). We have reviewed this approach and adapted it to our regulatory role, which does not require us to directly assess risks affecting the companies we regulate.
- 3.3 We have adopted a flexible approach that allows us to revisit previous steps as new information becomes available and to reassess our conclusions and actions over time.
- 3.4 Specifically, this methodology will allow us to adopt regulatory frameworks that are sufficiently flexible to enable regulated companies to adapt, as the climate changes, in a cost-effective and efficient manner.
- 3.5 It will also allow us to take account of:
- the long lifetimes of many of the assets of the companies we regulate
 - the long timescales over which climate change will occur
 - uncertainty about the future impacts of climate change.
- 3.6 We began our assessment by identifying the problem we were aiming to solve and the objectives of this exercise.
- 3.7 The main problem we face as a regulator is ensuring that such risks are mitigated by companies in a way that secures sustainable energy supplies and long term value for money for consumers.

3.8 We therefore set out to:

- to review the risks posed by climate change to us and to the companies we regulate
- to map these risks against Ofgem's regulatory tools and policies.

3.9 The statutory guidance states that our risk assessment should be "based on the current best evidence and projections". To review the risks posed to the energy sector we reviewed the findings of regulated companies to the UKCP09 scenarios and available literature.

3.10 Our review included⁴⁸:

- available adaptation frameworks and approaches (e.g. UKCIP and IPPC)
- studies on climate change impacts from other public sector bodies, such as Environment Agency and DECC
- academic papers
- regulated companies' own reports
- Defra's guidance documents.

3.11 In reviewing the risks to, and possible opportunities for the energy sector, we have focussed on the period between 2010 and 2099. We have considered this timescale for a number of reasons:

- climate change modelling projections are available for the end of the century
- the lifespan of many of the assets can be in the region of 50 years or more
- the GB electricity and gas infrastructure will undergo a major re-building over the next twenty years, as old plants are decommissioned, and new generation and transmission assets come on stream

⁴⁸ The full list of resources is available in the Bibliography

- regulatory frameworks and reforms can take time to have the desired effect and may need to be reviewed during their application to improve their performance.
- 3.12 We have not made distinctions in our assessment between different areas of the country, as a material impact in any of Great Britain's regions will affect our ability to fulfil our duties.
- 3.13 For both direct and indirect threats, we have not assessed the climate thresholds above which climate change and weather events will pose a threat to us, and have relied instead on information provided by companies and other relevant sources. Equally, we have relied on the companies' own ranking of the probability of each risk occurring and made a qualitative comparison of their assessments with available literature.
- 3.14 Different companies will face different levels of climate change risk, and these will have different impacts on each of them. We expect each company to gain a thorough understanding of what these risks are, of the remedial options available to them and of the resources needed to implement the chosen options, and demonstrate their case to us using the best available evidence.
- 3.15 We carried out a mapping of all our functions, regulatory tools and policies, to understand if, and how, each of them was related to adaptation to climate change, either directly or indirectly. For example, we considered that specific obligations network reliability contained in the price control frameworks are directly related to adaptation. Our policies aimed at the development of smart grids and smart meters are directly related to mitigation, as they aim to lower emissions and foster energy efficiency. They are also indirectly related to adaptation, as they aim, for example, to ensure that supply meets demand under all climate conditions in the most cost-effective manner, and could help identify promptly faults on the networks, including when they are caused by meteorological events.
- 3.16 Our assessment enabled us to conclude that the existing tools at our disposal enable regulated companies to adapt to climate change while ensuring long term value for money for consumers.
- 3.17 Some of our tools have been in place for a substantial period (e.g. licences, network codes, RPI-X price controls), while others, such as the RIIIO price control framework are being implemented for the first time. We will assess their effectiveness in addressing climate change impacts as part of the new monitoring and review processes.
- 3.18 We consider that there is no need to devise any new regulatory tool or policy specifically to address adaptation needs.

