NORTHERN POWERGRID

delivering power all day, every day

Adapting to Climate Change

Executive Summary

June 2015

1. Introduction

Northern Powergrid is responsible for delivering electricity to around 8 million customers across 3.9 million businesses and homes. We operate through our subsidiary companies Northern Powergrid (Northeast) Ltd in the North East and North Yorkshire and Northern Powergrid (Yorkshire) plc in South, East and West Yorkshire and northern Lincolnshire.

The Northern Powergrid network consists of more than 61,000 substations, around 93,000km of overhead line and underground cable and over 2,200 employees. It covers an area of 25,000 square kilometres, our network extends from north Northumberland, south to the Humber and northern Lincolnshire, and from the east coast to the Pennines.

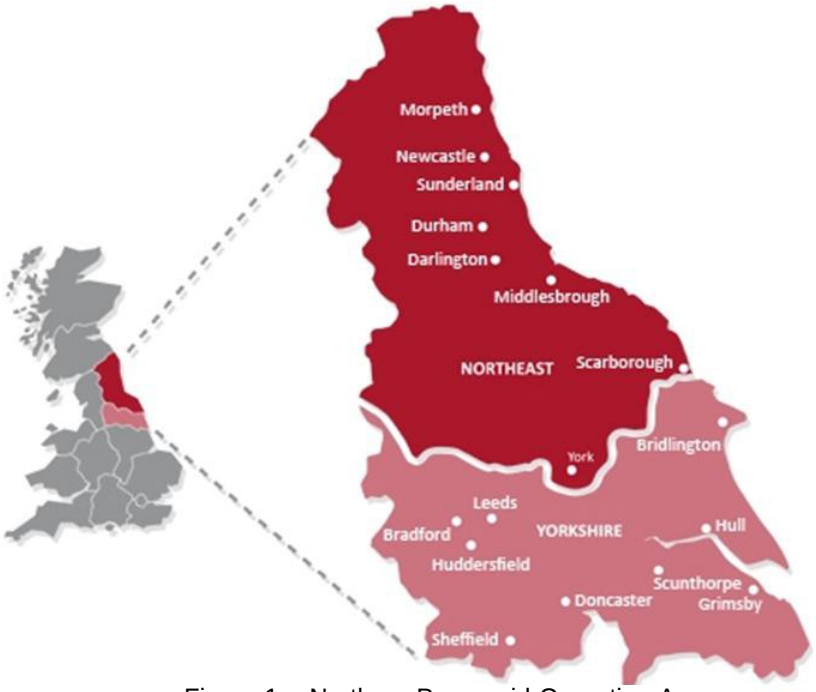


Figure 1 – Northern Powergrid Operating Area

As a distribution network operator (DNO), our role is to ensure safe, secure and cost-effective delivery of electricity to our customers. To do this, we:

- Invest around £340 million a year to maintain and strengthen the resilience of our network.
- Provide customers with new connections to the network. These can range from moving a single domestic supply to providing connections for new housing or commercial developments.

1.1 Method of producing the report and background information

Northern Powergrid first formally reported on how it identified climate change impacts on the functions of its two licensed electricity distribution companies, Northern Powergrid (Yorkshire) and Northern Powergrid (Northeast), the proposed mechanisms for monitoring and actions to respond to the likely impacts of climate change in 2011 as part of the first round of reporting initiated by the Department for Environment, Food and Rural Affairs (Defra) as a result of the Climate Change Act (2008).

In 2013, Northern Powergrid agreed to a request from Defra to participate in the second round of reporting, to be carried out during 2015, and to provide an update on their ongoing adaptation to climate change.

Although this report is specific to the geographical areas covered by the two licenses, it was recognised during the first round reporting process that, due to national equipment designs based on International, European and British Standards, many of the issues of climate change adaptation (CCA) related to our physical assets are common to all DNOs. A "core" assessment was therefore prepared by a task group of electricity distribution and transmission network operator members of the Energy Networks Association (ENA) - the industry body for the UK. During the production of this "core" report, Northern Powergrid, alongside other ENA members, engaged with government regulators, Defra, the Environment Agency (EA), the Department of Energy and Climate Change (DECC), the Met Office and other organisations. This "core" report considered the issues that are common to companies across the UK and formed the basis of the Northern Powergrid first round report.

Following the initiation of the second round of reporting, this working group reconvened to consider any updates to climate change science, projections and government thinking and their impact on the electricity industry. The output from this group has been incorporated into the Northern Powergrid second round report and forms the basis of this Executive Summary. The executive summary has been presented in line with the template for update reports provided by Defra.

Transmission and distribution companies in Great Britain are regulated businesses and operate under licences issued by Ofgem. They are also are subject to common statutory requirements which are overseen by DECC and the Health and Safety Executive (HSE). Allowed revenues for the industry are set by Ofgem in periodic price reviews and therefore any costs associated with adaptation to climate change would need to be agreed with Ofgem.

Transmission and distribution companies are responsible for transporting electrical power from generating plants to customers over their extensive networks. These networks comprise a mixture of overhead lines and underground cables and include points on the system called substations, where voltage transformation takes place and switching and control equipment are located. These sites supply large numbers of customers, typically 5,000 / 30,000 customer at primary sites and 50,000 / 500,000 customers at grid sites.

Overall levels of supply security are agreed by Ofgem and these standards specify the requirements for the availability of alternative supplies at various levels of customer load. Although these standards allow for the loss of multiple circuits they do not provide for certain low probability events including multiple failures or the total failure of a grid or primary substation. Particular attention must therefore be given to these sites when considering network resilience.

Whilst every effort is made to ensure network security, Northern Powergrid has well developed business continuity and emergency plans to ensure an effective response to a range of events that can affect both transmission and distribution networks. Under the terms of the Civil Contingencies Act, Northern Powergrid is a Category Two responder and works closely with other utilities, the emergency services and local authorities. We are also active participants in the DECC Energy Emergencies Executive Committee (E3C).

