Western Power Distribution

Adaptation to Climate Change
Second Round Report

May 2015

WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Contents

1 Executive Summary

Introduction
Western Power Distribution is the electricity distribution network operator for the East and West Midlands, South Wales and the South West. We are reporting as a second round reporter under the Climate Change Act.

Understanding Risk
There has been no change to the understanding of climate change risk since our first report. The UKCP09 climate predictions published under the Climate Impacts Programme remain in place as the base dataset for climate change in the UK.

We have been working with Newcastle University to complete more research on the effects of climate change. We have provided the university with locational data and other weather related impact data for our network. They have simulated the effects of climate change on the whole range of environmental impacts which may affect us.

The main climate change risks that impact our network remain unchanged as Extreme Events, Flooding and Temperature Change.

Understanding Uncertainties
Using the UKCP09 climate predictions we have prepared plans to mitigate climate change. New research has highlighted the increased risk of interdependencies, such as the effect of high winds after periods of prolonged rainfall. The effect of multiple weather events in a short period, as seen in the winter storms of 2013/14, is also now being considered.

Details of Actions
We are working through our programme of substation flood prevention work. We have developed our capability to respond to flood events using portable equipment and mobile pumps. We have altered our specification for pole mounted transformers to improve their resilience to lightning. We have amended our overhead line design standards to take account of the potential rise in temperature.

Addressing barriers and interdependencies
We do not see any barriers to our adaption to climate change. New interdependencies are being considered, including the impact of transportation issues when accessing our substation sites.

Monitoring and Evaluating
The recent report from the Adaptation Sub Committee highlighted the work which has been done within the electricity industry. We report on our actions to our regulator, Ofgem, and our response to the winter storms of 2013/14 showed that we are already well prepared for the current impact of climate change.

2 Introduction

2.1 Who we are and what we do

Western Power Distribution is the distribution network operator (DNO) for the East and West Midlands, South Wales and the South West. We deliver electricity to over 7.8 million customers in a 55,300 km^2 service area. Our service area includes the major cities of Birmingham, Nottingham, Cardiff and Bristol.

Our network consists of 220,000 km of overhead line and underground cable and 185,000 substations. We are responsible for:

- Maintaining this electricity network on a daily basis
- Repairing this electricity network when faults occur
- Replacing assets within the network when warranted by condition
- Reinforcing this electricity network to cope with changes in the pattern of demand
- Extending this electricity network to connect new customers

Western Power Distribution does not generate electricity or buy electricity from generating stations. We do not sell electricity to end-use customers.

2.2 The Climate Change Act

The Climate Change Act gave Government the power to direct certain public bodies to report on their climate risks and adaptation plans. Western Power Distribution received a direction to report issued by The Department for Environment, Food and Rural Affairs (Defra) in March 2010. We reported in June 2011 setting out our priorities and approaches. This subsequent report has been developed in response to the requirements placed on reporting authorities by the Climate Change Act under the Second Round of reporting.

We have included details of actions that we have started since the first report and have also included an update on our actions for the future. The format of this report follows the structure set out in the Defra guidance dated December 2013.

2.3 Regulation and Governance

The Electricity Act 1989 places a duty on Western Power Distribution to develop and maintain an efficient, co-ordinated and economical system of electricity distribution and to facilitate competition in the supply and generation of electricity within its authorised area.

Under the Utilities Act 2000 the energy market in the United Kingdom is regulated by the Gas and Electricity Markets Authority (GEMA), which conducts its business through the Office of Gas and Electricity Markets (Ofgem). All licensed distribution network operators report to Ofgem and who undertake a comprehensive price control review at regular intervals. We are currently entering the first price control set under the RIIO model (Revenue=Incentives+Innovation+Outputs).

We are also are subject to common statutory requirements which are overseen by the Department of Energy and Climate Change (DECC) and the Health and Safety Executive (HSE).

The actions proposed in this report have all been accepted by Ofgem as part of our recent price control settlement. They will be reported to Ofgem via our normal business reporting. Our climate change adaptation measures are supported at board level by our Operations Director.