Next Steps

- 3.19 Adaptation to climate change is an ongoing cycle of work that will require monitoring and additional work as issues arise. We will continue to monitor developments on climate change science, impacts and policies by liaising with relevant government departments (e.g. DECC, DEFRA, the Environment Agency), other regulators, industry, consumers, NGOs, think tanks and academia.
- 3.20 In carrying out our duties, we already undertake monitoring actions related to adaptation to climate change. These are:
- regular assessments of risks to security of supply, of which adaptation to climate change is one
 - regular assessments of price controls, licensing conditions and network codes performances.
- 3.21 In addition, the process of conducting this assessment has helped us to sharpen our thinking on adaptation, as we have undertaken an all-round assessment of the effectiveness of our regulatory tools and other activities focussed purely on an adaptation perspective.
- 3.22 This exercise also enabled us to meet with other reporting authorities to discuss the issues facing our sectors. This has helped to reinforce links, share thinking, and consider interdependencies. We intend to co-ordinate with other economic regulators who have been asked to report under the CCA, to explore risk interdependencies between sectors and compare approaches to address adaptation needs in our respective sectors. We hosted a meeting to initiate this co-ordination with other reporting authorities in September 2011.
- 3.23 We will continue to consult stakeholders to ensure their views, including on adaptation to climate change, are considered in the development of policy and in any review process. We do this by publicly consulting on policy decisions, licensing changes and price control reviews. This includes organising workshops, fora and communication strategies to engage relevant parties. To ensure consumer engagement in price control reviews for example we produce non-technical consultation documents that are accessible to a broad set of consumers and easier to engage with. This builds on existing fora for consulting consumers and network users - the Consumer First Panel and Consumer Challenge Group, and the price control review forums. These provide opportunities for open discussion on key issues and process to ensure all stakeholders including network operators and consumers have their views considered and allow better transparency on decisions taken by Ofgem.
- 3.24 Our regular assessments will consider whether our tools and policies enable regulated companies to meet their adaptation needs. If we find that this is not the case, we may consider reforming our regulatory tools to include specific requirements on adaptation.

Uncertainties and assumptions

- 3.25 We identified five main sources of uncertainty in devising our adaptation programme: scientific, political, regulatory, economic and organisational. We have made a number of assumptions to address them.
- 3.26 **Scientific uncertainty:** Climate change modelling, however robust, is not an absolutely accurate prediction of how the climate will evolve. We assume that the UKCP09 modelling and the literature we reviewed to corroborate its findings are methodologically robust and are represent the latest scientific forecasts. We deem that the companies' assessments, which are largely based on UKCP09 and related modelling tools, are equally sound. We will rely on DEFRA's comments to the reports and we will continue monitoring the scientific developments to update the information available to us.
- 3.27 **Political uncertainty:** The UK government has proposed reforms to the electricity market. The reforms aim to provide a clear signal for investors in low carbon technologies. Although the objectives of the government are clear, the reform is ongoing and as such it is a source of uncertainty.
- 3.28 **Regulatory uncertainty:** it is sometimes hard to establish ex-ante whether regulatory tools (e.g. price controls, licences, system operator incentives) will be able to deliver, given that there is often a long lag-time between the implementation of a regulatory framework, the adoption of the adaptation solutions and the assessment of their efficacy.
- 3.29 However, Ofgem is confident that all regulatory tools have a sufficient degree of flexibility to allow companies to adapt under the current climate change scenarios. Our regulatory tools are monitored, assessed and reviewed on an ongoing basis. Early warning systems and remedial measures are available. The tools are designed in consultation with the regulated companies, who are best placed to assess their needs, as well as with other relevant stakeholders (e.g. academia, consumer protection bodies and NGOs). Past experience shows that our engagement policies and our monitoring and review process have been successful in producing efficient and dynamic regulatory tools.
- 3.30 In the case of network companies, there is the additional difficulty of assessing whether the price controls will enable companies to adopt efficient and cost-effective adaptation solutions. This is a particularly relevant risk, as adaptation measures may, in some cases, require substantial infrastructure investments. However, we assume that our price controls will deliver for the following reasons:
- we regularly assess the economic efficiency of measures proposed by network companies, which have to demonstrate their needs case and the benefits of the proposed measures to consumers

- we also assess the cost-effectiveness of the proposed measures for consumers in setting our price controls, by carrying out studies on consumers' attitudes and willingness to pay
 - where applicable, Ofgem benchmarks the requests of network companies against comparing requirements made by other network companies.
- 3.31 **Organisational uncertainties:** There is often a time lag between adaptation solutions and when benefits are realised. There is a risk both for regulated companies and Ofgem that there is a loss of knowledge about adaptive actions.
- 3.32 Ofgem has robust audit processes to ensure that corporate memory is maintained in all our operations. Regulated companies have an interest to do the same in order to comply with their legal obligations.
- 3.33 **Economic uncertainty:** The economic climate may impact network company's ability to raise finance. We have duties to ensure that the companies can finance themselves. We will continue to ensure that the energy markets deliver energy cost-effectively to consumers by monitoring markets and fostering competition and transparency. With regard to the price controls, we are able to address such concerns through the control mechanisms highlighted in the 'regulatory uncertainty' section.