1.2 Summary of climate impacts

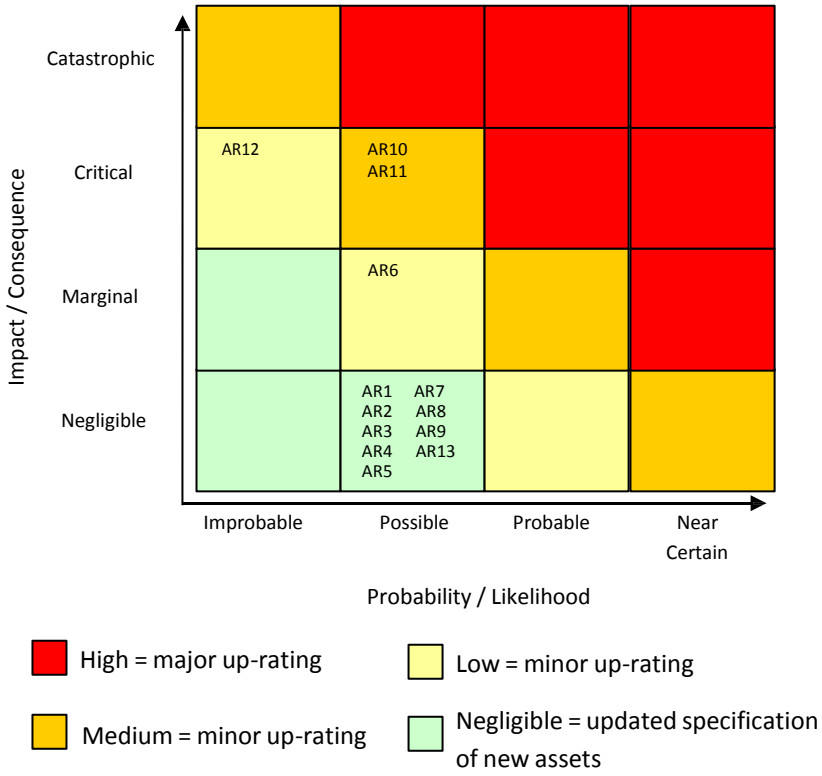
The main impacts on electricity networks from the current climate change projections are:

- Temperature—predicted increase.
- Precipitation—predicted increase in winter rainfall and summer droughts.
- Sea level rise—predicted increase.
- Storm surge—predicted increase.

In considering adaptation to climate change, electricity and gas network companies use the Met Office UK Climate Projection (UKCP09) and take into account projections to the end of this century because the different types of network infrastructure generally have very long operational lives, typically 30 to 80 years. There are no immediate plans to review these projections.

At present there is no firm climate change evidence to support increased intensity of wind or ice storms, both of which can cause extensive damage to overhead electricity networks. However, an increase in the frequency of stormy weather is possible and this is likely to lead to more frequent periods of high winds which can pose a threat to electricity distribution networks due to falling trees and windblown material.

The risk matrix below can be found in section 7.1 of the Northern Powergrid Second Round Report.



- AR1 Overhead line conductors affected by temperature rise, reducing rating and ground clearance.
- AR2 Overhead line structures affected by summer drought and consequent ground movement.
- AR3 Overhead lines affected by interference from vegetation due to prolonged growing season.
- AR4 Underground cable systems affected by increase in ground temperature, reducing ratings.
- AR5 Underground cable systems affected by summer drought and consequent ground movement, leading to mechanical damage.
- AR6 Substation and network earthing systems adversely affected by summer drought conditions, reducing the effectiveness of the earthing systems.
- AR7 Transformers affected by temperature rise, reducing rating.
- AR8 Transformers affected by urban heat islands and coincident air conditioning demand leading to overloading in summer months.
- AR9 Switchgear affected by temperature rise, reducing rating.
- AR10 Substations affected by river flooding due to increased winter rainfall.
- AR11 Substations affected by pluvial (flash) flooding due to increased rain storms in summer and winter.
- AR12 Substations affected by sea flooding due to increased sea levels and/or tidal surges.
- AR13 Overhead Lines and transformers affected by increased lightning activity.

Probability – Management judgement on likelihood of hazard occurring		Impact – Anticipated business consequence should hazard materialise	
H	It is judged to be Near Certain that the hazard will occur. (70% < p < 100%)	H	Should the hazard occur it is judged that the impact on the business would be **Catastrophic** e.g. failure of mission-essential service, death, cost of incident exceeds £10m
M	It is judged to be Probable that the hazard will occur. (40% < p < 70%)	M	Should the hazard occur it is judged that the impact on the business would be Critical e.g. significantly degraded performance, serious injury, cost of incident exceeds £1m
L	It is judged Possible that the hazard will occur. (1% < p < 40%)	L	Should the hazard occur it is judged that the impact on the business would be Marginal e.g. Failure of or degraded secondary performance, minor injury, cost of incident exceeding £100k
N	It is judged to be Improbable that the hazard will occur. (Less than 1%)	N	Should the hazard occur it is judged that the impact on the business would be Negligible e.g. inconvenience, cost of incident below £100k

Detail showing the changing risk profile during the century is shown in Figure 7 of the Second Round Report. This shows clearly that the greatest weather and climate threat to electricity networks is considered to be flooding. A summary of the industry's considerable efforts to manage existing and future flood risk is described in section 1.3.

The other serious risks are due to gradually increasing temperatures which reduce the amount of energy that electrical networks can transmit resulting in a requirement for network re-design/strengthening.

However, overall network investment plans also need to take account of increasing loads due to normal growth rates and the expected very substantial additional impact of "low carbon" loads/generation such as heat pumps, electric vehicles and solar PV. Current projections indicate that these are likely to have a far greater impact than potential temperature increases and "Smart Grid[1]" technology is being developed to provide minimum cost solutions that also have the potential to provide service enhancements for customers. In view of this it is currently considered that it will be possible to build adaptation requirements into "Business as Usual".

It will however be necessary to consider adaptation when designing the building blocks of the "Smart Grid" and information on adaptation requirements is being shared with those working on "Smart Grid" development.

1.3 Impact from flooding

In the event of serious flooding, electricity substations can be put out of action and the consequences can be severe. The flooding of a large substation can mean the loss of electricity supply to thousands of people, as well as to other types of infrastructure. The risk has been highlighted by severe flood incidents in the last few years, particularly those in 2007.

Such events show the need to understand and improve the resilience of substations to flooding. Action is particularly vital because, due to climate change, flooding of all kinds is likely to get worse. The Government has recognised this, and in 2007 asked for a comprehensive assessment of substations' resilience to flooding. Sir Michael Pitt's review of the 2007 floods also called for an improvement in the resilience of substations.

[1] Smart Grids use additional functionality to provide greater capacity and flexibility over their passive equivalents. Using a mixture of modelling, state estimation and active measurement systems they dynamically alter their settings and layouts to accommodate greater levels of load and generation without requiring additional conventional reinforcement.

DNOs realised they needed a consistent sector-wide approach to flood resilience, but no industry standards existed. Regulations required 'reasonably practicable' measures to be taken to prevent loss of supply, but there was no common view about what this meant.