2.4 Network Security

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 during extreme weather conditions or the total failure of a grid or primary substation. Particular attention must therefore be given to grid and primary substations when considering network resilience.

Whilst every effort is made to ensure network security, we have well developed business continuity and emergency plans to ensure an effective response to a range of events that can affect our networks. Under the terms of the Civil Contingencies Act we work closely with other utilities, the emergency services and local authorities. We are also active participants in the government, industry and regulator collaborative forum – the Energy Emergencies Executive Committee (E3C).

3 Understanding Climate Risk

3.1 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 United Kingdom Climate Impacts Programme (UKCIP) that forecast the risks under various scenarios to the end of this century.

In addition, 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 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. Our experiences in 2013/14 also highlighted a new risk for us regarding the coincident effect of prolonged wet weather and high winds.

We are continuing our research into the potential impact of climate change, including through a range of stakeholder engagement programmes. Through the Resilient Electricity Networks for Great Britain (RESNET) project we are working with Newcastle University on a project to develop predictions for the impact on climate change on our assets. This work is funded through the Engineering and Physical Sciences Research Council (EPSRC). Newcastle University have provided a report through the ENA for the whole of the UK. We have augmented the research completed in this report by providing the researchers with more detailed data of our network performance. The report to ENA considered wind effects only whereas our research with Newcastle University is considering all environmental effects, such as increased rain storm events or lightning.

Flooding presents a serious climate risk to us 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 we are carrying out a programme of flooding resilience work that will continue to 2023. Resilience measures already in place at major electricity substations have already provided protection against flooding events with our substation at Bridge Mills, Devon remaining operational during winter flooding events due to the protection provided in our programme of permanent flood defences.

Information on surface water flooding has become more reliable and we now consider it sufficient to justify additional flooding resilience measures. All the electricity companies are now reviewing the ENA's Engineering Technical Report (ETR 138) Resilience to Flooding of Grid and Primary Substations. The revised guidance is being redrafted to include surface water risk. We have included plans to protect strategic substations from surface water flooding in the period from 2015 to 2023.

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

We remain reliant on UKCP09 as the primary source of information. The research undertaken with Newcastle University uses UKCP09 as its base data.

As detailed in our 2011 report, we have worked with other electricity companies to carry out two research projects with the UK 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 with the Met Office to build a risk model that quantifies 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.

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

- Temperature—predicted increase.
- Extreme Weather Events – wind and lightning
- Flooding

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, we have supported the Resilient Electricity Networks (RESNET) project, led by Newcastle. The initial findings of Newcastle University are being considered by all companies and will form the basis of climate change adaptation plans for the future. As detailed above, we are undertaking additional research with Newcastle University across a wider range of environmental effects.

Flooding remains a serious climate threat to our networks. 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 Networks Companies, Government Departments and Agencies and the Industry Regulator and developed the industry approach to flood mitigation published in ENA's ETR138.

Based on this report, and starting in the 2010-2015 review period, we are undertaking a long term programme of work to improve substation resilience to flooding that takes into account predicted climate impacts. The conclusion of this programme, which now includes works related to surface water flooding, was agreed by Ofgem as part of our regulatory control settlement for the RIIO-ED1 period. All planned flood protection is due to be complete by 2023 with higher risk sites being completed early in the programme.

Temperature increase is a lower risk and a more long term consideration for us. Climate models predict increases of a few degrees and we are able to accommodate this level of change in our normal network designs. We have not experienced the same level of impact for temperature as we have with wind events or flooding, but will continue to monitor changes.

3.3 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.

We were able to carry out considerable detailed analysis on substation flooding resilience using the Environment Agency Flood Maps and this has greatly the assisted the understanding of risk at particular sites and ensured that appropriate protective measures are put in place.

The Environment Agency (EA) have recently issued flood mapping for surface water and the industry guidance on flood protection is being updated to take this into account. We have included resilience measures to protect key sites against surface water flooding in our RIIO-ED1 plan.