Barriers to adaptation and ways to address them

- 3.34 We have identified the following potential barriers to the implementation of adaptation measures and outlined the remedial measures that we currently use to address them.
- 3.35 **Organisational barriers:** we consider adaptation is sufficiently embedded in our processes.
- 3.36 We are already ensuring that adaptation needs are adequately considered in our activities where relevant. These include in particular monitoring and reviewing of our regulatory tools and policies. We strive to increase awareness of mitigation and adaptation needs for the energy sector among our staff on an ongoing basis. For example, staff attended training offered by Defra on the UK Climate Projections (UKCP09). We are also engaging actively on adaptation with other economic regulators, Defra and the Environment Agency.
- 3.37 **Regulatory barriers:** We identified a number of barriers through discussions with stakeholders during the RPI-X@20 review. The review highlighted the tendency of network companies to focus on the short term, and give limited consideration to innovation and cross-sector interactions. This could impact on the ability of regulated companies to proactively address their adaptation needs.

- 3.38 We addressed these shortcomings by extending the new price-control periods to eight years, and by requiring regulated companies to set out delivery strategies beyond the price control through secondary outputs. We will monitor the performance of the new price control framework and assess whether it has been successful in addressing these concerns.
- 3.39 **Economic barriers:** Measures to adapt to climate change entail costs. If the costs are high while the potential risks appear distant, immediate action may not necessarily be seen as a priority. With energy companies considering investment by evaluating the net present value, the long life of assets and potential extra cost of retrofitting existing equipment means that companies may favour delaying investment until the asset needs replacing.
- 3.40 A further potential constraint to investment in adaptation measures is how much consumers are willing to see bills rise to fund adaptation to climate change. This is particularly important when the benefit on an investment today is for changes that benefit future consumers. For the regulated monopoly network companies, as customers ultimately pay for the investment, Ofgem must ensure the investment delivers benefits to consumers.
- 3.41 We have been addressing these potential barriers on an ongoing basis in setting our price controls, by requiring network companies to demonstrate their needs case for investment and to set out delivery strategies beyond the price control through secondary outputs. Where appropriate, we benchmark the companies' requests against one another. We take account of consumers' perspectives by carrying out studies on consumers' attitudes and willingness to pay.
- 3.42 **Information asymmetry:** While we do not mandate investment by network companies, we do set their allowed revenue under price controls. This relies on the information provided by the network companies in their business plans. There is therefore a potential barrier from information asymmetry, and a risk that network companies either do not adequately address all the climate change risks they face, or they seek approval for unnecessary or inappropriate measures.
- 3.43 The RPI-X and RIIO price control regimes require network companies to demonstrate the needs case for their financial requests and the benefits for consumers. Independent technical experts' panels often assist us with the evaluation of the requests. We further assess the companies' requests by benchmarking them against comparable ones put forward by other companies.

Interdependencies within the energy sector and with other sectors

Interdependencies across sectors

- 3.44 There are strong interdependencies between the energy sector, other regulated sectors and across the economy. For instance, the electricity system affects the functioning of the railway sector. Similarly, the production of energy requires accurate and timely communication tools to manage the energy system, and water is an important resource in energy generation e.g. for cooling. As such, it is important that measures to adapt to climate change measures are taken across all sectors to be fully effective.
- 3.45 We met other economic regulators on 19 September 2011 to learn from each other's experience in drafting this report, and set out a coordination framework.

Interdependencies within the energy sector

- 3.46 Likewise, there are strong interdependencies within the energy sector. For instance, flooding and storms could affect both generation and transmission in the gas and electricity sectors. For example, there could be an increase risk of partial or complete shutdown of generation plants caused by disruption in fuel supply chains and by increased risks to plant operation and safety. Substations could be flooded, and overhead lines could be pulled down by high winds.
- 3.47 In their reports to Defra the energy companies have shown they have carried out extensive research to understand the risks from adaptation. For example electricity generators worked closely with each other as members of the Association of Electricity Producers (AEP) in order to help develop an impact assessment process applicable across the electricity generation sector as whole. Similarly network companies worked closely together.
- 3.48 It is important to continue this cooperation with companies, and that the companies put in place good internal systems and processes to continue assessing the risks from climate change.

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