The electricity network sector has addressed this gap, developing a systematic approach to flood risk assessment and protection. The approach is documented in the Energy Networks Association's Engineering Technical Report (ETR) 138 - Electricity Substation Resilience to Flooding (Issue 1 October 2009). This sets out industry guidance on:

- standards of resilience
- how to take account of increasing risk due to climate change
- methods of assessing the likelihood and impact of flooding
- measures to reduce flood risk
- cost-benefit analysis of measures.

Standards of resilience

The ETR identifies three different levels of acceptable flood risk, depending on the importance of the substation. These standards are the default, but can be raised or lowered if an analysis of the costs and benefits suggests that this is appropriate.

- Level 1: most important grid substations (typically supplying 50,000 to 500,000 customers) - likelihood of flooding should be no more than 1 in 1000 years.
- Level 2: other primary substations (typically supplying 5,000 to 30,000 customers) - likelihood of fluvial flooding no more than 1 in 100 (1 in 200 for Scotland) and 1 in 200 for sea flooding.
- Level 3: for sites where level 1 or 2 cannot be justified – other flood resilience measures.

Data specification

The ETR specifies the data that should be collected for the purposes of assessing flood risk. The specification requires companies to collect, for each substation:

- the likelihood of flooding in any one year from rivers or the sea (and surface water from 2015)
- the potential depth of flood water
- information about historic flooding
- existence and condition of flood defence scheme
- whether the site is in an area where the Environment Agency (EA) provides flood warnings
- the time required to activate flood protection measures.
- Societal risk – number of customers and number of critical / vulnerable customers

Climate change allowances

The ETR recommends allowances to take account of the impacts of climate change on flood risk for both fluvial and sea flooding. An additional allowance is included for uncertainties in data and modelling.

Cross-sector approach

The whole of the electricity network sector collaborated in developing ETR 138. Work was coordinated by the trade association, the ENA, and included representatives from all electricity network companies, government (DECC), the regulator (Ofgem) the EA, Scottish Environment Protection Agency (SEPA) and the Met Office. The involvement of DECC and Ofgem was particularly important as it helped to support companies' investment plans for flooding resilience.

Benefits

All DNOs now have programmes to raise protection to the agreed standards and the current programme will be completed by 2023. Northern Powergrid has consulted with its stakeholders and recognised the high priority assigned by them to flood protection. As a result of this consultation, we are planning to complete works to protect all major sites at risk from fluvial and tidal flooding by 2019.

By setting out industry standards and an agreed approach, companies know how to tackle flood risk. Because government and the regulator were involved from the start, business plans which follow this approach have been approved. The respective allowances are published and expenditure monitored on an annual basis by the Regulator.

Other benefits are:

- The government is clear about the standard of protection of this vital service.
- There is consistency across the country - customers in different areas enjoy the same standards of protection.
- Operators of infrastructure which rely on electricity understand the risks to their service.
- Resilience measures will take account of climate change, so will be robust in the foreseeable future.

Lessons in the development of ETR 138

- Developing a cross-sector approach and acceptable levels of risk.
- Allowing flexibility in the standard, depending on costs and benefits.
- Discussing resilience standards with operators of dependent infrastructure.
- Involving all relevant organisations, including government and the regulator to achieve acceptance.
- Agreeing climate change allowances to handle uncertainty about future risk.
- Keeping standards under review, and updating to take account of new information.
- These lessons can read across to other areas.

This approach is held up as an exemplar by the Infrastructure Operators Adaptation Forum (IOAF) (facilitated by the EA Climate Ready team) and details are published on the Institution of Engineering Technology web site. The work in developing the ETR is also referenced in the 2014 report on infrastructure resilience by the Adaptation Sub Committee (ASC) of the Committee on Climate Change.

2. Understanding Climate Risk

2.1 How has your understanding of climate risks, impacts and their effects on your sector/organisation and stakeholders advanced since your first round report?

There has been no significant change in the understanding of climate change risks since the first round of Adaptation Reports were submitted in 2011. This understanding was based on the UKCP09 data published under the Climate Impacts Programme (UKCIP) that forecast the risks under various scenarios to the end of this century.

Information recently provided by Defra confirms that following the publication of the latest Intergovernmental Panel on Climate Change (IPCC) assessment (2014), the Met Office conducted a study which shows that, in general, UKCP09 continues to provide a valid assessment of climate change. Furthermore, the 2014 report by the Committee on Climate Change provides a useful summary of the current knowledge regarding climate risks for infrastructure.

There have been a number of significant weather issues across the world and in the UK since 2011, notably the very extreme wet and stormy weather in the UK during the winter of 2013/14, that emphasise the importance of planning for the type of extreme event that could become more common with climate impacts, particularly flooding. Record levels of rainfall were experience between April and December 2012 and the events of 28th June 2012 in Newcastle and Gateshead (known locally as Thunder Thursday) led to the reconsideration and improvement of information on surface water flooding. This has become more reliable and is now considered sufficient to justify additional flooding resilience measures. In view of this the ETR 138 task group was reconvened to update the document to include the management of surface water risk.

Companies are continuing their research into the potential impact of climate change, including through a range of stakeholder engagement programmes which have been encouraged by the industry regulator, Ofgem.

Flooding presents the most serious climate risk to electricity networks and this includes current flood risk and the higher risks forecast as a result of climate change from increased rainfall and higher sea levels. To mitigate this risk, Northern Powergrid is carrying out a programme of flooding resilience work as detailed in section 1.3. Resilience measures already in place at major electricity transmission and distribution installations nationally prevented any loss of supplies from these sites due to river flooding during the severe weather in 2013/14. Northern Powergrid however did see some loss of supplies due to the flood defences at a major substation becoming compromised as a result of a coastal surge event in December 2013.

2.2 What climate change evidence or research have you used to better understand the implications for organisational functions?

To a large extent, companies are still reliant on UKCP09 as the primary source of information. As indicated in section 2.1, Defra has confirmed that, in general, UKCP09 continues to provide a valid assessment of climate change.

As detailed in section 6.1.2 of the Northern Powergrid Second Round Report, UK electricity networks companies have carried out two research projects with the Met Office that investigated the potential impact of climate change on energy companies. The initial project was a ground breaking initiative that brought climate science closer to business applications. This was the first project sponsored by an entire sector to review the specific impacts of climate change on their industry. Supported by climate scientists, experts from the industry worked together to understand their precise requirements and developed practical applications and business strategies for a changing world.

A second project was commissioned to build a risk model that quantified the relationship between climate and network faults, and also the vulnerability and exposure of the network to these faults. This model can be driven with climate projections to assess how network resilience may be affected by climate change.