3.4 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. However, as mentioned above, new work is being focussed on identifying risk from the possibility of multiple events such as more frequent wind storms and rainfall events. A serious risk occurs during very strong wind storms when trees are uprooted and cause damage to overhead lines. 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.

The industry approach to resilient tree cutting is set out in ENA's 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. As a result of the experiences of 2013/14 this document is now being reviewed by the industry.

We developed ETR132 in conjunction with DECC and Ofgem, it provides guidance on how to improve network performance by enhancing the resilience of the network to tree 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 coincidence of rainfall and strong winds. Climate change will also extend growth periods into seasons prone to severe weather events. Storm events in the autumn are particularly significant when wind and rain conditions can be exacerbated by trees which are still in full leaf.

4 Understanding uncertainties

4.1 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 Environment Agency led Infrastructure Operator's Adaptation Forum.

The EU is proposing to carry out work on Climate Change Services and this could prove a useful source of additional information in relation to uncertainties.. On behalf of all electricity companies the ENA have provided information to the EU on UK Energy Networks issues and requirements.

4.2 What new uncertainties have come to light?

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

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

Any emerging uncertainties have been captured within the risk management approach adopted in our business work plans. 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 have now been determined within our RIIO-ED1 business plans.

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 our approach to risk management and information will be shared with the sector via ENA, who will also update DECC and Defra of any significant developments.

The combined effect of strong winds and prolonged rainfall is a new area for research. We are aware that the modelling data used to model individual risks does not have the resolution required to model the combined effect of both risks. Newcastle University and the Met Office are working on this problem and we will follow their work.

4.4 What progress have you made to address information gaps?

We are working with EA to understand the latest surface water flooding information and update our flood protection plans. This will develop our plans for flood protection of substations at highest risk.

We are working with Newcastle University as detailed above. This includes the work undertaken by the ENA on behalf of all electricity companies and the additional work undertaken using our own network data.

Through the ENA and with the other electricity companies we have initiated a project to review the current guidance document on resilience tree cutting (ETR132).

Information on the impact on distribution networks and electricity supply of recent severe weather has been shared between network companies and large number of actions to improve emergency response have been co-ordinated through ENA and DECC.

Our operational managers and emergency planners who attend ENA resilience groups are now working with the Met Office. We use their long range winter forecast service to help predict likely consequences for the electricity network.

4.5 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. Our business strategies are driven by a number of factors including the following key issues:-

- The absolute need to keep our customers, the public and our employees safe
- Ensuring that our customers receive a very high level of service.
- The regulatory framework
- Asset life cycles

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.

As discussed in the First Round, a particular aspect of electricity networks is that many of our assets have very long lives, typically 40 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. As an example, flood protection currently being provided is designed to be resilient to the end of this century.

5 Details of actions

5.1 Commentary on Implemented Actions

In our first round report we concluded that the priority climate change risk areas were extreme events, flooding and temperature increase relating to overhead lines. We also considered the impact of changes in earth resistance as a result of climate change.

5.2 Extreme Events – Wind and Lightning

Our response to the winter storms in 2013/14 has shown that we are prepared for the predicted changes to wind and gales. This remains our top weather related risk and we will continue to develop and learn from each storm event we respond to.

Lightning is a risk which remains as the second ranking weather risk in three of our license areas and the third risk in the other licence area. Lightning affects our overhead networks and is a significant factor, with models indicating an increase in lightning activity. One of the most susceptible asset types on our network are pole mounted transformers, which can often be irreparably damaged by lightning. To help mitigate this risk we have revised our specification and have added lightning protection to all our 11,000 volt pole mounted transformers as a standard.

5.3 Flooding

Our plans to protect major and strategic substations against flooding were developed as a result of the 2007 floods and we began delivering improvements in the last price control period of 2010 to 2015. In this period we identified 159 locations across our area which were at risk of flooding, with supplies to over 2 million customers being potentially at risk. At the end of May 2014 we had completed flood prevention works at 79 locations, securing supplies to 840,000 customers.