DNOs are currently engaged in further work with Newcastle University. This work includes an assessment of the potential changes to wind speeds as result of climate impacts and the risks this could present for electricity networks.

At present there is no firm climate change evidence to support increased intensity of wind or ice storms both of which can cause extensive damage to overhead electricity networks. However, both of these natural hazards continue to be a serious risk to overhead line networks. In order to better understand potential changes in wind impacts, electricity companies have supported the RESNET project, led by Newcastle and Manchester Universities. Initial reports are currently undergoing review.

As noted in section 1, the greatest climate threat to networks is assessed to be flooding. This applies to present risks and as a result of predicted climate change. Following the 2007 floods in the UK an Industry Task Group was set up to produce a common approach to the assessment of flood risk and develop target mitigation levels that could be subject to cost benefit assessments. This was enabled by the great improvement in information on flood risk in recent years. The Task Group comprised representatives from DNOs, Government departments and agencies and the Ofgem.

Based on this report, DNOs are now undertaking a long term programme of work to improve substation resilience to flooding that takes into account predicted climate impacts. This programme was agreed by the industry regulator when they set the current allowances for DNOs as part of the regulatory control periods. The respective allowances are published and expenditure monitored on an annual basis. Northern Powergrid however did see some loss of supplies due to the flood defences at a major substation becoming compromised as a result of a coastal surge event in December 2013.

All planned flood protection is due to be complete by 2023 with higher risk sites being completed early in the programme. In the latest floods in the UK in the winter 2013/14, no customer supplies were interrupted as a result of river flooding at major substations operated by the network companies.

2.3 Has your understanding of thresholds of climate impacts advanced to better pinpoint organisational vulnerability? If so, how?

UKCP09 provides climate information for the UK up to the end of the century. The projections show three different scenarios representing high, medium and low greenhouse gas levels. Information is provided on observed climate data, future climate projections and future marine and coastal projections. These scenarios are still being used and remain the best existing available information.

Northern Powergrid has carried out detailed analysis on substation flooding resilience and this has greatly assisted the understanding of risk at particular sites and ensured that appropriate protective measures are put in place.

In addition, flood mapping for surface water has been improved for England and Wales and the industry guidance on flood protection has been updated to take this into account. Similar information is also expected for Scotland. Northern Powergrid, along with other network companies, included resilience measures to protect key sites against surface water flooding in their latest regulatory submissions.

2.4 How have you developed your quantified assessment and analysis of risk likelihood and impacts?

The risks identified in the first round are still considered to be appropriate.

All DNOs are committed to providing a safe, reliable and affordable network to deliver energy to customers. Whilst companies will always prioritise safety, reliability is the key measure in monitoring and evaluating whether they are performing effectively.

Whenever a customer loses supply, details of that interruption are recorded by DNO. Distribution networks are much more affected by climate impacts than the transmission system and all supply interruptions on distribution networks are recorded in the National Fault and Interruption Reporting Scheme (NaFIRS) database. This information is shared nationally and summaries are submitted to Ofgem. Data is available for over thirty years but the quality of the data has improved significantly over the last fifteen years since the introduction of the Ofgem Interruptions Incentive Scheme (IIS).

ENA Engineering Recommendation G43-3 (Instructions for Reporting to the National Fault and Interruption Reporting Scheme) sets out the details to be captured for each fault. For each interruption companies will capture a large amount of information and up to 100 separate fields will be populated. These include:

- location
- number of customers affected
- duration
- type of equipment
- manufacturer
- cause of the fault

Using this information companies can identify trends in all these areas and take action where appropriate. Prior to 2010 companies submitted an annual Medium Term Performance report to Ofgem which summarised the number of faults on overhead and underground networks, at each voltage level, in the following categories:

- lightning
- rain, snow, sleet, blizard, freezing fog, frost & ice
- wind, gale, growing trees, falling trees & windborne materials
- all other due to weather & environment causes plus birds, animals & insects
- company & manufacturer causes
- third party
- any other causes (including unknown & unclassified)

Since 2010, companies have provided the full dataset to Ofgem who perform their own analysis. Although the data is aggregated at this level, companies actually capture data to a more detailed level, attributing faults to one of 99 different direct causes specified in G43-3. Eleven of these are weather related:

- lightning
- rain
- snow, sleet, blizzard
- ice
- freezing fog and frost
- wind and gale (excluding windborne material)
- solar heat
- airborne deposits (excluding windborne material)
- condensation
- flooding
- windborne materials

Therefore, using data from the NaFIRS system, companies can monitor how their networks are performing, identify any trends in weather related faults and respond accordingly.

Incentives on network reliability

DNOs also have financial incentives to minimise the number and duration of interruptions including those caused by climate impacts.

Ofgem introduced the IIS in April 2002. Under this scheme, DNOs are set a target for the number of interruptions each year that last over three minutes, and the total length of those interruptions. If they beat these targets they are rewarded and conversely they are penalised if they do not achieve the targets.

The incentive rates have varied at each price review, but for the period from 2015 to 2023 they have been set so that the cost of an individual customer going off supply for over three minutes is approximately £15, with every additional minute costing a further £0.37[2].

The amount that DNOs can benefit or be penalised under IIS is capped, with the amount varying with the size of the DNO. For the largest DNO this is set at just over £33m and for the smallest at £14m.

[2] Figures quoted in 2012/13 value before application of IQI efficiency factors.

This money is not paid directly to the affected customers, but will be added or deducted from the allowed revenue that DNOs will collect from suppliers. This will result in adjustments to tariffs for all customers.

Transmission companies have a similar incentive scheme known as Energy Not Supplied (ENS).

DNOs are also subject to Guaranteed Standards (GS) of Performance enacted through the Electricity (Standards of Performance) Regulations which is a Statutory Instrument made under powers conferred in the Electricity Act 1989.

The GS' are a set of standards of service agreed with Ofgem, and backed by a financial guarantee – customers receive a payment if the DNO fails to meet these standards. From April 2015 the GS for supply restoration has been set so that domestic customers will receive a payment of £75 after they have been without supply for 12 hours and £35 for every subsequent 12 hour period. A non-domestic customer will receive £150 for the first 12 hours and a further £35 every 12 hours. These payments will be made directly to the customers affected.

For both IIS and GS' there are variations in the case of Severe Weather, recognising the additional difficulties in restoring supply under these conditions.

As mentioned in Section 2.2, new work is being focussed on identifying risk from the possibility of higher wind gusts or more frequent storms. A serious risk for DNOs occurs during very strong wind storms when trees are uprooted some distance from an overhead line but are close enough to damage the conductors or break supporting poles. During the winter of 2013/14 this was a particular issue because very strong wind storms were combined with prolonged rainfall which made trees more susceptible to uprooting. As a result, a review has been initiated of the industry approach to resilient tree cutting set out in Engineering Technical Report (ETR) 132 – Improving Network Performance Under Abnormal Weather Conditions By Use Of A Risk Based Approach To Vegetation Management Near Electric Overhead Lines.

This ETR was developed in conjunction with DECC and Ofgem and provides guidance for DNOs on how to improve network performance by enhancing the resilience of the network to vegetation (mainly trees) related faults under abnormal weather conditions, including high winds, ice, snow and prolonged high temperatures. This is particularly important due to the possibility of increased rainfall combined with strong winds and extended growth periods as a result of climate impacts. The Terms of Reference for this review are included in the Second Round Report as Appendix 9.

3. Understanding Climate Risk

3.1 What uncertainties remain in monitoring and evaluating climate risks to your sector's/organisation's functions?

There is a need for cross sector planning scenarios to ensure that sectors with interdependencies have used similar assumptions when reporting; this was not fulfilled in the first round of reporting.

This is important to address the wide variety of views regarding the extent and impact of climate change on national infrastructure. This important role is being developed by the IOAF.

As indicated in Section 2.4, there are now increased concerns about interdependencies between weather events such as very strong winds following prolonged rainfall and initial discussions are taking place with Newcastle University regarding dependent heavy rain and wind models.

When UKCP09 is updated it would be helpful if there was a better understanding of probable event frequencies. The EU is also proposing to carry out work on Climate Change Services and this could prove a useful source of information. ENA have provided information to the EU on UK energy networks issues and requirements.

3.2 What new uncertainties have come to light?

As indicated in Section 2.4, there are now increased concerns about interdependencies between weather events such as very strong winds following prolonged rainfall.

3.3 What further implications do uncertainties have on action your sector/organisation has taken or plans to take?

Any emerging uncertainties will be captured within the Northern Powergrid risk management approach and addressed within business work plans.

This process needs to ensure that any asset investment made is necessary, timely and appropriate. Northern Powergrid, like the other DNOs, is a regulated monopoly business and our expenditure is subject to economic regulation by Ofgem. This is achieved via a periodic price control process known as RIIO (Revenue = Incentives + Innovation + Outputs). The current price controls run from 2013 to 2021 for transmission and from 2015 to 2023 for distribution companies.

Unless there are very exceptional or unforeseen circumstances, then the levels of approved revenue needed to accommodate the planned asset infrastructure investment and maintenance for this period, including any work required to adapt to climate change must be agreed with Ofgem when the Price Control is set. This means that it is extremely important that the industry develops its CCA plans with Ofgem to ensure that plans and supporting information meet the DNOs' and Ofgem's requirements.

At present the current UKCP09 data does not support further asset investment beyond that already planned. Nevertheless, climate change risk will continue to be monitored as part of the DNOs approach to risk management and information will be shared throughout the sector via ENA, who will also update DECC and Defra of any significant developments.

3.4 What progress have you made to address information gaps?

The following initiatives are being undertaken:-

- Work with EA and SEPA to understand the latest surface water flooding information and update national flood protection guidance.
- Current / ongoing work with Newcastle University.
- Support for the EU initiative.
- Project initiated to review current guidance document on resilience tree cutting (ETR 132).
- Information on the impact of recent severe weather has been shared between network companies and a large number of actions to improve emergency response have been co-ordinated through ENA and DECC.
- DNOs are taking advantage of the Met Office's latest long range winter forecast. The Met Office is now invited to attend an industry emergency planning forum in the autumn to discuss the forecast and the likely consequences with the industry's emergency planners and operation managers. The first meeting took place in December 2014 and further discussions are planned during 2015 including a workshop run by the Met Office.

3.5 What are the strategic business and methodological assumptions that underpin your analysis of impacts and risks?

The strategic business and methodological assumptions have not changed substantially since the First Round. Northern Powergrid business strategies are driven by our six business priorities:-

- Customer service
- Employee commitment
- Financial strength
- Environmental respect
- Regulatory integrity
- Operational excellence

Customer service is particularly important and this includes minimising power cuts, restoring supplies quickly and efficiently in the event of a power cut and providing rapid and helpful information to customers.

Further details on these priorities and issues can be found in the Northern Powergrid Second Round Report and the issues were all covered in the first round reports. However, there is no doubt that the winter storms and the following DECC and Ofgem reviews have focussed companies on the critical importance of planning for severe weather events and a number of processes have been revised and strengthened as a result.

As discussed in the detailed report, a particular aspect of electricity networks is that many of the assets have very long lives, typically 30 to 80 years and this means that it is very important to take account of predicted climate change impacts when planning new installations or safeguarding existing key equipment.

Flood protection currently being provided is designed to be resilient to the end of this century, based on currently available data.

4. Details of Actions

Table of Actions: Implemented Actions

Summary of actions (as set out in first round report)	Timescale over which action planned	Progress on implementing actions	Assessment of extent to which actions have mitigated risk	Benefits/challenges experienced
It is expected that flooding adaptation work for current known threats including climate change will be completed over the next ten years. The following expenditure has been agreed on flooding resilience for DNOs: DPCR (2010 to 2015) £73m spent, RIIO (2015 to 2023) £100m planned.	2012 to 2021 for the Transmission System. 2015 to 2023 for the Distribution System.	On target. National programme details are held by Ofgem. Progress against the current programme was reviewed by the ASC in their July 2014 report. They found that progress was being monitored and was on target.	Risks are being mitigated as the work proceeds to 2023 with sites prioritised on order of risk.	No loss of supply to customers during the severe weather in 2013/14 due to flooding at major substations operated by DNOs.
ENA member companies propose to engage in discussion with Ofgem and DECC with a view to agreeing revised design standards for overhead lines to take effect from 2015.	Timescale under review: further consideration of work carried out by EATL and other available data is required.	Work has been carried out by specialist EATL to consider overhead line ratings. However, the initial results from the study have shown that further work is necessary.	The risk is a decrease in overhead line ratings leading to network overloading. This is a complex subject. Further work is necessary before any firm recommendations can be made.	Improving understanding of the issues involved in this complex subject.
It is proposed to review critical industry standards	2015	ETR 138 covering substation resilience to flooding has been updated to take account of data on surface water flooding.A review has started on ETR 132 covering resilience tree cutting.	The inclusion of surface water flooding provides additional resilience for key substations. It ensures supplies are protected against failure due to the increasing risks of surface water ingress as a result of increasing rainfall.	Strengthened the relationship between electricity transmission / DNOs and Defra, EA and SEPA.