In the 2015 to 2023 period we will be adding new locations to our plans as surface water flooding information is added into our risk assessments.

Since 2010 we have been designing for flood risk at all our new substations, including smaller distribution substations. The usual mitigation for a new site is to place equipment on raised plinths to ensure it remains above the predicted level of any flooding.

Our mitigation against flooding does not only address the permanent flood protection of major sites. We have developed an emergency response capability to help mitigate the effects of flooding at all of our sites. At the centre of our capability are 8 emergency response vehicles, each with a crew trained to Defra Module 2 “Water First Responder” standard which ensures that we work safely in and near water using land-based and wading techniques.

The emergency response vehicles are equipped with a range of pumping, flood barrier and sandbagging solutions to adapt and react to all situations. The vehicles are fitted with high volume pumps, from their previous role as fire engines.

We have also developed plans to deliver a diesel power pump and fuel to any site inaccessible by road using our helicopters, should the need arise.

During the winter storms of 2013/14 we provided assistance to Scottish and Southern Power Distribution under the industry mutual aid scheme. Our emergency response vehicles and temporary flood barriers were deployed into Oxfordshire to provide protection for substations near the river Thames.

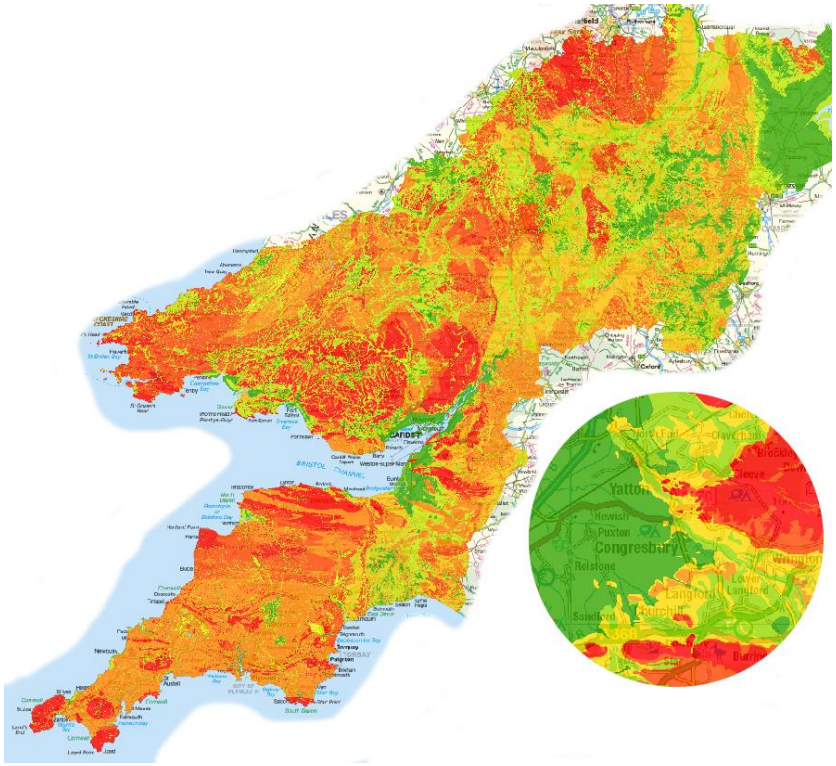
5.4 Temperature Increase

Since 2011 we have been designing all our new overhead lines to a higher temperature rating. Our 11,000 volt and 33,000 volt wood pole lines are the most susceptible to temperature change as they have the lowest clearance requirements. These are now designed with a minimum rated temperature of 55C. The practical effect of this change is that most designs now use poles with are 0.5m-1.0m taller than the previous design.

5.5 Changes in Earthing resistance

We have completed our work with Cranfield University and the British Geological Survey to establish possible changes to ground conditions as a result of climate change. This project has developed a surface map indicating the key properties of soil and geology, which can be used to establish the sensitivity to climate change. The modelling tool uses a simplified set of climate change model outputs to determine whether the materials possess characteristics that are prone to 'drying out' (e.g. free draining or highly porous and in an area of modelled reducing precipitation). We are able to use this information to forecast changes in soil and geology with respect to potentially drying out under climatic conditions.