Summary of actions (as set out in first round report)	Timescale over which action planned	Progress on implementing actions	Assessment of extent to which actions have mitigated risk	Benefits/challenges experienced
The scale of the change to "Smart Networks" is likely to be very large, entailing the re-design and re-building of many circuits and substations. The resultant upgrade may be far larger than required to accommodate potential adaptation requirements and it will be necessary to understand these two requirements fully before companies submit their financial plans to Ofgem. Therefore, although it is essential to research fully the potential effects of climate change in order to understand the possible impacts and mitigations, it is probable that the scale of any network upgrades will be dictated by the drive to low carbon networks	Some initial impacts are expected during the current price controls to 2021 and 2023 but significant impacts are not forecast until the following price controls, currently scheduled to 2029 and 2031.	The industry has worked with DECC & Ofgem through the Smart Grid Forum to assess the impacts of Carbon Targets on transmission & distribution Networks and how these impacts can be most effectively mitigated by the combination of network reinforcement & the deployment of "smart network" technology. This has resulted in a number of reports, which have provided guidance to both the industry & the regulator on the likely timing of impacts and the most cost effective action that can be taken to ensure reliable supplies to customers at minimum cost. Ofgem has introduced initiatives that encourage DNOs to carry out research into innovative methods of managing the introduction of low carbon loads & generation on a very large scale. The largest initiative to date, "The Low Carbon Network Fund" had a maximum value of £500 million between 2010 & 2015 and has produced remarkable results with DNOs initiating a wide range of projects.	The potential risk is caused by failing to understand the impact of low carbon technologies on transmission and distribution networks. The very wide and detailed research effort should ensure a very full understanding these risks and a range of cost effective initiatives that can be employed to mitigate the risks.	The initiatives outlined have advanced the industry's understanding of the risks and potential solutions, promoted partnership working with industry and academia and taken the UK into the forefront of this type of work internationally.

Summary of actions (as set out in first round report)	Timescale over which action planned	Progress on implementing actions	Assessment of extent to which actions have mitigated risk	Benefits/challenges experienced
The thresholds at which climate change will start to present a risk to companies is well understood for a number of impacts, e.g. increased temperature causing a reduction in equipment ratings. In these areas it will be necessary to monitor actual climate change effects and updated projections in order to ensure that planned adaptation activity is sufficient and timely.	Ongoing monitoring of actual climate impacts, initially over the current price controls to 2021 and 2023.	This monitoring will be carried out in conjunction with the work on low carbon networks described above.	Risks will be mitigated as understanding of climate impacts and speed of change improves.	
In other areas of activity, such as earthing systems and vegetation growth, further work will be undertaken to identify the thresholds at which action needs to be taken. In addition, research into the impact of air conditioning loads, low carbon loads/generation and smart networks is already in hand and climate change impacts will be factored into this work to ensure that the thresholds are fully understood and appropriate action factored into programmes of work.	During the current price controls to 2021 and 2023.	ETR 132 Risk based approach to resilience tree cutting is under review with a target to complete by December 2015. The other actions will be considered in the considerable R&D effort targeted at the development of smart networks for low carbon applications described above.	To be assessed and reported.	To be assessed and reported.
Low carbon networks and smart grids are an international issue and DNOs will be engaged in British, European and International Standards work to ensure standards are developed for the new networks and these will need to take account of the thresholds for climate change impacts on an international scale.	These standards are expected to be agreed during the period 2015-2017.	ENA is working closely with BSI and international standards committees to ensure that the UK is well represented in the development of new standards.	To be assessed and reported.	To be assessed and reported.

Summary of actions (as set out in first round report)	Timescale over which action planned	Progress on implementing actions	Assessment of extent to which actions have mitigated risk	Benefits/challenges experienced
Monitoring and evaluation Some of the issues will be company specific and it is expected that companies will establish their own individual monitoring processes and these will be monitored by Ofgem in future years via established processes. The industry approach to identification, risk assessment and development of mitigation plans for major substations at risk of flooding, provides an illustration of the way in which joint work on adaptation could be pursued. As described above, a Task Group was established under the ENA with membership from each of the member electricity network companies together with EA, SEPA, Met Office, DECC and Ofgem. A report was prepared by the group and submitted to the Energy Minister. That report has formed the basis of common standard submissions to Ofgem in the recent price control review and will be regarded by DECC as the industry standard, if necessary by referencing it in the guidance to the ESQCR in a similar manner to other ENA documents. Monitoring of progress on adaptation by Ofgem can then be facilitated via a common approach through the price control and the annual regulatory reporting processes which is companies' preferred approach. This process will continue to use latest information as it becomes available.	Ongoing and for flooding resilience, monitoring will be necessary over the current price controls for the next 8 years.	The recent ASC report confirmed that companies are monitoring progress against flooding and tree cutting resilience and this is being audited by Ofgem	To be assessed and reported.	To be assessed and reported.

Summary of actions (as set out in first round report)	Timescale over which action planned	Progress on implementing actions	Assessment of extent to which actions have mitigated risk	Benefits/challenges experienced
Ensuring a flexible response DNos will continue to work with ENA to review the latest information on climate change projections, including actual recorded climate change outcomes, and update action plans as necessary. This will include maintaining and developing the relationship with holders of key information including Defra, EA and the Met Office. DNOs will also maintain a dialogue with DECC and Ofgem as part of annual regulatory reporting and the periodic price control process. The general position regarding companies' resilience will be continually reviewed via the DECC, E3C bi-monthly meetings and the follow up work in the companies via ENA working groups.	Ongoing monitoring via established resilience groups	This monitoring is already in place through the following groups:- ENA : ACC Task Group, Emergency Planning Managers' Forum, Industry Standards Groups Other: Energy Emergencies Executive Committee (E3C) and associated Electricity Task Group. EA Facilitated--IOAF Cabinet Office led—Infrastructure Operators Security and Resilience Forum.		

Further or new actions planned	Risks addressed by action	Timescale for new/further actions planned
Information on surface water flooding has become more reliable and DNOs now consider it sufficient to justify additional flooding resilience measures. In view of this ETR 138 has been updated to include the management of surface water risk.	Surface water flood risk to grid and primary substation sites.	Protection works implemented by the end of the latest price controls finishing in 2023.

5. Addressing Barriers and Understanding Interdependencies

5.1 Where you've identified interdependencies, how have these assisted or hindered actions to address climate risk?

The First Round Reports highlighted key interdependencies with other sectors, some of which were not previously required to report via the mandatory process.

There are particular concerns regarding transport systems to enable access to key sites and telecommunications for control room SCADA[3] and voice communications.

As indicated in Section 2.4, there are now increased concerns about interdependencies between weather events such as very strong winds following prolonged rainfall which made trees more susceptible to uprooting, with consequent damage to overhead power lines.

As noted in Section 3.1, there is a need for cross sector planning scenarios to ensure that sectors with interdependencies have used similar assumptions when reporting; this was not fulfilled in the first round of reporting. This is important to address the wide variety of views regarding the extent and impact of climate change on national infrastructure. This important role is being developed by the IOAF and DNOs will play a full part in any collaboration projects that are initiated by this forum.

As mentioned in Section 3.3, there are interdependencies between improving climate knowledge and the current eight year regulatory process which could result in a delay between any change in climate knowledge and a corresponding change in investment. However, in view of the long term nature of climate considerations this is not considered to be a serious problem.

For electricity transmission and distribution companies there is a further interdependency due to Carbon Reduction Targets designed to limit the amount of climate change. These targets are resulting in a requirement to connect renewable generation and low carbon loads such as heat pumps and electric vehicles and are particularly affecting DNOs. Smart networks are being designed to accommodate these loads without completely rebuilding existing systems, however, there will still be a need for conventional network reinforcement and this will need to be designed to accommodate climate impacts.

Companies will continue to engage with Local Resilience Forums and Local Flood Resilience Forums where local interdependencies are discussed and plans put in place to manage potential problems.

5.2 What were the main barriers to implementing adaptation actions and why?

Defra have confirmed that following the publication of the 2014 IPCC assessment, the Met Office conducted a study which shows that, in general, UKCP09 continues to provide a valid assessment of climate change. However, there is also a need for stronger links between the forecasts and the actual projected impact at the local, regional and national environment level i.e. the level of rainfall, frequency of severe events, change in wind levels, the degree, extent and depth of flooding, increased rates of erosion and the exacerbation of land movement etc that will impact on all sectors.

The focus of implementation action has been on flooding resilience where climate impacts cause a relatively small increase over the baseline investment and the programme has been agreed over two regulatory periods to 2023.

[3] SCADA – Supervisory Control and Data Acquisition

5.3 Have new barriers been identified? Are these being addressed? If so, how?

Only one potential barrier has been identified and that is the uncertainty regarding future maintenance of joint flood defence schemes. ETR 138 encourages companies to investigate this type of scheme if it will reduce the overall cost of flood protection to the community and provide reliable protection. However, it is essential for companies to have confidence that this type of scheme will provide secure protection in the very long term and that responsibilities for the construction and maintenance of the flood protection measures are clearly defined and agreed.

6. Monitoring and Evaluation

6.1 How effectively has consideration of climate change risks been embedded within your sector or organisation?

There is an increasing level of awareness within the DNOs and their employees regarding climate change risks and the requirements for both mitigation and adaptation response. This is aided by the sharing of information and best practice via ENA. ENA represents both the electricity and gas network companies providing opportunities for further liaison and learning opportunities, as all energy sector companies are designated as Reporting Authorities and share some common issues. Climate change risks are recognised and monitored at Board level within Northern Powergrid.

The Committee on Climate Change, ASC recently produced a progress report—"Managing climate risks to well-being and the economy". This report assesses the current state of resilience to weather and climate of infrastructure, businesses, health care system and emergency services. It is therefore particularly pertinent for electricity networks. ENA together with DNOs provided evidence to the ASC.

The ASC reported that they found evidence that the electricity transmission and distribution sector are assessing climate risks, taking action in response, and reporting on progress against plans. The ASC noted that the electricity transmission and distribution sector has developed technical standards for managing current and future risks from flooding and storms. These provide a consistent approach across the industry to identifying the most critical assets at the highest level of risk in order to prioritise action. Application of these standards is used to make a business case to the regulator for funding resilience measures that provide value for money to the consumer through the price control process.

6.2 How effective have organisational monitoring and evaluation processes been to ensure adaptation responses are implemented and on track? If these have not been effective, what barriers prevented this?

Northern Powergrid has incorporated the key actions detailed in our First Round Report in our company business plans. A Second Round Report has now been produced which updates progress against actions as appropriate.

As indicated in section 6.1, the ASC reported that they found evidence that electricity transmission and distribution sector are assessing climate risks, taking action in response, and reporting on progress against plans.

6.3 How effective were monitoring and evaluation processes in determining how the organisation/sector handled recent extreme weather conditions?

Northern Powergrid and the other DNOs manage emergency response to weather related issues on a regular basis, sometimes several times in a year, and therefore have well developed and practiced emergency planning procedures, including a mutual aid agreement (detailed in section 3.1.5 of the Second Round Report).

Record levels of rainfall were experience between April and December 2012 and the events of 28th June 2012 in Newcastle and Gateshead (known locally as Thunder Thursday) led to the reconsideration and improvement of information on surface water flooding. This has become more reliable and is now considered sufficient to justify additional flooding resilience measures. In view of this the ETR 138 task group was reconvened to update the document to include the management of surface water risk.

During the exceptional winter weather of 2013/14 DNOs nationally faced an exceptionally demanding sequence of storms from November 2013 to February 2014 mainly as a result of wind storms causing damage to wood pole overhead lines due to falling trees and windborne material.

In particular, between 22 and 28 December 2013, as a result of two severe winter storms and consequent damage to the distribution overhead line network, almost one million properties nationwide suffered disruption to electricity supplies. Though 95.3% of customers were restored within 24 hours, 1.7% of customers experienced a disruption to supply in excess of 48 hours, and there were lessons to be learnt to improve the effectiveness of the industry response to disruptive events, and minimise customer inconvenience as much as possible.

Some companies experienced particular difficulties with customer communication and resourcing the amount of repair work. However it was noted independently that the industry's staff showed remarkable resilience, working long hours in potentially dangerous conditions, with no reportable accidents. As a result, staff were thanked for their tremendous efforts at a parliamentary reception.

Ofgem have established criteria that identify certain "exceptional events" that include particularly large interruptions that DNOs have limited ability to prevent. In order to reduce the volatility and impact of these occurrences on their performance (and future target setting), these "exceptional events" are excluded from annual performance figures. Exceptional events are classified as being either a severe weather exceptional event or a one-off exceptional event.

Severe weather exceptional events: refer to a level of interruptions occurring for a period of time that result directly from bad weather. To be considered a severe weather exceptional event, a specific and verified number of higher voltage interruptions, directly caused by bad weather, are required to have occurred within a 24 hour period. This is referred to as the severe weather exceptional event threshold and is currently eight times the average daily higher voltage fault rate.