We are now considering how to make this data available within the business and what actions to take to mitigate the potential changes. Our plan is to make the map available as a layer on our GIS system and to use the details held to increase the earthing infrastructure designed in sensitive areas.



5.6 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 or challenges experienced
Extreme Events Wind Whilst little change in wind impacts are predicted, wind remains a major risk for overhead lines	Ongoing		The winter 2013/14 storm response has shown that our overhead network remains resilient	91.8% of customers affected were restored within 3 hours.
Extreme Events Lightning Lightning remains as the second ranking weather risk and is predicted to increase in the future across our network area	From 2015	Specification amended to include additional lightning protection	New overhead transformers will be more resilient to the effects of lightning.	Customer interruptions as a result of lightning strikes to transformers will reduce.
Temperature Increase Temperature increases will be gradual but we are taking action now to accommodate changes predicted in the 50 year lifespan of our assets	Ongoing	Specification amended to increase the design temperature for overhead lines	New overhead lines are now designed to operate at up to 55C, reducing the effect of temperature increase on their rating.	

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 or challenges experienced
Flooding We have been protecting major sites since 2010 using fluvial and coastal flood data. We have protected 79 substations supplying 840,000 customers and will protect another 80 substations before 2023. In 2015 we commenced a plan to protect sites against pluvial flooding, with another 75 substations added to our programme. Since 2010 we have been designing all new substation sites to include flood resilience where appropriate. We have developed a fleet of emergency response vehicles and portable flood barriers. We have the capability of providing pumps to site using helicopters	To 2023	On target. Progress against the current programme was investigated by the ASC in their recent report. The ASC found that progress was being monitored and was on target.	Major site risks are being mitigated as the work proceeds to 2023 with sites prioritised on order of risk. All new sites are mitigated against the risk of flooding. Other flood situations are mitigated by the emergency response vehicles and barriers.	No loss of supply to customers during the severe weather in 2013/14 due flooding at major substations. Our response vehicles and portable barriers were deployed to the Thames in the winter of 2013/14.
Changes in Earthing Resistance	Ongoing	Forecast data is complete, integration into WPD systems continues		Reduced impact of climate change to soil/ground conditions on our earthing systems

6 Addressing Barriers and Understanding Interdependencies

6.1 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. All electricity companies have highlighted concerns regarding transport systems to enable access to key sites and telecommunications systems to enable control room SCADA and voice communications. We share concerns over transport and the ability to get to locations, but have developed a high level of self-sufficiency in telecommunications by owning and operating our own telecommunications network which connects our SCADA systems, our Control Rooms and our inter-office systems. We also operate a private radio network which provides communication links to all our operational vehicles.

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.

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 Environment Agency led Infrastructure Operator's Adaptation Forum and we will play a full part in any collaboration projects that are initiated.

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

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

No significant barriers to implementing adaptation actions have been encountered.

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

No new barriers to climate adaptation have been identified since the first round reports.

7 Monitoring and Evaluating

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

There is an increasing level of awareness within Western Power Distribution on climate change risks and the requirements for both mitigation and adaptation response. This is aided by the sharing of information and best practice with other electricity companies via the ENA. All energy sector companies are designated as Reporting Authorities and develop national guidance where we share common issues.

The Committee on Climate Change, Adaptation Sub-Committee (ASC) recently produced a Progress Report—"Managing climate risks to well-being and the economy". This report assessed 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. We provided evidence to the ASC through the ENA.

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.

7.2 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?

We have incorporated the key actions detailed in the First Round of Reports in our business plans. We report on adaptation actions such as substation flooding resilience programmes and storm weather response to Ofgem as part of our normal reporting requirements

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

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

During the exceptional winter weather of 2013/14 we faced an exceptionally demanding sequence of storms from November 2013 to February 2014. Whilst some of the individual weather events were not the most severe that we have experienced, the sustained nature of the multiple events was new to us. Electricity supplies were affected as a result of severe wind storms causing damage to wood pole overhead lines due to falling trees and wind-blown material. The weather events and high levels of rainfall also resulted in flooding issues on our network, from the coastal storm surges seen on the Lincolnshire coast to the more long term flooding of the Somerset Levels.

Over the period of 1st December 2013 to 8th January 2014, we restored over 498,000 customers, with the vast majority restored within just a few hours. We were exceptionally busy between the 23rd and 28th December 2013, and WPD South West experienced its busiest 24 hour period ever on 23rd December. During this time, we maintained suitable staffing levels and activated prepared emergency plans. In doing so we overcame many challenges associated with the sustained poor weather over a holiday period, including effectively mobilising resources, safely completing repairs in difficult weather and access conditions and maintaining effective communication with our customers.

Despite the challenging conditions, we encountered no significant issues. Customers received an excellent supply restoration performance during this time, whilst we have no evidence that customers struggled to contact us during the incidents. We were able to restore 91.84% of customers within 3 hours and only 13 customers remained off supply for more than 24 hours.

During the period we were also able to assist other electricity companies, and dispatched staff to Northern Powergrid, the distribution company operating in the North East of England, on 5th December. We also offered staff to the other companies across the Christmas period but were not called to provide them.

We received targeted flood warnings for our substations on 11 days across the period On 5th December we dispatched a flood response vehicle to Boston in Lincolnshire and were also called upon to provide a generator to ensure supplies to a pumping installation which is part of the local flood defences. On 24th December a substation at Bridge Mills in Devon was a cause for concern as rising flood waters in the area made in inaccessible. The permanent flood defences installed performed correctly and prevented the substation from being flooded.

Two enquiries took place into the Christmas Storms led by DECC and Ofgem, with companies required to report on how performance could be further improved in a number of areas as well to share best practice and implement actions to improve performance as a result of lessons learned. These resulted in reports by Ofgem and DECC which have been published.

7.4 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, which can be 40 or 50 years. This is the most cost effective way to approach mitigation and has been approved as part of our RIIO-ED1 settlement.

Prevention of flooding at substations saves direct costs on repairs and possible replacement of flood damaged switchgear and equipment. Our targeted plans have shown to be correct over the winter period of 2013/14 where no major substations experienced a loss of supply as a result of flooding.

Our specification change to include additional lightning protection on pole mounted transformers has led to a minimal increase in equipment costs. When measured against the replacement cost of a transformer damaged by lightning, this is a cost effective solution. The reduction in interruptions to customer's electricity supplies as a result of lightning damage is an added benefit.

Amending our overhead line designs and adopting a higher temperature rating has the effect of adding around 1m to all our new pole heights. This minimal additional material cost provides us with a good level of resilience against temperature rise over the 50 year life of our asset.

Our high level of performance during the winter 2013/14 storms showed the level of efficiency that we achieved which led to customers experiencing generally shorter interruption periods than in some other electricity companies. We had no Guaranteed Standards failures and our restoration actions saved the large costs that would have fallen on the community if lengthy and widespread power cuts were to occur.

7.5 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?

There industry operates within a flexible approach to providing 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 key buildings and equipment, protecting whole sites or contributing to wide area flood prevention schemes.

8 Opportunities and Benefits

8.1 What action have you taken to exploit opportunities?

In conjunction with the ENA we have taken the opportunity to strengthen our relationships with key organisations including Defra, the Environment Agency and the Met Office.

In addition to the ENA work to commission a report from Newcastle University on wind impacts, we have taken the opportunity to start more detailed research by allowing Newcastle University to access our data and assess other weather impacts.

8.2 How effective were your efforts?

Work undertaken to date was shown to be effective during recent storms where no customer supplies were lost as a result of the flooding of major substations and all but 13 customers affected by severe wind events had their supplies restored within 24 hours.

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