One-off exceptional events: are those where a single cause outside the DNO's control causes a significant level of interruption. To be considered a one-off event, a specific and verified number of interruptions and/or minutes lost are required to have resulted. These numbers are referred to as the one-off exceptional event thresholds and currently stand at 25,000 customers interrupted and two million customer minutes lost.

To justify company claims against these exceptional event criteria, Ofgem undertakes an investigation into the incident including the effectiveness of the company's preparations and response.

Due to the serious consequences of the 2013 Christmas Storms, two enquiries took place led by DECC and Ofgem, with companies required to report on how performance could be further improved in a number of areas. These resulted in reports by Ofgem and DECC which have now been published.

Following the initial DECC report, the industry undertook a major review of its performance to identify areas of good practice and areas for improvement. This review took place through the framework of the E3C with support from ENA. All the DNOs and DECC were involved and specialist Task Groups were established to address particular issues,

A number of actions to improve future preparedness and response were identified, including:-

- Developing a single national number for customers to call during a power disruption. The complexity of this programme necessitates a longer time frame, and is planned for implementation in April 2016.
- Identifying the levels of recognition amongst customers, and addressing any gaps using appropriate communications strategies. Ensuring that whilst a national power outage number is developed, each DNOs' customers are aware of the correct phone number to call in the event of disruption to power supplies.
- Developing worst case scenarios for customer calls and ensuring that telephony systems and call agents can provide a high level of service.
- Sharing with each other and key stakeholders, when weather forecast content causes them to trigger pre-emptive escalation.
- Production of a Customer Welfare Good Practice Guide (GPG) which sets down minimum standards for welfare provision during emergency events, with particular emphasis on customers held within its Priority Services Register.
- Production of a Social Media GPG and each DNO has developed a social media strategy, based around the recommendations from the GPG.
- Developing and implementing a common framework that clarifies standards expected around the identification and provision of a restoration time to customers and its subsequent proactive update in the manner agreed with the customer.

- Holding a workshop to share their resource and contractor management strategies to ensure the rapid availability of adequate resources to deliver resilience, particularly over extended holiday periods.
- Reviewing and updating the industry mutual aid protocol to ensure it is adequately proactive, and criteria around strategic prioritisation are clear.

These actions are reviewed in a DECC report published in December 2014 which recognises that this work is part of an on-going responsibility to review, maintain and improve the effectiveness of the response to disruptive events. E3C has agreed that an annual review of this work, following each winter, will ensure new lessons are identified and reflected in on-going processes and procedures for preparedness and response.

It should be noted that during the winter flooding, no electricity supplies were interrupted as a result of river flooding at major electricity substations operated by DNos and a number of substations were protected by new flood defences that incorporate protection against long term climate change. Northern Powergrid however did see some loss of supplies due to the flood defences at a major substation becoming compromised as a result of a coastal surge event in December 2013.

In addition, some sites were protected by portable flood barriers and the mutual aid agreement was implemented to provide support to the Thames valley area from the North of England. Helicopter transport and high volume pumps were also made available should they be required.

During January 2015, hurricane force winds affected parts of Scotland causing severe damage to the overhead distribution network. Performance of the DNOs was reviewed at the January E3C meeting. The response from public, press and government appeared to be generally positive to the supply restoration efforts.

Weather forecasts and contingency plans were shared before the event and at mutual aid conferences and there was a good response to requests for assistance, with staff being sent from a number of other DNOs in areas that had not suffered serious damage.

Northern Powergrid is continually striving to improve all aspects of its Emergency Planning. In the period since the first round report was issued in 2011, we have introduced additional resilience into our major incident command and control structure to give us the ability to sustain our response to major incidents over a longer period or to cope with an increased frequency.

A dedicated major incident support project has been undertaken which is delivering additional resources to ancillary roles for major incident response – in other words we are already deploying all available operational resources to restore supplies as quickly as possible and are now increasing our ability to deploy non-operational staff to support our customers whilst they are without supply.

Northern Powergrid now subscribes to the EA's Targeted Flood Warning Service which will enable us to provide a specific response to our primary and grid sites declared at risk of flooding, separating them from the more generic flood warnings.

Northern Powergrid representatives also attend the national Category 2 Chairs forum, organised by the Resilience and Emergencies Division (RED) of the Department of Communities and Local Government (DCLG). This is aimed at sharing best practice and incident lessons learned across all Category 2 responders.

6.4 Has the sector/organisation identified any financial benefits from implementing adaptation actions? Perhaps through cost benefit analysis, fewer working days lost, more efficient operations etc?

Current flooding resilience projects incorporate provision for climate adaptation and this ensures that protection measures should not require rebuilding for the life of the asset. Of course, this is based on our current understanding of climate change and we cannot be sure that if climate change is worse than currently predicted that our defences will be suitable, in which case additional expenditure may be necessary.

Prevention of flooding at substations saves direct costs on repairs and customer compensation and also saves large costs that would have fallen on the community if lengthy and widespread power cuts were to occur.

Detailed information on the justifications for flood defence works and vegetation management can be found within the Northern Powergrid Well Justified Business Plan documentation, published on our internet site.

6.5 Has there been sufficient flexibility in the approach to adaptation within the sector/organisation, which allowed you to pursue alternative courses of action? If not what remedial measures could you take to ensure flexibility?

Northern Powergrid operates with industry guidelines to provide a flexible approach to protection. For example, the industry standard on flooding resilience provides a framework for identifying those sites requiring improved resilience and a variety of methods by which that resilience can be achieved to ensure the best value for money. This includes, protecting whole sites, protecting key buildings/equipment or contributing to wide area schemes. Examples of different approaches to flood protection are provided in Appendix 15 of the Second Round Report.

7. Opportunities and Benefits

7.1 What action have you taken to exploit opportunities

Through working collaboratively with the ENA and other DNOs, Northern Powergrid has taken the opportunity to strengthen their relations with key organisations including Defra, EA, SEPA and the Met Office.

A report has been commissioned with Newcastle University on wind impacts.

Northern Powergrid had also participated in an inaugural meeting for a local infrastructure operators adaptation forum for Yorkshire and the Humber and discussions with Newcastle City Council regarding their policies on CCA.

7.2 How effective were your efforts?

The work with EA and SEPA has resulted in an important strengthening of substation flooding resilience measures as described in Section 3.

The work with Newcastle University is helping the industry to understand the potential impacts of climate change on wind patterns and further work may help to identify dependencies between climate impacts such as wind and rain.